ANOMALOUS APPARITIONS OF LIGHT IN COLONIAL AMERICA: VISIONS OF COMETS, NEW STARS, THE AURORA BOREALIS, AND RAINBOWS

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ABSTRACT

This dissertation examines the body of literature that formed around anomalous light apparitions (comets, new stars, the aurora borealis, and rainbows) as it explores questions about the representation and response to celestial and meteorological phenomena during the seventeenth and eighteenth centuries in colonial America. I further consider the ways that these texts’ meanings are informed by rational scientific thought and by other non-scientific or non-rational, emotive, or aesthetic modes of thinking. I consider how these phenomena elicit a set of empirical yet emotionally-charged observational practices that complicate how we understand the roles of the rational and the non-rational in the scientific literature of this period. I argue that non-rational passionate investments are evident within or as part of the period’s rational scientific literature; they act as the impetus for scientific inquiry therefore forming an integral part of the scientific endeavor. This dissertation further explores how the practice of writing about these phenomena generates and facilitates the formation of communities of amateur scientific observers in colonial America. I further investigate how practices of data collection contribute to knowledge about the regular and irregular behaviors of celestial bodies, and how this knowledge impacts everyday practices essential for survival such as farming and travelling. What science writing from this period demonstrates is the ability for multiple ways of thinking to be in play simultaneously; these texts show how several worldviews (i.e. science, Puritanism, popular religion) are intrinsic to each other. Because of their liminality, these texts function outside of traditional categories such science, religion, and natural philosophy. Furthermore, they destabilize traditional conceptions of genre with their blend of rational and non-rational modes of thought and their
incorporation of fact and fiction. While I treat these literary texts within their historical contexts, I am also interested in the ways in which these texts reach modern audiences, particularly in academia at a time when the humanities and sciences are positioned against one another.
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INTRODUCTION

In 1719, the northern lights made a rare and magnificent appearance over Boston. This event incited people to venture outside to experience the wonderous display and inspired them to record and share their observations. Those who contributed to the body of writing on this event, such as Cotton Mather, Thomas Prince, and Thomas Robie, represent the aurora borealis in their writing by offering qualitative details about its size, shape and color; however, these empirical observations are accompanied by imaginative, aesthetic, and wonder-filled references to images of a great conflagration, spirits battling, and blood spilling in the sky. Comets, the appearance of new stars in the heavens, and rainbows elicited a similar set of rational and non-rational responses from observers as these phenomena were interpreted as confirming or challenging God’s intervention in the earthly realm.¹ The stories these writers tell are curiously complex: they elude the colonial American sense of genre as well as our modern sense of it with their frequent interweaving of the rational and the non-rational, the real and the imagined, and fact and fiction. I argue that this elusiveness is what makes these texts transformative, both in their respective historical periods and our modern world, as they resist categorization and reveal the instability of genre. It is this instability, when genre fails to hold meaning together in one way or format, that catalyzes new imaginative pathways, ultimately leading to the transformation of knowledge boundaries. More pointedly, my project calls attention to the instability of “science” and “religion” as categories and it demonstrates how these labels fail as ways of discussing the texts’ content. Literary analysis of these

¹ I employ the terms “rational” and “non-rational” to discuss two modalities of thought and expression. Rational responses rely on reasoning and sound judgement while non-rational responses are emotive or rely on intuitive principles.
early “scientific” texts reveals how the meaning behind these categories or genres is constantly shifting.²

My dissertation examines the body of literature that formed around anomalous light apparitions (comets, new stars, the aurora borealis, and rainbows) as it explores the following preliminary questions: How are these phenomena represented in colonial literature during the seventeenth and eighteenth century? Why does this set of phenomena come to the fore or, in other words, why is this culture so responsive to these phenomena? What groups of people were interested in the phenomena and why? How do these texts speak to the cultural issues of the time, such as the rise of science as an institution, the Enlightenment, and changes within the Puritan faith? In what ways are these texts’ meanings informed by rational scientific thought and in what ways are they informed by other non-scientific or non-rational, emotive, or aesthetic modes of thinking?

As secondary questions, I consider: How do these texts function within a genre or constitute a genre? In what ways do the categories of “science” or “religion” support or fail these texts? What we think of as science in the twenty-first century is different from science in the seventeenth and early eighteenth centuries, but is our modern sense of this disciplinary category—as producing something real, factual, and rational—stable?

Within the body of literature on meteorological and celestial events, I consider how these phenomena elicit a set of rational yet emotionally-charged observational practices that complicate how we understand the roles of the rational and non-rational in

² I use the term “science” with the awareness that science is not yet an established discipline as it is in the modern sense with categorical distinctions such as physics, geology, etc. While the term natural philosophy or natural history is more of an apt fit in certain contexts, I frequently use “science” to call attention to the practice of empirical observation that is underway during this period.
the scientific literature of this period. My project is concerned with how passionate investments such as fear, wonder, and joy shape scientific inquiry and offer a lens through which we can understand the emerging discipline of science among colonists during the seventeenth and eighteenth centuries. I argue that these non-rational passionate investments are evident within or as part of the period’s rational, empirical scientific literature; they act as the impetus for scientific inquiry therefore forming an integral part of the scientific endeavor. In New England, these passionate investments typically manifest as religious ones; however, I purposefully avoid an argument that places all emotive outpourings within the scope of Puritanism as it is difficult to know when New Englanders’ emotions were prompted by their faith or when their faith acted as coping mechanism for what they inherently felt. Although New England Puritans were well equipped to process complex emotions, it is likely the case that many would have difficulty pinpointing the origin of their emotions, or they would never imagine their emotions as separate from their faith.  

Scholars have discussed the ways in which science and religion, as disciplines and genres, interact with each other: science and religion have been represented as being at war, coexisting, or complementing each other. The work of Robert K. Merton, Marjorie H. Nicolson, and Perry Miller make up some of the earliest scholarship arguing for the complementary interaction between science and Puritanism. As a sociologist, Merton’s

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3 The conversion narrative may present the best way to understand how Puritans were in touch with their feelings. Conversion narration was an intense practice of self-scrutiny as these deliverances displayed, externally and publicly, an interior, private experience (i.e. conversion). Additionally, they provide some insight into the experiences of the laity. See for example Thomas Shepard’s Confessions.
Science, Technology, and Society (1938) makes use of Max Weber’s thesis in The Protestant Work Ethic and the Spirit of Capitalism (1905) in which Weber argues that Puritan devotion to work and the Reformation’s promotion of work as one’s sacred calling influenced the rise of capitalism. Merton adapts Weber’s claim to argue for the pivotal role that Puritanism played in the development of Western science.\(^5\) Merton’s thesis challenged the popular nineteenth-century conflict thesis, which positioned science and religion as polar opposites, destined to always do battle with each other. This oppositional view was espoused in works such as John Draper’s The History of the Conflict Between Science and Religion (1874) and Andrew Dickson White’s A History of the Warfare of Science with Theology in Christendom (1896). Both Draper and White pit religion against science as their works tell the story about how science triumphs or is freed from the shackles of religion. Merton’s argument that science is both indebted to and inextricable from religion generated a multitude of responses from numerous scholars. While some scholars have supported and advanced Merton’s thesis, other scholars such as Barbara Shapiro and Richard L. Greaves dispute the catalytic impact of Protestantism or Puritanism on the rise of modern science.\(^6\) I. Bernard Cohen’s

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\(^4\) A few other scholars contemporary with Merton, such as Dorothy Stimson also contributed to the idea that science and religion were compatible with each other in interesting ways.

\(^5\) Merton’s thesis from “Puritanism, Pietism, and Science”(1936):

It is the thesis of this study that the Puritan ethic, as an ideal-typical expression of the value-attitudes basic to ascetic Protestantism generally, so canalized the interests of seventeenth-century Englishmen as to constitute one important element in the enhanced cultivation of science. The deep-rooted religious interests of the day demanded in their forceful implications the systematic, rational, and empirical study of Nature for the glorification of God in his works and the control of the corrupt world. (2)
*Puritanism and the Rise of Modern Science: The Merton Thesis* (1990) is particularly helpful for its summary and extensive annotated bibliography cataloging the range of responses to Merton’s clearly provocative claim.

From a historical perspective, Perry Miller’s *The New England Mind: The Seventeenth Century* (1939) and *From Colony to Province* (1952) argued similarly for the Puritans’ reliance on rationalism in their daily religious lives. His inquiry demonstrates the ways in which Puritans created and functioned in a highly intellectual and imaginative culture. Like Merton, Miller challenged a previously well-accepted thesis that the Puritans were a rigid, backwards, uninteresting, anti-intellectual group, wholly lacking in imagination. For example, in “Puritanism A Literary Force” (1917), H.L. Mencken describes Puritanism as a “God-crazy,” hostile force plaguing American culture and its literature (209):

> The Puritan’s utter lack of aesthetic sense, his distrust of all romantic emotion, his unmatchable intolerance of opposition, his unbreakable belief in his own bleak and narrow views, his savage cruelty of attack, his lust for relentless and barbarous persecution—these things have put an almost unbearable burden upon the exchange of ideas in the United States…” (202)

Mencken further describes Puritanism as devoid of “aesthetic spirit, and its concomitant spirit of joy” (208) and associates it with smugness, cocksureness, “distrust of new ideas,” and the “incapacity for seeing beauty as a thing itself” (205). Throughout his essay, Mencken blames Puritanism for the current moral state of American literature (which he does not favor) and looks forward to a future in which America offers a superior literary product.

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Miller’s project penetrated the intellectual depths of New England in ways that other historians had not. His makes this point most clearly in the his preface to *The New England Mind: From Colony to Province* (1956), in which he identifies his project as an “intellectual” rather than a “social” history. Miller calls for a study of the history of ideas over material concerns. As examples of a materialist study Miller lists “ship trade routes, currency, property, agriculture, town government and military tactics” while arguing that these topics “are not, and cannot be made, the central theme of a coherent narrative” (*From Colony to Province*, 1961 Preface). Miller considers “the terms of Puritan thinking” as “the instruments through which people strove to cope with a bewildering reality” and further argues that for one to understand social patterns, one must first understand the intellectual patterns at work (*From Colony to Province*, 1961 Preface). Miller, in *The New England Mind*, set the stakes for a new methodology in the study of New England and American history and is therefore compelled to promote the importance of thinking or the “mind” over materiality. Moreover, to successfully challenge the perspective espoused by Mencken, Miller seems inspired to make bold claims about Puritans’ allegiance to reason and rationality, thus giving credence to a historical perspective that the Puritans were modern subjects of the early Enlightenment.7

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7 This view is supported in more recent scholarship such as Reiner Smolinski’s “How to Go to Heaven or How Heaven Goes? Natural Science and Interpretation in Cotton Mather’s ‘Biblia Americana’ (1693-1728)” (2008), which situates Mather within the early Enlightenment and views his later scientific work as redemptive, as making up for or atoning for past transgressions such as the witch trials. In commenting on Mather’s *Biblia Americana*, Smolinski argues that there are too few (if any) traces...to validate the popular caricature of Mather as an old witch doctor and diehard bigot; instead his grand project allows him to reclaim his rightful place in the early Enlightenment in America and the transference of European scholarship to the colonies. (328)
The degree to which New England Puritans were participants in the early Enlightenment has been discussed by David D. Hall and Richard Godbeer. Their respective texts, *Worlds of Wonder, Days of Judgement: Popular Religious Belief in Early New England* (1989) and *The Devil’s Dominion: Magic and Religion in Early New England* (1994) make compelling cases for why it is important to consider the ways that seventeenth-century New Englanders were not modern or even “protomodern.” As Hall argues, “in certain ways the colonists remained Elizabethans…What seems true of European rural culture was emphatically the case for people in New England…their faith was leavened with accustomed ways of thinking that amounted to a folklore” (11). While early New Englanders certainly participated in rational modes of thought, Hall and Godbeer highlight the import of popular religion, magic, and the occult in seventeenth-century New England society. As both authors point out, belief systems apart from Puritanism were operating in the colonies, and their relationship to organized religion, such as Puritanism, is not entirely clear. These popular religious beliefs were difficult to isolate because they were woven into daily life and often inseparable from organized religion.

Hall and Godbeer offer important insight into the complicated relationship between religion and the rise of science in early America by emphasizing the complexity and amorphousness of “religion” in early America. Moreover, their studies also lead to the question of what constitutes “Puritanism.” The problem of defining Puritanism is an issue that John Morgan has explored in his essay “Puritanism and Science: A Reinterpretation” (1979) and in his book, *Godly Learning: Puritan Attitudes towards Reason, Learning, and Education, 1560-1640* (1986). He writes:
Few facets of English society of the late sixteenth and early seventeenth century have received as much attention as the problem of the definition of what precisely, constituted a ‘puritan’ or, in its generic form, the collection of beliefs known as “puritanism.” (J. Morgan 9)\(^8\)

J. Morgan’s “problem of definition” applies to colonial Puritans as well. In the foreword to *From Colony to Province*, Perry Miller described the New England landscape as providing the historian with an “ideal laboratory” because of its relative isolation and the homogeneity of its population. Furthermore, according to Miller, “the forces of history played upon it in ways that can more satisfactorily be traced than in more complex societies” (2). Miller’s intention is not to suggest that New England Puritans were a simple society, yet at times his study does seem to take the definition of Puritanism for granted. In the first volumes of *The New England Mind, The Seventeenth Century*, Miller argues that Puritan culture, in its early days, was cohesive and coherent: “…the first three generations in New England paid almost unbroken allegiance to a unified body of thought, and that individual differences among particular writers or theorists were merely minor variations within a general frame” (vii). Miller quotes liberally from a variety of sources without mentioning the speaker or author, as he claims: “In most instances, it is a matter of complete indifference or chance that a quotation comes from Cotton instead of Hooker, from Winthrop instead of Willard…”(ix). By assuming cultural sameness and uniformity, Miller runs the risk of obfuscati the individual voices, and their differences, in New England culture. Likewise, Robert Merton’s study makes some of the

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\(^8\) On this issue of defining Puritanism, see also H.F. Kearney, “Puritanism and Science: Problems of Definition” (1965).

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same assumptions about the homogeneity or unity within Puritan culture in England. As J. Morgan cautions in *Godly Learning*: “The historian who looks for internal consistency in the thought of a single man, let alone uniformity in a host, may well be forcing an unnatural structure upon his evidence” (2).

Part of John Morgan’s project in *Godly Learning* is to “comprehend the religious fervency of the puritans” or their “‘fear and trembling’” before God, which he argues “was the core of their being” (3-4). Morgan specifically critiques Perry Miller’s perspective on New England Puritans’ approach to knowledge and learning via reason. Morgan writes:

So Perry Miller, while acknowledging that the puritans on occasion stressed enthusiasm in religion and criticized the contribution of reason, was forced by his desire to stress the development of a ‘puritan mind’, to downplay this aspect, and to slough it off as, really, no more than a theatrical gesture, almost an aberration in the puritan character. (3)

While my project has different goals, Morgan’s exploration of the non-rational within processes of learning and rational modes of thinking in Puritan culture speaks to my investigation of these same concepts in literature on celestial and meteorological phenomena in New England. *Godly Learning* also resonates with my suspicions about the telling of history and methodology. Regarding the production of historical knowledge, Morgan aptly writes,

Part of the difficulty is that historians themselves are products of the stress on the rational. With questions of non-rational behavior and belief in the past, however,

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9 By reassessing what is “Puritan,” John Morgan also challenges Robert Merton’s claim regarding Puritanism’s effect on the development of science as he questions the way Merton selects Puritans who may have been already interested in science independently of their religious views. Morgan also comments on the disunity among Puritan thinkers: “It is important to understand that while there was general unity of purpose on specific topics puritans could (and did) disagree among themselves even while publicly offering a common front against those whom they perceived as their foes” (2).
the question immediately arises as to whether the historian’s reason is sufficient to capture the past, or whether it will inevitably create a false picture of a continuum of thoughtful action and behavior. (3)

In critiquing his scholarly process, Morgan captures one of the ways in which studying the history of rationality can lead to its ambiguity. As Morgan puts it, the historian who attempts to capture a true version of the past may be confounded by their lack of reason or non-reason and arrive at an opposite result: fiction. In this way, the meanings of reason and non-reason as well as the meanings of truth/fact and falsity/fiction seem to lose their clarity, resulting in a zone of indistinction. I suggest that an awareness of this conundrum is an opportunity for the imagination, as it forces the mind to question and work outside traditional or predefined structures of meaning.

Literary analysis, I suggest, offers us the best opportunity to understand and appreciate the content of these early American texts. Marjorie Nicolson’s work *Science and Imagination* (1956) provides one model for a literary approach to the relationship between science, technology and literature during the seventeenth and eighteenth centuries in England and Europe. Nicolson’s first chapter considers how Galileo’s *Sidereus Nuncius* (*The Starry Messenger*) (1610) influenced seventeenth-century English poetry, especially the works of John Donne. This text was important mainly for its announcement that he had found four satellites around Jupiter (with the use of the telescope) and its observation that the moon was not a smooth and perfect surface but had craters and looked rough like earth. Both of these observations contradicted Aristotelianism in that Galileo was suggesting that the heavens were imperfect and that not all heavenly bodies revolved around the earth. Subsequent chapters investigate how scientific and technological breakthroughs catalyze the literary imagination of Johannes
Kepler in *Somnium* (1634), John Milton in *Paradise Lost* (1667), and Jonathan Swift in *Gulliver’s Travels* (1667).

Any attempt to emulate Nicolson’s project with the colonial American world produces drastically different results. Colonial American literature, appearing mainly in the forms of sermons, pamphlets, almanacs, and poetry, responded to their life situations, which were invariably altered by the foreignness and particularity of the American landscape. While colonists identified as English subjects, they were changed by their life in America. As James Walsh describes in “Holy Time and Sacred Space in Puritan New England” (1980), the great migration initiated a “wrenching dislocation, a final separation from family, friends, and a familiar way of life” (93). While these seventeenth-century migrants, their offspring, and subsequent generations prior to the American Revolution were technically English, their identity was consistently transformed by their “American” experiences. Throughout this dissertation, I employ the terms “early American” and “colonial American” or “colonist” to identify, generally, the group of people that I am writing about. My use of the term “American” is intended to encompass the sense of newness that colonists felt as they established their lives in a land foreign to them. I also use the term purposefully for its meaning associated with European imperialistic practices and prospects of empire. At the same time, “colonist” or “colonial” serves to identify this group as both the colonizer-oppressor as well as the colonized-oppressed. “Early” also calls attention to their time, in this case, the time after the northern portion of the land was named, by Europeans, America and before it became the United States. While they were not yet Americans in the revolutionary sense, colonists were no longer traditionally English: their identities were complicated by their liminality as they stood on
the threshold of an old culture fading and another one newly forming. Among New England Puritans, subsequent generations felt the strain of their fathers’ vision and lived with the fear that they were falling short of this initial errand. As this investigation into early American astronomy reveals, colonists felt their separation: they were on the periphery, and frustrated by it. They relied heavily on imported knowledge and attempted to keep pace with developments in England and Europe as best they could. But, even in the basic task of collecting and reviewing that information, colonists were already generating their own forms of knowledge. These forms of knowledge were further informed by the circumstances of their environment as well as their shared status as migrants or colonists. Their living situation afforded them a different perspective, thus adding another dimension to the new rigorous study of the celestial landscape that was already underway in England and Europe.

Life was precarious in the seventeenth century, and it was particularly so for American colonists. The relative newness of the land accompanied by variable weather conditions prompted colonists to produce and consult almanacs for practical information related to celestial events and meteorology. Crucial knowledge was contained in data about the tides, rainfall, weather, eclipses, and the rising and setting of the sun and the moon. Moreover, the idea that these forces of nature could be predicted (despite the unreliability of some predictions like the weather), was psychologically comforting. Religious motivations also led to a keen interest in heavenly space as New England Puritans sought empirical evidence of God and Angels. For Puritans, success in obtaining empirical information about God as well as for practical matters such as farming was confirmation that their errand into the wilderness was exactly what God had intended.
Colonial Americans’ worldviews were inevitably altered by their encounters with peoples indigenous to the Americas. Captivity and war were realities for colonists and native groups. Furthermore, for Puritans, there was an impulse to convert native peoples. John Cotton’s *Gods Promise to His Planation* (1630) promotes an exchange that highlights the imperialistic aspect of conversion as he asks his flock:

Sixthly, and lastly, offend not the poore Natives, but as you partake in their land, so make them partakers of your precious faith: as you reape their temporalls, so feede them with your spiritualls…Who knoweth whether God have reared this whole Plantation for such an end? (20)

Cotton’s emphasis on “partake” suggests a mutual sharing between colonists and natives, yet this supposed mutuality is complicated by his use of the imperative, which reveals the urgency behind his command for conversion: colonists must “make them partakers” (20). Converting the native peoples was an essential part of the Puritan mission; it was not optional. The conversion experiences of native peoples, delivered in their own language, attracted much attention from colonists and their English counterparts as sites for the display of empirical data about the invisible world. For certain thinkers, the idea that experimental philosophy could reveal certain truths in Christianity was very appealing. As Sarah Rivett describes in *Science of the Soul in Colonial New England* (2011), Robert Boyle considered “the Indian soul as an empirical site upon which to increase the imaginative intellectual capacity of the Christian philosopher” (131). Furthermore, indigenous groups had an intimate and sophisticated knowledge of the North American landscape, and they had much to offer in this regard.10

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10 In *Frontiers of Science: Imperialism and Natural Knowledge in the Gulf* (2018), Cameron Strang reveals the ways in which modern science was an imperialistic project that relied heavily on observations and gathering practices of Indians, African slaves, and other groups not traditionally identified within the borders of “intellectual” science. For
These cross-cultural exchanges, coupled with the practical circumstances of everyday life, invariably affected the way colonists perceived and investigated the natural world and the universe.\textsuperscript{11} However, celestial and meteorological phenomena were unique because, unlike the earth sciences, they did not offer tangible resources that could be exploited. The heavens were common to all of earth’s inhabitants. No matter what nationality or cultural identity, everyone stood below the same sky, observing the behavior of the sun, moon, and stars. Even anomalous light events could sometimes be seen across oceans. Furthermore, because of the intangibility of these celestial and meteorological events, theories or any advances in their science had to be carried out by observation or through abstract forms of reasoning such as mathematics. In this way, these events generated a community of amateur observers, thus demonstrating that even those without formal training in natural philosophy could participate in the discovery and investigation of both regular and anomalous phenomena. As Raymond Phineas Stearns points out, “science in the New World was largely in the hands of amateurs, many of whom have hitherto escaped the scrutiny of history. They were persons with little or no formal scientific training” (\textit{Science in the British Colonies of America} xiii). Stearns further addresses some of the challenges colonial Americans faced: “They operated in an

\footnotesize{further insight into the connections between the rise of modern science and Native American thought, see also Gregory Cajete’s \textit{Native Science: Natural Laws of Interdependence} (2000).}

\textsuperscript{11}My study of astronomical and meteorological texts in early America is limited, with some exceptions, to New England. A thorough study of these types of cross-cultural intersections, as well as scientific practices in other regions of the Americas, is the next phase of this project. Bruce Stanley Burdick’s \textit{Mathematical Works Printed in the Americas}, 1554-1700 (2009) provides a catalogue of works of mathematical value, offering some explanation and analysis into the calculations employed by almanac writers throughout the Americas in this period.
atmosphere rarely favorable to scientific inquiry, working in isolation, without adequate libraries, apparatus, and the stimulation provided by able co-workers and by an informed, sympathetic public opinion” (Science in the British Colonies of America xiii). While colonists often lacked the latest technology and scientific literature as well as leisure time, I disagree with Stearns’s claim that the intellectual atmosphere was hostile toward science. The texts surveyed by this project reveal an enthusiasm about science and a dedication to it, which is revealed by the community of (amateur) observers and writers that formed in colonial America during this period.

Each chapter of my dissertation makes use of several different types of texts read by early Americans: sermons and religious pamphlets, textbooks, and almanacs. The Puritan sermon perhaps best represents the Puritan aesthetic by showcasing the leadership’s rhetorical prowess as they delivered the word of God, while carefully making use of complex imagery and metaphor in the traditional plain style, to their readers and listeners. My project considers how the sermon acts as a literary vehicle for disseminating new scientific knowledge while at the same time maintaining its religious, emotional fervor, speaking, in effect to peoples’ rational and non-rational minds simultaneously. My ideas have been informed by numerous scholars who focus specifically on the Puritan sermon as a genre such as Emory Elliot, Sacvan Bercovitch, and Teresa Toulouse.12

12 Sacvan Bercovitch’s The Puritan Origins of the American Self (1975) and The American Jeremiad (1978) are also well-regarded texts on the New England sermon form. In these texts, Bercovitch performs a technical analysis of rhetoric, arguing that the sermon, namely the jeremiad, was “the colonists’ first literary innovation and their most enduring social legacy” (The American Jeremiad xii). Bercovitch demonstrates how the rhetorical features of the Puritan jeremiad help to construct the myth of America. His
In *Power and the Pulpit in Puritan New England* (1975), Emory Elliott describes the sermon as “the outlet for public expression of the deepest tensions of the society” (10). He further explains:

ministers provided the symbolic keys whereby their society could be touched, and eventually exposed, understood, and released or appeased. Sensitive to the changing moods of the people, the ministers created a literature continuous with human experience, constantly in the process of reconciling objective observation with subjective experience. (11)

These “literary artists” (i.e. the ministers) aided their society in the shift from, as Elliott describes, “the sense of disorientation and alienation that marked the years of separations from the fathers (1665-1675) through the transition years of frustration and social malaise (1670-1682) to the final years of assurance and confidence (1680-1695)” (14). Elliott traces the sermon form across multiple generations, arguing that the older generation “embolden[ed] the young” by offering “powerful imagery to the unconscious emotions of the new generations,” which thereby “enabled the younger generations to adapt and accommodate to the rapidly changing world of a new age” (15).

In *The Art of Prophesying: New England Sermons and the Shaping of Belief* (1987), Teresa Toulouse investigates the sermon as an aesthetic form, citing Perry Miller’s dismissal of aesthetics among Puritans:

He [Miller] preferred to focus on the Puritan concern with making logical propositions in a plain style which would touch the understanding of the entire community—and stopped there, arguing either that ‘aesthetics’ were of no interest to the Puritans, given their task of forming a community, or that what aesthetic they possessed was a fairly threadybare derivation of European models. (5)

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13 Toulouse further notes: “Later scholars have argued that in downplaying the role of aesthetics in Puritan life, Miller not only ignored the importance of the emotional side of
Toulouse also builds on Elliot’s ideas regarding the sermon’s relationship to its author and audience:

If the community’s vision informs these texts—the ministers are, after all, its spokesmen—the sermon also provides a means not simply of expressing, but also of forming and controlling, this vision. The resulting interplay implicit in the sermon’s structure may thus seem balanced, but the attitudes informing it often prove contradictory. The structure of sermons, then, reveals fluid rather than static balances; it manifests the attempts made to unify response against the doubts, uncertainties, and countervailing beliefs and desires that pull against and undermine these attempts. An examination of the structuring of sermons provides, in short, another means of gauging how a culture maintains a sense of its continuity as it incorporates into its patterns the facts of change. (9)

Both Elliot and Toulouse highlight that the sermon form is the genre or platform by which society’s leadership grappled with their sense of doubt and insecurity; whether spoken or published, the sermon contains a private experience that has been tailored for public broadcast. Toulouse’s study probes at the psychology behind the sermon as she asks: “How did ministers who felt uncertain….express their confusions and their attempts to reconcile or even repress them in the structure as well as the content of their sermons?” (11). This question certainly applies to Cotton Mather, who as Michael P. Winship describes “straddled…two stages” of change, the first stage consisting of the elite’s attempt to reform society and the second stage in which elites distanced themselves from beliefs in prodigies in favor of wholly logical, natural explanations (“Prodigies” 94). Toulouse also draws from Sacvan Bercovitch’s argument regarding the jeremiad sermon form and how it is foundational to the idea of the myth of America. Like Bercovitch and Elliot, Toulouse offers an analysis of the sermon’s rhetoric, highlighting the ways that the “sermon form holds old assumptions and new desires together in one form…” (11).

Puritanism, its ‘stretched passion,’ but also discounted the historical and literary insights made available by studying the Puritans from this perspective” (5).
In early America, the counterpart to the sermon was the almanac. If there was one literary form the common people were reading besides the Bible, it was the almanac. With the exception of religious texts, the almanac outnumbered all other books during the course of the seventeenth century. As Marion Stowell explains in *Early American Almanacs* (1977), with the rise in literacy rates post Reformation, most households contained the Bible and the almanac: “The Bible took care of the hereafter, but almanac took care of the here” (x). Sermons represented the feelings and intellect of society’s elite members; they delivered the word of God, filtered through their writing, and instructed the laity on how to receive it. While ministers were receptive to the needs of their congregation, it was their task to demonstrate how to be Puritan—power was located clearly at the top of the pulpit and that voice spoke down to the congregation. The almanac offered a reversal of this power structure. While almanac writers were typically learned men, their relationship to their audience was entirely different. Those who produced the almanacs were in touch with their readership and altered what they wrote to meet public demand, even when the writers themselves disagreed with the information that they were publishing. Most almanacs contained a monthly calendar, eclipse and tide tables, and some sort of short essay, usually promoting Copernican, and eventually Newtonian science. Almanacs from the earlier portion of the seventeenth century are typically filled with this sort of factual information along with an essay that delivers new scientific ideas in a rational, organized way. Their uniformity is due to the control that Harvard had over printing; however, once Harvard lost its monopoly, publishers began to offer occult material to satiate readers’ desires and drive their sales. Thus, almanacs printed in the latter portion of the seventeenth century offer a selection of verse poetry,
weather predictions, the anatomy, and horoscopes.

Almanacs reached common folk in ways that other texts did not as they gave people the tools to practice a type of popular religion using celestial events. Marion Stowell suggests that the almanac’s

humorous diversions may have served to brighten dull days for many stolid, hardworking Puritans who, in the words of Samuel Briggs, had ‘left Merrie England’ to find a place where they could be miserable according to the dictates of their own desire. (18)

As scholars such as Richard Godbeer have noted, magic and astrology offered people a sense of control over their lives by providing a means of predicting the future (in spite of its actual outcome). Godbeer further suggests that alternative belief systems held a certain appeal for Puritans, particularly as they grappled with their lack of agency in the covenant of grace.14 People relied on the almanac for entertainment as well as its practicality for informing them of celestial and earthly events. It was an economical text designed for all types of people in both New England and the Mid-Atlantic colonies: the farmer, fisherman, clergyman, etc. For instance, in his 1686 almanac, Samuel Atkins’s writes about how its chronologies, notes, rules and tables are “very fitting for every man to know & have.” Atkins further emphasizes the importance of the almanac:

I having journeyed in and through several places, not only in this Province, but likewise in Maryland, and elsewhere, and the People generally complaining, that they scarcely knew how the Time passed, nor that they hardly knew the day of Rest, or the Lords Day, when it was, for want of a Diary, or Day Book, which we call, an Almanack. And on the other side, having in my Travels met with Ingenious Persons, that have been Lovers of the Mathematical Arts, some of which have wanted and Ephemeris to make some Practice thereon: I say, hearing

14 The covenant of grace was a Puritan notion that only the elect would be admitted into heaven. One’s position was predetermined, there was no way to change it, and no way to know for sure that one qualified as part of the elect. The covenant of works was the belief that one could alter one’s position (i.e. join the elect) if one performed good works throughout one’s life.
this general Complaint from such abundance of Inhabitants, which are here. I was really troubled, and did assign according to that small Knowledge that I had, to pleasure these my Country men with that which they wanted. (2)

Almanacs transmitted information from abroad as their writers stayed current with European astronomical endeavors, yet they also spoke to and for the common American colonist by generating material that catered specifically to their needs.

Textbooks offer yet another lens for understanding views on astronomy and meteorology in this period and they provide further insight into the function of rational and non-rational modes of thought in scientific inquiry. This study focuses primarily on the representations of celestial and meteorological phenomena in *Compendium Physicae* (1687), a newly introduced textbook at Harvard university. Its author, Charles Morton, was originally from Cornwall, England but emigrated to the colonies in 1686 after being arrested for dissenting in his violation of the Stamford Oath, which required those with a graduate degree to teach only at Oxford or Cambridge. Morton journeyed to the colonies with the prospect of becoming the next president of Harvard. Increase Mather invited Morton to replace him and Morton accepted the offer; however, between Morton’s acceptance of the position and his arrival in Massachusetts Bay, the colony lost their charter and a royal governor assumed leadership. This change of authority thwarted Morton’s prospective job opportunity since, as a dissenter, he was clearly at odds with the king.

Morton’s *Compendium Physicae* is intriguing for the way it spans the “old” and “new” world both in terms of its imported knowledge (Morton brought the manuscript with him to New England) and its inclusion of new science, Aristotelianism, religion, and popular folklore references. While Morton had completed this work before departing for
the colonies, it appears he edited some portions of it to accommodate his new colonial audience. The main addition to the colonial version is the inclusion of rhyming couplets, which likely served as mnemonic tools for students (Cohen “The Compendium” 658). Morton’s textbook offers some sense of what ideas university students encountered. Although some of the theories contained in Compendium were quickly displaced by Isaac Newton’s publication of Principia (1687) in the same year, Morton’s work was still taught in 1723 and perhaps even later (Morison “Charles Morton” xiii). While Morton was a proponent of these new ways of thinking, the intrigue of his text seems to lie in its ability to straddle different worlds, effectively bridging the gap between old and new knowledge. Compendium does not read as eloquently as a sermon, nor is it as entertaining and accessible as the almanac; however, it maintains a certain literary aesthetic in its rhetorical structures as they are designed to support several modes of thinking simultaneously. Moreover, readers receive a glimpse into Morton’s own literary-scientific imagination in his representations of rational and non-rational ways of knowing.

Chapter one of my dissertation lays the foundation for a discussion of anomalous light apparitions by reviewing some of the major works that influenced colonists’ perceptions of the heavens during the seventeenth and eighteenth centuries. This introductory chapter also reviews and engages with the different scholarly perspectives on scientific thought in colonial America, thus providing an essential base for reading the successive chapters, which discuss mainly primary texts. Scholars maintain some conflicting impressions of the cultural milieu of colonial America and disagree about how seventeenth- and eighteenth-century colonial Americans interpreted what they witnessed.
in the sky. Some argue that colonial Americans were strongly influenced by their belief in the supernatural, magic, and occult practices while others portray them as enlightened, modern subjects. My dissertation engages with this question of Americans’ intellectual status by arguing that they occupied both mindsets or worldviews simultaneously and there is not necessarily a clear historical progression or evolution from medieval to modern.

Chapter two investigates the significance of the comet as both an observable phenomenon and as an imagined sign or symbol in sermons, almanacs, and educational works. The comet, in the seventeenth century (and prior to it), was a popular topic of discussion, particularly because the Bible features comet-like events. This chapter investigates shifts in rhetoric in Samuel Danforth’s An Astronomical Description of the Late Comet or Blazing Star; As it appeared in New-England (1665), Increase Mather’s Heavens Alarm to the World (1681) and Kometographia: A Discourse Concerning Comets (1683), Charles Morton’s Compendium Physicae (1687), Cotton Mather’s An Essay on Comets (1744) and The Christian Philosopher (1721). The chapter probes the various conceptualizations of comets in this array of literature as it seeks answers to the following questions: How do writers vision or envision comets? What role does observation play in their writing and how are observations interpreted and/or translated in writing? At what point does the literal morph into the figurative? How is sight (i.e. observation) changed by the imagination? Do these texts destabilize or reinforce comet lore? In some cases, the writers’ own observations seem to work against their belief. In their writing, they appear to resist drawing conclusions that deviate from pre-established
knowledge or their faith. I explore this apparent resistance and consider how it may testify to the workings of an involuntary or unconscious revisionary procedure.

Chapter three explores the early American literary response to appearing and disappearing stars in Cotton Mather’s *The Christian Philosopher*, Charles Morton’s *Compendium Physice*, and early American almanacs. New starlight presented another enigma for observers in the seventeenth century. While new star formations (novae) were recorded in other cultures prior to the seventeenth century, unlike comets, no long-standing body of literature on novae existed for reference. Novae lacked the same set of metaphors associated with comets; however, the realization or acceptance of appearing and disappearing starlight had profound existential implications, both personal and social, as it directly contradicted the immutability of the Aristotelian celestial landscape. To accept changes in the starscape was to renounce the Aristotelian model in favor of the Copernican, eventually Newtonian, version of the cosmos. This chapter begins with an overview of a few key European works by astronomers such as Tycho Brahe, Johannes Kepler, and Johannes Hevelius. Since little has been written about appearing/disappearing stars in colonial America, this chapter answers some basic questions about how these events are represented in writing: What texts offer a record of new or disappearing starlight? How are these events depicted and/or interpreted in writings (what is their figural status)? In what ways did observing novae and/or theorizing about novae provoke a literary imagination?

Chapter four discusses sightings of the aurora borealis in the colonies. Similar to novae, this phenomenon is discussed less frequently in both primary and secondary sources. This chapter focuses on Thomas Prince’s *An Account of a Strange Appearance*
in the Heavens (1719), Thomas Robie’s A Letter to a Certain Gentleman (1719), and Cotton Mather’s A Voice From Heaven (1719). These three texts demonstrate a variety of responses to the aurora borealis as they combine scientific, emotional, imaginative, superstitious and religious perspectives. Albeit in different ways, these authors also provide their respective audiences with an interpretive guide for making sense of the aurora borealis, thus demonstrating how a community of observers develops and interacts.

Chapter five explores rainbow sightings and the significance of their interpretation as a positive sign from heaven. In the seventeenth and eighteenth centuries, most aberrant celestial and meteorological light phenomena were often approached with trepidation. Rainbows, however, were an exception. For early Americans such as Samuel Sewall, William Williams, Cotton Mather, and Jonathan Edwards, rainbows were a source of both scientific and godly wonder. Scientifically, the rainbow raised pressing questions about the behavior of light; in terms of religion, it symbolized a covenant between God and Noah (and humanity generally) that God would not flood the world again. This chapter addresses the following questions: How do interpretations of the rainbow differ from interpretations of other forms of celestial/meteorological phenomena? How does the absence of fear change the way people respond, in terms of wonder, to the rainbow? How did early Americans navigate or reconcile their religious understanding of the phenomenon with the developing scientific explanation of it (are they compatible or mutually exclusive)? Does a scientific understanding of the rainbow destroy or alter its significance in the religious sense?
The conclusion seeks to underscore the importance of imagination and narrative in these seventeenth- and eighteenth-century documents by considering what may be gained by reading these texts in our modern context. Moreover, the conclusion addresses some of the interpretive challenges these documents pose as they frequently seem to elude our modern twenty-first-century modes of classification. Although these texts employ literary devices and narrative schema, they are not fictional (nor intended to be fictional); they may proclaim theological intention, yet they appear to offer what modern readers might consider scientific data. Modern categories, which typically position science and mathematics as distinct from the arts and humanities, seem unable to accurately support the complexity of these early texts. As literary texts/literature, they appear to elude or resist genre. Without making an inappropriate link between the seventeenth and the twenty-first centuries, I consider what may be gained by engaging in reading practices that intentionally make use of a twenty-first-century perspective; in this way, we may discover or refresh our own existential pursuits in theirs.

Like many other historians who write about the history of American science, Raymond Phineas Stearns, in *Science in the British Colonies of America* (1970), compares the development of science in America to England and Europe, noting that science in colonial America lagged significantly:

> With the exhilaration generated by the success of the American Revolution, they were, like most adolescents, anxious to cast off the old scientific leadership and grope their way to scientific maturity. They were loath to admit that Europeans still led the way in science… (xiv)

My project has been informed by claims about the origins and development of a uniquely “American” science as well as those that argue for a specific locus marking the shift from old (medieval) to new (modern) knowledge. While I engage with some of these
arguments, my goal is to explore how rational and non-rational ways of thinking inform each other in early American literature on celestial and meteorological events rather than to deliver another authoritative statement regarding the historical progress of modern science. In *The Art of Prophesying*, Teresa Toulouse states: “I offer an exploratory interpretation, not a conclusive statement” (12). This project seconds that objective by offering an exploration and investigation of the body of literary that formed in response to comets, new stars, the aurora borealis, and rainbows in the seventeenth and early-eighteenth centuries.
CHAPTER 1: COLONIAL SCIENCE: THE EARLY AMERICAN INTELLECTUAL LANDSCAPE

This introductory chapter surveys some of the major works and ideas that influenced colonists’ perceptions of the heavens during the seventeenth and eighteenth centuries. Colonists derived information about celestial events from a mixture of sources such as the Bible, almanacs, English astrological/astronomical texts, and textbooks that may have taught either the Aristotelian/Ptolemaic system or Copernicanism, or both. Prior to the popularity of Copernican astronomy, Christianity generally favored the Aristotelian/Ptolemaic, or geocentric, model of the universe because its Prime Mover could be considered God. This model was scrutinized by Tycho Brahe, Galileo Galilei, and Johannes Kepler (among others) during the late sixteenth and early seventeenth centuries as heliocentrism gained popularity in the field of astronomy. Following its invention, Galileo’s subsequent improvements of the telescope forever changed astronomy by enhancing observational practices, thus revealing new optical information about the heavenly bodies that was previously inaccessible to the naked eye. Via the telescope, astronomers acquired the visual evidence necessary to overturn the Aristotelian/Ptolemaic hypotheses and rule in favor of a mutable, heliocentric solar system.

Another goal of this chapter is to establish a picture of the cultural and intellectual milieu of the American colonies, which seems essential for understanding how early Americans perceived, processed, and participated in the developments taking place in the growing field of astronomy. To establish this picture, I draw from numerous scholarly texts such as the works of Jon Butler, Norman F. Cantor and Peter L. Klein, Margaret
Denny, Peter Eisenstadt, Richard Godbeer, David D. Hall, S.K. Heninger, Theodore Hornberger, Rick Kennedy, Perry Miller, Reiner Smolinski, William D. Stahlman, Marion Stowell, Keith Thomas, Pershing Vartanian, James Walsh, and Michael Winship. These authors maintain different perspectives on colonial culture and, with some exceptions, can generally be divided into two camps: one approaches colonial Americans as modern or protomodern subjects while the other argues that they should be considered “Elizabethans” living in a world of wonder and magic. When this body of scholarship is read together it reveals the complexity of early American culture, which is both religious and rational yet in many ways still wedded to superstition and magic. In addition to highlighting some of the confusion amongst the scholarship, this chapter argues for the necessity of understanding the colonists as a diverse group of thinkers who maintain multiple worldviews simultaneously and sometimes seamlessly. The chapters that follow demonstrate the manner in which these worldviews function together in colonists’ reactions to specific celestial phenomena.

Throughout the course of this chapter, I engage with the following questions prompted by scholarship on science in colonial America: What is gained or lost by labeling the colonists’ universe as “enchanted” or a “world of wonder” (Hall 71) or “too trivial for analysis” (Walsh 88)?¹⁵ Likewise, what is gained or lost in reading early American texts in the context of the Enlightenment? How does historical categorization (i.e. imposed labels such as science, religion/Puritanism, folklore, magic, etc.) distort and/or assist our understanding or perspective of “science” in early America?

¹⁵ See James Walsh, “Holy Time and Sacred Space in Puritan New England” (1980): “Like everyone else [Puritans] accepted a good deal of the universe as given, too true or too trivial for analysis, as everyday reality” (88).
Scholars have debated when “science” was born as a discipline in England. Some have placed its origin in the works of Francis Bacon; however, as Raymond Phineas Stearns emphasizes in “The Scientific Spirit in England in Early Modern Times (c.1600)” (1943), “to place the origins of the English scientific spirit in the seventeenth century is to ignore a long list of significant sixteenth-century forerunners” such as Robert Recorde (1510-1558) and John Dee (1527-1608) (294). Furthermore, it obscures the contributions of earlier figures like Roger Bacon (1219/20-1292) and Robert Grosseteste (1175-1253).

My goal in the following section is to provide a brief and general overview of the state of science in sixteenth-century England while highlighting some of the key transitional points in the rather complicated shift from scholasticism to the new science.

During the sixteenth century, science in England was in a transitional phase slowly moving away from medieval scholasticism and toward experimental science. The theology and philosophy taught in European universities was speculative yet dogmatic, offering students a clear and stable picture of nature that need not be challenged. For instance, as S.K. Heninger describes in “Tudor Literature of the Physical Sciences” (1969), the goal of a student practicing encyclopedism, a form of scholastic science, was to order, classify, and label everything in nature according to “its proper position in the plenum” (102). The preexisting order of nature usually conformed to the following pattern: God and the angels, the four elements, man, the animals, and plants and stones (Heninger 102). However, during the sixteenth and seventeenth centuries, new ways of thinking, such as the experimental philosophy of Francis Bacon, challenged these dogmatic ways of pursuing knowledge.
One important change in scientific thinking was the shift from purely qualitative assessment to quantitative assessment. During the sixteenth century, a growing number of people were collecting data by way of observation and making conclusions based on reason rather than elucidating the qualities of any given item using scholastic methods (Heninger 107). Quantitative assessment relied on an understanding of mathematics, which was a developing field in sixteenth-century England. Mathematics was generally divided into three main categories of learning: number theory, geometric measurement, and computation (Heninger 107). One of the central figures writing about mathematics at this time was John Dee, a fellow of Trinity College. In his “Mathematicall Praeface” (1570) to Euclid’s Elements of Geometry, Dee writes,

> These Mathematical things have a marvelous neutrality, yet they also have a strange participation between Supernatural, immortal, intellectual, simple, indivisible things and Natural, mortal, sensible, compounded, divisible things. Probability and sensible prose may well serve in natural things, and is commendable. However, in Mathematical reasonings a probable argument is not regarded as useful, nor can its testimony serve as proof. Only a perfect demonstration of certain essential and invincible truths (which have been universally concluded with certainty) will suffice for an exact and pure mathematical argument. (150)

Here Dee elucidates what mathematics can achieve by providing definitive answers as evidence instead of pure conjecture or speculation. The remainder of his preface provides readers with a thorough survey of mathematics. Training in mathematics was a given at any university, but non-university trained persons also required a set of math skills to carry out their daily work. Some texts, such as Robert Recorde’s The Pathway to

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16 Dee was also a strong supporter of Copernicus’s astronomy. While Dee made important contributions to mathematics and the new science, like many sixteenth-century scholars, included within his writings are references to magic and other supernatural forces. For instance, Dee viewed the 1572 nova as an augury, which seemed to prompt a practice of crystallomancy, or gazing into a crystal or stone to induce a trance-visions (Roberts).
Knowledge (1551), The Castle of Knowledge (1556), and The Whetstone of Witte (1557) were written for this type of working-class audience. These texts reveal what common people were learning, which differed from what was being taught in the universities. Those with no training in Latin were restricted from learning classical science since many of the esteemed texts by writers such as Pliny, Seneca, Plutarch, and Aristotle remained untranslated (Heninger 106). However, for those who did attend university, they were likely to encounter the rigid teachings of Aristotle rather than newer, cutting-edge theories about the nature of the universe (Heninger 103). Working-class individuals had access to handbooks and other “folk science” texts that offered a mix of practical and entertaining fantastical material. One popular work was The Kalendar of the Shyppars, a prototype for the almanac, containing a calendar, illustrations, physic and physiognomy, astrology, and basic astronomy (Heninger 121, 105).

A better understanding of mathematics contributed to the field of astronomy and the shift from geocentrism to heliocentrism as empirical data suggested that the universe was not a finite system consisting of planets moving on concentric spheres with earth at the center. The new, preferred theory was of orbits in infinite space. As a science, astronomy was considered a subdivision of cosmography, which also included geography, astrology, and chorography (Heninger 119). The relationship between

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17 Recorde is noteworthy for producing the first English text to print the plus and minus signs (+/-) and, in general, the first text to print the equal sign (=) (Heninger 109).

18 Raymond Phineas Stearns, along with other scholars, have noted the importance of scientific texts written in English or the vernacular. In “The Scientific Spirit in Early Modern Times (c.1600)” (1943), Stearns cites Pollard and Redgrave’s Short-Title Catalogue of Books Printed in England, Scotland, & Ireland, 1475-1640, which reveals that of the scientific literature published, “ninety percent were published in English” (297).
astronomy and astrology is an important one; however, historically it is not always straightforward where one discipline ends and the other begins. As defined in the Oxford English Dictionary, astrology (i.e. “natural astrology”) was considered “the practical application of the medieval art or science of astronomy” (1), which involved “the calculation and prediction of natural phenomena and meteorological events (such as the measurement of time the times of tides and eclipses) on the basis of astronomical observations” (1a). Judicial astrology, the predictive form, involved the “foretelling or counselling in human affairs by interpretation of the motions of the planets and stars; star divination, astromancy” (OED 1b). Likewise, the definition of astronomy is also confusing:

Originally: the science or art dealing with the positions and motions of planets and stars and their effect on natural phenomena and human affairs...In later use: the science which deals with the universe beyond earth’s atmosphere, comprising the study of celestial objects and extraterrestrial phenomena, and of the nature and history of the universe. (OED 1)

Additionally, prior to the mid-eighteenth century, astronomy was also: “the art of astrology practised as a means of predicting human affairs” (OED 2). Thus, the disciplines of astrology and astronomy meant different things at different times and could ostensibly be used interchangeably.

Astrology was greatly popular throughout England and Europe in the sixteenth century. It had real authority as it presented a rational system of knowledge and stemmed from a belief that all things were interrelated: the behaviors of the planets and stars and anything else in the sky affected earthly life. In his “Mathematicall Praeface,” John Dee considers both astronomy and astrology mathematical arts, yet they are distinctly different:
I make Astrology a separate Art from Astronomy, not by my own whim, but by good reason and authority. For Astrology is a Mathematical Art that reasonably demonstrates the operations and natural beams of light and the secret influence of the Stars and Planets in every element and elemental body, at all times and from any given Horizon. (171)

Dee defines astronomy as:

a Mathematical Art which demonstrates the distance, magnitudes, and all natural motions, appearances, and passions of the Planets and fixed Stars, for any time (past, present or to come) in respect to a certain Horizon or without respect to any Horizon. By this Art we can ascertain the distance from the center of the Earth to the Starry sky and each of the Planets, or how large any visible fixed star or Planet is compared to the size of the Earth. (“Mathematicall Praeface” 169)

Astronomy, according to Dee, emphasizes calculation and numerical value, yet it appears to share some similarities with astrology, particularly in its necessity to human affairs: “It [astronomy] is required for an understanding of other human affairs, like covenants between man and man…There would be great uncertainty, Confusion, untruth, and brutish Barbarity without the wonderful diligence and skill of this Art” (“Mathematicall Praeface” 170). In Dee’s view, both arts have bearing on human life, but one key difference is astrology’s “secret influence,” which marks this art as occult or a type of hidden knowledge that is immeasurable (“Mathematicall Praeface” 171).

Dee also provides a sense of what an astrologer should know in Propaedeumata aphoristica or “Preparatory Aphorisms” (1588). He begins his list of aphorisms by first calling attention to the sovereignty of God: “Against the laws of reason and nature, God created all things from Nothing” (Propaedeumata aphoristica 27). However, Dee accommodates changes in the scientific method by allowing them to be what God has revealed: “What God has revealed clearly to the eyes of mortals in a Magnet, he has left to be discovered in other things through the more subtle investigations by the mind and through diligent experimentation” (Propaedeumata aphoristica 30). Dee’s astrology is
ultimately mathematical, consisting mainly of geometry and arithmetic. According to Dee, the astrologer should be familiar with the size of the earth, the other planets, as well as the fixed stars; he should also understand the distance from the earth’s center to the planets and fixed stars (*Propaedemata aphoristica* 30).\(^{19}\) Dee’s emphasis on mathematics reflects a broader desire among English audiences for explanations on how astrological predictions work, as opposed to taking the predictions of professional astrologers at face value (Heninger 121). Later texts responded to readers’ curiosity, giving them the tools and instruction for making their own prognostications (see, for example, Leonard and Thomas Digges’s *A Prognostication Everlasting*, c.1596).

Astronomy, though sharing much with astrology, was utilized in the medieval period to project feasts in the church calendar. Astronomy also served as a guide for daily life practices such as instructing people on the best time for administering medicinal cures (Heninger 123). By the sixteenth century, however, astronomy adopted a different agenda.\(^{20}\) One of the first serious astronomical works to appear (one that did not simply

\(^{19}\) Dee also emphasizes the correct and incorrect methods of conducting astrology as he criticizes those who either deny astrology altogether or practice it wrongly. He divides these groups into the “Light Believers,” the “Light Despisers,” and the “Light Practicers” (“Mathematicall Praeface” 173). The first group believes that the stars are all powerful, and capable of “answer[ing] any question or fulfill[ing] any desire” (“Mathematicall Praeface” 173). The second group, which Dee seems particularly vexed by, denies that that the celestial realm has any influence over the world. The third group is the “vulgar Astrologer” who lacks skill or knowledge and makes errors, thus discrediting “the Cautious and modest Astrologer” (“Mathematicall Praeface” 173). These varying degrees of astrology make it even more difficult to discern astrology’s role and its reception in both England and the colonies during the seventeenth century since there was no clear standard of practice.

\(^{20}\) One sixteenth-century explanation can be found in Thomas Blundeville’s *His Exercises* (1594), which defines astronomy as “a Science, which considereth and describeth the magnitudes and motions of the celestial or superior bodies...” and astrology as “a
rehearse medieval astronomy) is Anthony Ascham’s *A Lytel Treatyse of Astronomy* (1552). Thomas Digges, a proponent of Copernicanism, produced a groundbreaking astronomical text, *A Perfit Description of the Celestial Orbs* (1576), which included what is likely the first printed diagram of the Copernican system (Johnson and Larkey 71).

T. Digges writes,

> But in this our age, one rare wit (seeing the continual errors that from time to time more & more have bin discovered, besides the infinite absurdities in their Theorickes, which they have bin forced to admit that would not confess any mobility in the ball of the earth) hath by long study, painful practice, and rare invention delivered a new Theorick or model of the world, showing that Earth resteth not in the Center of the whole world, but only in the Center of this our mortal world or Globe of Elements, which environed and enclosed in the Moon’s Orb, and together with the whole Globe of mortality, is carried yearly round the Sun…

T. Digges readily discards the old model of the universe in favor of the new theory proposed by Copernicus. Like many others writing about astronomy at the time, T. Digges makes a point of placing limits around human agency by referencing God’s role in the human pursuit of knowledge:

> Why shall we so much dote in the appearance of our senses, which many ways be abused, and not suffer our selves to be directed by the rule of Reason, which the great GOD hath given us as a Lamp to lighten the darkness of our understanding, and the perfect guide to lead us to the golden branch of Verity amid the Forest of errors.

Science which by considering the motions, aspects, and influences of the starres, doth foresee and prognosticate things to come” (134).

21 In “Thomas Digges, the Copernican System, and Idea of the Infinity of the Universe in 1567” (1934) Francis R. Johnson and Sanford V. Larkey highlight the important role that Thomas Digges played in the introduction of Copernicanism to England. While some scholars have attributed the introduction of the Copernican worldview to the presence of Giordano Bruno in England in 1583, Johnson and Larkey point out that it is unlikely Bruno communicated the significance of this worldview since he neither spoke nor wrote English. Instead, they credit Thomas Digges as being “the first to advance the idea of an infinite universe as a corollary to the Copernican system” (69).
In this way, T. Digges refocuses religion to champion reason in favor of relying on the senses alone.

While shifts toward reason and acceptance of the Copernican system occurred in the field of astronomy during the sixteenth century, meteorology (e.g. comets, the aurora borealis, the Milky Way, etc.) failed to undergo such a transformation and instead remained almost wholly Aristotelian. The Aristotelian theory that the sun causes the earth to emit vapors and exhalations that changed meteorological form as they ascended in the atmosphere remained unchallenged and continued to permeate explanations of atmospheric phenomena until the eighteenth century. Despite the inaccuracy of these meteorological theories, they did have the benefit of focusing on natural causes, thus rejecting the idea that atmospheric events were supernatural or miraculous. Further developments in meteorology were aided by the invention of measuring instruments, which could provide researchers with specific and precise information. Despite the slower progress of meteorology, in general the seventeenth century marked a new era of empirical science, which began to probe at the universe’s mysteries through observation and experiment. As experiments yielded answers, they suggested that humans could potentially know something like the truth of nature or the truth of the universe. In effect, the role that humans played in the universe was fundamentally changed as greater faith was placed in human reason and sensory experience rather than religious dogma.

Many historians have attempted to explain the shift from the orderly universe of the Middle Ages to the seemingly dynamic universe of the eighteenth century. Francis Bacon (1561-1626) and René Descartes (1596-1650) emerge as two key intellectual players aiding this transition from medieval thinking to modern rational scientific
thought. Bacon’s approach was based on the experiment and empirical data while Descartes’s approach was theoretical, making use of human rationalism. In *Seventeenth-Century Rationalism* (1969), Norman Cantor and Peter Klein suggest that these two modes of thinking converge in the ideas of Sir Isaac Newton, who, in building the foundation for modern science, “borrow[ed] the best” from Bacon and Descartes (2). Cantor and Klein further argue that shifts in worldview are based on people’s attitude toward newness as opposed to renewal:

> Martin Luther called for a reformation of the church, a return to the original and pristine Christianity, not for a new faith. But, by the first quarter of the seventeenth century, innovation had replaced renewal; and men began to entertain the thought that the moderns were equal to, if not better than, the ancients (1).  

This idea of newness is reflected in Bacon’s *Novum Organum* (1620) where he writes, “It is idle to expect any great advancement in science from the superinducing and engrafting of new things upon old. We must begin anew from the very foundations, unless we would revolve forever in a circle with mean and contemptible progress” (9). It is also significant that science in the seventeenth century becomes a social venture in a way that it was not in prior times. Conducting scientific experiments within an institutionalized or corporate environment increased the success and productivity of the experiment: “The former [period] is dominated by independent and isolated investigators; the latter maintains a corporate existence and possesses clearly defined rules and regulations governing its activity” (Cantor and Klein 5). The central issuer of these rules and regulations was the London Royal Society, established in 1662.

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22 Cantor and Klein’s argument regarding innovation also applies to the colonial project. While the early colonists considered themselves English subjects, their mission or errand in America was completely new.
The birth of the London Royal Society had a global impact on the development of science during the seventeenth century and onward. Although colonists resided across the Atlantic, their distance from England did not stop them from communicating and participating with the Royal Society. As Margaret Denny states in “The Royal Society and American Scholars” (1947): There is a general agreement that the Royal Society of London exerted a profound influence upon Americans during the colonial period” (415). The Society encouraged scientific progress yet also acted as an educator, schooling its fellows, contributors, and followers in the scientific method. Likewise, *Philosophical Transactions*, the Royal Society’s journal, played a crucial role in the development of scientific rhetoric by using and repeating certain terminology that would become associated with scientific endeavors:

In the *Transactions* the work of fact gathering was always called a “relation” or an “account” or a “history.” To describe another type of scientific research the words uniformly used were “observations,” “causes,” “hypotheses,” “thoughts,” or “suppositions.” Constant repetition of terms and multiple papers exemplifying each phase of the scientific method—these comprised the Society’s mode of indoctrination. (Denny 416)

The importance of this form of scientific literature should not be understated: it required those who considered themselves scientists to be writers capable of organizing and translating their findings into intelligible sentences appropriate for public readership. It is likely that the necessity of literary communication also improved correspondence

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23 S.K. Heninger is critical of the literary quality of sixteenth-century scientific texts, labeling them as “utilitarian” writings “with scant regard for any literary virtues except clarity” (264). Since the audience of these texts was non-aristocrats, rhetoric and literary style were abandoned in favor of readers’ ability to understand the text. Even those who “would be expected to write with power and imagination,” such as John Dee, fell short and were “disappointing as authors” (Heninger 264). Heninger further argues that these scientific texts, despite their being many of them, did not amount to a genre of science writing; he gives credit to the Royal Society for encouraging its members “to formulate a suitable style for scientific prose” (264).
among members of the society and any other people who were contributing their data or ideas. Furthermore, for those who did not live in the vicinity of London, *Philosophical Transactions* provided a link connecting the science of London to, for example, the science of the American colonies.

Although there were strict guidelines for attaining membership, the Society encouraged contributions from anyone and stressed the importance of a collaborative approach to the pursuit of science:

If scientists could be induced to work cooperatively upon a common problem, they would prove that in truth “many hands make light work.” Only experience would convince the worker that in science the policy “what’s yours is mine” was not only a good but an essential one. The machinery of the Society’s organization was designed, therefore, to make sure that the Fellows worked cooperatively and that their scientific finds were pooled. (Denny 416)

One of the projects that the Royal Society was actively engaged in during the late seventeenth and early eighteenth centuries was the establishment of longitude and latitude around the world. To get accurate figures, more than one measurement was required and information sent by colonists proved particularly helpful. For instance, the longitude of Cambridge was determined after Thomas Brattle submitted his estimate, which was then compared with mathematician and Royal Society Fellow James Hodgson’s observations. Similarly, it was New York Governor William Burnet’s eclipse observations of Jupiter’s first satellite (1724/1725) that helped Astronomer Royal James Bradley establish the longitude of the fort of New York (Denny 420). Thomas Robie was
another frequent contributor, providing a copious amount of meteorological data to English scientist William Durham from 1713 until his death (Denny 420).

In its nascent period, the Society depended on its few colonial fellows to “act as foreign correspondents” who would keep up with new knowledge and contribute findings, particularly those specific to America (420). Those who contributed data were not necessarily fellows; however, a number of colonists did eventually become fellows. A well-known figure to achieve membership was Cotton Mather, elected in 1713, who remained dedicated to the Society’s mission of furthering scientific knowledge by making annual contributions to London. Other candidates selected for membership were William Brattle and John Leverett in 1714. The Society was interested in the scientific work of Brattle’s late brother, Thomas, particularly his study of eclipses. Thomas Brattle became well-known to the Society after sending in his observations of the comet of 1680, which Newton referenced in the second edition of Principia. Apparently, the Society wished to compare Thomas’s eclipse accounts with accounts published in Transactions between 1704 and 1707 (Denny 417). While Leverett accepted the honor, William Brattle declined it, claiming that he was “unqualified” (Denny 417).

Over the course of the eighteenth century, the Royal Society’s requests for types of information changed. In the seventeenth century, the Society desired historical papers or “accounts” (experiments and observations) while later calls for papers placed greater value on hypotheses or thoughts on causes. The seventeenth-century submissions protocol, voiced by Robert Hooke, specifically forbade general submissions that offered

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24 For additional reading and information on the Royal Society, see Thomas Sprat, The History of the Royal Society (1667) and Dorothy Stimson, Scientists and Amateurs: A History of the Royal Society (1948).
hypotheses or explications of phenomena (Denny 421). At this point, the Society was on a data gathering mission that prioritized facts. Only under special circumstances, approved by the society, would hypothetical or speculative summaries be accepted. The papers published in *Philosophical Transactions* during the seventeenth century reflect this style, as they typically provide only data rather than attempts to explain whatever phenomena.

As the colonies became more established in the eighteenth century, its thinkers became less willing to rely solely on their communications from overseas. Correspondence required a certain degree of patience as it took time to send writing to England and wait for a reply. Furthermore, it was not uncommon for messages to be lost. In effect, colonists began considering how to build their own scientific institutions, basing them on the structure exemplified by the Royal Society. They established the first two independent scientific societies: the American Philosophical Society in Philadelphia (1743) and the Academy of Arts and Sciences in Boston (1780).

Margret Denny’s study of colonial participation and correspondence with the London Royal Society raises questions regarding the status of colonial science and the overall intellectual landscape in the colonies during the seventeenth and early eighteenth centuries. In Denny’s view, the London Royal Society acted much like a parent instructing their children, the colonists. Denny explains: “In colonial times the Royal Society had furnished Americans the encouragement and supervision they sorely needed” (427). Although the Royal Society held a dominant position, Denny portrays the colonists as willing and ready to learn, thus suggesting that they were active participants in a cultural Enlightenment. Yet, this question of colonial Americans’ intellectual stance
during this period proves itself a complex one to answer and scholarship on the early American intellectual landscape entertains a wide variety of perspectives. While some scholars approach early American culture as modern or protomodern, others seek to demonstrate the ways in which early America culture was still imbued with medieval ideas. In effect, two different versions of colonists emerge: one in which people are rational actors working progressively toward a modern way of life, and another in which people are attempting to navigate a non-rational world of supernatural horrors and delights. Even organized religious belief systems, such as Puritanism, appear to vacillate between these two worlds: medieval and modern.

Evidence of this vacillation between medieval and modern worldviews appears in the works of first generation Puritan colonists such as John Cotton’s *A Brief Exposition with Practical Observations Upon the Whole Book of Ecclesiastes* (1657) and *God’s Mercie Mixed with His Justice: or His Peoples Deliverance in Time of Danger Laid Open in Severall Sermons* (1641). In *A Brief Exposition*, Cotton writes,

Against Copernicus’s opinion of the Revolution of the earth, and the standing still of the sun, Psalm 19:5 and 119:90. If the earth moved swiftly, when a man throwing a stone the same way the earth moveth he might easily overtake the stone before it fell; or (it may be) standing still, the earth speedily moving would carry him so far, as to be under the stone when it should fall. (14)

What is notable about Cotton’s thought process is not that he rejects Copernicanism, but that his explanation for why it is nonsensical is not based on scripture.\(^25\) Other works by

\(^{25}\) Like Robert K. Merton and Dorothy Stimson, Theodore Hornberger addresses the Weber-Tawney thesis as he considers the potential link between Puritanism, capitalism, and science (see R.H. Tawney, *Religion and the Rise of Capitalism*. Harcourt, 1926). Hornberger considers Cotton’s practical attitude as supporting “the belief that love of gain led even Puritans to the study of science, and to the theory that Puritanism is intimately connected with the rise of utilitarian, capitalistic society” yet is reluctant to endorse this notion wholeheartedly (“Puritanism and Science” 514).
Cotton reveal similar non-scriptural explanations of natural phenomena such as why a red sky at night yields a beautiful morning. In God’s Mercie Mixed with His Justice, rather than interpreting the red sky as a divine sign, Cotton provides readers with an explanation of how this event occurs as a natural phenomenon. Theodore Hornberger, who also calls attention to Cotton’s non-scriptural reasoning in these sermons, argues in “Puritanism and Science: The Relationship Revealed in the Writings of John Cotton” (1937):

Many men in the seventeenth century, Puritans or not, would have agreed to testing Aristotle, Plato, and Copernicus by the Bible. That is also medieval, And yet, when Cotton came to expatiate upon the whole of that first chapter of “Ecclesiastes,” he drew from it a “doctrine” almost as modern as those we associate with the Royal Society of with Benjamin Franklin. (513)

Drawing on the work of Samuel Eliot Morison, Hornberger further points out that while Copernicanism was a familiar theory by the early 1600s, it was not taught at Oxford or Cambridge until the 1640s. Likewise, although Copernicanism was part of the curriculum of Harvard in 1659, it was considered progressive. In effect, it is not surprising that John Cotton did not endorse it: “Cotton was no progressive, but on the other hand, he was not disinterested” (“Puritanism and Science” 511). For Cotton, answers within scripture ultimately prevailed, yet his reasoning in these texts reveals his scientific curiosity about nature, which complicates a perception of New England Puritanism as a dogmatic, repressive, reactionary culture that shunned new forms of knowledge and non-scriptural or scientific ways of thinking.

John Cotton’s thought process and, more broadly, the Puritan thought process has been greatly informed by Perry Miller’s The New England Mind, which offers a thorough investigation into the colonial intellect as it argues for New Englanders’ use of reason in their daily lives. Miller’s views challenge prior conceptions of Puritan culture such as the
view espoused by H.L. Mencken that Puritans were a fanatical group that thwarted the development of modern, intelligent and imaginative American culture. By the time Miller began his work, these denigrating approaches to Puritanism had already been challenged by texts such as Kenneth Murdock’s *Increase Mather* (1925) and Samuel Eliot Morison’s *Builders of the Bay Colony* (1930) (E. Morgan 12). However, Miller was still writing during a time when religion was an unpopular topic in academia and generally (E. Morgan 12). In the introduction to the first volume of *The New England Mind*, Miller hints at Puritanism’s ill repute and makes a point of distancing himself from its ideology: “I wholeheartedly admire the integrity and profundity of the Puritan character but…I am far from sharing in its code or from finding delight in its every aspect” (viii). Miller treats Puritanism as “one of the major expressions of Western intellect” that “achieved an organized synthesis of concepts which are fundamental to our culture,” which is the reason why it needs serious attention (*The Seventeenth Century* viii). In the first volume, which focuses on the early seventeenth century (before 1660), Miller refutes earlier historical constructions of Puritan culture by arguing that Puritan thought processes were complex as he demonstrates how they synthesized several different philosophical systems. Miller writes: “Puritan theorists sought to unite in one harmonious system both science and religion, reason and faith” (*The Seventeenth Century* 77). Miller’s second volume of *The New England Mind*, titled *From Colony to Province*, explores the ways in which Puritan society was faltering in the latter portion of the seventeenth century. As Miller and other historians like Edmund S. Morgan explain, church membership was at a low, and ministers worried about the future of Puritanism. The half-way convent of 1662 was a way of alleviating this crisis, yet the establishment of such a policy spoke to the
urgency of the situation. Miller also dwells on literary and rhetorical formats such as the jeremiad, which made “intelligible order out of the transition from European to American experience” (*From Colony to Province* 31).

Miller’s work marks a great achievement in Puritan studies; however, many scholars have taken issue with his assessment of New England life. In focusing on the New England mind or intellect, Miller sidelines other social, political, and emotional realities of New England life. Since Miller’s time, scholars have taken these factors into account and have produced several alternative perspectives. Jon Butler, David D. Hall, and Richard Godbeer investigate New England culture through a lens of fragmentation rather than cohesion, as they point out that colonists demonstrated different levels of commitment to the Puritan faith. Thus, it may be inaccurate to view New Englanders as a coherent and cohesive lot since there is significant evidence to support their practice and participation in various forms of popular religion, folk belief, magic, and the occult.

Jon Butler expresses skepticism about viewing early American Puritans as a cohesive lot in his article, “Magic, Astrology, and the Early American Religious Heritage, 1600-1760” (1979). In addition to arguing that historians have been too focused on organized, official religion and ignorant of “noninstitutional, popular religion,” Butler

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26 Hall’s perspective is echoed by later scholars such as Ned C. Landsman in *From Colonials to Provincials* (1997):

New Englanders, and almost all seventeenth-century Americans, lived in what they perceived as a world of magic, or what David Hall has called a “world of wonders,” where supernatural forces impinged constantly on everyday life. Before the ascendancy of the scientific viewpoint associated with the world of Isaac Newton, the appearance of a comet or a war or a plague was sure to be a sign of powerful forces at work on the lives of individuals and nations. Puritans as well as other Protestants opposed attributing such events to the spells of magicians and sorcerers or to the influence of the stars but not to supernatural powers in general. All were signs of the providential will, carried out by angels and spirits under God’s command. (12)
refutes earlier historical perspectives that portrayed New Englanders as a unified group of
churchgoers: “Colonists also proved surprisingly ignorant of elemental Christian beliefs
and practices...Colonial religious opinion embodied heterodoxy and sometimes simple,
unprincipled confusion” (317). Butler argues for a historical reassessment of what
constitutes religion as he investigates the transplantation and persistence of European
occult and magical practices in the colonies. His findings indicate that colonial
Americans were practicing forms of “popular religion,” but not the “full range of English
occult practices” (Butler 323). According to Butler, it is “the character of early
migration,” namely the “aims of prominent colonizers” and “the land” that “militated
against the occult” (325). As part of the colonial project, colonists were pressured to
scrutinize each other in new ways. Furthermore, Butler suggests that the land impacted
the ways in which people processed magical belief. America was perceived by colonists
as wilderness whereas England’s landscape was embedded with a type of magical history
that had been passed down throughout the generations (Butler 325). While occult and
magical practices persisted throughout the seventeenth century, Butler notes their decline
in the eighteenth century as he provides some reasoning for the demise of these ways of
processing life and the world. He cites the typical reasons such as “Enlightenment
philosophy,” “experimental science,” and “evangelical Christianity,” but also notes how
changes in England’s “educated elite” ultimately impacted the types of literature sent to
the colonies (Butler 339).

Building, in part, on this perspective, David Hall convincingly argues for the
persistence and centrality of folk beliefs, which comprise a “popular religion,” in colonial
New England. Hall considers the colonial demographic, a point that Jon Butler also
makes, emphasizing that those who left England were not the peasantry, but people “of ‘middling’ status—yeoman, artisans, merchants, and housewives who knew how to articulate the principles of religion, and who shunned the ‘superstitions’ of Catholicism” (15). Hall also argues that the “‘disenchantment’ of the world” was in progress well before Englanders became colonists. Yet, despite the changing attitudes of this already “transformed culture,” Hall warns against a historical perception of the colonists as “protomodern”: “in certain ways the colonists remained Elizabethans…What seems true of European rural cultural was emphatically the case for people in New England…their faith was leavened with accustomed ways of thinking that amounted to a folklore” (10-11). Thus, for early colonists, folk beliefs such as magic, superstition, and supernatural occurrences such as “shape shifting dogs” remained the status quo (Hall 11). According to Hall, folk practices empowered the people and disrupted other forms of authority, particularly the clergy, which is why an understanding of the presence of folk belief is necessary to colonial history (100).

In *The Devil’s Dominion*, Richard Godbeer also explores the prevalence and power of magic among the colonists. Godbeer remarks on the difficulty of comprehending magic use since its presence was amorphous and indivisible from organized religion, i.e. Puritanism: “Magical beliefs were essentially informal, and therefore elusive: they were part of no coherent doctrinal system; neither were they implemented through an organized institutional structure” (6). Furthermore, as Godbeer suggests, these beliefs posed a real threat to Puritanism because they were “so amorphous” (6). Since no clear rules existed, layfolk might lapse into magic practice in lieu of Christianity and be completely unaware that they were doing anything wrong.
Both religion and magic contained elements of the supernatural; however, the supernatural forces of magic were not “officially sanctioned” (6). Godbeer further clarifies that “Magical belief rests on the assumption that human beings can control occult forces (whether personal or impersonal) through ritual techniques” whereas Religious belief assumes the existence of a supernatural authority (usually personified) that controls the world in accordance with its own will; people can attempt to influence this divine power through prayer and other devotional exercises, but there is no guarantee that their desires will be fulfilled or their requests granted...Religion thus empowers the supernatural, whereas magic empowers human beings through their command of the supernatural. Religion is supplicative, magic manipulative. (9)

By granting people the authority to influence their lives, magic offered a type of agency that Puritanism did not: “Magic also enabled them to harness the world and adapt it to their own ends” (Godbeer 31). Marion Stowell makes a similar point in Early American Almanacs as she argues for the palliative effects of magic: “Magic appealed to such people in part because it enabled them to alleviate spiritual anxieties created by Puritanism itself” (47). The authority of God was empowering for believers, yet the church warned people of being too empowered since this form of taking religion into one’s own hands was considered antinomianism.

Butler, Hall and Godbeer build on arguments put forth by Keith Thomas’s Religion and the Decline of Magic (1971), in which he discusses the inseparability of magic and religion in medieval England:

This belief that earthly events could be influenced by supernatural intervention was not in itself a magical one. For the essential difference between the prayers of a churchman and the spells of a magician was that only the latter claimed to work automatically: a prayer had no certainty of success and would not be granted if God chose not to concede it...A prayer, in other words, was a form of supplication: a spell was a mechanical means of manipulation. (46)

Even still, the line between magic and religion was blurred when it came to the Church, which often claimed to exercise magical or mystical powers: “The magical aspects of the Church’s function were often inseparable from the devotional ones” (Thomas 57).
For both Hall and Godbeer the development of scientific thinking is peripheral to their central claims, yet the growing presence of scientific insight throughout the seventeenth century does seem to have some bearing on their arguments. Regarding science and its relationship with religion, Hall writes:

However old or up-to-date, science remained allied with religion in the sense of affirming coherence that depended on the will of God. But science also taught that disruption and disorder were endemic. The conjunction of two planets could send shock waves through the universe. Stars could wander out of their ordained paths, and storms arise as nature fell into imbalance. (79)

Hall specifically mentions figures such as Increase Mather, diagnosing his interpretations of celestial events, which frequently called attention to both natural causes and prognostications, as a “double sense of audience” (107). Hall acknowledges that by the 1690s wonder-lore is on the decline, citing Thomas Robie’s dismissal of prognostications in *A Letter to a Certain Gentleman*: “Robie manifested a self-consciousness of separation from the culture of the people; he rejected what had once prevailed, a common culture of the lore of wonders” (108). However, prior to the 1690s, Hall considers texts that combine providence with observable events in nature as “wonder tales” that are either derivative or directly transplanted from Europe. According to Hall, whenever colonists wrote or told stories containing supernatural events, they were relying on “an old tradition” and using a “borrowed language” (74).

Peter Eisenstadt’s “Almanacs and the Disenchantment of Early America” (1998) offers yet another view in the debate about colonists’ intellectual status. While focusing on the almanac, Eisenstadt follows Max Weber’s idea of the “disenchantment of the world” from Weber’s essay “Science as a Vocation,” as he argues that Enlightenment thought “led to a disenchantment of magic and occultism in eighteenth-century America”
Yet, Eisenstadt diverges from Weber’s claim that disenchantment meant “the rationalization of modern life,” instead claiming that this disenchantment yielded “a teeming intellectual and cultural confusion and eclecticism, in which an extraordinarily wide range of views on the occult and magic had simultaneous currency” (146). In this way, Eisenstadt highlights the complex way in which the Enlightenment impacted magic and the occult, as opposed to the arguments put forth by scholars such as Richard Godbeer, which maintain, according to Eisenstadt, that magic was “untouched by the currents of the enlightenment” and “continued to flourish throughout the eighteenth century” (Eisenstadt 144).

Regarding the status of science in colonial America, scholars have focused on its relative slow growth, arguing that colonists’ focus on survival detracted from scientific pursuits. While some scholars argue that (pre)scientific practices in the seventeenth and eighteenth centuries lay the foundation for greater things to come in the nineteenth century, others dismiss colonial American science altogether, arguing that since their scientific knowledge is imported and unoriginal, studying English texts makes for a more worthwhile project. In “Seventeenth and Eighteenth Century American Science: A Different Perspective” (1975), George E. Bates Jr. asserts that our present mindedness misleads our perception of science and scientists in the colonies, and in the seventeenth century generally. He argues that Copernican theory made up “a relatively minor” portion of the worldview of Europeans and subsequently Americans—“its significance is easily exaggerated” (179). Instead, Bates describes the premodern perception as a “dualistic,” “transcendental” reality in which the cosmos was “an all-pervasive sympathetic unity between the natural and preternatural worlds” (180). Bates suggests that this view is
essentially unintelligible to modern readers and interpreters; however, he asks that we understand the views of the seventeenth and eighteenth century as “empirical descriptions of the premodern cosmic reality stated in terms and concepts which were easily grasped and readily accepted by men occupying all social stations and educational levels well into the eighteenth century” (190).

These views on magic, the occult, science, and the early Enlightenment inform the practice of astronomy in colonial America. Grasping the development of astronomy requires an awareness of what astrology meant to colonists. However, as earlier English texts demonstrate, the relationship between astronomy and astrology was precarious. In effect, deciphering the practice of astrology in the colonies proves a difficult task, as suggested by the mixed scholarly views on its prevalence. For examples, in “Astrology in Colonial America: An Extended Query” (1956), William Stahlman argues for the importance of astrology in colonial America, yet his study also points to some of the challenges that historians face when trying to get a sense of which astrological texts early Americans had access to. According to Stahlman, the break between astrology and astronomy is a clean one:

…the development of astronomy itself had left astrology far behind…Astronomy and astrology were clearly divided now not only in terms of respectability but also in terms of the possibilities for future growth. Astronomy could look forward with completely new vitality and expectancy because of the tools technology was placing in its hands. What of astrology? It could only fear what it saw happening. (555)

Thus, astrology is effectively killed, or relegated to nothing more than “willful quackery,” by the rational science of astronomy and the invention of the telescope
Stahlman also views astrology as detrimental to the progress of science: “When the bonds were finally cut between astrology and the recognized sciences—not merely formally, but in the energies of the scientists—then and only then did astrology cease to usurp the potentials of scientific progress” (554). In the colonies, the popularity of astrology is further complicated by “the very nature of the colonizing venture” as “energies were largely spent on immediate problems” (Stahlman 560). Additionally, the purpose that astrology served could be supplanted by the Special Providences doctrine, which interpreted “Comets, signs on the moon, earthquakes, floods” as “messages from God, portending good or evil”; however, what was mainly different is that God’s messages did not equal fate in quite the same manner as astrology (Stahlman 559). According to Stahlman, Puritanism resulted in rationalism, thus paving the way for science, whereas astrology did not (560).

Stahlman perceives astrology and astronomical science as divorced; however, as scholars such as Marion Stowell and Michael Winship have demonstrated, their breakup is not always obvious as astrology appears to come along with both astronomy and religion well into the eighteenth century in America. In *Early American Almanacs*, Stowell discusses how astrological material reached the public throughout the seventeenth and

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28 Stahlman further explains how astrology became associated with the occult:

Astrology was seen as a means for turning the mystery into a puzzle, and puzzles are capable of solution. But because it existed to predict human futures, astrology inevitably gathered up and carried along with it the most fantastic occult sediment, and eventually, as in all but the most carefully controlled philosophies, the sediment outweighed the essence and from then on directed its downfall.” (553)

29 See also T.J. Tomlin, “‘Astrology’s from Heaven not from Hell’: The Religious Significance of Early American Almanacs” (2010). Tomlin argues: “the astrological content of almanacs was not a subversive undercurrent in early American religious life. To the contrary, almanacs and their astrological formulations complemented and even promoted orthodox Christianity across eighteenth-century British America” (289).
eighteenth centuries. Although the Harvard press was relatively successful at controlling the type of astrological material disseminated to the public, their almanacs, which were devoted to promoting astronomical science, still provided readers with the necessary information for practicing predictive astrology. Furthermore, the astrological material that appeared at the end of the seventeenth century after Harvard lost their monopoly over printing is evidence of a public desire for this type of text. In “Cotton Mather, Astrologer” (1990), Michael Winship notes that while predictive astrology or fortune telling was “considered entirely blasphemous,” Puritans in seventeenth-century New England held differing views on how celestial events impacted earthly life (308). Winship points to an interesting moment in Cotton Mather’s *Magnalia Christi Americana* in which he calls upon astrology to discuss the life of Jonathan Mitchel:

The precise *day* of his birth is lost, nor is it worthwhile for us to enquire, by an *astrological calculation*, what aspect the *stars* had upon his birth, since the *event* has proved, that God the Father was in the *horoscope*, Christ in the *mid-heaven*, the Spirit in the *sixth house*, repentance, faith and love in the *eighth*: and in the *twelfth*, an eternal happiness, where no Saturn can dart any malignant rays. (81)

C. Mather seems to be supporting Mitchel’s piety while making fun of astrology, yet Winship calls attention to the horoscope’s “intriguingly detailed quality” (“Cotton Mather, Astrologer” 311). This level of detail signals that C. Mather knew “the rules” of astrology and “could manipulate them comfortably and ingeniously” (“Cotton Mather, Astrologer” 311). Winship performs a detailed analysis of C. Mather’s horoscope, noting his understanding of the twelve houses, the planets’ relationship to the houses, and the aspects. Winship suggests that C. Mather’s knowledge was not necessarily from studying, since astrology “was still part of the general cultural milieu when Mather was writing” even though it had “fallen pretty thoroughly into disrepute among the intelligentsia”
(“Cotton Mather, Astrologer” 313). Even still, he notes, “it is hard to imagine how such a well-knit and detailed chart as Mitchel’s could have been put together without careful study of astrology” (“Cotton Mather, Astrologer” 313). This horoscope leaves many unanswered questions about C. Mather’s astrology, and since there is no other subsequent or preceding work of astrology for comparison, it is unclear what C. Mather’s intentions were. On one level, C. Mather is satirizing astrology with tongue-in-cheek rhetoric, yet as Winship points out, C. Mather’s seemingly intricate knowledge of astrology is worth investigating. C. Mather’s study of astrology may have been an intellectual exercise, or he may have been interested in the subject, perhaps for its alternative mechanism of determinism. With reference to Robert Breitwieser’s study of C. Mather’s persona, Winship further suggests that C. Mather may be “attempting to throw off his fashioning of a Puritan representative self” and the horoscope serves as a “manifestation of Mather’s fascination with the supernatural and the occult at the time he was writing the Magnalia” (“Cotton Mather, Astrologer” 314). Thus, while Winship notes the blasphemous nature of astrology in New England, he also reveals its prevalence throughout New England culture as it appears in the discourse of both commoners and the elite.

These studies on the popularity of occultism, magic, and judicial astrology complicate the notion of a scientific, rational, and enlightened colonial New England. Yet there exists a group of scholars who argue for the view that New Englanders were modern, or at least protomodern, subjects on the cusp of the Enlightenment as they highlight ways in which particular members of society were forward thinkers. For example, in his analysis of Cotton Mather’s Biblia Americana, Reiner Smolinski challenges the notion that Puritans lived in an enchanted universe as he makes a strong
case for the destabilizing effect that new science had on colonial America. Moreover, he disputes the idea that Puritans felt no sense of contradiction between science and religion. Smolinski refers to the “philosophical torment” that Cotton Mather felt as “he is clearly torn between the letter and spirit, the authority of tradition and Newtonian science” (329). Smolinski further explains, in this particular case, C. Mather’s torment arises from the Bible’s claim that the sun stood still.³⁰ If one accepts the new science, a stagnant sun proves cantankerous: “Mather’s halfhearted disapproval of natural philosophy lays bare his ambidextrous approach, one that looks forward and backward but one that can never again admit pure miracles without substantial qualification” (Smolinski 324).³¹ Ultimately, Smolinski aligns C. Mather more closely with the Enlightenment than with folklore tradition and he credits C. Mather with the ability “to reconcile the venerable tradition of the Bible with Newtonianism,” although C. Mather often accomplishes this task “at the cost of separating the letter of the Word from its spirit” (328).

Pershing Vartanian, like Smolinski, presents a convincing argument that supports C. Mather as a figure of the Enlightenment based on his employment of experimental science in his daily life. In “Cotton Mather and the Puritan Transition into the Enlightenment” (1973), Vartanian writes:

the touchstone to Enlightenment thought lies in the interest in science, and it is possible to describe the Puritan transition into Enlightenment through such a figure as Cotton Mather, whose scientific interests pushed him, if not always the fastest, furthest into the new age. (214)

³⁰ See Joshua 10:1-14, King James Bible.

³¹ Regarding C. Mather’s “ambidextrous approach” (Smolinski 324), see Kenneth Silverman, The Life and Times of Cotton Mather (1984). Silverman repeatedly refers to C. Mather as “ambidexter” (see, for example, page 108).
According to Vartanian, both New England and C. Mather rest on the threshold of Enlightenment thinking with science as a pivot point. Vartanian further argues that C. Mather’s piety was linked to his rationalism and these two forces existed together in a reciprocal relationship (217). One example of this rational/religious reciprocity appears in C. Mather’s observation of possessed persons. Vartanian suggests that C. Mather was interested in the possessed subjects more so than the possessing demons, which indicates that he treated these situations as illnesses of mind and body (220). While acknowledging that his preoccupation with preternatural occurrences is unscientific in *Wonders of the Invisible World*, Vartanian still reads this text within the context of the Enlightenment, arguing that C. Mather’s “controlled experimentation, logical consistency and inferential analysis of spirit behavior were wholly consistent with the scientific rationalism of the early Enlightenment” (219). Thus, in Vartanian’s view, C. Mather is always an “experimental scientist” (215) “entering the modern world” (222).

Despite extensive sketching out of C. Mather’s life by his biographers, scholars are clearly troubled by his duality or ambidextrousness as they struggle to navigate a course through his oeuvre, which expresses both an interest in witchcraft and Newtonian laws of nature. Mather’s witch-hunter/scientist persona evokes a variety of responses: some attempt to reconcile these seemingly disparate identities while others scold him, yet ultimately excuse his error. Reiner Smolinski, who clearly champions C. Mather, suggests that C. Mather is redeemed by his later scientific work: in *Biblia America* there are too few (if any) traces...to validate the popular caricature of Mather as an old witch doctor and diehard bigot; instead his grand project allows him to reclaim his rightful place in the early Enlightenment in America and the transference of European scholarship to the colonies. (328)
Pershing Vartanian takes a stance similar to Smolinski’s and focuses on rebuilding C. Mather’s reputation in history:

His belief in sorcery, witchcraft and possession, and his role in guiding the Massachusetts colony through its first crisis under the new charter by vindicating the magistrates who presided over the Salem trials, cast an unfading shadow over his life and historical reputation. (215)

Vartanian further blames impressions of C. Mather’s “intense piety” as unfairly fixing him in “the historical imagination” (222). Thus, according to Vartanian, even though C. Mather demonstrated a receptiveness to Enlightenment thinking and promoted rational scientific practices based on experiment in ways that were on par with his colleagues abroad, his contributions are “admired” yet ultimately “discounted” whereas his colleagues’ roles in the early Enlightenment go unchallenged (Vartanian 222).

A close-reading of a selection of Cotton Mather’s works immediately reveals the challenges that scholars face when attempting to accurately position his intellect within the early Enlightenment, on its periphery, or still immersed in medievalism. 33 His

32 Vartanian offers an explanation of the difference between Puritan and Enlightenment thought, explaining that Puritanism was teleological while Enlightenment thought was naturalistic (213). According to Vartanian, while these two ways of thinking were certainly different, they are united by rationalism, which is “shaped” by science. Vartanian marks science as playing an integral role in the development of rationalism, which ultimately “altered the relationships between God, man and nature throughout the Enlightenment, while providing the era with an internal coherence” (214).

33 David Levin, in “Giants in the Earth: Science and the Occult in Cotton Mather’s Letter’s to the Royal Society” (1988), publishes Mather’s “Curiosa Americana” and twenty-six additional letters that he sent to the Royal Society between 1712 and 1724. Levin argues that these letters reveal: the close relationship of Mather’s biblical, literary, and theological scholarship to his most advanced glimpses of the Enlightenment’s scientific methods. For Cotton Mather, the occult, God’s revealed will (in both Scriptures and history), and scientific inquiry all belonged to the same harmonious structure of knowledge. (752)
Wonders of the Invisible World posits a chaotic world full of non-rational elements. C. Mather tells readers how the devil interferes with humanity:

‘Tis the Destroyer, or the Divel, that scatters Plagues about the World: Pestilential and Contagious Diseases...And when the Divel has raised those Arsenical Fumes, which become Venemous Quivers full of Terrible Arrows, how easily can he shoot the deleterious Miasms into those Juices or Bowels of Mens Bodies, which will soon Enflame them with a Mortal Fire! (Wonders 13)

In Wonders rationality and science seem inoperative, yet at the same time Mather was writing Wonders, he also produced The Wonderful Works of God Commemorated (1690) and Winter Meditations (1693), both of which offer strikingly different perspectives on the natural world. The Wonderful Works and Winter Meditations illustrate C. Mather’s preoccupation with new science, particularly astronomy. In The Wonderful Works, he contemplates the vastness of the universe and the relative smallness of earth, which is “a Pins point” when “compared with the mighty Universe,” and he further ruminates: “but were we among the Stars, we should utterly lose the sight of our Earth.” C. Mather produces a similar scientific contemplation in Winter Meditations as he writes:

We have the fairest and fullest view of the Stars in the Winter...but what are those few, for they are not many more than a Thousand, of the Stars, which we see without a Telescope, compared unto the Innumerable Missions, Wherewith from That, we justly suppose the AEther to be replenished? The Wandring Stars, the Fixed Stars, and the Satellites of each, how inexplicably circumstanced are they? How Regular to the Hundreth part of a Minute, are they in their Motions? and how more Bulky than our Earth, an hundred times over, in their Dimensions? If at last we Descend into the Sun, that vast Fiery Globe, which is the Counter, and the Support, of the whole Visible World besides; The Philosopher thought himself Made and Born for nothing so much, as to Behold this. Heavenly Fire ball: ‘tis by the Ancient, and Soberest Computation, at least an hundred & sixty times bigger than That Planet, whereof we are the Inhabitants: whereas indeed such more Accurate Astronomers, as the Incomparable Hevelius, have asserted the Sun to be three thousand, four hundred, and sixty two times bigger than this Earth, which is given to the Children of Men; but how much does it then, Declare the Glory of

Levin further describes C. Mather as an “enlightened, almost courtly scholar” (752).
Both sermons position scientific wonder within a divine framework, yet in these sections of text, C. Mather’s questions and curiosity are pointed explicitly at astronomy and only implicitly at God. C. Mather expresses his desire for quantitative and qualitative knowledge about the heavens, but he also allows himself to imagine what it would be like to exist amongst the stars, thus revealing how scientific knowledge can prompt an emotional, poetic response. Thus, as early as 1690, C. Mather demonstrates not only his fascination with astronomy, but also his ability to experience beauty and wonder when contemplating the heavens scientifically.

*The Wonderful Works of God Commemorated and Winter-Meditations* contain seeds of C. Mather’s scientific interest, which come to fruition in *The Christian Philosopher* (1721). *The Christian Philosopher* shares a similar scientific and poetic spirit when compared with his earlier work in *The Wonderful Works and Winter Meditations*, yet this text is strikingly different when compared to *Wonders of the Invisible World*. *The Christian Philosopher* is a rational, organized, and seemingly “enlightened” text in terms of both its ideas and its composition. God’s power and glory still permeate *The Christian Philosopher*, yet as a series of essays, this work produces a sense of order dedicated to new scientific knowledge that is wholly different from the sermon form. Moreover, the world of C. Mather’s *The Christian Philosopher* is a notably friendlier one in which fear, prevalent throughout earlier texts such as *Wonders of the Invisible World*, is almost absent while curiosity is abundant and joyfully celebrated. In the chapters that follow, I suggest that what changes for C. Mather is not necessarily his logic or thought process; rather, what transforms is his emotional relation to the world.
Among the scholarship, there exists a variety of perspectives on what *The Christian Philosopher* means for the development of C. Mather’s intellect and what the development of C. Mather’s intellect means for the intellectual landscape of early America. In “The Date, the Source, and the Significance of Cotton Mather’s Interest in Science” (1935), Theodore Hornberger maintains that little had changed in C. Mather’s thinking as he argues that Mather used essentially the same sources for *The Christian Philosopher* as he did for *The Wonderful Works and Winter Meditations* (419) while Pershing Vartanian notes the appearance of new science in these earlier works, but highlights the difference in *The Christian Philosopher*’s rationalism: “In many instances where scripture or theology could have been conveniently introduced…Mather ignored the opportunity. Such supernatural interruption in nature’s regularity was inconsistent with the spirit of *The Christian Philosopher*” (218). What Vartanian observes as ignoring an opportunity is informed by Michael Winship’s suggestion that C. Mather altered his presentation of information in order to conform to new intellectual standards set forth by the London Royal Society as he sought to be accepted within these elite intellectual communities. Winship attributes the change in C. Mather’s work to his (self) consciousness of “legitimate speech within circles promulgating the new science” (“Prodigies” 94). To varying degrees, Hornberger, Vartanian, and Winship portray C. Mather as interested in science and involved in the early Enlightenment, yet Rick Kennedy, in “Thomas Brattle and the Scientific Provincialism of New England” (1680-1713), seems to dismiss the seemingly modern qualities of *The Christian Philosopher* altogether by arguing that its “…eclectic compilation of many people’s ideas and over-
arching concern for metaphysical explanations separate it from the most important philosophical tenets of modern science” (598n38).

What can we make of this range of perspectives on Cotton Mather’s intellect and commitment to science? What do they reveal about the development of C. Mather’s scientific worldview and to what degree is this change representative of the status of science in early America more broadly? As part of a privileged class of intellectuals and an elite member of New England society, in certain ways Cotton Mather is a poor representative of the general early American attitude toward science; however, his works (and there are many of them) provide an invaluable lens through which we can observe a cultural setting that was very much in flux during the seventeenth and eighteenth centuries. Members of colonial America’s intellectual elite were conscious that they were on the periphery of a more “enlightened” European culture and were frustrated by it. As William Byrd (Sr.) put it: “We are here at the end of the World, and Europe may bee turned topsy turvy ere we can hear, a Word of itt” (392). Increase Mather lamented his intellectual isolation in the “American wilderness” as his position in the colonies prevented him from participating on Europe’s scientific front line (Kometographia “To the Reader”). Cotton Mather was also frustrated with being on the periphery, although he emphasized the import of colonial knowledge and resources when he eventually became a member of the London Royal Society. In a letter to Dr. John Woodward of the Royal Society, C. Mather explains his views on the recent discovery of large teeth and bones that were unidentifiable as belonging to any known animal:34

34 C. Mather’s skeptical contemporaries speculated that these teeth or bones might be from an elephant or some large sea creature like a whale. Later study of these bones and teeth revealed that they were from a mastodon.
Of all those Curiosities, I know none that exceeds what has lately been found in an American plantation, adjoining to New England. And its being found in America makes it yet the more curious and marvellous. For I beseech you, How did the Giant find the way hither? (C. Mather quoted in Levin 764)35

He further writes,

But America too, will come in, to shelter the Reputation of these Historians. They may Shield themselves with the Teeth Lately dug up, at Albany...Had Johannes Cassion’s Book, De Gigantibus, ever come over into America, I do not know, but I might have had a larger Entertainment for you. But what matters it, as long as the Giants themselves have come over to America! (C. Mather quoted in Levin 766)

Here C. Mather discusses the prospect of giants in America in a spirit similar to that found in The Christian Philosopher.36 For C. Mather, these giants bones are exciting for their scientific value as well as their religious value: if deemed legitimate, they confirm biblical events, namely the great flood. Other well-known colonists such as Ezra Stiles and Edward Taylor commented on these findings. Taylor even composed a poem (unfinished), “Upon the Gyant,” writing one hundred and ninety verses that considered the monster as one of God’s marvelous creations (Stanford 54).37 Rather than engaging the jeremiad form to focus on the potential failure of the New England errand, C. Mather

35 Bones and teeth were discovered in 1705 and the Royal Society was attempting to figure out whether they were animal or human. C. Mather seems unaware of this particular finding, but was able to analyze a large tooth and bone fragments sent to him by Governor Joseph Dudley of Massachusetts (Levin 755).

36 Although C. Mather cautions his audience about the overstimulation of the imagination in texts such as A Voice from Heaven, as Paul Semonin points out, C. Mather’s imagination appears in full swing when considering the notion of giants in North America: “Yet Mather’s own exaltation of the Claverack giant proves what fertile ground the scientific imagination could be for creating such fanciful images of the American monster, especially when they served to confirm biblical truths” (30).

praises the North American land for the special scientific treasures or curiosities that it may contain. As Paul Semonin states in *American Monster*: “Symbolically speaking, the giant bones of Claverack became a banner of missionary zeal for these clergymen because the fossils had come from the inland frontier whose conquest gave a deeper spiritual meaning to their errand in the wilderness” (39). In this way, C. Mather uses science as a means of bolstering the notion that America, their New World, was the promised land.

C. Mather’s letters demonstrate that early Americans understood their environment in ways that Europeans did not; just as colonists received information from abroad, they provided valuable data in return. In the same letter to Woodward, C. Mather also writes,

I do with much Alacrity apply myself immediately to obey your Commands...I go *cheerfully* about this point of my Obedience, you will conclude it, when you see me begin with assuming the air of telling you, That you must look upon all the *American Curiosities* which are sent you, as being some sort *Subterraneous*... (C. Mather quoted in Levin 757)

Here C. Mather plays into the dominant position of the Royal Society while at the same time asserts a superior knowledge about America to which his fellow Englanders do not have access. In his letter, C. Mather also promotes his work, *Biblia Americana*. Just in the list of topics that it covers, which is everything from scripture to minerals, the letter demonstrates how he moves seamlessly between science, religion, and philosophy (761).

Scholars differ in their perspectives on how early Americans utilized ideas that came from overseas and express varying degrees of colonists’ dependency on European knowledge. For example, Rick Kennedy discusses the contributions of John Foster and his colleague Thomas Brattle to the Royal Society in “Thomas Brattle and the Scientific
Provincialism of New England” (1990), emphasizing that Brattle and Foster were provincials who apparently arrived at their conclusions by “‘naïve insight’ rather than rigorous, informed projection” (590). In his analysis of Foster’s reasoning, Kennedy asserts: “[Foster] was simply applying the Copernican theory of planetary orbits to comets without knowing how radical was his belief” (590). These individuals were provincial in the sense that they were on the fringe or periphery of English culture by the fact that they were living in the colonies; however, to inscribe colonists’ reasoning within the borders of provinciality predetermines and curtails their imaginative capacity as it forecloses potential interpretations of their work. Regarding scientific education in colonial America, Kennedy further writes: “An important link between the Old World and the New, Brattle directly imported the scientific ideas of Boyle and Flamsteed and taught them to interested students at Harvard, thus nurturing ideas that would bear fruit in subsequent generations” (600). While true, this fertility-offspring metaphor, similarly employed by other scholars, has the effect of discrediting the intellectual fervor of seventeenth-century New England, offering it up only as a breeding ground where the seeds of America’s intellectual future are sown.

These different scholarly views on the intellectual landscape of seventeenth-century colonial America highlight the malleability of historical texts as scholars interpret them in whatever manner best serves their perspective. For instance, to argue aggressively that Cotton Mather is a figure of the Enlightenment seems to miss important aspects of his life and psyche that do not align with Enlightenment thinking. The opposite is also true: to picture C. Mather as a religious zealot living in a world of wonder on the periphery obfuscates his interest in science and his participation in an international
intellectual community of scientists. Likewise, reading sermons and essays on celestial phenomena (comets, eclipses, and other [super]natural events) as fantastical accounts that involve more fiction than fact or as evidence of superstition, magic, and occult practices transplanted from the old world to the new, occludes possible interpretations of colonists’ engagement with astronomy in both its observational and theoretical forms. But, to ignore the prevalence of these alternative belief systems misses an essential component to understanding how colonial Americans processed and responded to light apparitions as celestial events. It seems more interesting to consider how colonial Americans embodied numerous and sometimes contradictory worldviews at the same time as they explored and attempted to explain their universe by drawing on religious, magical, and scientific bodies of knowledge.

These contradictions, manifested in the science writing of the late seventeenth and early eighteenth centuries, are apparent both in the minds of individual writers and across the culture. The views of the individual and the views of the culture are inherently linked: writers are informed by their cultural setting just as the cultural setting is influenced by those writing within it. As a vehicle for both the voice of culture and the individual, the scientific literature of this period exposes a problem with the idea of historical progression or the evolution of ideas from medieval to enlightened. History frequently pits the fraught and partly medieval cultural landscape of figures like the Mathers against the seemingly organized and rational world of figures such as Benjamin Franklin and Thomas Jefferson; however, this historical trajectory is troubled by what the texts from the earlier period actually reveal, which is a complex way of understanding of the world that is both rationally scientific and steeped in emotive wonder simultaneously.
My objective in the chapters that follow is to explore the rhetoric of science in the colonies during the late seventeenth and early eighteenth centuries by analyzing writings on comets, new stars, the aurora borealis, and rainbows, and to track the ways in which wonder, inquisitiveness, and curiosity about these phenomena generated and influenced scientific communities. What science writing from this period demonstrates is the ability for multiple ways of thinking to be in play simultaneously; these indicate how several worldviews (i.e. science, Puritanism, popular religion) are intrinsic to each other. Because of their liminality, these texts function outside of traditional categories such science, religion, and natural philosophy. Furthermore, they destabilize traditional conceptions of genre with their blend of rational and non-rational modes of thought and their incorporation of fact and fiction. These destabilizing properties lead us to question how we understand texts like Cotton Mather’s The Christian Philosopher or the essays contained in early American almanacs. Are these texts natural philosophy, science, sermons or religious tracts, or educational texts? Does rethinking their categorization or genre change our understanding? What might a reconsideration of category and genre in this period teach us about these markers in our modern period? While I treat these literary texts within their historical contexts, I am interested in the ways in which these texts reach modern audiences, particularly in academia at a time when the humanities and sciences are positioned against one another.
CHAPTER 2: ‘COMETOMANIA’: THEORIES OF BLAZING STARS IN COLONIAL AMERICA

The great blaze produced by the comet of 1680 prompted many New Englanders to pause their daily activities to consider the implications of such an event in the sky. They recalled passages from the Bible such as Luke 21.11, which told them: “Fearful sights and great signs shall there be from Heaven” or Revelation 13:13 “And he doeth great wonders, so that he maketh fire come down from heaven on the earth in the sight of men” or Jude 1:13: “wandering stars, to whom is reserved the blackness of darkness for ever.” Prior to the seventeenth century, people around the world had long been in the habit of looking at the night sky and documenting naked-eye observations of comets. With little understanding of how or why these luminous apparitions appeared, the presence of a comet evoked fear and panic as many believed they were forerunners of disaster. For Christians, the comet was an apocalyptic sign, telling them that Judgement Day was upon them. For those who participated in popular religion and occult belief systems, the phenomenon generated similar anxieties of disaster to come.

In these moments of heightened emotion, early Americans turned to their literature for instruction on how to interpret this fear-inspiring sign from God. New Englanders had a few options for instruction on interpreting comets: sermons or religious tracts, textbooks, and almanacs. In response to the comet of 1680, Increase Mather delivered *Heaven’s Alarm to the World* (1681) and *Kometographia: A Discourse Concerning Comets* (1683) while his son, Cotton Mather, published his *Boston

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38 Seventeenth-century England witnessed several comets, all of which coincided with unfortunate events such as political upheaval (1618), the plague and the fire of London (1665/1666).
Ephemeris, which contained a short segment on the recent comet. Students at Harvard could learn the developing theories on comets from Charles Morton’s *Compendium Physicae* (1687). Almanacs by John Foster (1681) and William Williams (1685) also discussed the recent comet appearance, providing people with a mixture of objective data, astronomical theory, and religious references. The comet of 1680 was neither the first nor the last comet observed by the inhabitants of New England; however, its brightness and long tail made it a particularly spectacular phenomenon. Fifteen years prior to the comet of 1680, Samuel Danforth wrote *An Astronomical Description of the Late Comet or Blazing Star; As it appeared in New-England* (1665) and comets continued to fascinate colonial New Englanders well into the eighteenth century and beyond, as demonstrated by Cotton Mather’s “An Essay on Comets” published in *The Christian Philosopher* (1721). This chapter investigates the rational and non-rational responses to comet phenomena as it explores the following questions: How are explanations of comets informed by rational, scientific thought processes and non-rational, emotive or aesthetic thought processes? In what ways do non-rational and rational modes of thought inform or catalyze each other? How does the rationalism of the new science impact the Puritan idea that human knowledge is limited? How does each author present the scope of human knowledge and do these boundaries expand or contract as time moves forward?

The aforementioned texts demonstrate the complex and multifaceted intellectual attitudes circulating in the colonies during the seventeenth and eighteenth centuries. For instance, although Increase Mather’s *Heavens Alarm* and *Kometographia* were published after Samuel Danforth’s *An Astronomical Description*, in many ways Danforth’s text seems to present a more rational, science-based explanation than Mather’s, which
suggests that the influence and pervasiveness of the new scientific thinking in the colonies is not a straightforward, linear evolution. Similarly, just because Cotton Mather authors *The Christian Philosopher*, which seems more rational and scientific than earlier works such as *Wonders of the Invisible World* (1693), does not necessarily mean that he had forsaken a prior set of beliefs in favor of new ones. Rather, these figures maintained multiple worldviews simultaneously and, in certain cases, worked hard to negotiate between old and new ideas. Each author carefully navigates the border between human and divine knowledge, wary of the potential for transgression. It is not until Cotton Mather’s “Essay on Comets,” published in *The Christian Philosopher*, that the rationality of the new science appears to fully harmonize with the non-rational fervor generated by religion. In his essay, Mather invokes these rational and non-rational elements simultaneously to the extent that it is unclear whether he intends rational science as a way of celebrating the non-rational (i.e. love and fear of God), or the other way around. This ambiguity pervades *The Christian Philosopher* as Mather rhetorically interweaves the rationality of new science into the Puritan way of life. In this way, I argue, Mather sanctions new ways of learning that were previously off limits by positioning the human capacity for knowing inside of a divine framework and essentially allowing it limitless functionality. Furthermore, I suggest that *The Christian Philosopher* portrays a conversion of perception as the emotive relationship to the comet, a mystery imbued with fear, transforms into wonder and curiosity that evokes joy.

When placed on a historical trajectory, these texts demonstrate how difficult it is to make assessments of how early American cultural attitudes shift toward new scientific thinking. Scholars maintain some conflicting impressions of the cultural milieu of
colonial America, and generally disagree about how seventeenth- and eighteenth-century colonial Americans interpreted what they witnessed in the sky. Richard Godbeer and David Hall represent one camp, as they argue colonial Americans were strongly influenced by belief in the supernatural, magic, and occult practices. Their argument conflicts with a view suggested by Max Weber in “Science as a Vocation” (1917/19) that the world’s “disenchantment” resulted in capitalism and modernity. According to Weber, the dissolution of enchanted life resulted in the decline of a certain type of social sharing, thus allowing concepts of individualism, fragmentation, and privacy to grow (Eisenstadt 145). Peter Eisenstadt outlines the scholarly debate on enchantment versus disenchantment (occult practices versus rational “scientific” inquiry), taking a middle ground as he argues that the “effort to gain power over nature and human activities through secret knowledge” lives on after occultism (161). Disenchantment, according to Eisenstadt, is not the end of the process, but “the beginning of the continuing confrontation, adjustment, and redefinition of the boundaries between magic and the culture of scientific rationality” (162). While Hall and Godbeer emphasize the Elizabethan mentality of colonial Americans, scholars such as Reiner Smolinski, Dagobert De Levie, Pershing Vartanian, and Winton U. Solberg present a strong case for the destabilizing effect that new science had on colonial America, thus suggesting that the spirit of the Enlightenment was pervasive in the colonies.39 This chapter engages with these arguments as it considers how these critical historical frameworks affect the way we read texts on comets and interpret the rational and non-rational responses within them.

The beginning of the seventeenth century ushered in new ideas on the nature of comets as theories about the solar system were shifting. Moreover, the invention and subsequent improvements of the telescope provided a more accurate and thorough viewing experience of the phenomenon. For centuries, in accordance with Aristotelian teaching, comets were assumed to be sublunary meteors or “vaporous terrestrial exhalations” (Donahue 575). Tycho Brahe and Galileo Galilei disagreed with this argument. In his assessment of the comet of 1577, Brahe suggested that the comet was above the moon, orbiting the sun.40 Galileo agreed with Brahe somewhat; however, there was much dispute between Galileo and the Jesuit Horatio Grassi about the nature of comets. Both Galileo and Grassi questioned their composition (whether comets were the same as planets) and how far they were from the Earth. It was thought that by measuring the parallax, a geometric method for calculating distance in which a star’s apparent movement is measured in relation to other stars, one could figure out a comet’s distance from the Earth. Their disagreements went beyond these issues. As Lynn S. Joy explains in “Scientific Explanation from Formal Causes to Laws of Nature,” the two thinkers disputed on “a variety of other issues, including the nature of human sense perception, the reflection of sunlight by planets, and the heating of terrestrial bodies” (71). Tycho Brahe, who thought that comets might be celestial bodies, measured the parallax, which he found to be quite small. Moreover, his observations showed that comets did not follow

40 Brahe’s assessment of the comet of 1577 is significant. He stated that the comet had “no observable parallax” and concluded that this comet was very high, above the moon. If this was in fact the case, the comet was then another change in what was thought to be an immutable space according to the Aristotelian model of the universe. Brahe’s theory was not widely accepted as some rejected his findings while others argued for two types of comets, one sublunary type, and another superlunary type (which was thought to be of the supernatural sort). Others considered “a fluid heaven” thus forgoing the traditional sub- and super- distinctions (Blair 386).
the allotted paths laid out by the spheres. In effect, Brahe concluded that these spheres did not exist, and that planets were free to follow their own motions. While this news confirmed Brahe’s suspicions, the question of how planets moved together in a complex system remained unsolved.

Questions about the motions of comets and planets were not solved until the physical theories of Sir Isaac Newton, who established the fundamental rules for planetary orbits and paved the way for new theories to emerge. Newton’s observation of the comet of 1680-1681 and the comet of 1682 (Halley’s Comet) made an important contribution to his theories of orbital motions, which he explained in his most famous work, *Principia Mathematica* (Donahue 592). The third book of *Principia* provides details on lunar changes and the orbital motions of comets. While this work is not an astronomical text per se, it offered a physics for planetary motions and approached what Johannes Kepler sought to achieve: an “astronomy without hypotheses” (Donahue 592). Additionally, Newton’s theory of universal gravity transformed the way people conceived of heavenly space.

Perhaps the most profound advancement in the study of comets came from the mind of Edmund Halley who, with the help of Newton, figured that comets maintained an elliptical orbit. In *Principia*, Newton used his theory of gravitation and proposed that comets travelled in a conic orbit, but favored a parabolic path. After studying Newton’s calculations, Halley found an error and it is this mistake that led him to the formula for the elliptical pathway of comets, thus allowing him to further speculate that comets returned to Earth as they travelled (Olson and Pasachoff 28). In 1705, Halley produced a pamphlet on comets, describing his computation method for the motion of comets and
established their periodicity. He analyzed all available comet observations from the fourteenth to seventeenth centuries and mathematically figured the orbits of 24 comets between the years 1337 and 1698, further noticing that three of the orbits (1531, 1607, and 1682) were similar. Halley believed they might be the same comet if that comet travelled in an ellipse over the course of roughly 75 years (due to Jupiter’s interference). Although Halley did not live to see the return of this comet, his prediction was confirmed when the comet was spotted again in 1758.

Writing about comets was popular in England and in colonial America during the seventeenth century. One English example is John Gadbury’s book, *De Cometis* (1665), which surveys religious (Christian as well as folk-beliefs) and scientific thinking on the nature of comets. Gadbury was an English astrologer who also produced numerous almanacs during the seventeenth century. Gadbury’s *De Cometis* highlights the massive amount of information that readers had to sift through in the seventeenth century, and he further points out that the potential for confusion is great since few of the circulating theories were consistent. Like their European counterparts, colonial Americans shared similar views on comets: most theories favored Aristotle’s ideas as foundational, and many people believed that comets were portents. However, early Americans’ experience in the colonies set them apart, both physically and intellectually. They lacked access to equipment such as telescopes and other instruments of measure necessary to perform some of the more complex observations and calculations. They also lacked educational reading material, and communication was difficult intercolonially and transatlantically. In addition to rising political turmoil between the colonies and England, their living circumstances demanded attention to daily routines in order to survive amidst a different
landscape, particularly one already occupied by peoples indigenous to the Americas. While these factors seem like major roadblocks thwarting the development of astronomical science in early America, early American texts on comets reveal a profound interest in data collection as they also promote new rational, scientific thought processes among readers. In some ways, colonists’ dearth of technology and information may have had a productive impact on observational practices and computation methods as colonists were forced to improvise. Without consistent access to telescopes, many observations were made with the naked eye. Since these naked-eye observations were less precise and more prone to error than assessments made with the aid of instruments, it was even more crucial that people share their findings with each other. In many cases, knowledge sharing relied on literature or the written word, as this was the most effective way to disseminate and receive information.

Samuel Danforth’s *An Astronomical Description of the Late Comet or Blazing Star* of 1664 is one of the earliest astronomical works printed in America. Danforth (1626–1674) was a Puritan minister, born in England, who emigrated to Massachusetts in 1634. When his father died five years after their arrival, he took up residence with Thomas Shepard of the Cambridge church. Danforth graduated from Harvard College in 1643 and remained as a tutor until 1650. In addition to his ministerial duties, he also dabbled in poetry and astronomy, publishing several almanacs between 1647-1649 that also contained some of his own original poetry. Danforth is also well-known for his jeremiad sermon, *A Brief Recognition of New-Englands Errand into the

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41 Other famous observers of this comet included Isaac Newton, Giovanni Domenico Cassini, Robert Hooke, Samuel Pepys, Stanislaus Lubinetski, and Matasaburou. This is the comet thought to be referenced by John Milton in Book II of *Paradise Lost* (Royster).
**Wilderness**, published in 1670. Like other Puritans writing about astronomical phenomena in the seventeenth century, scientific discovery was typically conceived within a framework already controlled by the Divine. Thus, religion and science could co-exist peaceably. However, it is this supposed harmony between theology and science that makes Danforth’s *An Astronomical Description of the Late Comet* so peculiar as it elicits the question of why he divides his text instead of merging the theological application with his observations and explanations. Thus, in *An Astronomical Description*, the scientific and theological appear unreconciled as each section stands alone without reference to each other.

*An Astronomical Description* reads almost as two separate documents: the first half is wholly devoted to relaying accurate observational data while the second half expounds upon the portentous nature of comets and their theological applications. Danforth’s description of the comet is prefaced with a poem by Guillaume de Salluste Du Bartas (1544-1590) highlighting the threat of “Famine, Plague & War” that comets bring. However, the text that follows proffers none of the fear and anxiety suggested by this introductory poem. Instead, Danforth synthesizes contemporary methods for understanding the nature of comets with his own observations. Throughout the first section, he uses observational data and experience to discern the following: that the comet is a celestial body farther away than the moon; that it is not ablaze, but rather its tail reflects the sun’s rays from the head’s exhalations; that the tail points away from the
sun; and that its movement is uniform. Danforth’s explanations are rational, empirically-based and unadulterated by scriptural references or dramatic metaphor.

Part of Danforth’s task is to disprove prior conceptions of comet phenomena. He adopts a rhetorical posture that seeks to show his readers why the ideas he puts forth are more accurate. He first dismisses the notion that comets are fiery meteors because empirical evidence suggests a different reality: “Had it been a Sulphereous Vapor kindled in the Aire; it might have been consumed in a short time; as other fiery Meteors are: but this continued about three months” (Danforth 2). Danforth employs a combination of empiricism and logic to debunk the myth that comets were sublunary:

We already hear that this Comet was seen at Virginae, Jamaica, St. Martha, Cartagena and Barbados and no doubt but it was visible to the whole habitable World. But the highest region of Aire is accounted not much above fifty English miles from Earth, and had this Comet been no higher, it had been impossible that other Countries and Nations so far distant, should have beheld it. (2)

Because the comet was visible in so many locations, Danforth concludes that it must be higher than the moon. Danforth uses a similar combination of observational evidence and logic to argue that the light of the comet is not “a real and natural flame”:

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42 Danforth indicates an elliptical orbit; however, as this was a non-period comet, its path is parabolic. It passed within 0.1699 AU (25.4 million kilometers, or 15.8 million miles) of the Earth on 19 December 1664 in the contemporary English calendar system. It is believed to have attained a brightness of magnitude −1, roughly equivalent to the brightest stars (Yeomans “Great Comets”).

43 In the seventeenth century, comets were thought to be aflame; however, twenty-first-century science now understands them to be icy bodies that give off gas or dust (they contain dust, ice, carbon dioxide, ammonia, methane, and more). As they approach the sun, the ice turns into gas, forming the coma. The comet also acquires a dust tail when dust particles are pushed away from the coma by the sun’s radiation. An ion tail occurs when some of the comet’s gases are converted to ions by charged particles from the sun. While these points are well determined, astronomers can still only theorize about where comets originate from: “Astronomers think comets are leftovers from the material that initially formed the solar system about 4.6 billion years ago” (Choi). Most comets are
Had it been a natural flame, arising from it’s [*sic*] flagrant head, it would have constantly moved upward, as the flame of a Lamp or Torch; unless it had broken forth by violence: but this streaming was sometimes upward, sometimes somewhat downward, sometimes westward, sometimes northward, sometimes eastward, according to the position of the Sun: neither can I imagine that any violence caused it so to move…Had it been a real and natural flame, it is difficult to understand how the head of the Comet could have supplied it with food and fuel for so many months together. (3-4)

Danforth demonstrates a rational approach to understanding why comets appear as they do by basing his reasoning on observation, yet also makes use of his imagination by thinking inquisitively about the comet’s motion and its ability to sustain its illumination. Danforth’s interpretation provides his readers with science-based information about comets, yet in his thorough and candid display of his thought process, he also teaches his readers how to think inquisitively, critically, and imaginatively. Moreover, by engaging in this type of thought process publicly via his text, Danforth sanctions scientific curiosity for his readers.

In his study of comets, Danforth relies on his observations, but he also depends on the observations of others:

From Dec. 5th to the 8th (which was the time between my first and second observation) the Comets [*sic*] apparent motion in it’s [*sic*] proper line upon the celestial Sphere, was about 2 degrees & a halfe in a day, one day with another. Dec. 17. it was observed by some to move about 13. degrees…[I cannot precisely determine it’s [*sic*] diurnal motion, especially when it was so exceedingly swift, because I know not certainly the hour of the night, when these observations were made.] (6)

Since Danforth places such importance on scientific accuracy and precision for diagnosing the motion of the comet, the lack of precise data in this case was likely frustrating. He expresses his anxiety regarding accuracy by telling his readers: “If in these

thought to reside in the Oort Cloud, beyond Pluto’s orbit, although short-period comets are thought to originate from the Kuiper Belt, beyond the orbit of Neptune (Choi).
observations I have not attained that accurateness which the Reader desires, my want of Astronomical Instruments may bespeak his indulgence therein” (Danforth 6). Danforth’s comments reveal the impact of early America’s lack of technology and scientific instruments capable of rendering precise and accurate measurements. While this lack of equipment was likely vexing for those who wanted explanations backed with a certain level of scientific accuracy, the situation required improvisational methods such as culling data from other observers. Rather than relying on instruments alone, observers interested in astronomical phenomena like comets relied upon each other’s records to arrive at the most accurate result possible from their combined efforts.

This community of observers that Danforth refers to in his description also comprises the audience to which he writes. Danforth accomplishes more than simply telling his readers what he knows about comets; instead, he walks them through his methods for understanding the phenomena. By stressing the importance of precision and accuracy in observations and calculations, Danforth both avoids and implicitly discourages indulging in wild speculation, which leads to the generation of misinformation and misconceptions about comets. Just as Danforth presents what he knows with confidence, he acknowledges the limits of his knowledge as he refrains from speculating on what he does not know. Danforth poses seemingly scientific questions to his reader: “If the stream be an irradiation of the Sun, how comes it to be conspicuous and visible to us?” He provides the following answer:

The only reason thereof (that I can yet learn) is the Refraction and Reverberation of the Sun-beames, as they pass through the Comet’s condensed body, whereby they are so congregated and so nearly united, as that they terminate the sight and become conspicuous in the Heavens. (4)
Danforth’s parenthetical remark “(that I can yet learn)” further indicates his scientific posture as he embraces both unknowingness and the desire to learn more. These rhetorical steps, carefully presented in the first part of *An Astronomical Description*, set an example for readers as they carry out their own investigations of astronomical phenomena.

While the first section of Danforth’s text offers readers rational, scientific discourse explaining the comet phenomenon, the second section, titled “A Brief Theological Application of this strange and notable Appearance in the Heavens,” presents an entirely different set of postulates based on scripture and the notion that comets are portents. In this section, Danforth produces a poetic vision of humanity woven into a grander cosmic scheme. The phenomenon that Danforth labors to demystify in the first section of the text returns to its mysterious state as “a strange and notable appearance” (12). However, Danforth’s method of delivering this information remains the same as he treats theological and historical data in a similar manner, by making a claim and then providing examples about why that claim makes sense. The first subsection proclaims that the Holy Scriptures “are the Authentick and unerring Canon of truth” and they “teach us to look at Comets, as Portentous and Signal of great and notable Changes” (Danforth 12). Danforth provides a few short biblical examples and then moves to the second subsection, which highlights how “Histories of former Ages, do abundantly testifie that

\[\text{Danforth begins this section by quoting Joel 2.20, 21. “I will shew wondering in the Heavens and the Earth, Blood and Fire, and Pillars of Smoak. The Sun shall be turned into Darkness, and the Moon into Blood before the great and terrible day of the Lord to come,” Luke 21. 25, “There shall be signes in the Sun, and in the Moon, and in the Stars,” and Acts 2.19.20, “I will shew wonders in Heaven above, and signes in the Earth beneath: Blood, and Fire, and Vapor of Smok. The Sun shall be turned into Darkness and the Moon into Blood before the great and notable day of the Lord come” (16).}\]
Comets have been many times Heralds of wrath to a secure and impenitent World” (13). Using a few select examples, Danforth aligns comets with tragic events such as sickness, war, and natural disasters, among other calamities. The third subsection makes note of God’s direct involvement, asserting that God holds the power “to pluck up and to pull down and to destroy” any nation; however, if that nation “turn[s] from their evil,” they will be spared (Jeremiah 18: 7-8) (Danforth 14). The fourth and final subsection returns to the portentous nature of comets, citing more instances of comets bringing death, drought, and early frosts. 45 Danforth ends his jeremiad with a both a warning and a call to action:

God forbid that any of us, should be ἀσέρες πλανητας wandering Stars, ECCentrick and Erratick in our motions, as all Seducers and Imposters are: for whom is reserved the blackness of darkness for ever. Jude, V. 13. but the Lord grant that we may all become fixed Stars in the new Jerusalem, which cometh down from God, observing the Heavenly order prescribed in his holy word, and shining as lights in the midst of a crooked and perverse generation, clearly reflecting that pure and precious light, wherewith we are irradiated by the Sun of Righteousness: and then we may assure ourselves, Christ will still hold us in his right hand, and not suffer us to be cast down from Heaven, but enable us to finish our course with joy, & at length translate us into the Kingdom of the Father, where we shall shine forth as the Sun, and as the brightness of the firmament, and the Stars forever and ever. Amen.

In this conceit, Danforth sets up an intriguing relationship between humans and comets as he figures the comet as a means of describing human behavior: according to Danforth, it is better to be a “fixed star” than a “wandering” one. Despite his lament over the “crooked and perverse generation,” his final image is hopeful and even joyful as he asks

45 Danforth further emphasizes the comet’s ostensible impact on the local community: The late removal by Death of some of our eminent Prophets and seers, who were as eyes unto us in the Wilderness, and the Charets of Israel and the Horse-men thereof. April 5th, 1663, That burning and shining Light, who shone in the Church of Boston, and gave light to the whole Colony and Country, Mr. John Norton, a man eminently accomplished, was taken from us, and translated to an higher Orb. Of whom New-England was not worthy. (15)
that God “enable us to finish our course with joy, & at length translate us into the Kingdome of the Father, where we shall shine forth as the Sun, and as the brightness of the firmament, and the Stars forever and ever.” Here the non-rational, emotive perception of the heavens as a divine space is informed by the earlier section of Danforth’s text that presents the rational new science of comets. In this image, Danforth depicts humanity being translated into both a divine, metaphorical space (“the Kingdome of the Father”) and a scientific, observable space (“the Sun,” “the Stars,” “the firmament”) by showing that these spaces are the same.

The great comet of 1680, appearing approximately fifteen years after Danforth’s *An Astronomical Description*, prompted Increase Mather to produce *Heavens Alarm* and *Kometographia*. Both texts present the rational science of comets, yet they also speak to the emotional experience of witnessing the comet by promoting the notion that comets are portentous, thus inspiring sentiments of fear and anxiety about the calamities that might follow its appearance. One of the key differences between these two texts is the agency that I. Mather ascribes to humans and their ability to comprehend the comet phenomenon. *Heavens Alarm* accepts uncertainty as I. Mather claims that humans cannot clearly interpret the comet’s appearance. *Kometographia*, with its inclusion of scientific explanation, indicates a different view on humans’ capacity to know. In tracing new scientific theories on comets, I. Mather extends the borders of knowledge, suggesting that humans can interpret and know what the comet is and how it works.

Increase Mather (1639-1723), son of Richard Mather and father of Cotton Mather, was a Puritan minister involved with the government of the Massachusetts Bay Colony as well as Harvard College. I. Mather took an interest in comets, particularly after the
appearance of the Great Comet of 1680. As Kenneth Silverman describes in *The Life and Times of Cotton Mather*, Increase “undertook a course of reading in the latest European astronomical studies, from which he emerged (or perhaps confirmed him in being) a champion of observation and mathematical reasoning and an opponent of the abstract logic of Aristotle” (40). I. Mather frequently traveled to Cambridge to use Harvard’s telescope and eventually decided to have a telescope along with other scientific instruments installed in his townhouse (Silverman 40). He also played a pivotal role in the cultivation of local scientific interest by founding a society dedicated to scientific pursuits. He proposed that this society would “lay ‘the foundation for that which will be for future edification’” (Silverman 41). The group met regularly between 1683 and 1688; however, since no records exist, it is impossible to know exactly what they talked about. Yet, it was a place where the Boston community could gather to discuss various scientific interests. This social experience also had an impact on young Cotton Mather, who was a part of the gathering (Silverman 41).

The worldview that Increase Mather propounds in *Heavens Alarm* is dominated by fear and uncertainty. In the beginning of *Heavens Alarm*, I. Mather makes clear his purpose, which is to explore comets “only, (that being the most proper for one under my circumstances) to make a Theological Improvement therefore” (“To the Reader”). While he proclaims no direct scientific intentions, his sermon does suggest an interest in the “physical and mathematical” aspects of comets, as well as the number of comet appearances throughout history, which is something he explores in greater detail in *Kometographia* (*Heavens Alarm* “To the Reader”). In *Heavens Alarm*, I. Mather writes,

I see little reason to conclude, that it [the comet] is an *Omen* of happy dayes to the world, until God hath made way for mercy by great Judgements. Especially
considering, that we are fallen into the dregs of time, wherein the dayes must and shall be perilous. (“To the Reader”)

In this worldview, all celestial phenomena, with the exception of rainbows, were a source of great anxiety: “There are fearful sights & signs appearing in the Air, sometimes in the lower heaven, which we move and breathe in. Prodigious Meteors are sometimes seen there. And strange Appearances, which are either seen or heard speaking” (*Heavens Alarm* 4). Regarding these ominous light apparitions that were “seen or heard,” I. Mather refers to imagined sightings of “Chariots and Souldiers in battle array” and voices that spoke the following: “Let us be gone from hence” (*Heavens Alarm* 5). I. Mather, who does not dispute these accounts, goes on to make a series of connections between comet appearances and similar events described in scripture. By using biblical examples, he gives his readers evidence of why they should be afraid, thus reinforcing a fearful mentality about celestial phenomenon. I. Mather encourages his readers *not* to aim for specificity when attempting to interpret what calamities may arise from any given celestial event, thus instilling a sense of uncertainty:

We must not be particular & positive in interpretations of things of this nature. When a fearfull sight appears in heaven which the whole world cannot but take notice of now to make a particular and absolute determination, that such a place, or such a person, such a Judgement is certainly intended thereby, is too much boldness…Judgement, is not for us to determine, but we must leave that with God, who best knows what himself intends to do. (*Heavens Alarm* 7)

Unlike Danforth’s *An Astronomical Description*, which supports an observational scrutiny that suggests humans are capable of understanding the nature of comets, *Heavens Alarm* encourages passivity rather than active curiosity. Humans cannot know why comets appear or what they mean; all they can do is prepare, through prayer, for God’s judgement.
Increase Mather’s longer treatise on comets, *Kometographia*, sets out with the same task as *Heavens Alarm*: to demonstrate how comets are portentous. However, in *Kometographia*, I. Mather reveals his interest and enthusiasm about comets as scientific phenomena, thus suggesting a different attitude regarding the limits of human knowledge. The first portion of *Kometographia* synthesizes many theories and ideas about the behavior of comets, offering readers rational explanations for the comet’s appearance, motion, and duration. I. Mather makes clear that he has perused many books on the subject of comets, citing well-known figures like Johannes Kepler and Johannes Hevelius.\(^{46}\) As I. Mather relays other scholars’ tales of scientific discovery, he infuses them with his own excitement. For instance, in describing Hevelius’s astonishment at the size of the comet when measured with mathematical instruments, he writes:

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\text{he [Hevelius] professeth he could not have believed what they said, if his own eyes had not beheld it. Nay, he said, that that Comet did almost equal the Sun little before its disappearing, (g) yet the Sun is (according to his judgment) 3462 times as big as the Earth. Is it likely that a body of so stupendous a magnitude should be contained in this low & little Heaven, wherein Mortal Creatures have their Breathe and Being? (Kometographia 6)}
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Here I. Mather seems to adopt Hevelius’s perspective as he weaves his own amazement into the fabric of Hevelius’s awe.

Unlike *Heavens Alarm*, which cautions people against pursuing certain forms of knowledge, *Kometographia* offers readers new, non-scriptural knowledge about comets and promotes new ways of learning by demonstrating how these new theories and ideas

\(^{46}\) I. Mather summarizes the work of Kepler and Hevelius and compares their observations of the comet height, and is led to support the following conclusion:

the subtle Doctrine of Parallaxes demonstrates that Blazing Stars are beyond the Aery Region, but other consideration also evince it, e.g. that of its continuing so many hours above the Horizon, and being observed by persons in Countryes remote one fro another at the same hour to be in the same constellation or place in the Heavens. (4)
work. I. Mather begins by disputing the Aristotelian conception of the comet, which he claims no longer makes sense:

The *Peripatetick School* has phansied them to be *Meteors*, generated out of the Bowels of the Earth, exhaled and extolled by the Sun to the supream Region of the Air, and there set on Fire. It would be needless and endless to tell how many have after *Aristotle* embraced this fiction, but it may not be unprofitable in a few words to evince the contrary, *viz.* That *Comets* are not placed in the *first* heaven or Air, but farr above it in the *second* or *Starry Heaven*, and that therefore they are rather *Stars* than *Meteors*. (*Kometographia* 1)\(^47\)

I. Mather appears to take some additional pleasure in Aristotle’s error as he mocks the “Popish Authors (Jesuites especially)” who “strain their wits to defend their *Pagan Master Aristotle* and his Principles” (*Kometographia* 7). He highlights how Aristotle’s folly works in favor of Protestantism by recounting the story of a Florentine physician who refused to look through a telescope “because he was afraid that then his Eyes would make him stagger concerning the truth of *Aristotles Principles*, which he was resolved he would not call into question” (*Kometographia* 7). I. Mather conveys additional scientific information about the comet’s motion by explaining how its movement resembles that of the planets, the difference being that “comets then are temporary, whenas the true planets

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\(^47\) I. Mather does not appear to believe that comets can be predicted because he assumes them to be generated in the aether, or the substance thought to permeate space, essentially holding everything together in its right place:

Indeed, if Comets were sempiternal bodies, by experience and observation their appearance might be exactly praedicted. But since they are generated in the *Aether*, no man can any more tell when they shall be seen, then he can know when a *Paraelion*, or *Draco volans* or the like will be generated in the Air. (16)
The existence of the aether was not questioned until Newton proposed the inverse-square law of gravitation, the theory that would replace the concept of aether, in *Principia*. 

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are perpetual” (*Kometographia* 10). Furthermore, he expresses his excitement about the possibilities that new technologies might offer to people:

Now the *Telescope* discovers that part of the skye to be exceeding full of little Stars. Blazing Stars do not alwayes (though often) appear there. Nevertheless, I believe that when we know more of the true and natural reason of the *Via Lactea* [Milky Way], we shall understand more of the nature of Comets. (*Kometographia* 12)

*Kometographia* contains many references to scripture, yet in these sections, I. Mather refrains from offering arguments that rely on divine interference. Instead, he reveals his scientific curiosity by admitting his desire to know what is still unknown about the celestial sphere. In *Kometographia*, I. Mather’s worldview appears changed from the one he establishes in *Heavens Alarm*. Unlike the entirely passive role ascribed to humans in the earlier text, in *Kometographia*, humans do appear to have some control as they make these discoveries. God is certainly not out of the picture, but divine power appears to reside in the background.

Like *An Astronomical Description*, *Kometographia* displays a split narrative structure: the first section offers rational scientific detail while the second portion of the text demonstrates how comets are forerunners of disaster. I. Mather provides an extensive, tedious year-by-year account of every comet sighting in the written historical record “from the beginning of the World” to the late seventeenth century. Most early entries follow a similar formula: a comet arrives and bad things happen. For example, “A.D. 586. A Comet appeared for a Moneth. It is observed, that this Comet was attended

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48 I. Mather makes no mention of the aurora borealis, yet he expresses an interest in sunspots: “Our modern *Mathematicians*, have observed, that there are *Maculae Solares* or spots about the Sun, which sometimes may be discerned for many dayes together: & sometimes for several Moneths, nothing of that nature can be perceived” (*Kometographia* 10).
with the death of many Princes” (*Kometographia* 52). Later examples, such as the more recent comets of 1618 and 1682 contain specific details regarding their location, when they were seen, and how long they remained visible in the night sky. In this second portion, Mather returns to his claim in *Heavens Alarm* that the operation of comets must remain unknown: “the manner of their [comets] operation is by us silly Mortals undeclarable…” (*Kometographia* 133). Considering the first section’s interest in exploring the science of comets, this statement seems contradictory and hints at the difficulty of reconciling new scientific knowledge with the tenets of Puritanism, which inscribes limits on human knowledge. In comparison to *Heavens Alarm*, the worldview posited by *Kometographia* seems more organized and supportive of human initiative toward understanding astronomical phenomena. However, while I. Mather provides some scientific basis for comets, he does an equally thorough job demonstrating how comets are portents, which reinforces a worldview still thriving on fear and anxiety. Furthermore, *Kometographia* demonstrates the slipperiness of concepts such as rationalism, science, religion, and the non-rational. At the end of *Kometographia*, I. Mather writes,

> From the things which have been expressed, We may rationally conclude, that all the wise Men who lived in all former Ages were not altogether mistaken when they believed that Comets are forerunners of some great and commonly miserable Events hastening upon the World. (131)

In Mather’s view, by providing readers with numerous examples of how comet appearances coincide with calamitous events, he has sufficiently and rationally demonstrated the correlation between comet and calamity. However, these arguments, as they play on emotions of fear and dread, inevitably invoke non-rational and non-scientific processes of thought.
In addition to Samuel Danforth’s and Increase Mather’s Puritan treatises, comets were a popular feature in colonial almanacs. During the seventeenth and eighteenth centuries, the almanac offered people another source of information for understanding celestial events as it made the heavens legible for their readers. Aside from the Bible, the almanac was the most popular book published in colonial America. Early American almanacs, like those published in England, provided readers with thorough astronomical data in a twelve-month calendar or “ephemerides.” Readers could find information about the sun and moon, the weather, and the tides. Furthermore, the ephemerides contained calculations of the stars and planets that people could use to determine their horoscope. Some almanacs informed readers about the best days for bleeding based on the moon phase, and the application of medicinal herbs according to planetary alignment. Additionally, the almanacs’ “vulgar notes” provided a list of auspicious and inauspicious days, numbers, and letters. These forms of forecasting were labeled “natural astrology,” and indulging in it was common and unremarkable. Judicial astrology, or the prediction future events, was more controversial. While natural astrology was tolerated, judicial astrology generally was not, and it was denounced by religious leaders such as Increase Mather.

In “Magic, Astrology, and Early American Religious Heritage, 1600-1760” (1979), Jon Butler illuminates the complex relationship between mainstream religion (i.e. Protestantism or Puritanism) and popular or “occult” religion during the seventeenth and eighteenth centuries in colonial America. The inclusion of science as a third belief system

49 There were two main forms of judicial astrology. One used celestial events, like comets, to make predictions regarding politics or society matters. The other form made predictions about the life and well-being of an individual or nation based on zodiacal configuration (Tomlin 290).
adds yet another layer to this already complicated set of composite worldviews. Furthermore, different almanac makers had different views on celestial phenomena and “did not speak in a uniform voice” (Schechner-Genuth 1). As examples, the almanacs of John Foster (1681), William Williams (1685), and Cotton Mather (1683) demonstrate the various portrayals of comets to a popular culture-based audience as they supplied readers with rational scientific data, popular religious views or folklore, and Christian perceptions.

Foster’s 1681 almanac contains a section devoted to a discussion of the “terrible” but also “wonderful” comet seen in New England in the winter of 1680. Foster provides readers with an ephemeris and straightforward instructions for interpreting the information contained within the calendar. In general, his inclusion of occult material is limited. He provides important numbers in the “vulgar notes,” but the almanac lacks the anatomy (a crude figure of a man used for making predictions with zodiacal signs) and any other overt astrological references. While the calendar could be used for astrological purposes, it also alerts readers to recent noteworthy events such as attacks and assaults, for example, “In this moneth…Northampton, Warwick, Malborough and Rehoboth assaulted by Indians” (Foster). Foster’s discussion of comets in the last section of the almanac is rational and scientific; however, Foster consciously alerts readers that he is working within a divine framework and posits that comets are set in motion by “the hand of the Creator.”

Foster champions empiricism by suggesting that comprehension of knowledge depends on the senses. Therefore, according to Foster, the senses dictate the limits or boundaries of the capacity for humans to know:
if it be a true (as well as a common) Saying...Nothing comes to the understanding but what hath first passed the senses, then it will follow that such things as are far removed from our senses, will also be remote from our understandings...

Foster acknowledges that he lives in an age of “many rare discoveryes of such things in the heavens” yet people are “still ignorant” and “no man knows concerning Comets whence they are, what they are, for what they come, or wither they go.” Despite humans’ ignorance, Foster embraces the scientific spirit by hoping “that it should be otherwise,” as he looks forward to a future where people will eventually understand the phenomenon. Foster engages in his own exploration of comets as he investigates their motion, distance, and magnitude. Additionally, he dismisses some misleading notions about comets: he denies the possibility that comets could be “Vapors” or “Sulphurous Exhalations” and dispels the idea that their distance is “no greater then the upper Region of the air, and their magnitude not exceeding an hill or mountain” (Foster). As more recent observations of parallaxes show, comets are “far beyond the moon” (Foster). The question of the comet’s magnitude intrigues Foster, and he expresses frustration with some seemingly convoluted calculations about the comet’s size and distance from the Earth. Rather than speculating, Foster provides readers with a detailed account of eye-witness observations of the comet of 1681 with the hope that it might shed new light on some of the previously unanswered questions. Foster tracks the comet from its first sighting in New England on November 18 through January 24, after which it was seen only “obscurely” until February 10. His final comment calls attention to limits of naked-eye observations, noting that only those who have access to a telescope might continue to see the comet: “[the comet] is now so far exiled that it is beyond the view of a naked eye, but by the help of a good Telescope may be for some time yet discerned” (Foster).
Like most writings on comets in this period, Foster’s account is not without reference to the portentous nature of comets and the fear that accompanies them. Foster proclaims comets as “Fore-runners of evil coming upon the World” and one of the “prodigious Sights and Signs in Heaven” that presage “great Calamityes coming upon the World.” Foster’s text exhibits a duality similar to Samuel Danforth’s and Increase Mather’s texts as scientific explanation is divorced from speculations about the comet as a portent. His reference to portents seems almost compulsory as the energy of his text is focused on the science of comet phenomena.

Cotton Mather’s *Boston Ephemeris* (1683) offers another, quite different discussion of the comet. *Boston Ephemeris* begins like most almanacs by charting out the celestial cycles for each month of the year. However, C. Mather uses his almanac as a vehicle for proselytizing, hoping that any unconverted people indulging in the almanac’s occult aspects will be influenced by his Christian message. As Jon Butler mentions in his article,

Two years before the Salem trials, Mather was so concerned about the number of settlers who used occult techniques for curing illnesses and settling quarrels that he described the Christian defense against them in occult term as “amulets” so readers could more readily understand him…Thirty years later Mather still was concerned about the use of occult remedies in New England. (332)

Thus, C. Mather makes use of the almanac’s popularity to deliver both an ephemeris as well as a sermon aimed particularly at the unconverted:

And so tis hop’d if thou art already converted, thou wilt give all diligence for an open and abundant entrance into the Kingdome: Or if thou art a Stranger to Religion, thou wilt cry no more with unconverted…But thou wilt unfeignedly turn from all they Idols, to God in Christ without delay. (*Boston Ephemeris*)

As a measure of the passage of time, the almanac is an appropriate symbol of the fleetingness of time and life, which allows C. Mather to emphasize his central message
about the urgency of conversion since: “life will not, and cannot be long” (*Boston Ephemeris*).

With an awareness that the almanac is a frequently read text among New Englanders and other early Americans, C. Mather addresses his unconventional use of it:

the very meanest things should have Holines interwoven, and be consecrated unto a Divine Service. Reader, a sorry Almanack will become Noble, if it may share in such an Honour: and what should hinder it from doing so? Such an Anniversary Composure comes into almost as many hands, as the best of Books; And why should not every eye be entertained with what is Intelligible, and may be profitable? Though we don’t go with Schiller to put Christian Names upon the Constellations, let it not be absurd to beseech the Readers of an Almanack to become Christian Men: Hath not the Parallel project of Protestant Primers; yea, and Protestant Almanacks too, on this very score had the good word of all honest Protestants? (*Boston Ephemeris*)

C. Mather uses the almanacs to convey his Christian message, yet he also considers the almanac like a primer or tutorial, with a lesson in reading comprehension: “So one of the most considerable Questions, which though art to be askt, is, Understandest thou what thou readest?” (*Boston Ephemeris*).

The last section of C. Mather’s almanac offers a brief description of the recent comet appearance of 1680. Mather provides technical, objective observations of the comet’s color, size, direction, and time of appearance while at the same time promoting his father’s comet sermons. C. Mather’s almanac presents an intriguing amalgamation of astronomical and astrological data, theology, and contemporary science. C. Mather shifts quickly between these rhetorical modes, making little effort to bridge any gaps between these different modes of speaking. Perhaps no bridge was needed if science and religion flowed so harmoniously with one another. Or this might be further evidence of the difficulty he faced in reconciling these different rhetorical postures. With a clear interest
in the science, he was constantly negotiating his personal curiosities with the fact that he was a public figure working in service of God.

Written only two years after Cotton Mather’s almanac, William Williams’s 1685 almanac offers yet another discussion of comets in his essay “Concerning the nature of Comets &c.” In this essay, Williams omits any reference to the portentousness of comets, yet he holds on to the Aristotelian view that comets are

*Meteors*, whose matter is an Exhalation, hot and dry….drawn by the vertue of the heavenly bodies into the highest parts of the Aire, (and sometimes [into] the Starry region)…Thus are Comets made to be meteors, and certain it is that there are difficulties which will arise from the other notion which some have of them, which may be as difficult yet far more difficult to a rational head then any that will proceed from this notion we have here presented you with.

While Foster’s dismissal of the Aristotelian comet theory may be interpreted as a progressive step towards modern science, Williams’s essay indicates that the Aristotelian model remained in play and was still quite persuasive.

Sermons, religious essays and almanacs made up the bulk of popular literature on comets during the seventeenth and eighteenth century in the colonies. Students, however, had access to yet another source: textbooks. Insight into colonial education about comets, and science generally, can be found in Charles Morton’s textbook *Compendium Physicae*, which was published in the same year as Newton’s *Principia*. Despite the changes taking place in the world of physics, Morton’s *Compendium* was the textbook used by Harvard College for about forty years from 1687 until 1728. Born in Pendavy, Egloshayle in Cornwall, Morton grew up with strong Puritan influences. Due to administration trouble at Cambridge during the Great Rebellion, Morton attended Oxford where he received his BA in 1649 and his MA in 1652. Oxford offered a nurturing atmosphere for the study of science during this period; as Samuel Eliot Morison states in
his biography of Morton (included in his edition of *Compendium*) Oxford was “much more friendly to experimental science—the ‘New Philosophy’—than Cambridge” (“Charles Morton” xi). Morton was at Oxford during the formation of the “Invisible College” in 1645, which is considered “the nucleus of the Royal Society” (“Charles Morton” xi). When the Royal Society convened on November 28, 1660, twelve men agreed that it would be a forum in which “all subjects could be discussed but politics and religion” (“Charles Morton” xi).50 The group received its official charter in 1662. Poor record keeping makes it difficult to establish the extent of Morton’s involvement but as Morison points out, “it seems hardly possible that a student in a small academic community of fifty or sixty members, where scientific tastes were encouraged by the authorities, can have failed to receive guidance and inspiration” (“Charles Morton” xiv).

After Morton’s time at Oxford, he took a position as a pastor of a small church of “dissenters” or Puritans (“Charles Morton” xv).51 Since the Test Acts barred entrance into universities for those who would not conform to the Anglican Church, dissenters began opening their own schools in which they promoted the study of modern languages and the natural sciences (“Charles Morton” xv). Eventually, Morton opened one of these schools at Newington Green, a London suburb, where Daniel Defoe was one of his pupils. It is because of his career as an educator that he ended up in the Massachusetts

50 The twelve members were: John Wilkins (1614-1672); Seth Ward (1617); John Wallis (1616-1703); Thomas Willis (1621-1675); Lawrence Rooke (1622-1662); Robert Boyle (1627-1691); Sir William Petty (1623-1687); Sir Christopher Wren (1632-1723); Jonathan Goddard (1617-1675); Thomas Sprat (1635-1713); Gilbert Ironside (1632-1701); Walter Pope (d 1714); and Samuel Lee (1652-1691) (Morison xii). Wilkins, Rooke, Boyle, Petty, Wren, Goddard were part of the early group of twelve that met at Gresham College in 1660 (“Charles Morton” xii).

51 Lack of sufficient records prevents historians from knowing more about Morton’s life.
Bay Colony, which is where he was sent after being arrested for violating the Stamford Oath requiring MA recipients to only teach at either Oxford or Cambridge (“Charles Morton” xviii). Morton made several efforts to defend his actions by arguing that the Church did not object to graduates lecturing in noble houses or publicly at Gresham College. Furthermore, since his academy did not confer a degree, he was not technically violating the oath. But seeing no end to the harassment, Morton ultimately decided to emigrate to New England in 1685.

Once in New England in the spring of 1686, Morton became pastor of the First Church in Charleston in the Bay Colony. He was invited to take this position by Increase Mather who, as acting president of Harvard at the time, also suggested that Morton might replace him as the permanent president. Harvard had been in some turmoil since President Hoar was driven out by student and tutor strikes, and between Morton’s acceptance of the position and his arrival, significant changes had occurred in the Massachusetts Bay Company. After losing their charter, the Mass Bay Co. was now ruled by a royal governor and council as the Dominion of New England. This change of authority thwarted Morton’s prospective job opportunity since he was a figure clearly at odds with the king. While the position was likely desired by Morton, Morison suggests that he may have found Harvard disagreeable and its students “impossible to manage” (“Charles Morton” xxii).

*Compendium Physicae*, as I. Bernard Cohen describes, is “an odd compendium” (“The Compendium”). Although Morton’s text proposes ideas consistent with the new science, it relies on an Aristotelian structure as a delivery mechanism. Morton explains his structure in his preface: “because the former Phylosophers had their Method more
Systematical, than the latter; I have therefore Chosen their method…” (5). Cohen, in “The *Compendium Physicae* of Charles Morton (1627-1698)” (1942), is flabbergasted by Morton’s choice as he argues that this seemingly “arbitrary and preconceived system” obfuscates the new discoveries that Morton is about to present. To modern readers, Morton’s format does seem cumbersome, yet for seventeenth-century students, it was likely a familiar model. Had Morton chosen a new method, in addition to learning new ideas, students would also need to confront a new, potentially daunting system. Despite these particulars, Harvard adopted Morton’s work, which was “copied and recopied by students; it is found in the programme of studies in 1723; several copies are found with marks of Harvard and Yale ownership at an even later date” (“Charles Morton” xiii).

Some of the ideas and theories contained in *Compendium Physicae* were quickly displaced with Isaac Newton’s publication of *Principia*, yet according to Samuel Eliot Morison, the text helped pull Harvard College “out of the bog of medieval science, and set her face toward experimental philosophy and the ‘century of enlightenment’” (“Charles Morton” xxiii). Theodore Hornberger, in the introduction to The Colonial Society of Massachusetts’s publication of *Compendium* (1940), praises the book as “a revelation of colonial intellectual life and the transfer of ideas from Europe to America” (xxxii). In a note about Morton’s sources, Hornberger situates Morton’s work among all three lines of thought: Aristotle, Descartes, and the Royal Society. He further identifies

52 The 1764 fire in Harvard Hall destroyed the Hollis apparatus and likely some of Morton’s work, like his syllabus, which could shed further light on what he was teaching to his students. Upon Morton’s death, the executor of his will was endowed with the power to destroy much of his work. Hornberger mentions some of the confusion surrounding the few documents of Morton’s that are currently known to exist, and mentions that there may be others. At the time of Hornberger’s study, he was aware of thirteen copies of Morton’s manuscript (Intro to *Compendium* xxxiii).
the ideas contained in the text as a mixture of brand-new contemporary theories and concepts from the Middle Ages, or in some cases, from antiquity: “in a very real sense the Compendium is a microcosm of men’s speculation about the external world from the tie of Empedocles down to the eve of Newton’s Principia—a span of well over two thousand years” (Intro to Compendium xxxvi). Moreover, Hornberger points out what an “impossible task” Morton had at hand: anyone attempting to write “complete systems of natural philosophy” was pressured to repeat what had already been written, and also comment on every topic so as not to look like they had nothing to say (Intro to Compendium xl).

Throughout the introduction, Hornberger continues to champion Compendium, placing Morton “at approximately the Boylean stage in the development of modern thought” (Intro to Compendium xxxix). However, in “The Compendium,” I. Bernard Cohen delivers scathing criticism of Compendium, described it as “dull and extremely difficult to read” (660). Regarding Morton, he writes:

One can hardly imagine, to judge only by the book, anyone more poorly qualified to present the “new science” than Morton. As far as one can discover, the selection of new discoveries included in the book is purely arbitrary and based upon haphazard acquaintance with some of the writings of his contemporaries, many of whose actual discoveries Morton but imperfectly understood. (660).

Cohen further expresses his dissatisfaction with Hornberger’s lavish praise of Morton and some of his editorial decisions. Apparently, Hornberger omits chapter summaries essential to the book’s pedagogy (“The Compendium” 665). Cohen’s comparison of multiple versions of Compendium confirm certain calculation errors, and a close reading of some of the work’s chapters reveals that Morton may have struggled to understand
some of the more complex scientific theories, thus some sections of his text are questionable for their accuracy (“The Compendium” 663).

While Samuel Morison and Theodore Hornberger position Morton as a writer at the beginnings of enlightened thinking, Morison also points to Morton’s views on witchcraft: “he doubted not its existence; he believed that people could confederate with the Devil” (“Charles Morton” xxv). Morton believed that these persons should be sentenced to death if convicted by a diligent trial and this view aligned with most educated men’s ideas. Although beliefs in witchcraft may seem part of a medieval or unenlightened worldview, this assessment is complicated by a consideration of the seventeenth-century perspective that witchcraft was a phenomenon worth investigating and the trials were experiments. Morison puts forth this idea as well: “If the Boston and Salem clergy had been more old-fashioned and less curious respecting the phenomena, we might never have had the hangings of 1692” (“Charles Morton” xxvi).

Although clearly shaped by Aristotelian teachings and further informed by mainstream popular culture beliefs, Compendium encouraged the new science’s experimental methods as a means of fostering the scientific mind. Compendium is a relatively compact textbook, a result of Morton’s practice of economy in his writing as he was “‘a declar’d Enemy to large Volumes’” (“Charles Morton” xvii). Morton dedicates the thirteenth chapter to comets. He begins by dispelling previous misconceptions, explaining that comets are not “fiery meteors” but should be thought of more like the planets. In the first paragraph, he outlines the elements of comets that he will discuss in the chapter: Matter, Motion, Distinction, Place, Magnitude, and End. In addition to providing information to his readers, Morton encourages rational thought processes by
putting forth an idea and explaining why that idea makes sense (or doesn’t). For example, he writes:

The Matter of Comets formerly suppos’d to be combustible is certainly not So; for If they ware fires it cant be conceived how they should last so long, or send forth a [Stream] one way [Sidewise]; or be of Such a dim Colour as Usually they are; or whence should come so much combustible matter? (89)

Rather than simply feeding his readers information, Morton’s rhetoric encourages interrogation and logical comprehension of the ideas presented. In response to his own question, Morton suggests that it is more likely that comets are composed of either “Gelatine mater” or “Christalline” so instead of generating their own light, they reflect and transmit sunlight, which accounts for their luminescence (89). He further investigates the notion that comets are meteors and ultimately rules out the possibility that comets result from steams rising from the earth: “Earth cant aford matter for Comets of such a Magnitude” (Morton 91). Skeptical about how “Earthy matter” could “rise to such a [Height], or wander so far from home as beyond the moon where some comets have been” (91), he therefore concludes:

the most likely oppinion is that they are not meteors at all; but rather a kind of Christalline planets, Concreated with the Universe which have the Circle of their revolution excentrical from the rest; So that they Sometimes approach nearer to the Earth, and then they come into our view, and [so] continue [on] in the revolution untill by distance they pass out of Sight again. (Morton 91)

The theory that Morton posits demonstrates his currency with contemporary conversations regarding the nature of comets by noting “the same comet will return again in view after a certain period of time” as mentioned in “the Phylosophycall transactions” (91). He positions these newer ideas alongside those of the ancients to show how contemporary astronomy differs from the former model:
The Motion of the Comets is either diurnal, or Periodical. Diurnal is Such as the Planets have appearing only by the revolution of the Earth about its own axis (according to Copernicus) for to be Snatched about by the Primum mobile of the Antients crosses their own principles; for that tis not fixed in a Solid orb, and hath [no] intelligence to guide it being but a Sorry meteor, and this indeed adds no Small strength to the oppinion of the Earths revolution… (Morton 91)

Morton seems particularly excited about recent discoveries, emphasizing the human impact on learning and acquiring data about the heavens. For example, regarding the proposition that comets have a periodical motion, he writes:

This is a hansome Solution of the p[h]ainominon, and possibly in hereafter appearing Comets men may compleat that work already begun (as is before noted) [in] taking a Skilfull and exact notice of a comets motion and Difference of its distances; whereby a Segment of its Circle of revolution might be known, and thence also might be infer’d not only how long at present it would appear, but after how many years it would appear again. (Morton 92)

Here Morton promotes new knowledge and new forms of learning, encouraging students to investigate the behavior of the comet in order to understand it.

In general, Morton’s discussion of comets is rational and scientific and contains no mention of portents or divine intervention until the last section of the chapter. Morton mentions the “supposed effects” of comets, noting that some people believe they “prognosticate some Great evills…So that they have stricken Great terror into the Vulgar” (93). He quickly dispels these superstitious notions by saying “But [wiser] men see no satisfactory reasons for these Supposed Omens” (93). His reference to prodigies in an educational textbook indicates that the idea that comets portended disaster was widespread. Furthermore, his need to dismisses these beliefs suggests that those fears and anxieties may thwart new science and new learning processes. Morton’s reference to God arrives in the last line of the chapter as he writes:

The true End therefore may be of these things conceived rather to be somewhat like that Ecclipses; to give men some light into the nature of the heavens…and
Chiefly to raise admiration in the minds of men, and that the rather by the rarity of their appearance to convince us how little we know of the Universe, and So to magnifye the Creator. (93)

Morton’s syntax here is particularly revealing as scientific interrogation of phenomena appears to precede the act of praising God. While Morton perceives himself as working within a divine framework, he illustrates a new path to new knowledge that places human ability at the forefront. Morton’s words in this final line also demonstrate how perceptions can be can be reframed, thus turning fear into hopeful wonder. Instead of fearing the comet as a mysterious, unknown phenomenon, Morton suggests embracing its mystery by accepting its rarity as a sign of how little humans know about the universe. By placing the human mind within the scope of divine knowledge, Morton calls attention to the smallness of human thought while still supporting its growth. In effect, students of astronomy and physics can continue to search for answers without worry of transgressing the boundary between human and divine knowledge and repeating the fall or their original sin.

Cotton Mather’s “Essay on Comets,” published in The Christian Philosopher in 1721, and republished posthumously as a separate essay in 1744, offers a poetic merger of the comet’s science and the emotional reception of its appearance. In the book’s introduction, C. Mather establishes his view on the relationship between science (or, philosophy, in C. Mather’s world) and religion as he proclaims: “The Essays now before us will demonstrate, that Philosophy is no Enemy, but a mighty and wondrous Incentive to Religion...” (8). Furthermore, C. Mather identifies his intended audience by writing:

Behold, a Book, whereof we may agreeably enough use the words of honest AEgardus; Lectu hic omnibus facilis, et si nunquam legere didicerint, &
Based on what we know of C. Mather’s life and persona, we can infer that he produced this project, *The Christian Philosopher*, with the European educated elite in mind, hence his use of Latin; however, his statements also suggest that he had his local, colonial scientific community in his mind as well.

*The Christian Philosopher* demonstrates what has changed, particularly for C. Mather, between the publication of *Kometographia*, which he helped his father write, and *The Christian Philosopher*. The world posited by *The Christian Philosopher* is not the fearful, anxiety-ridden place that Increase Mather and Samuel Danforth seemed to inhabit. The human relationship to natural and celestial spaces appears much friendlier. In a manner similar to his father’s narrative in *Kometographia*, C. Mather provides a scholarly history of the recent study of comets, introducing and summarizing some of the discoveries of Brahe, Kepler, Newton and Halley. C. Mather is most impressed by Halley’s recent discovery of the recurrence of comets and the theories, in general, of Newton. C. Mather writes,

> Sir Isaac Newton, from whom ‘tis a difficult thing to dissent in any thing that belongs to Philosophy, concludes, That the Bodies of Comets are solid, compact, fixed, and durable, even like those of the other Planets. (*The Christian Philosopher* 50)

Regarding the comet’s luminous tail, C. Mather further explains:

> he [Newton] takes to be a long and very thin Smoke, or a mighty Train of Vapours, which the ignited Nucleus, or the Head of the Comet, emits from it. And he easily and thoroughly confounds the silly Notion of their being only the Beams of the Sun, shining thro the Head of the Star. (*The Christian Philosopher* 51)
In these ways, C. Mather embraces new science’s rationalism as he disparages older, theories now considered incorrect. In describing the comet of 1680, he continues to relay Newton’s theories by taking his readers through the following steps:

A famous one [comet], in the Year 1680, passed so near the Sun, that the Heat of the Sun in it must be twenty-eight thousand times as intense as it is in England at Midsummer; whereas the Heat of boiling Water, as he tried, is but little more than the dry Earth of that Island, exposed unto the Midsummer-Sun: and the Heat of red-hot Iron he takes to be three or four times as great as that of boiling water. Wherefore the Heat of that Comet in its Perihelion was near two thousand times as great as that of red-hot Iron. If it had been an Aggregate of nothing but Exhalations, the Sun would have render’d it invisible. A Globe of red-hot iron, of the Dimensions of our Earth, would scarce be cool, by his Computation, in 50,000 Years. If then this Comet cooled an hundred times as fast as red-hot Iron, yet since his Heat was 2,000 times greater than that of red-hot Iron, if you suppose his Body no greater than that of this Earth, he will not be cool in a Million of Years. (The Christian Philosopher 51)

Although this explanation may appear labyrinthine to modern readers, it is notable for its rational presentation and lack of previous rhetorical strategies designed to elicit a fearful emotional response. Instead of citing references to divine intervention and power, the explanation offers mathematical calculation as a way of making sense of the phenomenon. In many ways, C. Mather’s presentation of this information suggests that humans control access to knowledge: they have the power to observe, reason, and calculate. However, he is careful to position human agency within a framework in which God ultimately receives the credit:53

‘Tis an admirable Work of our God, that the many Globes in the Universe are placed at such Distances, as to avoid all violent Shocks upon one another, and

53 Another example in which God receives credit for human achievement:

The telescope, invented the Beginning of the last Century, and improved now to the Dimensions even of eighty feet, whereby objects of a mighty distance are brought much nearer to us; is an instrument wherewith our Good God has in a singular manner favoured and enriched us… (The Christian Philosopher 27)
Comets play an important role in this schema, as they “move to serve the Holy Ends of their Creator!” (The Christian Philosopher 50).

C. Mather ends his chapter with a note on portentousness of comets and a characteristic reference to Judgment Day. However, rather than lapsing into a jeremiad, C. Mather ventriloquizes the words of Dr. Cheyne. C. Mather’s last words are: “The Sentiments of so acute a Philosopher as Dr. Cheyne upon Comets, deserve to be transcribed” (The Christian Philosopher 53). It is Cheyne who delivers the potentially fearful news to readers: “I think it is most probable, that these frightful Bodies are the Ministers of Divine Justice, and in their Visits lend us benign or noxious Vapours…” (Cheyne quoted in The Christian Philosopher 53). Because these words come from someone else, it is unclear whether C. Mather is endorsing this view or simply including it for his readers to decide. Moreover, by referring to Cheyne’s words as “sentiments,” C. Mather distances these thoughts from the scientific ideas of figures like Newton and Halley, who provide rational arguments based on diligent observation and calculation, not emotive conjecture. C. Mather’s synthesis of various scholars’ viewpoints coupled with what is likely a self-conscious writing style, make it difficult to locate his actual

54 When “Essay on Comets” is republished in 1744, Cheyne’s quotation is altered, beginning with:

There is a Species of Heavenly Bodies, call’d COMETS, which revolve about the Sun; in very Oblong Elliptick Orbits, approaching to Parabolick Curves. The Times of their Periodical Revolutions are very long, since in three or four Thousand Years, we have not positively determin’d the Returns of above one or two; however, its certain, that like our Planets, they do move in a recurring Orbit, that the Sun is in one of the Foci of this Orbit...(Cheyne quoted in “Essay on Comets” 4)
thoughts on comets. However, a passage from the middle of the essay appears to reveal his position:

Yea, he [Newton] has a suspicion, that the Spirit, which is the finest, the most subtile, and the very best part of our Air, and which is necessarily requisite unto the Life and Being of all things, come chiefly from Comets. If this be so, the Appearance of Comets is not so dreadful a thing as the Cometomania, generally prevailing, has represented it. (*The Christian Philosopher* 52)

This moment seems important because it is one of the few times, perhaps even the first time, his readers have been told that they need not fear the comet. Rather, C. Mather suggests that the comet may be cause for celebration as vehicle for “the Spirit,” the life force of all things. In proposing this theory, Mather reveals his search for some proof that comets do not portend calamity so that he can celebrate their arrival rather than fear it and, in doing so, assuage others’ anxiety so that they may do the same. This passage seems to represent a significant revision of C. Mather’s earlier views on comets. Just ten years prior in his sermon-essay, *Thoughts for the Day of Rain* (1711/12), he wrote:

some Learned Men, foretel the Appearance of another Comet...which may bring our Globe, under the other Destruction, for which, we know, it is reserved. Nor am I without Suspicions, That a Comet may be intended by the Vapour of Smoke, which is to bring on the Great and Notable Day of the Lord; which also is most Literally, A Star falling from Heaven. (10)

As Michael Winship notes, this revision of thought may have also been prompted by C. Mather’s awareness of “correct speech for a learned person,” as he was “painfully aware” that some of his Puritan views were considered inappropriate by the natural philosophers he sought to impress (“Prodigies” 105).

As these texts on comets by Samuel Danforth, Increase Mather, John Foster, William Williams, Charles Morton, and Cotton Mather demonstrate, the appearance of a comet catalyzed fear and panic among those who witnessed it. For some time, people had
been told to accept the comet as a sign from God and prepare themselves for the calamities that might accompany its presence. However, while the emotional, non-rational fear-response is still prevalent and even promoted in these texts, each author also introduces new ways of learning in the rationalism of the new science. These revised ways of learning alter peoples’ relationships to the unknown as they offer new methods for understanding the natural world. The effect of this form of rational explanation accomplishes more than just providing answers to questions. Rather, it changes the way people intuit mystery by altering their emotive stance, transforming their deep-set fears and anxieties into curious wonder at the mysteries that the universe holds. Deciphering celestial phenomena like comets yielded some answers which, in turn, dissolved some of the mystery; however, many questions remained unanswered. In effect, what was once a mystery to be feared becomes a curiosity to be celebrated.
CHAPTER 3: ‘NEWS FROM THE STARS’: THE IMPACT OF FIXED AND NEW STARS ON COLONIAL AMERICAN LIFE

For many years prior to the seventeenth century, people around the world had been monitoring the stars and tracking the movement of the planets. The organization of the cosmos, as presented by Aristotle and Ptolemy, offered stability by providing an impression of the heavens that was incorruptible, finite, and unchanging. However, in the seventeenth century, this model was challenged by several new discoveries and theories, particularly the appearance of new starlight in the heavens. While comets could be explained as meteorological phenomena or planetary exhalations, changes in the fixed star realm were not as easy to dismiss, because they shook the stability of the Aristotelian model of the universe. Historically, new stars have received less attention than other transitory light phenomena like the comet. The appearance or disappearance of stars occurred, or was observed, far less often than other celestial phenomena. Additionally, a new star’s duration or how long it appeared bright in the night sky was relatively short. Nevertheless, the discovery of these types of changes among the stars had wide-reaching implications for seventeenth-century society in both Europe and colonial America.

This chapter explores the early American conception of the heavens in the seventeenth and early eighteenth centuries in religious, academic and popular writing. Although colonial Americans were not the first to observe appearing and disappearing stars, their interest in and vigilance over the heavens is demonstrated in the written record left behind in texts such as Charles Morton’s *Compendium Physicae* (1687), Cotton Mather’s *Wonders of The Invisible World* (1693) and *The Christian Philosopher* (1721), and early American almanacs. While the works of C. Mather and Morton provide insight
into scholarly approaches to new astronomical developments, the early American almanacs reveal the different ways in which common people used the stars and planets to provide them with information about earthly life.

In many ways, early Americans lived their lives by the stars, vacillating between different belief systems: in some ways, the stars issued a controlling or manipulative force over their earthly lives, yet in other ways growing knowledge about the heavens equipped people with the tools for regaining control. The seventeenth century marks a historical shift in peoples’ interests about the stars as their reasons for mapping or charting the night sky change and their vigilance over the stars assumes a new set of goals with new meanings. The appearance and disappearance of starlight, in conjunction with the theories proposed by the new science, disrupts both religious and popular culture belief systems by suggesting that the heavens are changeable. The goals put forth by the new science no longer centered on individual lives, but formed part of a greater project to understand the workings of the heavenly realm. However, to say that new rational, scientific goals simply supplanted non-rational, astrological or other religious beliefs about the stars would be inaccurate. As these texts demonstrate, the ideology of science coexisted and interacted with astrology and Puritanism in colonial America. This chapter analyzes a series of almanacs along with sections of Charles Morton’s *Compendium Physicae*, Cotton Mather’s *Wonders of the Invisible World*, and *The Christian Philosopher* as it explores the following questions: In what ways do almanacs present rational and non-rational ways of thinking about the stars? How does astrology complicate the meanings of “rational” and “non-rational”? Is there a change in the
emotive stance presented by these texts over the course of the late seventeenth century to the early eighteenth century?

By the time colonists embarked for the land that would become America, discussions about a variable starscape and a Copernican universe were well underway in Europe so these shifts in worldview were commonplace. Yet, colonists were perhaps uniquely poised to process new scientific information about the heavenly landscape. At the moment that Europeans became colonists during their migration, their identities and consciousnesses were disrupted and reconfigured both temporally and spatially. Migration took them out of a familiar space, relocating them in a different place as well as a different time: they became both literally and figuratively out of sync with the rest of the known world. Subsequent generations were conscious of their intellectual position as colonists on the periphery of the burgeoning scientific community abroad. However, as colonists were drifting away from their English roots, the stars offered a sense of connection, serving as a reminder that even though they were on another continent, they were still very much a part of the world.

Perhaps the most well-known reference to anomalous starlight is Tycho Brahe’s observation of the new star in 1572 (see *De Nova Stella*, 1573) or, as we know today, his observation of a Type Ia supernova. Although he was not the first person to witness this change in starlight, his observations are notable for their accuracy, particularly since they were carried out without technological intervention. In 1572, a new star appeared in the Cassiopeia constellation, lasting from November until March of 1574. Along with Brahe, other famous observers of the supernova were: Thomas Digges, Thaddaeus Hagecius, Ciprianus Leowitz, Michael Maestlin, Cornelius Gemma, Elias Camerarius, Hannibal
Raimundus, and Jerónimo Muñoz (Brotóns 33). In addition to those who specialized in astronomy, the event interested many people from different professions, thus resulting in various perspectives and interpretations (Tessicini 51).

Along with observing the new star, astronomers speculated on the nature of the phenomenon. In 1574, Bartolomé Barrientos, professor of Latin at the University of Salamanca, wrote about comets, dedicating one chapter of his work to the supernova (Brotóns 34). Barrientos was not alone in classifying the new star as a comet, which aligned with Aristotelian thinking that the aberrant light would fall under the category of “meteor.” Other scholars, such as Juan Molina de la Fuente, considered the phenomenon some variant of a fixed star, and not at all meteorological (Brotóns 34). Jerónimo Muñoz also agreed that this new light more closely resembled that of starlight more than light from a comet. What made Muñoz’s conception of the phenomenon stand apart from other astronomers such as Gemma, Digges, and Tycho was his focus on the new light’s natural causes instead of concluding that it was simply miraculous. Others accepted that the phenomenon was supralunary, but resisted associating it with natural causes (Brotóns 35). Thinkers like Muñoz began considering how this new light affected the cosmological schema, as they found its presence difficult to reconcile with the idea that the heavens were immutable and incorruptible.

No other celestial event challenged the overall makeup of the heavens in quite the same way as the anomalous starlight. The new star’s presence forced astronomers to make serious decisions about planetary motion, celestial matter, and the dimensions of the universe. Prior to Newtonian science, several theories about planetary movement were in play. Some believed planets moved by way of orbs while others speculated that
the planets had their own force. Some even believed that the planets had a type of intelligence (Brotóns 42). Regarding the universe’s dimensions, many considered it a finite space; however, the discovery of the new star of 1572 challenged that idea and led some astronomers to consider the possibility that the universe was infinite (Brotóns 33). Furthermore, in the Aristotelian universe, the material of the heavens was not the same as the material of Earth: the heavens were immutable, Earth was obviously not. The breakdown of this idea, spurred by the changeableness and imperfection detected in the celestial realm, led astronomers to the conclusion that the matter which made up the heavens was in fact no different from the matter that made up the Earth. This idea was somewhat radical and had significant existential ramifications as it brought heaven closer to earth, and subsequently closer to humanity. This new knowledge was disruptive, but it did not suddenly shatter the way people perceived the world. In many cases, these new ideas and their existential meanings were slow to make their way to the general public.

Scholars also demonstrated a reluctance when it came to abandoning their former worldviews in favor of new astronomy. For instance, Francisco Valles, who wrote about the 1572 nova completely rejected the idea that anything new could be generated in the heavens because, if that were true, it would mean “that the creation of the world had been incomplete” (Brotóns 38). In *Astronomiae instauratae progymnasmata*, Tycho Brahe responded to Valles’s ideas, rejecting them for their physical as well as their theological flaws and arguing that Valles’s arguments implicitly denied God’s power and sovereignty. Brahe argued that God could absolutely change the heavens by adding new bodies because he is capable of producing miracles.
Cornelius Gemma, a Belgian physician, is another well-known observer of the 1572 new star. Gemma wrote about this phenomenon as well as the comet of 1577. His first publication about the new star, *Stella Peregrinae* was published in December of 1572 in Leuven when the new starlight was still visible in the sky. For Gemma, the position of the new star among the fixed stars had religious significance: it formed “a cruciform image with the stars in the constellation of Cassiopeia” which symbolized “the passion of Christ” (Tessicini 52). In his attempt to make sense of the phenomenon, Gemma ruled out what the new light could not be: if it were a planet, it would not be scintillating and if it were a comet, it would exhibit physical characteristics of a comet. The closest connection Gemma assumes is that this new light is in some way related to the fixed stars, even though it is apparently not fixed. Overall, Gemma resists providing any definitive answer to the nature of the new starlight. He ultimately rejects natural causes in favor of a supernatural explanation as he considers the new star a miracle generated “by divine power which transcends human capability and can change the course of nature” (Tessicini 56). Furthermore, for Gemma, the new star carried an apocalyptic significance as he believed its “cruciform configuration” presaged the second coming of Christ, thus signaling the end of the world (Tessicini 55).

Gemma received criticism from other astronomers such as Giordano Bruno who scolded him for attempting to hold onto an Aristotelian universe.\(^{55}\) Bruno claimed that by interpreting the new star as a miracle, Gemma was resisting dealing with the phenomenon’s natural causes (Tesscini 59). Bruno’s conception of the new starlight, and subsequently that of the universe, differed significantly from Gemma’s. Bruno considered

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\(^{55}\) See Giordano Bruno, *De immenso et innumerabilibus, seu de universo et mundis* (1591).
the possibility that the new star was a planet only visible at certain times. He also accepted the idea that comets and new or variable stars were the same types of celestial bodies as earth, made with the same materials. Bruno’s theory implied a form of motion by suggesting that there was some sort of change in distance between the earth and the star, which accounts for its visibility and invisibility. To entertain Bruno’s theory, one basically had to dismiss the Aristotelian idea that the starlight was a product of ignited exhalations. As Tesscini summarizes:

Therefore, the new star, as a celestial event, is interpreted by means of an optical explanation based on the conditions regarding the visibility of celestial bodies, thus abandoning interpretations from both a celestial physics viewpoint which affirm processes of generation and corruption in the upper regions of space, and from an Aristotelian perspective of meteorology established to defend the immutability of the skies. (59)

Because Bruno’s theory depended on variable distance between the star and the earth, it also implied that the physical space of the universe was much greater than previously calculated, perhaps even infinite.

Other esteemed astronomers such as Johannes Kepler could not accept Bruno’s provocative theories. Kepler argued that Bruno’s ideas gave “rise to dangerous considerations with regard to the homogeneity of the universe, the plurality of worlds, and the existence of invisible stars” (Tessicini 60). In contrast to Bruno’s theory, Kepler believed that the new star was indeed “new” and had physical causes as opposed to miraculous ones. The two main works in which Kepler discusses new stars are *Astronomica Nova* (1609) and *De Stella Nova* (1605). Kepler accepted that the heavens were mutable and that the nova was supralunary, rejecting the traditional Aristotelian explanation that the light originated from sublunary exhalations. Although Kepler promoted the idea that the supernova had natural causes, he also believed that astronomy
could provide answers to important religious matters “by providing a model of true
harmony, revealing the correct path for all else to follow” (Rothman 116).56

In September of 1604, Europeans got another chance to observe what appeared to
be a new star. Like the 1572 nova, which appeared as a crucifix, the 1604 nova was also
noted for the location of its appearance: “it appeared in close proximity to the conjunction
of Mars, Jupiter, and Saturn in the sign of Sagittarius—a conjunction which initiated the
Fiery Trigon, a period of great astrological significance” (Rothman 122). In “The Fiery
Trigon Conjunction,” Margaret Aston discusses the significance of planetary
conjunctions, focusing on a momentous conjunction during the 1580s:

The year 1583-1584 marked the change from the watery to the fiery trigon which
had also coincided with the birth of Christ. It also witnessed a conjunction of
which there were only six parallels in the entire history of the world since Adam,
only one of these being since the time of Christ…The fiery trigon…must have
become the subject of discussion not only among the astrologically learned but
also among commoners, who heard the predications refuted or ridiculed in public
places, including the London stage and the pulpit at Paul’s Cross. (183)

Astrologers linked this event with old prophecy which forecasted an imminent
apocalypse.57 Aston further explains how conjunctions were ranked. While any
conjunction was important, the conjunction of Saturn and Jupiter was thought to be the
most astrologically significant:

It was in effect for the macrocosm what a horoscope was for the microcosm: it
patterned the terrestrial future…A great conjunction occurred every twenty years
when two planets conjoined in a new sign within a given triplicity; a greater
conjunction, which recurred every 240 years (or every 200 according to some
calculations) happened when they moved into a new triplicity; a greatest
conjunction came at the end of the complete cycle of all four triplicities after 960

56 Even in Kepler’s work, it was not uncommon for thinkers to address the effects of
something like new starlight on the earthly realm, and it was standard to think that the
appearance of this anomalous light caused events like vapors and rains on the earth.

57 See also Holinshed's Chronicles (1577).
(or about 800) years. This, the most critical of all conjunctions, took place at the end of the watery triplicity, with the beginning of a whole new sequence of conjunctions in the first, fiery trigon of Aries, Leo, and Sagittarius. It was an epoch-making event, looked upon as portending the arrival of a new phase of history, the history, the prophetic fulfillment of religious innovation, great political mutations. (162)\(^{58}\)

To think in these astrological terms during the sixteenth century was commonplace, and these ideas were prevalent amongst specialists in astronomy such as Tycho Brahe. Brahe believed there was a connection between the appearance of the new star of 1572 and the move from the watery to the fiery triplicity. In effect, he thought this stellar change would bring impactful political and religious alterations throughout the world (Aston 164).

While it is clear that European intellectual elites such as Kepler and Galileo were invested in uncovering information about the new star, it is less apparent how the general population responded to the phenomenon. Common people considered the phenomenon as a wonderous or a terrifying event, yet they did not necessarily make connections between the appearance of the new light and cosmology (Vermij 137). They recognized the significance of new stars, but did not consider what it meant in terms of the current conception of cosmology: they continued to accept the ancient layout without questioning its accuracy. This attitude may have been prevalent among European astronomers generally, with certain exceptions like Kepler and Galileo who were stand-out figures of this period (Vermij 135).

In addition to the novae of 1572 and 1604, a third surprising light in the night sky was seen in 1596 and then again 1609, appearing in the neck of the Whale constellation.

\(^{58}\) Western scholars learned much about conjunctions from Arab astrologers, particularly from the work *De magnis coniunctionibus* of Albumasar (Abu Ma'shar, d. 886), which influenced Christian astrology (Aston 162).
(Cetus) from February until March. Historically, this occurrence has received less attention than the 1572 and 1604 star discoveries and over the course of the next thirty years, few observations of this new light were made (Hatch 153). One observer of the light in Cetus was David Fabricius, an amateur astronomer from the Netherlands, who informed Tycho Brahe and Kepler. This light was not observed again until Johannes Phocylides Holwarda saw it in 1638 and believed that he was seeing something new for the first time. The phenomenon that Fabricius and Holwarda observed is now identified as Mira Ceti or Omicron Ceti, a star with variable luminosity located in the Whale constellation. Its luminosity varies over the course of eleven months so that it is only visible with the naked eye when it reaches its maximum intrinsic brightness (Vermij 138).

One of the most well-known suppliers of variable star data to the community of astronomers was Johannes Hevelius, a member of the London Royal Society, who focused specifically on Mira Ceti. In many ways, Hevelius was instrumental in communicating the discoveries and theories of figures like Fabricius and Holwarda to the European intellectual elite. As Robert Alan Hatch summarizes:

When Hevelius published his Historiola in 1662, Learned Europe knew little about Fabricius or Holwarda, and indeed, the New Star was all but forgotten. During the 2 decades following Holwarda’s death—between 1640 and 1660—no one searched systematically for the New Star. Hevelius changed that tradition. (158)

As an astronomer, Hevelius was vigilant: he kept himself on a strict observation schedule that ensured the utmost accuracy and precision in the observation process. His discipline is evidenced by his findings: in the three years between 1659 and 1662 Hevelius made approximately seventy-five observations of the star Mira, which according to Hatch was

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“five times more than all the observers since Fabricius in 1569” (160). However, even under this intense viewing schedule, Hevelius was unable to determine any regularity to Mira Ceti’s appearances and disappearances.⁵⁹

Many of these European thinkers contributed their observations and insights to the London Royal Society and subsequently their views appeared in Philosophical Transactions, the Society’s publication from 1665 onward.⁶⁰ In many ways, Philosophical Transactions offered one of the best ways for scholars across Europe and beyond to access new knowledge pertaining to science, particularly astronomy. Moreover, the establishment of the society and its journal is significant to the development of science since it marks an institutionalization of the discipline in a way that was previously unheard of. Prior to the existence of the Royal Society “scientists” worked privately, perhaps recording their findings, but never engaging in the sharing process that the Royal Society demanded from its members (Cantor and Klein 5). The establishment of Philosophical Transactions was equally as momentous: not only did it foster the genre of science writing, it also encouraged a type of collaborative thinking process by compiling writing from a variety of different authors around the world. Additionally, Philosophical Transactions demanded that its contributors make

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⁵⁹ Today scientists know that Mira Ceti (also known as Omicron Ceti) is a star with a tail that is 350 light years from Earth. The tail is created from the high speed of Mira’s movement through space and its shedding of gas or stellar wind. The star “pulsates” as it “physically expands and contracts,” which is why it is considered a variable star. It becomes bright enough to observe with the naked eye, but then loses a significant amount of that brightness and becomes invisible (“Mira: A Real Shooting Star!”).

⁶⁰ The journal was initially published by Henry Oldenburg, the Society’s first secretary, as a personal expense. Editors after Oldenburg include Edmund Halley and Hans Sloane, and in 1752, the Royal Society assumed financial responsibility for it (McDougall-Waters 4).
observational data intelligible and exciting for a wide range of readers. One section of

*Philosophical Transactions* about new stars states:

> Before I conclude, I must give notice to the Lovers of Astronomy, that on the 24. of September (ft.n.) of this year, I have observ’d that New Star in *Pectore Cygni* (which from the year 1662. until this time hath been almost altogether hid) not only with my naked Eye, like a Star of the sixth or seventh Magnitude, but also with a very great Sextant. It is still in the very same place of the Heavens...It is therefore certain, that it is the self same Star, which Kepler did first see A. 1601 and continued until A. 1662. But whether in time it will grow bigger and bigger, or be lost again, time will shew. He that will observe this Star, must take care, lest he mistake those three more *Southern* ones, of the *Sixth Magnitude*, and now in a manner somewhat brighter (though not extant on the *Globe*) than the new Star in *Collo Cygni*. (‘‘Promiscuous Inquiries’’ 349)\(^{61}\)

*Philosophical Transactions* addresses its readership and assumes that they are active participants in the scientific process by providing instructions on how to make the best possible observations. “Lovers of Astronomy” is an apt phrase as it characterizes the attitude of star-watchers: one had to truly be a lover, dedicated and diligent in the practice of observing and analyzing the night sky. Astronomers, like Hevelius, seem to have had little time for much else, as their time was spent looking away from earth toward the stars and planets.

While many astronomers and thinkers shared their data and theories about new

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\(^{61}\) References to new stars appear throughout *Philosophical Transactions*. Mira Ceti is mentioned in a review of books:

> The chief end of the Author in publishing this Tract, seems to be, To excite Astronomers to a diligent observation, both of that New Star in the Neck of the Whale, to be seen in February and March next; and of that other, in the Northern part of Andromeda’s Girdle, to be seen at this very present. (Colepresse 381)

See also M. Hevelius, “The Figure of the Stars in the Constellation of Cygnus; Together with the New Star in It, Discover’d Some Years Since, and Very Lately Seen by, M. Hevelius Again” (1665) and “An Accompt from Paris, in Two Letters to the Publisher, Dated July 5. and July 19. 1670. Concerning the Earlier Discovery of the Same New Star, Which is Described in the Precedent Letter” (1670).
stars, no consensus was reached regarding their nature and origin. In Book III of *Principia* (1687), Isaac Newton writes:

So also fixed stars, which are exhausted bit by bit in the exhalation of light and vapors, can be renewed by comets falling into them and then, kindled by their new nourishment, can be taken for new stars. Of this sort there are those fixed stars that appear all of a sudden, and that at first shine with maximum brilliance and subsequently disappear little by little…But fixed stars that alternately appear and disappear, and increase little by little, and are hardly ever brighter than fixed stars of the third magnitude, seem to be of another kind, and in revolving, seem to show alternately a bright side and a dark side. And the vapors that arise from the sun and the fixed stars and the tails of comets can fall by their gravity into the atmospheres of the planets and there be condensed and converted into water and humid spirits, and then—by a slow heat—be transformed gradually into salts, sulphurs, tinctures, slime, mud, clay, sand, stones, corals, and other earthly substances. (938)

Unlike many of his sixteenth-century predecessors Newton acknowledges the phenomenon as a type of star and then attempts to provide a natural explanation, as opposed to a supernatural one. He resisted the supernatural explanation that rested on the idea from Genesis 14-19 that on the fourth day “he made the stars also. And God set them in the firmament of the heaven to give light upon the earth” (King James Bible). Nevertheless, as *Principia* demonstrates, by 1687 the investigation into new starlight remained far from resolved.

The concept of a “new star” or a “variable star” disrupted established belief systems and their foundations of the universe. Introducing the potential for celestial change and the revision of order in the universe was a serious matter with profound existential implications for humanity. Astronomers were realizing that understanding the celestial realm required more than a conceptualization of space; rather, time must also be a factor in their equation. These ideas generated during the fifteenth, sixteenth, and seventeenth centuries eventually made their way to the American colonies via almanacs,
textbooks, correspondence, and through the exchanges between colonial intellectual elite and the London Royal Society. In many ways, much of the colonists’ knowledge was borrowed from their European counterparts, yet the meaning they attached to the phenomena was different, affected by their living situation as migrants inhabiting a “New World.”

In early America, references to stars and planets could be found in a variety of different sources such as almanacs, textbooks, and sermons. One of the best examples demonstrating the centrality of the stars to early American life is the almanac, a form of popular literature during the colonial period. Almanacs reached common folk in ways that other texts did not: they were written to inform and entertain the common person, not the intellectual elite (although the elite read them as well). They provided colonial Americans with a wealth of practical information related to certain celestial and meteorological events. For example, John Foster’s 1678 almanac lends itself to the New England farmer by offering an essay, “The Course of the Spring-tides this year.” This essay addresses the dangerous rise in tides during the spring, which can have a detrimental effect on farming: “Husbandmen…sometimes neglect their Opportunity of Mowing for fear of the Tide, and at another time they Mow for the Tide to carry away; which might be in great measure prevented if the Course of the Tide were observed” (Foster 17). By better understanding the moon-cycles, some prediction of the tides can make a significant difference on the outcome of farming.

Additionally, knowledge of celestial events, provided by the almanac and interpreted by the almanac’s authors, gave common people the tools to practice a type of popular religion using those events. For instance, in the same almanac that discusses
mowing and the tides, John Foster includes astrological and occult material to satiate readers’ desires. This almanac presents the anatomy, an illustrated figure of a man with zodiac signs matched to specific parts of the body, along with the title: “The Dominion of the Moon in Man’s Body (According to Astronomers).”

Historians such as Keith Thomas, Jon Butler, David Hall, and Richard Godbeer have called attention to the importance of popular religion in early America, as they highlight the statistics on church membership. Even those who were avid churchgoers may not have been as committed as some of their ministers’ zealous writing suggests. In Early American Almanacs, Marion Stowell suggests that the almanac’s entertaining qualities may have lightened Puritans’ “dull days” (18) and Richard Godbeer further argues that by offering people a way of predicting their future (regardless of its validity), magic and astrology gave people a sense of control over their lives, which may have been a response to the lack of agency inherent in the concept of predestination.

The almanac was crucial to colonial America literary life. Aside from providing a vault of useful information, the almanac was one of the few forms of literature available, preceding newspapers by sixty-five years (Stowell xiv). At the outset, the almanac was printed exclusively in Massachusetts where “eighty almanacs made up four fifths of the secular literature published there before 1700” (x). Except for religious texts, the almanac was the most popular book during the seventeenth century. Most almanacs contained a monthly calendar, eclipse and tide tables, and some sort of scientific short essay, usually promoting Copernican or Newtonian science. For example, Zechariah Brigden’s 1659

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62 Foster was one of the first colonists to open a printing press, from which he produced his 1678 almanac. While his earlier almanacs remain true to Harvard’s astronomical rules, by operating his own press, he could print material at his discretion.
almanac cites Ptolemy, Tycho Brahe, Galileo, and Kepler. Appearing nearly fifteen years later in 1675, John Foster’s almanac provides an even more thorough level of instruction and greater accessibility for early American readers by including detailed instructions for its use as well as woodcut illustrations. In this almanac, Foster offers a diagram of the solar-system, making it so that even those who were not literate could visualize the Copernican system. His essay, “A brief Description of the Coelestial Orbs according to the Opinion of that Ancient Philosopher Pythagoras, and of all latter Astronomers,” dismisses former celestial systems in favor of Copernicanism: “The Ptolemaick Hypothesis having for many Centuryes of years been the Basis of Astronomical Calculations, is now in this latter age of the World by Astronomers wholly rejected” (Foster 14). There is now discovered “a way far more plausible for the salving of the wonderful variety of motions and appearances among the Planets” (Foster 14). Yet, Foster remains acutely aware that his readers might not readily throw out old ideas for the new as he acknowledges how strange it seems to conceive of an earth in motion, and how this theory conflicts with scriptural descriptions of the earth-sun relationship.

John Sherman’s 1676 almanac and William Brattle’s 1682 almanac share Foster’s instructive tone as they seek to explain the causes of certain celestial phenomena. In his eclipse calculations, Sherman goes out of his way to define eclipses, further explaining their totality or partiality:

An eclipse is the Obscuration or hiding of one or other of the Luminaries by the Interposition of some dark or dense Body so that when the Earth comes between the Sun and the Moon, it not only hideth, but (for a time) taketh away and depriveth her of her borrowed Light…(1)

Brattle’s essay, “An Explanation of the Preceding Ephemeris,” specifically targets readers who read “without Understanding” and are “Parrat-like” (16). He hopes:
That men might not only know the *oti* [that] of things made mention of in the *Ephemeris*, as that there will be an *Eclipse* of the Sun or Moon or such a Configuration on this or that day, and the like, but that they also know the *dioti* [because] of them, and what the [reason] of an *Eclipse* of the Sun or Moon is; and whence it comes to pass that there is said to be Trine, Quartile and the like of these and those Planets at such times, &c. (Brattle 17)

Brattle encourages his readers to desire to know the cause of an eclipse rather than simply being told that it will happen.

Almanacs from the earlier portion of the seventeenth century remained scientific because printing was tightly controlled by the Harvard printing press; however, once Harvard lost its monopoly on printing, more publishers began to offer occult material to satisfy reader desires and drive sales. There is a clear difference between the almanacs produced during the Harvard printing period and those that came after. Almanacs from the first portion of the seventeenth century are distinguished as “philomath” almanacs: they were academic and focused on science. The later “farmer’s” almanacs appearing at the end of the seventeenth century offered a wider array of popular material, featuring astrology, prognostication, and health advice. Almanacs printed later in the seventeenth century routinely offered readers a selection of verse poetry, weather predictions, the anatomy, horoscopes, etc. As Stowell points out, evaluating this material using traditional literary registers proves difficult since so much content was borrowed or copied without giving credit to the original source. Furthermore, there is some intricacy surrounding the relationship between the almanac author, printer, and publisher. As Stowell explains, with the exception of “the Cambridge Press (1639-1692), where the printer was hired by Harvard College, the colonial almanac printer was usually the publisher. Often it is he, rather than the author, who is given credit historically for the almanac” (27). For instance, although the first almanac in Pennsylvania was put together by Samuel Atkins, it is
William Bradford, the printer-publisher, who is typically awarded the credit (Stowell 27). Almanac-makers sometimes quarreled with each other about stealing each other’s materials or calculations, and these feuds, which played out in any given edition of the almanac, also inspired sales among the public.⁶³

One of the most notorious producers of occult material, judicial astrology, and egregious weather forecasts was John Tulley. His 1690 almanac offers weather predictions, yet based on the owner’s corrections, it appears that Tulley’s forecast was less than accurate. In October, Tulley predicted that there would be “cool mornings” and the following day would be “Cloudy Cool” yet the almanac owner wrote “very hot” and “very hot” next to both of these days. When Tulley calls for “wet sign” the same person substituted “Hot” and “dry.” On days where no weather prediction was present, the owner filled in the weather, thus indicating common peoples’ participation and contribution (even if it was for personal use only) to the almanac project. Furthermore, this type of active reading reinforces the idea that colonists were well aware of the potential value of weather prediction. Despite the inaccuracy of weather prediction,

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⁶³ John Tulley’s 1696 almanac demonstrates the bickering and rivalry that took place between almanac makers as he responds to Christian Lodowick’s criticism of his style. On the front cover of his 1695 almanac, Lodowick writes: “To which are added some seasonable Cautions against certain Impieties and Absurdities in Tulley’s Almanacks…” In response, Tulley tells his readers that he follows almanac rules established in England; however, he does seem apologetic for the failure of his weather predictions: “As for the Weather in the Preceeding Pages, I have endeavored to insert it according to the common Rules of Meteorology, which I have often found to fail, as to hit right.” Tulley continues to shirk responsibility for what he writes by blaming the publisher for intervening in inappropriate ways:

As for the French Kings Nativity, it was acted and put into my late Almanack by the Printer unknown to me, for which I was much displeased with him for so doing; for I would not that any thing should put into my Almanack, that I did really apprehend or think might be displeasing to God, whatever it were to man, but I would gladly please man also. (9)
documenting it after the fact, at the very least, provided a means by which weather trends, if they existed, could be analyzed over time. Tulley’s essay, “Of the Rainbow; Whence it is, and what signifieth,” makes some remarkably unscientific claims about how the rainbow can forewarn of future meteorological events. He claims that if the rainbow appears in the afternoon around three or four o’clock, then fair weather is on its way.

Additionally, Tulley’s almanac also offered some rather humorous astrological predictions:

Now Mars & Mercury are in a friendly Conjunction with Venus, which may invite many young people to enter into the marriage-state: and indeed a wife is no Curse when she brings the blessings of a good estate with her: but to marry a Town-flurt with a painted face, a rotten reputation…that man had better go to hanging than be so married. (12)

Tulley proceeds to give his advice for how to find a nice wife, naming the qualities that she should embody. His essay titled “Astronomical Observations of the Weather & Winds from the Planets & their Aspects” from his 1692 almanac makes use of planet configurations for causes of the weather: “Saturn causeth cloudy, dark, obscure Aire, cold and hurtfull, thick, black and condense clouds (13).” Additionally, Tulley remarks on how the planets impact the human body in terms of disease:

The diseases of this Quarter are signified by the Planets that have most Dominion in the sixth house which are Venus and Mars, Venus is going out of Aries into Taurus, signifying such diseases as are incident unto the Neck and Throat, as Colds, Coughs, soar-Throats &c. (13)

The idea that light phenomena was portentous also remained popular amongst the layfolk and some of the intellectual elite. For instance, Israel Chauncy’s essay “The Natural Portents of Eclipses according to approved Authors,” featured in his 1663 almanac, discusses “Prognosticating the effects of eclipses,” specifically how they are harbingers of “Temperatures and Stormy Winds” and how they may “presageth Famine and Pestilent
Although much of the reading public seemed to enjoy these additions, not all members of colonial American society were in favor. Religious leaders such as Increase and Cotton Mather objected to the inclusion of judicial or predictive astrology in the almanac. In *Wonders of the Invisible World*, Cotton Mather chides those who engage in astrological reading of the stars: “From the life Sinful Curiosity it is, that the Prognostications of Judicial Astrology, are so Injudiciously Regarded by multitudes among us” (50). C. Mather points out how astrologers “do scarce ever hit Right” except when making general statements such as “many Old Men will Dy such a year…and that there will be much Lying and Cheating in the World” (*Wonders* 50). Moreover, those who believe in these astrologers are “Foolish Admirers” who “will not be perswaded, but that the Innocent Stars have been concern’d in these Events” (*Wonders* 50). C. Mather further considers the material produced by these “Idle, Futil, Trifiling Star-gazers” disgraceful “to the English Nation” and “perillous to the Sould of men” (*Wonders* 50). Engaging in certain magical practices or astrology may have serious consequences such as inviting the Devil himself: “And furthermore, I pray, that it may be considered, Whether a World of Magical Tricks often used in the World, may not insensibly oblige Devils to wait upon the Superstitious Users of them” (*Wonders* xvi). In “The Devil Discovered,” C. Mather specifically connects astrology and fortune-telling, claiming that they represent manipulation by the Devil: “The Devil would have us to Try the Purpose of God…by Consulting Astrologers, or Fortune-tellers; or perhaps, by letting the Bible fall open, to see what is the first Sentence we light upon” (*Wonders* 16).

C. Mather further clarifies his position on studying the stars in *The Christian
**Philosopher**, in which he distinguishes between “the foolish *Astrology of the Star-gazers*” and the correct way to understand the Stars as God. C. Mather cautions his readers not to indulge in pagan astrology, and even goes so far as to request that “Christian Astronomers” replace the Pagan constellation names with Christian ones. C. Mather clarifies that he is not against reading the heavens for signs of God, but once again, he scolds those who practice astrology:

I would by no means look up unto the *Stars*, with the foolish *Astrology of the Star-gazers*, who try to *read*, what the Great GOD that made then has not *written* there. But there is very plainly to be read there, the Power and Grandeur of the Glorious GOD.” *(The Christian Philosopher 34)*

He further claims that “the true *Reading of the Stars* is to look up, and spell out, the glorious Perfections of GOD, who is the *Father of those Lights*, and who *made* and *moves* them all. *(The Christian Philosopher 34)*. C. Mather does not always discourage his readers from star-gazing; however, he instructs them on the appropriate ways to read heavens.

Similarly, educators like Charles Morton felt the need to guide their students on the appropriateness of consulting almanacs containing occult material. In *Compendium Physicae*, Morton offers a section titled: “Nativities horary Quest[i]on[s] are Evill/Stars ruling [countries] are all from the Divill” *(30)*. Morton does not object to all of the almanac’s content, and even suggests a way in which astrology could improve its reputation:

On this Affection (the Influence) is Grounded Astrologie which for want of Sufficient Observations to make rational inductions is therefore very Imperfect and uncertain in its rules; Dr. Beal (tis said) advised the Royal Society that old almanacks were better to be written than new; meaning a Register kept of all Changes of Weather; that So a probable conjecture may be made of what will be, by a comparing of what had been already; which would be of Excellent Political, and Economic Use; then would Astrologie Gain a well Grounded repute whereas
now as it is commonly practised, tis by prudent men thought folly; and most suspected [to be] knavery, and a Cheat. (28)

Morton further emphasizes the foolishness of astrology: “what reason is there in their calculating nativities that the position of planets at the moment of birth should So influence the whole life…What is there is [your] horary Questions, that the moment of asking should direct to the answers…” (29). Morton’s intent is to highlight the absurdity in allowing the stars to govern one’s life in this manner, yet he does acknowledge some of astrology’s redeeming qualities:

On the Whole matter I judge, that as to weathers, and temperatures of our bodyes with relation to health or Sickness by Good observations of prudent, and Phylosophical minds, a Usefull knowledge might be framed; but for all the rest that is pretended the books written about then might make a curious bonfire… (30)

Thus, for Morton, an astrological study of the stars and planets can yield useful information regarding the weather and illness, yet Morton is careful to expresses his complete disapproval of prodigies.

Early American almanacs encompass several different ideologies: astrology, scientific astronomy, and mainstream religion. Furthermore, they offer key insight into the layman’s experience with the stars. Notes contained within these staple household texts reveal how people reacted to information about the celestial world. Some early Americans used the almanac like a diary, recording their personal information as well as their reactions to the almanac’s content on the text’s blank inner leaflets. The almanac demonstrates how early Americans conceived of time as they organized their life around the behavior of the heavens. By offering readers a level of temporal specificity (e.g. times of sunrise/sunset, days of the week and months of the year, etc.) it assisted colonial Americans in ordering their lives in an otherwise chaotic world.
New stars were one of the many celestial events that almanac makers discussed in their almanacs. Nathaniel Mather, the younger brother of Cotton Mather, mentions appearing and disappearing stars in his 1685 almanac as he praises the telescope for its ability to offer truth about the heavens in a way that the naked eye cannot. He writes, “Before the last Age Telescopes were altogether unknown to the world, but since their invention, most wonderful discoveries in the Heavens have been made” (N. Mather 15). In addition to clarifying that planets “are so many Opaque dense bodies without any light whatever,” the telescope offers a more accurate understanding of the eclipse (N. Mather 15). Moreover, the device revealed Saturn’s ring, and “the four little Moons” of Jupiter. In his short essay “Concerning the late discoveries respecting the fixed Stars,” N. Mather further mentions how the telescope offers insight into the stars: “The Telescope discovers in the Pleiades in a Circle of one gr. diameter, the number of 46 Stars, whereas with the naked eye we can perceive but six in that Compass, the seventh having disappeared many Ages since” (2). While N. Mather mentions the disappearing star, he provides no further details, explanation, or discussion of the impact of this mysterious disappearance. Like Foster, N. Mather seems aware that his audience might not easily accept this new and consistently developing picture of the universe: “These things may seem strange and vulgar minds are unapt to believe them; but they are real truths…” (2). Furthermore, N. Mather explains that he accepts these discoveries as “real truths” because “Mathematical

Zechariah Brigden also praises the invention of the telescope in his almanac, which he describes as “the late admirable invention of the Telescope, by which the Solar spots are discovered to move around the body of [the] Sun,” allowing people to see what is “not visible without [the] help of the forenamed instrument.” Likewise, Alexander Nowell, in his 1665 almanac praises the development of the telescope as an instrument that might provide truth: “The Telescope may convince us of this Truth.”
demonstration evinced it to be true” (22). Although mathematics offered an abstract way of conceptualizing the happenings of the universe, here N. Mather seems to consider math as empirical and capable of providing this sort of evidence when observation alone falls short.

Henry Newman’s 1691 almanac, “News from the Stars” presents one of the most thorough surviving accounts of new and variable stars in the colonial almanac as he focuses on their discovery. Like Mather, Newman praises the telescope in his short essay “Of Telescopes,” noting how “it is now made 20, 30, and unto 60, or 80 foot long” and “Objects at a great distance are clearly and more distinctly seen and discovered” (2). In effect, the telescope reveals crucial information about planets, moons, and stars:

…there is discovered new Stars in the Firmament, the which having appeared a certain time, do so decrease of their bigness, that they cannot any longer be discerned and then afterwards, after the revolution of Months, Years or Ages, do appear again as if they were newly come into Being. *This Prospective discovers to us in the Heavens, a far greater number of Stars than we can discern with the naked Eye. It discovers to us in the Pleiades, in a Circle of one degree of Diameter, which encompasseth them, the number of 46 Stars, whereas we can perceive but six, the seventh having disappeared a long time agone.* (Newman 2)

Both Nathaniel Mather and Newman register similar amazement at how the telescope enhances human vision. In both cases, they emphasize that certain celestial information would be unavailable without the visual assistance of telescope technology.

Newman provides a short scientific essay at the end of each calendar month. His essay for September, “Of New Stars which appear for a time, and then disappear at another time,” reviews the new star of 1571 and provides readers with factual information such as where and when it appeared on November ninth in “the Chair of Cassiopeia”
Newman notes that it was a “Star of the first Magnitude” and lasted for sixteen months before “it grew quite invisible” (19). Twenty-nine years later, another star appeared in the Swan’s Breast, which remained visible until 1626. This same star returned after thirty-three years and was observed by Hevelius at Danzig in 1659, but after a year, in 1660 “it seemed plainly to diminish, and quite disappeared soon after” (Newman 19).

Newman also discusses Mira Ceti in his second short essay, “Of the Star in the Whale’s Neck.” He presents information in a manner similar to his description of the star of 1571 by telling readers where, when, and how bright the star appeared. According to Newman, this star first appears dim (of the sixth magnitude) but gradually grows brighter over the course of one hundred days until “it arrives at its full period and greatest brightness and eminency, which is, to be of the third Magnitude” (21). This brightness lasts for approximately fifteen days, after which the star grows dimmer until it is no longer visible. Furthermore, Newman notes that the star appears to have a pattern: “It doth appear every year in this greatest brightness thirty two or thirty three days sooner than the precedent year, and compleats its Revolution in about three hundred and thirty three days” (21).

Newman’s third essay on stars, “Of other Stars, of which it is very probable that they are new Stars,” identifies three additional stars appearing in Cassiopeia, which “in all likelihood be new Stars” and two in the constellation of Evidannus, “of which it is certain they were not there in 1664” (23). Additionally, Newman refers to four dimmer stars near the Artic Pole that may be new; he reasons that since astronomers have been

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65 It is likely that Newman is referring to the new star, or Tycho’s supernova, of 1572.
looking at this part of the sky for some time, if these stars had existed, they would have appeared in the star catalogues (23). In his fourth and final short essay, “Of Stars which have appeared heretofore, and now disappear,” he references the seven stars of the Pleiades, noting that “at Present there is to be seen but six, a very probable sign that one of them is retired and become invisible” (Newman 24).

In all four essays, Newman does not elaborate on the oddity of stars’ appearance or disappearance, nor does he speculate or theorize about why or how they appear or disappear. Instead, he only offers readers factual details about the stars. In providing readers with numerical values for the interval of the stars’ appearance, Newman’s almanac suggests that simply noting the star’s appearance or disappearance alone, or speculating as to why or how they appear and disappear may be less interesting or valuable to his readers. In other words, readers may be less enthusiastic about an explanation that relies on supernatural circumstances and more receptive to the temporal order that the new astronomy is now able to offer. Being able to time or predict the behavior of these new types of stars imbues them with some sense of order, which subsequently offers people a more stable picture of the universe that humanity can approach and potentially understand.

In an academic setting, students at Harvard consulted Charles Morton’s *Compendium Physicae* for information about the stars. *Compendium* provided an historical overview of the well-known cosmological systems: “the Old System of Aristotle, and Ptolomie,” “The latter Hypothisis, (or Supposition) by Nicholas Chopernicus,” and “The last System was by Ticho Brahe…who did nothing but restore
the Earth to the center of the Universe” (Morton 20). Morton reviews the Aristotelian/Ptolemaic model, which placed the earth in the center of the universe “with its water, 3 regions of Air, and the Element of fire round about it,” emphasizing the lack of scientific inquiry into certain mysteries such as planetary movement, which was explained “heavenly orbs…because they knew not else how to Solve the various motions which they had observed, and could give no other account of” (21). Rather than looking for a new model, astronomers continued to ascribe new theories to the current one (Aristotelian/Ptolemaic) in order to explain anomalies, which resulted in a rather scientifically frustrating series of additions:

also to each of the Planetary Orbs they added Epicicles and other inventions in a most intricate, and perplexed model, and all still to solve, the p[h]aynomia or appearances rising from the Variety, and seeming Irregularity of their motions; they Gave also to each orb its Intelligence (or [Angell]) who was allways to Impel, and direct it…(Morton 22)

This system has further intricacies, as Morton outlines for his readers. Even he expresses surprise that such a system could make any sense: “And all these incredibles of the primum mobile are only to solve the diurnal motion, the rising and setting of the Stars, and planets which we dayly see…” (22). Despite the overdone complexity, some of the images generated from these ideas are quite beautiful. For instance:

The Inner Surface of the one [sphere] rub’d against the outward Surface of the next [sphere], and though very polite and Smooth (else the motion would have

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66 Morton also makes note of the telescope’s impact on astronomy and cosmology:

The Ground of the Antients to pronounce the heavenly bodies simple, was because they could observe no Changes, Generations nor Corruptions in them, but by the late invention of Tellescopes (besides other Reformations in Astronomy) there is also another doctrine of heavenly bodies…our Eyes by the help of this new art being fortified above a 1000 fold can see there those things which he [Aristotle] could not Generations, and Corruptions, and many other matters…Therefore certainly many of the Coelestial [globes] are concreat bodyes, as our Earth is, and are no more simple than this. (20)
been hindered) yet made a noyes with Such an harmony as the musick could be admirable if it could be heard. (Morton 22)

Morton is clearly in favor of the newer model, the Copernican System, which placed “the Sun in the Center of the Universe not moving from its place but turning swiftly on its own Axis” and grew out of “some old hints of Pythagoras, and the Manifest absurdityes discovered in the Ptolomayi Hypothesis” (22). Nevertheless, Morton’s ultimate dismissal of the old system is respectful:

I Shall not further enlarge on this matter nor insist on all the Arguments alledged to distroy the Old System of Ptolomie…Nor what Galeleus, Dr. Wilkins, and others Say to defend the Copernican Scheme, and how they answer those Scriptures which are against his [motion] of the Earth…What is said may suffice to Shew that the old doctrine of the heavens was imperfect, and that this latter seams more probable… (24)

Morton’s care in explaining, logically, why the newer version of the universe makes the most sense reveals his awareness of his audience as they learn a new theory as well as how to let go of a former one now obsolete.

As Morton demonstrates in *Compendium*, the state of the stars is important to physics. He explains that in the Copernican scheme, the fixed stars do not “Stir from their fixed place are above all the planets and are all luminous bodyes, as So many Suns in the firmament and that they appear not to us So great, and bright is only because of their distance” (Morton 22). He further defines the fixed star in the fifth chapter of *Compendium*: “Fixt stars are those at Greatest distance from one another, but appear still the same in the same respective place (and perhaps Absolute too) they are distributed into Constellations and degrees of magnitude” (Morton 31). Clearly the stars play an important role in the development of modern physics, yet Morton offers no sustained

67 Morton also includes that the Copernican system was “confirmed, and Illustrated by Galeleus” and “Approved after by Kepler…and others most skilfull in Astronomy” (23).
discussion of the “new stars” that have appeared in the sixteenth and seventeenth centuries.

As the almanacs, *Compendium Physicae*, and *Wonders of the Invisible World* demonstrate, seventeenth- and early eighteenth-century readers were familiar with both rational and non-rational approaches to interpreting the stars. Cotton Mather effectively synthesizes these interpretations in *The Christian Philosopher* where two chapters are devoted to the stars.\(^{68}\) C. Mather’s statements shed light on the relationship between human and universe, as well as the relationship between human and technology in the early eighteenth century. Human perception is forever altered by the visual assistance that the telescope offers: “Among the Pleiades, in a Circle of but one Degree diameter, where our naked Eye sees but Six, thus assisted we see Forty Six” (*The Christian Philosopher* 29). Functioning as an extension of the human body, an enhancement of the human eye, the telescope brings the invisible world into collision with the visible realm. This merging of visible/invisible worlds is particularly relevant to a figure like Cotton Mather, as his Puritan upbringing primed him to search for signs of the invisible world on a daily basis. As a non-human filter of vision, the telescope seems antithetical to Puritanism, which asked people to look deep within themselves for evidence of God’s work upon their lives. While some argued that telescope distorted reality and therefore could not be trusted as

\(^{68}\) The term “star” can be confusing since authors, C. Mather included, tend to use it interchangeably to describe planets and moons. For instance, C. Mather refers to Jupiter’s satellites as “stars.” Furthermore, some observers of new starlight might have also used the term “comet” to explain the light they witnessed in the night sky. Previously, there was no distinction between comets and new stars; for instance, Tycho’s star (1572) was commonly described as a ‘comet’” (Zsoldos 107). However, this confusion does not seem present in *The Christian Philosopher*. 

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true vision, most Puritans did not share this view.\textsuperscript{69} In \textit{The Christian Philosopher}, C. Mather weaves the development of new technology into religion almost seamlessly by assigning the credit to God for allowing humans to access science and invent the telescope:

\begin{quote}
Glorious GOD. Thanks unto thee, for the Benefits and Improvements of the Sciences, granted by thee unto these our latter Ages. The Glasses, which our GOD has given us the Discretion to invent, and apply for the most noble Purposes, are Favours of Heaven most thankfully to be acknowledged. The World has much longer enjoyed the Scriptures, which are Glasses, that bring the best of Heavens much nearer to us. But, tho the Object-Glasses are here, the Eye-Glasses are wanting. My GOD, bestow thou that Faith upon me, which, using the Prospective of thy Word, may discover the Heavenly World, and acquaint me with what is in that World, which, I hope, I am going to. (\textit{The Christian Philosopher} 29)
\end{quote}

As he champions the use of modern technology, C. Mather reminds his readers to rely on the Scriptures as well, which offer another way of seeing the heavens. Just as one can experience the heavens through the telescope, one experiences the heavens through the word of God. Thus, according to C. Mather, discovering the heavens is a sensory process that included seeing, yet also depends on hearing or reading (i.e. scripture). Both the telescope and scripture are tools for potential discovery of a new world, the “Heavenly World.”

C. Mather’s statements regarding fixed stars are intriguing for what they reveal about his conception of infinity and his understanding of humanity’s position in relation to the rest of the universe. In his discussion of fixed stars, C. Mather focuses on the star count and how that number has consistently increased over the years to 1900; although, Mather imagines there are many more than 1900 stars. He describes the Milky-Way as

\begin{footnote}
\textsuperscript{69} In \textit{Kometographia}, Increase Mather mentions a Florentine physician who could not be persuaded to look through a telescope because “he was afraid that then his Eyes would make him stagger concerning the truth of Aristotle’s Principles, which he was resolved he would not call into question” (7). See Chapter 2.
\end{footnote}
“nothing but an infinite Number of Stars, which are so small, and lie so thick, as to give but a confused Glare unto us…” (The Christian Philosopher 29). Most sixteenth- and seventeenth-century European astronomers were reluctant to consider a universe with infinite dimensions, favoring a model that had finite boundaries. Even in the early eighteenth century, the concept of infinity, when applied to the physical matter of the universe, was a relatively new idea. Yet, C. Mather appears to embrace it readily by asserting that there is “nothing but an infinite Number of Stars” in the Milky-Way. Mather establishes a relationship between humanity and the stars by personifying them: although the stars are “small,” they “give but a confused Glare unto us” (The Christian Philosopher 29). His description highlights something important about perspective and the human perception of the universe: it is easy to feel powerful when the rest of the universe looks so small, but actually the bodies that look so tiny are quite large and also powerful, and humanity appears small to them. C. Mather’s use of the word “Glare” is intriguing as it carries a dual meaning: a glare is “dazzling brilliance (of a light, fire, sun, etc.)” or a “strong fierce light” (OED 1a) but it is also a “fierce or piercing look” (OED 3 “glare n”). Thus, “glare” fits the context of a star’s behavior, yet it implies a type of unbenevolent surveillance that is perhaps akin to the eyes of God or Angels.

A significant portion of C. Mather’s text is devoted to interpreting celestial phenomena within a religious context. Yet, C. Mather’s inclusion of precise numerical figures suggest that he is equally intrigued by humans’ ability to quantify the heavens. For example, C. Mather expresses amazement at the quantification of the distance between humans and the stars:

The Distance of the nearest Fixed Stars from us, compared with that of the Sun, is as 27,664 to 1: So then the Distance of the nearest Fixed Stars is at least
2,404,520,928,000 Miles; which is so great, that if a Cannon-Ball (going all the way with the same Velocity it had when it parts from the Mouth of the Gun) would scarce arrive there in 700,000 Years. Great GOD, what is thy Immensity! (The Christian Philosopher 28)

By providing numerical figures, C. Mather suggests that the process of calculation is important; it is no longer enough to describe the universe with qualitative terms. C. Mather may be interested in exploring the mathematics behind these figures, yet he carefully ends with a theological conclusion. In effect, the numerical values serve the argument that God is immense. However, C. Mather’s phrasing is curious, since he is also asking a question: “Great God, what is thy Immensity?” C. Mather may simply be calling attention to humans’ inability to comprehend that which is infinite and his question may be just a rhetorical figure, yet the term “immensity” may also suggest an implicit desire to quantify that which is God. This idea is consistent with the view that science could offer empirically-based answers to religion and provide evidence of the divine realm.

C. Mather also appears to entertain a many worlds theory as he considers the possibility that each star is a sun with planets that may harbor life. He writes, “[stars] they have their Planets; and these Planets have Satellits; and these Planets and Satellits have Inhabitants, rational and irrational” (The Christian Philosopher 30). For some, this idea conflicted with Christianity since it implied that Earth and humanity were not unique. Yet, C. Mather celebrates a diverse universe, thus indicating that the many worlds idea finds no conflict with his Christianity:

Great GOD, what a Variety of Worlds hast thou created! How astonishing are the

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70 In his last essay of The Christian Philosopher, “Of Man,” C. Mather refers to a Philosophy that terminates in Theology (295)—an idea that is demonstrated here and throughout the text.
Dimensions of them! How stupendous are the Displays of thy *Greatness*, and of thy *Glory*, in the Creatures, with which thou hast replenished those Worlds! Who can tell what *Angelical Inhabitants* may there see and sing the *Praises* of the Lord! Who can tell what *Uses* those marvellous *Globes* may be designed for! Of these *unknown Worlds* I know thus much, ‘*Tis our Great GOD that has made them all.* (The Christian Philosopher 29)

By breaking down the finite borders that once limited God’s creation to Earth, C. Mather reveals a different universe that is expansive, inclusive, and perhaps even infinite. In his mind, there is no doubt that God is sovereign; however, here it is C. Mather who authorizes God to take possession and responsibility for a universe of creation beyond Earth and humanity.71

C. Mather devotes a second chapter to stars, with a focus on new stars discovered in the firmament. He provides a very brief historical catalogue of new star sightings, citing only two before the observation of the new star of 1572. C. Mather notes the location of the star’s appearance in “the Chair of Cassiopeia” and its duration: “[it] continued sixteen Months; then decreased; anon grew quite invisible” (*The Christian Philosopher* 31). The next sighting is in 1601, during which a new star appeared in the Swan’s Breast and remained for twenty-five years before disappearing. According to C. Mather, this star reappeared thirty-three years later, but remained visible for only a year or two. It came back a third time, this time five years later, yet it was much dimmer (C.

71 Cotton Mather and Isaac Newton share a similar point of view. In *Principia*, Newton writes:

This most elegant system of the sun, planets, and comets could not have arisen without the design and dominion of an intelligent and powerful being. And if the fixed stars are the centers of similar systems, they will all be constructed according to a similar design and subject to the dominion of *One*, especially since the light of the fixed stars is of the same nature as the light of the sun, and all the systems send light into all the others. And so that the systems of the fixed stars will not fall upon another as a result of their gravity, he has placed them at immense distances from one another. (940)
Mather records a magnitude of 6 or 7 as opposed to its original magnitude of 3).\textsuperscript{72} The most recent new star appeared in 1671, in the Swan’s Bill, lasting about a month.

C. Mather distinguishes between these new creations and variable stars like Mira Ceti. C. Mather refers to the intermittent star in the whale’s neck, noting its special appearance:

There is an admirable Star in the Whale’s Neck: This first appears as one of the sixth Magnitude, and then increases by little and little, for one hundred and twenty Days together, till it arrives to its full Bigness and Brightness,” which is that of the third Magnitude wherein it continues fifteen Days together: after which, it then decreases until it becomes invisible. It appears every Year… thirty two or thirty three Days earlier than in the foregoing Year; so that its Revolution is compleated in about three hundred and thirty three Days. (The Christian Philosopher 31)

Mira Ceti is not the only star that has appeared and disappeared for observers. C. Mather lists several other variable star sightings, such as one “Cloudy Star” that appeared and then disappeared in 1612 and 1613 (The Christian Philosopher 31). The same star reappeared in 1664, but behaved similarly by disappearing again shortly after it presented itself. C. Mather also mentions how “there were Seven Stars observed in the Pleiades” but now only six out of the seven can be seen, so “probably one of them is retired” (The Christian Philosopher 32).

Along with this practical information about new stars, C. Mather’s essay also reveals a somewhat conflicted view of human agency. At the end of this chapter, he asks:

Are the very Stars themselves liable to Vicissitudes? And shall not I look for them in this our miserable World? How little can I comprehend the Condition and Intention of the Stars? O Incomprehensible GOD, I will not cavil, but adore, when I find Mysteries in thy Providence, altogether beyond my Penetration!" (The Christian Philosopher 35)

\textsuperscript{72} The magnitude of a star is a measure of its brightness. The lower the number, the brighter the star’s appearance.
By arguing that it is God’s will for him to observe and investigate the stars, C. Mather sets up a no-conflict zone for science and religion. In effect, both ideologies can coexist harmoniously. However, C. Mather appears to struggle with the investigative limits of humanity. According to C. Mather’s belief system, there is only so much humans can understand about “the Condition and Intention of the Stars” since these conditions and intentions are controlled by an “Incomprehensible God” (*The Christian Philosopher* 35). C. Mather says that he accepts there are things he cannot know, and in fact, not knowing everything is necessary since God is definitionally infinite and unknowable. Nevertheless, C. Mather’s inquisitiveness in *The Christian Philosopher* seems to challenge the beliefs he asserts as it reveals a latent desire to know the secrets of the universe.

As these texts demonstrate, the stars were a crucial element of early American life. Yet, in relation to writings on other types of transient celestial light, such as comets, discussions of the stars as scientific phenomena are limited. Until the discovery of their appearance and disappearance, people took the stars for granted as fixed in time and space. They assumed the stars were always there, and they would remain forever into the future: they were regular, reliable, and stable. As Increase Mather states in *Heavens Alarm*, the regular, fixed stars of the heavens were signs of “events that in the ordinary course of nature should come to pass…They are Signs of heat and cold, wet and dry seasons, and the like” (*Heavens Alarm* 3). Recognizing that stars undergo change initiated a shift in their status from stable to transient, and subsequently, this shift had a ripple effect on an entire cosmological schema. Colonial Americans were certainly not at the fore of this discovery, and their ability to assist European astronomers throughout the
seventeenth and eighteenth centuries was restricted by their life needs and their lack of
access to technologies necessary for making certain types of discoveries. Nevertheless, it
is clear that colonial Americans were keenly interested in the behavior of the stars as
discussions about them, both fixed and new, permeated their religion, their studies, and
their popular literature. Furthermore, texts colonial Americans produced on the stars
demonstrate a transformation of their intellectual and emotional status as their thinking
shifts from pure speculation and astrological premises towards a newly ordered universe
based on a scientific understanding that demanded careful experiment and mathematical
calculation.
CHAPTER 4: ‘UNCOMMON OCCURRENCES IN THE CLOUDS’: OBSERVING THE AURORA BOREALIS IN COLONIAL AMERICA

The strange and unexpected appearance of the aurora borealis over New England in 1719 prompted Cotton Mather to warn his flock: “Be sure, People are never more fanciful and whimsical, their Imaginations are never more fertile, than when they have Uncommon Occurrences in the Clouds to work upon” (8). C. Mather’s words from A Voice From Heaven (1719) speak directly to the non-rational fear and anxiety that the imagination can provoke. As a student of both prodigies and natural philosophy, C. Mather speaks to his audience with candor. While his text offers rational, scientific observations of the aurora borealis, it also addresses the intense emotional reaction that the phenomenon evokes, and the ways in which negative emotions such as fear can divide a community.

This chapter investigates the confrontation between human beings and their perceivable universe in colonial America by exploring accounts of the aurora borealis: I consider how the historical act of observing the appearance of aberrant, transient celestial light precipitates shifts in the affective dimensions of knowledge pursuit, and contributes to the formation of new scientific communities during the late seventeenth and early eighteenth centuries. The central texts of this chapter are Thomas Prince’s An Account of a Strange Appearance in the Heavens (1719), Thomas Robie’s A Letter to a Certain Gentleman (1719), and Cotton Mather’s A Voice From Heaven (1719). All three texts rely on eschatological explanation and rehearse theological rationale, yet it becomes apparent within each narrative that these heuristics are insufficient for the task of depicting and interpreting the physical properties of the phenomena to which the writers
bear witness. In many cases, it seems that writers’ own observations work against their belief as their texts demonstrate a struggle between a keen interest in the data and their pre-established belief systems.

In this chapter, I explore the following questions: How does the appearance/sighting of the aurora borealis affect preexisting ideas about the earth-sky relationship? What new forms of knowledge emerge from scrutinizing the aurora borealis as writers translate mysterious visions into knowable data? What do eye-witness accounts reveal about the community of observers in the seventeenth and eighteenth centuries? How do writers address and reconcile non-rational emotional reactions with rational, scientific explanation? In what ways do these seemingly antithetical modes of thought inform each other?

In answering these questions, I focus on the works of these three figures—Prince, Robie, and C. Mather—who represent an emerging discourse that promotes a different emotional perspective by inviting readers to investigate and analyze the unknown with joyful curiosity rather than God-fearing despair. Furthermore, Prince’s, Robie’s, and C. Mather’s texts are part of a growing global network of scientific discourse dedicated to investigating and understanding earth-sky phenomena. All three texts reveal how the aurora borealis disrupts the normal function of society and serves as an interrogative catalyst: people suspend their routines and venture outdoors to look at the sky together, thus forming a community of active observers who purposefully scrutinize, rather than passively or fearfully watch. For early Americans, the aurora borealis, as a phenomenon that is translated, transcribed and interpreted via literature, becomes a reminder of their shared human condition and their existence not just on a continent, but on a globe.
Appearances of the aurora borealis have been documented throughout history by many cultures and, as one might expect, interpretations of this phenomenon vary. Although the aurora appears only in certain geographical locations near the earth’s magnetic poles, a telescope is not required to view the event, so anyone can participate in the observational act simply by looking at the sky. Aside from biblical references, what is likely earliest record of the aurora borealis in England was documented by Matthew of Westminster in 555 A.D.; thirty years later Gregory of Tours accurately wrote of an unusually spectacular aurora in 585 A.D. (Eather 41). Other references to the aurora appear in the Chronicles of Scotland, the Anglo-Saxon Chronicles, and the Irish Chronicles (41). The descriptions contained in these texts offer dramatic portrayals of the light display, likening it to a burning sky or fiery dragons. Numerous illustrations of the aurora borealis also exist; the first scientific illustration was published by Cornelius Gemma, born in Belgium, in 1575 (Eather 42).

In Western Europe, much of what was known about this phenomenon stemmed from Aristotle who wrote about different types

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73 Potential biblical references to the aurora borealis include: Joel (2:30-31), Acts (2:19), Genesis (15:17), Jeremiah (1:13), Ezekiel (1:1-28), and Zachariah (1:8).

74 There are extensive records of aurora borealis sightings among other cultures, particularly those closest to the polar regions. For example, in Nordic literature, the thirteenth century chronical Kongespeilet or The King’s Mirror provides vivid descriptions and discussions of the aurora. The legends and folklore of Inuit culture and groups native to the Americas also offer richly detailed explanations of the northern lights.

75 The printing press made it possible for the dissemination of writing about the aurora borealis in England and Europe. On October 11, 1527, a pamphlet was published describing a “comet,” yet it is considered the first auroral description (early on, “comet” was used broadly for any luminous appearance) (Eather 43). Other publications include a description from 1561 and one from 1563 titled A Goodly Gallerye, written by William Fulke, an English Puritan from Cambridge (Eather 44). Unlike some of the superstitious accounts of the phenomenon, Fulke’s pamphlet employs predominantly natural scientific explanations of the phenomenon.
of light appearances in the night sky. In *Meteorologica*, Aristotle discusses the various atmospheric “meteors,” which is a blanket term for any weather event occurring in the atmosphere such as thunder, lightning, and rainbows. He also speculated that certain celestial bodies (as we now understand them) such as comets qualified as sublunary atmospheric meteors. Aristotle conceived that the atmosphere was comprised of various types of vapor originating from the earth. Heavy, moist vapor that came from water sources and lighter, dry vapor that came from the ground. A meteor occurred when fire, air, water and soil combined in an unstable manner, and this event was responsible for changing wind and weather patterns. Aristotle considered light phenomena as meteors, explaining their luminescence as a type of fire ignited when earth’s gases rose and interacted with the element of fire (as the lightest of all four elements, fire naturally rose to the top). Aristotle frequently used the term “chasmata” to refer to light phenomena, but had many names to describe the behavior of light, one of which was “jumping goats” (Brekke and Egeland 35). By the end of the sixteenth century, Aristotle’s teachings remained as the standard of learning for many students in Western Europe. However, some scholars, namely Nicolaus Copernicus, were beginning to question Aristotle’s conception of the universe. Despite the Renaissance of arts and sciences in Europe during the sixteenth century, superstition and fear of the aurora borealis, which increased in activity during this time, continued to prevail in the seventeenth century (Eather 48).

In the early seventeenth century, rapid scientific and technological advances were taking place in the field of astronomy with the works of Kepler and Galileo, both of whom witnessed and wrote about their experience seeing the aurora borealis. Pierre Gassendi also mentioned the aurora of 1621 in physics textbook. Gassendi sought to
explain the aurora as a phenomenon that occurred at high altitude, which accounted for its being visible in many places distant from one another. The name “aurora borealis” or “northern dawn” is typically accredited to Gassendi, although credit is also given to Galileo (Eather 49). René Descartes also weighed in on the nature of this incredible light phenomenon, perpetuating the idea that the aurora resulted from sunlight hitting ice crystals; this idea made sense since the aurora borealis was typically seen in a more brilliant form in the polar regions. Like other erroneous explanations, this theory appears in several documents from the seventeenth century (Eather 49).

In general, after the 1620s, the solar activity level for the seventeenth century decreased significantly, thus there were few occurrences of the aurora borealis during this time period (also known as the Maunder Minimum). In An Account of the late surprising Appearance of the Lights seen in the Air, on the 6th of March last, Edmund Halley laments the limited documented appearances of the aurora borealis in English history. He mentions a few accounts from the sixteenth century, but from 1621 onward, he can

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76 Anders Celsius (1701-1744) criticized Gassendi and other European physicists for using the Latin term aurora borealis, since in Scandinavian culture, this phenomenon was called, more accurately, northern light (Brekke and Egeland 61).

77 Halley mentions a book, A Description of Meteors, that was reprinted in London in 1654 and signed by W.F.D.D. In this text, the author describes a vision of “Burning Spears” appearing in January of 1560 (An Account...on the 6th 219). There is also an account in 1564 of what seems to be an aurora. Halley refers to foreign authors such as Cornelius Gemma, quoting from his work to demonstrate the descriptive similarities: “a great many bright arches, out of which gradually issued spears, cities with towers and men in battle array; after that, there were excursions of rays every way, waves of clouds and battles…” (Gemma quoted in An Account...on the 6th 219). Regarding auroral appearances occurring after 1621 but before 1716, Halley mentions three occurrences, briefly documented in 1707, 1708, and 1710.
find no documentation of the aurora “either at home or abroad” for eighty years. While Halley is best known for his studies on comets, he was also interested in the aurora borealis, which he had never seen in his lifetime. In his account from March 6, 1716 he recounts his dismay at the possibility that he might never witness it:

This was the only one [meteor] I had not yet seen, and of which I began to despair, since it is certain it has not happened to any remarkable degree in this part of England since I was born: nor is the like recorded in the English annals since the year of our Lord 1574. (218).

Upon hearing about aurora’s appearance, he recounts how he “immediately ran to the windows” to get a glimpse of this “strange sort of light…” (An Account...on the 6th 214), and he stays out until “near three in the morning” to observe the it (An Account...on the 6th 217). Even after returning home, Halley camps out by the window in hopes of seeing “how this phenomenon would end” (An Account...on the 6th 217). What Halley observes prompts him jettison certain Aristotelian theories speculating that the aurora is caused by “the vapour of water rarefied exceedingly by subterraneous fire,” which was also a supposed cause of earthquakes (An Account...on the 6th 220). The aurora’s wide range of visibility leads Halley to the idea of “magnetical effluvia” (An Account...on the 6th 221):

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78 At least two students from Leipzig, Germany wrote dissertations on aurorae: Christopher Harvey Starck “De Aurore Bore (accent ague) ale” and Nikolaus Daneil Frueauff “De Aurore” written in 1675 (Eather 50).

79 Halley had a second viewing opportunity in 1719. In An Account of the Phenomena of a very extraordinary Aurora Borealis, seen at London on November 10. 1719. both Morning and Evening, Halley recounts:

I found certain white Streaks in the Sky, seeming nearly Perpendicular; which whilst I considered them seemed instantly to vanish, and soon after others came as instantaneously in their room. I began to image that this was likely to be some part of the Phenomena of the Aurora Borealis.
Some of these [atoms], by a perpetual efflux, arise from the parts near the poles of the magnet, whilst others of the like kind of atoms, but with a contrary tendency, enter in at the same parts of the stone, through which they freely pass; and by a kind of circulation surround it on all sides, as with an atmosphere, to the distance of some diameters of the body. (An Account...on the 6th 221)

He applies these ideas to “our globe of earth,” which he theorizes is “one great magnet” (An Account...on the 6th 221). Halley tracks the shape of the aurora as it moves toward a central point and theorizes that its appearance is a matter of perspective (the rays of light align on the magnetic field direction). Although he fails to make connections between his measurements and the local magnetic field in London, Halley’s observations are remarkably astute (Eather 52).

When compared with other anomalous appearances of light, the aurora borealis is particularly remarkable because of its extreme transience and changeability. Moreover, it stands out as a particularly novel phenomena in the eighteenth century due to its rarity throughout the seventeenth century. As Halley writes in his account from March 6, 1716: “But as this phenomenon found all those that are skilled in the observation of the heavens unprepared, and unacquainted with what was to be expected; so it left them all surprised and astonished at its novelty” (216). The European auroral display in 1716 marked the end of the Maunder Minimum period, and the beginning of a new era in the scientific study of the aurora borealis. Although witnessed by Thomas Prince while he was in England, the 1716 display was not seen across the ocean in the American colonies. However, New Englanders did receive a glimpse of the northern lights shortly afterwards in 1719, which is the event that Thomas Robie and Cotton Mather wrote about.

The appearance of the aurora borealis in early America does not receive as much attention in early American scholarship as other celestial events, such as comet sightings.
Robert Eather, in his book *Majestic Lights* (1980), dedicates one chapter to the northern lights in colonial America, citing Cotton Mather’s sermon as “the most complete account” of the phenomena. He writes,

The previous chapters mention just three contributions from America to the development of auroral science, viz., the theories of Franklin and Olmstead, and the auroral zone map published by Loomis. This is about as much space as historians ever give to early American research in the field and carries with it the implication that the aurora was merely an occasional curiosity to colonial American science. Nothing could be further from the truth. (94)

While Eather affirms that “auroral studies constituted an important part of colonial and post-Revolutionary science in America,” aside from C. Mather, most of his references to the aurora borealis in America are from the mid-eighteenth century and onwards. Despite Eather’s note about the dearth of scholarship on the aurora borealis in colonial America, few scholars have taken up this field of inquiry since the publication of *Majestic Lights* in 1980. A study of early eighteenth-century colonial American auroral literature is inevitably impacted by the phenomenon’s rarity at lower latitudes and, subsequently, by the paucity of documented observations of it. While this lack of material presents a certain challenge to this study, the texts I explore in this chapter demonstrate how the phenomenon’s scarcity makes its occurrence even more extraordinary and evocative for colonial American observers.

Thomas Prince’s *An Account of a Strange Appearance in the Heavens*, Thomas Robie’s *A Letter to a Certain Gentleman*, and Cotton Mather’s *A Voice From Heaven* reveal that there are many ways to discuss phenomena like the aurora borealis. All three authors explore some scientific aspect of the aurora by providing readers with empirical

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80 The 1719 aurora is considered the first to be seen in the American colonies, although there are references to light apparitions appearing in the journal of John Winthrop, recorded on Jan. 18 1644 and in Samuel Sewall’s diary on Dec. 22, 1692.
data. Yet, they also address the human emotional response (fear, wonder, curiosity, etc.) as they offer their readers interpretative guidance for understanding the presence of the aurora borealis and celestial phenomena like it.

Thomas Prince (1687-1758) was a New England clergyman and scholar who wrote about the earlier 1716 appearance of the aurora borealis in England. Prince attended Harvard University, entering in 1703 and graduating in 1707 with a BA and then an MA in 1710. He later accepted a post as pastor at the Old South Church in Boston. In 1728, Prince began writing *A Chronological History of New England, in the Form of Annals*. It took him almost ten years to complete the first volume, which only covered beginnings to the year 1630. Unfortunately, he was told by publishers that the book was too detailed and long to be interesting for readers. Despite the discouragement, Prince continued to work on a second volume; however, few people seemed interested in the work and it was eventually discontinued. Prince was also acquainted with the well-known New England Puritan minister, Cotton Mather. In his acclaimed biography of C. Mather, Kenneth Silverman refers to Prince several times as C. Mather’s protégé. Prince shared C. Mather’s interest in science; however, as a younger minister, Prince displayed a skepticism regarding prodigies that C. Mather could never wholly embrace. Prince’s eyewitness account of the aurora borealis is animated and reads as a kind of personal narrative describing his conversion from skeptic to believer in phenomena like the aurora borealis. Prince’s letter provides valuable scientific observations of the aurora borealis, yet his letter is as much about the aurora as it is about the human condition. Prince acknowledges the emotional impact of seeing the aurora borealis and its effect on the
imagination. Furthermore, his letter reveals the existence of a community of sky-watchers who observe together, or share their information afterwards.81

The title page of Prince’s publication contains a selection from the Book of Joel, which calls attention to the auspices of the aurora and reminds readers that Judgement Day is imminent. However, the contents of Prince’s letter suggest a different agenda, revealing Prince’s interest in the mystery and wonder of the aurora borealis. Prince begins his letter much like a personal narrative by highlighting his skepticism about the phenomenon and then revealing his amazement upon witnessing it. On the night of the aurora display, March 6, 1716, Prince was in town was approximately two miles from his home “in Company with several Ladies” discussing a newspaper article about sea monsters that had been recently seen in the Mediterranean. Prince does not reveal his thoughts on the existence of sea monsters, but when the conversation turns to anomalous light appearances, Prince makes his position clear: he considers “things as those” as the products of “fertile Tongues & Inventions of some Romantick People, & the fanciful & fearful Imagination of others” (2). Prince further admits to “depreciating the Stories & Opinions of the Ladies” almost to the point of rudeness (2). Prince’s condemnatory

81 In “The Science of Thomas Prince” (1935), Theodore Hornberger investigates Prince’s interest in Newtonian science and sheds further light on Prince as a figure who embodied “paradoxical” views similar to those of Cotton Mather. He explains how both Prince and C. Mather display “a frequent and confident use of scientific information and hypothesis, almost at the same time with an assumption of an interrupted and providential order of nature” (27). While Hornberger celebrates Prince’s scientific contributions as “a convenient index to important notions prevalent in America at the time” for students concerned with “scientific, philosophical, or theological” aspects of culture in colonial America, he holds the view that Prince’s writing has little if any “intrinsic value” as literature (26). My analysis of Prince’s account of the aurora borealis challenges this argument as it takes Prince’s writing seriously as both a work of science and literature.
speeches are interrupted by a little girl who informs the party of “a Great Sight in the
Air,” a happenstance that humors Prince and further contributes to his skepticism:

Upon observing them to listen with some Concern & Fear, I confess I coud’nt
forbare Laughing easily, & telling them in some sort of Triumph; I Believ’d it was
from the Whimsies of such little Girls as these that such Reports & Apparitions
arose. (3)

Prince eventually ventures outdoors, insisting that his decision to look was not to satisfy
lingering curiosity, but only to “oblige the Gentlewomen” in his party (3). However, upon
seeing the sky, Prince’s skepticism of the aurora borealis transforms into a belief in its
realness:

…about a Quarter after Seven. [I] was forc’d immediately to fall a Sacrifice to
what I then at least thought to be their more Orthodox Judgment. Heaven itself
seem’d to undertake their Argument & to prove it in so surprising & evident a
manner that I dare not any longer resist them. I saw what I cou’d never have
imagined before, and what I believe is utterly impossible for me to represent
exactly to your Imagination. (3)

Prince’s reaction to seeing the aurora borealis demonstrates the power and necessity of
experience, where one can visually confirm the real existence of phenomena. For Prince,
visual confirmation of the phenomenon is also a confirmation of divine intervention
where “heaven itself” authorizes human examination of the phenomenon. Furthermore,
Prince reveals how the aurora borealis acts upon him as it challenges the very limits of
his imagination. In effect, Prince must find a way to process the reality of what he
thought previously unimaginable. He then faces a secondary challenge of his imagination
as he struggles to narrate his experience to his audience. For Prince, seeing the aurora
borealis acts as a catalyst of the imagination, altering or expanding its potential scope.
The majority of Prince’s letters offers several, somewhat repetitive portraits of the aurora borealis, reflecting the common images associated with the phenomenon. These portraits are highly dramatized with figurative language, but retain their rational, scientific value by documenting important observational data. Prince writes:

There seemed to be a great Stream of Smokey Light rising in the N.E., reaching from near the Earth, ascending & waving like the Light of a great House or Bonfire in a dark Evening about half a Mile off, which we therefore tho’t it at first to be: But soon alter’d our minds when we saw it increasing in Breadth Length & Brightness, & pushing forwards, retreating & advancing in the shape of a Broad Sword & like the shooting Vibrations of a very high Blaze, until it extended to the Point over our Heads. As it increased in Bigness, so did it likewise in the Swiftness & Fury of its Motion & grew by Degrees into a blewish & fiery Colour, almost like to that of the Flame of Brimstone. Both the Colour & Figure continually changed I know not how, ‘till at length on sudden it brake forth into the Appearance of a raging & mighty Torrent of bloody Waters, that at first look’d like the sudden giving way of a Damm & the Sea hearing all irresistibly before it: Whereupon all that Part of the Heavens over us turned of an inconceivably bright Rainbow Colour, & immediately run into an admirable inexpressible Confusion of an infinite Variety of Motions that were amazingly quick and terrible to behold. (3)

Thomas Prince’s description of the aurora borealis is generally consistent with modern observations of the phenomenon. The aurora borealis, also known as the northern lights, and aurora australis (southern lights) occur when electrons collide with the upper parts of Earth’s atmosphere. The energized electrons attach to Earth’s magnetic field and move toward the polar regions where they collide with oxygen and nitrogen atoms in the planet’s upper atmosphere. During collision, the electrons transfer energy to the atmosphere, exciting atoms and molecules. As these atoms and molecules return to a lower energy state, they release energy in the form of light. The shape and range of the light is affected by the magnetic field of the earth, resulting in electrons forming two ovals around the earth’s magnetic poles. During geomagnetic storms, the ovals move away from the poles allowing the aurora to be seen at a given distance from the polar regions. There are several different auroral forms, but they commonly appear as curtain-like rays. As day progresses to night, the rays transform into arcs that span the horizons. Around midnight, the arcs change shape again, twisting as though being blown by the wind. At the peak of the storm, the light arcs enlarge to cover the entire sky; they can move and brighten quickly. As dawn approaches the aurora changes again, to resemble cloud-like formations. These formations are more diffuse and phase on and off for hours until sunrise, at which point the aurora disappears. The aurora typically forms 80 to 500 km above Earth’s surface. The occurrences of the aurora borealis correspond with space weather: during large storms, the aurora extends towards the equator, thus allowing the aurora to be observed in parts of the United States, Europe and Asia (“Aurora”).
Prince combines qualitative data with metaphorical interpretations to illustrate the physical properties, behavior, and impact (on the senses of observers) of the aurora borealis. Details such as the “smokey” appearance, the “ascending & waving” nature of the light, its increase in “Breadth Length & Brightness,” its “shooting vibrations” and its eventual transformation from red to a “blewish & fiery Colour” to a “bright Rainbow Colour” offer a foundation for successive viewing: once recorded, the signs of this aurora borealis may be compared with other anomalous appearances of light.83 With a base set of observations in place, a pattern may be established, which is a step towards comprehending why and how the aurora borealis occurs.

This information is important, yet the letter contains more than just a recording of Prince’s observations: it is also a story about the emotional experience of witnessing the phenomenon. Prince attempts to convey not only what he sees, but the feeling of seeing something extraordinary. To accomplish this task, Prince relies on metaphor and simile to depict the sensory and emotional impact of the event. Violent, threatening imagery such as “broad sword[s],” “Flame of Brimstone,” and “raging & mighty Torrent of bloody Waters,” pervade Prince’s introductory description of the aurora, thus suggesting a fear-response to the event. However, these violent images of devastation give way to “an

83 What Prince observes about the changing color of the aurora is relevant to recent projects which seek to uncover and analysis recorded information about past aurorae. Understanding the behavior of the aurora borealis historically may elucidate their behavior in the future. In “Evidence for Recurrent Auroral Activity in the Twelfth and Seventeenth Centuries,” David M. Willis and Chris J. Davis compile historical data regarding aurorae and draw conclusions from their findings. Although these researchers remain focused on the applications of historical observations to modern advances in science, their work reveals that early witnesses of the aurora borealis often made note of the color, which frequently appeared as red, and commonly described it as looking like the heavens were ablaze.
inconceivably bright Rainbow”; the light is then further characterized as “an admirable, inexpressible Confusion of an infinite Variety of Motions that were amazingly quick and terrible to behold” (4). Prince’s perceptions of the aurora in the final sentence of the passage indicate both fear and awe, as words like “admirable” and “amazingly” accompany confusion and terror. The strange light in the sky is “terrible,” but also compelling.

Even though Prince is unable to identify the nature of the light, he employs earthly imagery in an attempt to relate the phenomenon to knowable occurrences in the nature. A later passage further reveals how Prince’s perceptions appear to change as he personifies the light:

Sometimes they ran into Circular Forms, sometimes into Ovals, sometimes the Circles & Ovals were variously compres’d on their sides by their approaching nearer to one another, or the greater Interflux of the nameless & unknown Matter. Sometimes the winding within & hastily pursuing one another in the manner of whirlpools, & sometimes they ran around & cros’d like an 8, & in numberless other different Figures; that something resemb’d the various, quick & confus’d Rambles of Flies in the midst of a Room, or Spiders on the surface of a Pond; or the perplexing Contortions & Turnings of a great Heap of living Eels just cover’d with Water in the bottom of a Boat; or as the little Foldings & Ridges at the Tops & Bottoms of the Fingers; or to mention more Comparisons, like the Figures it is probable you have seen of Cartesius’s Vortices. (6)

To a certain degree, Prince demystifies the “nameless & unknown Matter” by employing commonplace, earthly images to make sense of this seemingly otherworldly phenomenon. Moreover, the figurative language is notably different from the previously violent, destructive imagery in the preceding section. Images of fire, blood, and weaponry are supplanted by images of the natural world such as “Rambles of Flies,” “Spiders on the surface of a Pond,” “Eels just cover’d with Water in the bottom of a Boat,” and “little Foldings & Ridges at the Tops & Bottoms of the Fingers Equipped.” These familiar,
earth-focused images naturalize the aurora borealis, yet the essential mystery of the phenomenon remains, as these images are qualified by “confused rambles” and “perplexing contortions.”

Prince’s use of metaphorical imagery to depict the aurora borealis to his readers suggests a type of literary imagination, or scientific literary imagination. Prince is neither a scientist nor a poet, but his writing incorporates elements of both science and poetics. As a writer, Prince acknowledges the difficulties in representing the aurora borealis to his readers in the letter’s opening paragraphs. Later in the letter, Prince writes: “I know not how to give you an Idea of this part of the Appearance; unless you may conceive something of it by the various & most violent Motions that are in a great Body of Waters...” and by the end of the auroral display, Prince writes about how its dissipation “put a gradual End to this real & most incomprehensible Vision” (10). Ironically, in writing the letter, Prince does express the very ideas he believes are “inexpressible,” incomprehensible” or un-representable. It is through language that Prince attempts to organize, express, and make tangible the “Appearance,” the “inexpressible Confusion of an infinite Variety of Motions.” But, by calling attention to the potential failure of language to capture what the aurora borealis has revealed to the observer, Prince preserves the non-rational mystery and sublimity of the phenomenon.

The content of Prince’s letter offers important information about how community forms during the event as people bear witness together. Over the course of one evening, Prince’s conception of reality changes as the universe reveals something completely new and unexpected in its presentation of the aurora display. Prince’s choice of imagery and metaphor throughout the letter demonstrate the profound psychological impact of the
aurora borealis on an individual, but the letter also reveals that the experience is not a private one. Prince uses his social encounters as a framework for his narrative and emphasizes his role as an eye-witness observer along “with all the Town of Stow-Market” as they “beheld [the aurora] for above an Half an Hour together” (1). In doing so, Prince establishes himself as part of a community of observers who share similar degrees of terror and awe at the sight of the aurora borealis consuming the night sky. Furthermore, experiencing the aurora borealis in a public locale obviates the possibility of any ocular deception: as part of a community of watchers, the failure of one’s senses seems less likely if others are around to confirm the presence of strange appearances. The community of observers allows for a consensus about what has been seen, so that seeing can truly be believing.

By using the first person plural and referencing the presence and reaction of other watchers, Prince highlights how observing the aurora borealis is a shared experience both physically and psychologically. Upon first seeing the aurora borealis, Prince writes: “[it] soon alter’d our minds when we saw it increasing in Breadth Length & Brightness…” (3). Wonder strikes everyone together as well as the fear that the aurora borealis portends havoc and mayhem:

It seem’d to threaten us with an immediate Descent & Deluge of Fire, filled the Streets with loud & doleful Ourcries & Lamentations &frightened a great many People into their Houses & we all began to think whither the Son of God was next to make His Glorious & Terrible Appearance, or the Conflagration of the World was not begun. (6)

While some people seek shelter in their homes, others remain outdoors to monitor the development of the phenomenon. In either case, the aurora borealis proves to be a disruptive force, altering the typical course of daily life by either forcing people indoors
Prince writes about a moment of shared vigilance as he describes walking out of town with an unnamed gentleman:

I then walked with a Gentleman out of the Town & went up on a Rising Ground, whence we saw a thick & lightsome Cloud directly in the North...And as the Cloud arose the Streams increas’d & flashed towards us & we thought the Aerial Armies were going to rally & make another onset: But they retreated again, as the Cloud passed on by the Borders of the Horizon to the West & slowly moved to a greater Distance from us. (9)

Prince is clearly not alone in his awe or his compulsory vigilance. His interaction with the gentleman further reveals how watching the aurora borealis has the potential to bring even complete strangers together.

Prince refrains from any deep theorizing about the phenomenon and ultimately attributes the aurora borealis to an act of God:

Great & Marvelous are thy Works O Lord! The Inlightened Heavens show forth the Glory: & the Flaming Firmament thine handy Operations! They Signs are Unsearchable: They Judgments are a great Deep: Thy Path is as in the mighty Waters: Thy Footsteps are not known: & thy Ways & Purposes are past, finding out. (12)

Although Prince names God as the supreme operator, the curiosity and intrigue implicated in his own words seem to betray that very statement, thus suggesting that God’s “Ways & Purposes” are not entirely “past, finding out.” Prince has been searching the signs in the sky, and he does attempt to make some sense of them. Since his readers have requested the information, they too seem unlikely to concede the search for knowledge to God alone. The answers may not be immediately forthcoming, yet the act of searching is perhaps inevitable—to not investigate is contrary to the spirit of humanity.

Thomas Robie, born in Boston and a teacher at Harvard, produces a different account of the 1719 aurora in a pamphlet titled A Letter to a Certain Gentleman. Throughout his life, Robie pursued interests in a variety of fields such as meteorology,
astrology, chemistry and medicine. Along with articles on these subjects, he published an almanac annually from 1709 to 1720. Although Robie was not a professional astronomer, his interests in planetary motion prompted his purchase of a telescope. Around 1723, Robie moved to Salem to further pursue his astronomical interests, but died suddenly in that year. *A Letter to a Certain Gentleman*, was his first pamphlet and it was well received by others in the scientific community. Like Thomas Prince’s *An Account of a Strange Appearance*, Robie’s pamphlet probes the workings of the aurora borealis, underscoring his interest in its mystery and wonder. Similarly, Robie’s letter addresses a community of sky-watchers and those interested in the aurora borealis. However, Robie’s account lacks the sensationalism present in Prince’s letter; it is noticeably more scientific as it favors empirical evidence and rational explanation over personal, emotional reaction.

*A Letter to a Certain Gentleman* presents an empirically-based investigation of the aurora borealis. Robie’s description of the phenomenon offers qualitative data regarding the physical properties of the aurora such as its location, distribution, color, opacity, and duration of the light. Robie bases this description both on eye witness testimonies and his own experience:

This Evening about Eight a Clock, there arose a *bright red Light* in the E.N.E. like the Light which arises from an house when on fire, (as I am told by several credible Persons who saw it when it first arose) which soon spread itself thro’ the *Heavens* from *East* to *West*, reaching about 43 or 44 deg. in height, and was unequally broad: It streamed with white Flames or Streams of Light down the Horizon (as most tell me) very bright & strong. When I first saw it, which was when it had extended itself over the Horizon from E. to W. it was brightest in the middle, which was from me N.W.: and I could resemble it to nothing but the Light of some Fire: I could plainly see Streams of Light redder than ordinary and there seemed to me to be undulating motion of the whole Light so thin was this Light as I could see the Stars very plainly thro’ it. (3)
Although Robie employs the threatening image of fire to characterize the light, he refrains from jumping to any apocalyptic conclusions. Instead, he uses his observations to form some theory about how, where, when, and why the aurora borealis occurs. Robie appeals to the rational reader by offering an analytical explanation, grounded in the terrestrial world, of how the aurora borealis came to exist. He presents his ideas through a series of rhetorical questions, which anticipate his readers’ questions and demonstrate his curiosity about the nature of the aurora borealis.

It is clear that Robie draws upon the teachings of Aristotle to formulate his explanation. Like Aristotle, Robie considers the possibility that the light emerges from the earth, as a meteor or exhalation. He attributes the lights, in part, to the “abundance of Nitro-Sulphurous Particles” which are “exhaled or forced out of the Earth continually,” particularly during the summer (5). As for the cause of the aurora, Robie strongly considers the possibility that the light display is related to weather conditions. According to Robie, two or three days before the appearance of the aurora, the weather was “Sultry hot” (5). Thus, he concludes that the unseasonably warm weather must be related to fire-like light display. Robie offers the following rationale:

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84 Robie further suggests that these particles are responsible for thunder and explains why thunder is more prevalent in the summertime:

That tho’ in the Summer time we have more hot weather, and so more Vapours are without doubt exhaled; yet whenever the Weather is what we call sultry hot, we commonly have much Thunder and Lightening, or a good deal of Rain; and so the Matter which occasions Meteors is consumed in Thunder and Lightening, or is mixed with the Particles of Water, and so descends to the earth again; and I am confirmed in this Opinion, in that (as the Chymists say) from Rain-water may be distilled a burning Spirit. (6)

For these explanations, Robie draws on John Wallis’s nitrous-sulphureous theories (Kilgour 479).
Now I believe there was a very great quantity of such Particles exhaled or forced out of the Earth in this hot weather, and this evening were fired; which because fire in such inflammable matter moves very quick, was the cause of the quick motion of Light from the East to the West, tho’ not contrary to the wind, yet across it: for the wind was then North. (5)

Robie interrogates his answer by posing several follow-up questions regarding the timing and abundance of these particle exhalations, the process by which the particles become inflamed, the aurora’s location, and the color of the light. Robie further proposes that the particle exhalations “were occasioned by some Subterraneous heat” and this heat is the result of “igneous Eruptions…which fires are the causes of dreadful Earthquakes which have sometimes occasioned the rise of Mountain and Land even out of the water it self” (6). While heat may be the cause of particle ignition, Robie wants to understand the chemical process of how exactly the particles catch fire. He suggests that the flame is caused by some type of combustion, a process by which the inflammable matter meets “with something of a contrary Nature to it” (Robie 7). Robie gives the following example: “For Experience shows, that if we take Niter, Brimstone and Quick Lime, mix them, and put them into an Egg-shell, as soon as they touch the Water they will fly out in an actual Flame...” (7). This passage highlights the need for experimentation to confirm the theory. However, since it is not possible for Robie to conduct experiments with the aurora borealis because of its intangibility, he must rely on applied logic:

Now according to Philosophy where there is heat there is fire. Or if it was not thus, as has already been explained, I don’t see why some fiery Vapour or other might not be driven out of the Earth or Sea so in its Ascent, meet with and give fire to this combustible Matter. As to its appearing more than once, the reason is the same as is given for the Repetition of the Flashes of Lighting. (7)
Robie’s explanations, though incorrect, are rational as he attempts to make scientific sense out of what he sees. Moreover, he does not attempt to hide the fact that he is theorizing.

At several points throughout the letter, Robie calls attention to his uncertainty. He recognizes the merits of his explanation, yet he knows and accepts the possibility that he is wrong. He ends the letter with the following statement:

I am apt from the Nature and of the thing to believe it was so. And this I shall take to be the true Solution of this wonderfull Appearance, 'till somebody will give me, or I can find, a better. (Robie 8)

Robie’s expression of uncertainty and his anticipation of a better explanation is not a weakness but a strength as it demonstrates an important milestone in scientific thinking. What is important here is not that Robie gets the right answers, but that he has a method that favors empirical data and experiment.

_A Letter to A Certain Gentleman_ provides its readers with a rational, scientific interpretation of the aurora borealis; however, it is not entirely devoid of religious references and emotional responses to the aurora. God remains operative in the grander scheme:

Its appearance was now somewhat dreadful; sometimes it looked of a Flame, sometimes a blood red colour; and the whole N.E. Horizon was very light, and looked as though the Moon had been near her rising. The dreadfulness as well as strangeness of this Appearance, made me think of Mr. WATTS’s Description of the Day of Judgment in English Sapphic. (4)

Like many observers, Robie acknowledges the human fear-response as he employs threatening images of fire and blood to describe the aurora. Furthermore, the repetition of “dreadful” conveys the notion that the aurora is a portent of evil to come. Robie shares
his intimidation with his readers, but also warns them not to jump to hasty conclusions regarding terrible occurrences that might follow (8). Robie writes:

And here I would intreat you to take me right, for I don’t mean that this Sight was not surprising to me, for I have said it was before, but I only mean that no Man should fright himself supposing that dreadful things will follow such as Famine, Sword or Sickness; Nor would I be understood to imagine, that there will not be fearful sights in the Heavens before the great and terrible day of the Lord.” (8)

Without debunking the potential imminence of Judgment Day, Robie addresses his readers’ emotions and reassures them that the phenomenon does not portend devastation.

Regarding prognostications, Robie dismisses those notions immediately:

I utterly abhor and detest ‘em all, and look upon these to be but the Effect of Ignorance and Fancy; for I have not learned Philosophy or Divinity, as to be dismayed at the Signs of Heaven; this would be to act the part of an Heathen not of a Christian Philosopher. (8)

Similar to what Cotton Mather proposes in The Christian Philosopher, Robie’s statement demonstrates the harmony of religion and science: the idea that scientific understanding, as opposed to irrational superstition, supports the Christian way. However, despite these pronouncements of no-conflict between science and religion, Robie does take measures to protect himself against saying something inappropriate or even heretical:

And then, By telling you what may in all probability be looked upon to be the Natural Cause thereof. And I hope (tho’ I believe I shall differ from some) I shall say nothing that shall be inconsistent either with Divinity or Philosophy. (3)

Robie does not go into further detail, yet this statement seems to reveal his anxiety about contradicting religious authority in the wake of science, which was a newly arising institution in the eighteenth century.

While Robie might be concerned with saying the wrong thing, he reinforces the harmony between science and religious thought in the closing lines of his pamphlet:

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If this is acceptable to you, I shall heartily rejoice, and allow you to expose it as you please, only concealing my Name; hoping what I have said may serve in some measure to illustrate the works of Nature, which all they who have Pleasure therin will inquire into, that so they may be excited to love, honour, and adore the GOD thereof; to whom be Glory forever. (8)

Robie’s request for anonymity and his dedication to the pursuit of knowledge about the works of Nature underscore his role as a scientist. By framing his science with religion (i.e. God), Robie establishes a way to investigate freely since whatever he discovers falls beneath God’s already established umbrella of creation. In sum, Robie’s pamphlet exhibits a rational, non-scriptural, scientific mode of inquiry that also demonstrates how science and religion can work together harmoniously—a point that Cotton Mather further illustrates in his sermon on the aurora borealis, A Voice From Heaven.

Cotton Mather’s sermon, A Voice from Heaven, reads almost like a fusion of Thomas Prince’s sensationalism and Thomas Robie’s rationalism. But, A Voice from Heaven seems a more complicated text than the other two, which has something to do with its author, who is a notoriously complex figure. C. Mather’s purpose is to address and instruct his flock, those who turn to him for spiritual guidance. More so than Prince’s and Robie’s account, C. Mather’s work makes use of the aurora borealis as a means of prompting self-reflection. Mather takes on some of the more intense philosophical

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85 C. Mather does not have a chapter dedicated to the aurora borealis in The Christian Philosopher, but refers to sunspots in the fourth essay:

Upon the Convexity of the Body of the Sun, there are observed black Spots, which are moveable, and changeable…These Maculae Solares are probably Evaporations, which arise from the Body of the Sun, somewhat as Vapours do from the Earth, and they form themselves into Clouds…Sometimes their Number is greater, and sometimes lesser, and sometimes there are none at all. Some of them shine, and others that shone, become dark. Diligent Astronomers, who have waited on them for nine or ten Years together, have never found them in all this time to return unto the Same Configuration. (37)
questions that Robie and Prince shy away from, offering an interpretation of the aurora borealis as a sign of God’s work.

For a glimpse into Mather’s life, Kenneth Silverman’s biography is particularly helpful. Silverman reveals Cotton Mather as a dynamic yet incredibly fraught figure and frequently defines Mather’s personality and behavior as “ambidextrous”—a quality both good and bad for C. Mather. In a section of the biography commenting on C. Mather’s dealings with witchcraft, Silverman writes,

In the style of the leading Christian scientists of his time, Cotton Mather dealt with pneumatological questions in both religious and scientific terms…He found nothing new in scientific ideas contrary to his belief in Spirit. At the height of the Salem crisis he wrote Winter-Meditations (1693), which discusses the formation of fossils and gives thanks that ‘we are born in an age of light.’ For Mather devils and telescopes both proved the existence of God… (94)

Michael Winship’s “Prodigies, Puritanism, and the Perils of Natural Philosophy: The Example of Cotton Mather” (1994) also illuminates Mather’s interest in both prodigies and science.86 Winship argues:

Left to his own devices, Mather would have been able to reconcile Newtonian physics and prodigies with little difficulty. But he was not left to his own devices. Rather, he grew aware that the transatlantic learned culture in which he avidly located himself scoffed at prodigies and dismissed those who believed them as vulgar enthusiasts. Thus, Mather realized that his attachment to prodigies put him at risk of ostracism from that culture. He never felt threatened by science itself, as he understood it; the source of his anxiety was the limitation on legitimate speech within the circles promulgating the new science. (93)

Winship further characterizes A Voice From Heaven as a “tortuous and revealing publication, partly a description of the aurora borealis and partly an attempt to justify his own resistance to the secularizing interpretations of the groups to which he was drawn”

86 What Silverman and Winship call attention to in C. Mather’s personality and subsequently in his science is similarly identified by Theodore Hornberger as “paradoxical” (“The Date” 419).
(“Prodigies” 102). This struggle between C. Mather’s “attachment to prodigies” and his desire to say the right thing in order to be accepted by an elite scientific community is revealed in the following lines from *A Voice from Heaven*:

> Indeed, it is a Weakness, to be too Apprehensive of *Prodigies*, in all *Uncommon Occurrences*. Yea, some things may be thought *Prodigies*, which may really be *Kindnesses* to the World; among which things we may particularly reckon *Exploded Meteors*. (3)

In a self-conscious manner, C. Mather attempts to weave his belief in prodigies into the currents of scientific thought. However, while he seems to downplay their significance in this section, he backtracks in a later portion of the text, as he writes: “Yet I will not utterly deny, but that something may be Read sometimes by the Light of those Fires. There is not always Nothing in them” (*A Voice* 10).

Regarding C. Mather’s position on science and religion: Mather tends to explore scientific principles within a larger framework of divinity, which is also demonstrated in *The Christian Philosopher*. C. Mather’s reading of the aurora borealis has two main tasks: to demonstrate how God is at work and to investigate the aurora borealis as a scientific phenomenon. But really these tasks are one in the same for C. Mather, because God is science and science is God. C. Mather refuses to sacrifice scientific explanation to blind faith; likewise, he does not abandon his faith for the sake of more seemingly rational scientific explanations. In *A Voice from Heaven* science never threatens religion; rather, C. Mather’s sermon demonstrates how science and religion function harmoniously, complementing one another in intriguing ways.

C. Mather begins *A Voice from Heaven* in a way similar to Robie and Prince, describing where and when the aurora appeared:
But the Account of *Ours*, which I now hasten to give you, is; That on the Eleventh of this *December*, (1719.) In the Evening we were here at *Boston*, pretty much surprised, with a Luminous Appearance in the *Northern part* of the Heavens, which extended in the Form of an Arch, from the *North-West* unto the *North-East*, a considerable way. It was a sort of Cloud, but so thin, that the Stars could be seen through it; and first of a Lighter, but anon a Redder, and a more Bloody Aspect. The Region of it, was much higher than the ordinary Clouds, which were plainly seen moving below it. Of this, we were soon more fully satisfied, when we received Accounts from our Friends, Fifty Miles Northward, and twice fifty Southward of us; That (as One letter informs us) at this time the Hemisphere being very clear, (which it was not at Boston,) and not a Cloud in the Sky, they saw a Glade of Light, grow from a smaller Bulk, first into paler Flames, and then into Redder, and so into the color of Blood. And, that (as Another) the Red was darker at the Western End of it, and Brighter at the Eastern. It seemed something to Expire, and then to Revive again. As midnight came on, it Renewed with what was commonly thought a more Terrible Aspect, than in the former part of the Evening. Yea, some Hours after That, it so Revived, that People at Work about their Saw-Mills, perceived their Trees to look Red with the reflection of it; and they could see to manage their work by it, as if the Light of the Moon, (which was now set) had favored them. (4)

C. Mather’s observations have a scientific value as he notes the time of the appearance, the shape, the direction of movement, the color and opacity of the light. His observations also comment on the emotional response to seeing the aurora borealis, indicated by his use of foreboding imagery. Furthermore, his reference to “Friends” northward and southward and the pause of people at work emphasizes the community of observers as well as the disruptiveness of the aurora on typical daily activity.

C. Mather is clearly interested in the science of the aurora, but *A Voice from Heaven* spends more time exploring the impact of the phenomenon on the human psyche. The majority of the text is comprised of reflection, and in it, C. Mather says some interesting things about knowledge:

It is remarkable to see, how much we are left in the Dark, and how much our Philosophy, is at a loss, about the Lights, that are ever now and then enkindled in the Heavens that are so near unto us. We may talk some fine Things, about the Sulphur and the Nitre, and the Je ne scay quoy, in the composition of them, and make our selves be admired for our Learned Jargon, among them that have
learned the Language. We may also propound unto Consideration, how far the Origin of such a Northern Twilight, as Gassendou’s [Gassendi, Pierre] and Our late One, may be found, in that constant Milky Way of the Sun, or, Glade of Light, which every Year strikes from that part of the Horizon where the Sun sets, up towards and almost unto the Pleiades, in the latter End of February, and the Beginning of March, whereof there is in the Posthumous Works of Dr. Hook, and Account Endeavoured. But still the Old Philosophers ingenious cry of, Darkness, Darkness! will return upon us. (A Voice 5)

C. Mather emphasizes the humbling effect that the aurora borealis has on humanity: for a man who has lived his life with access to scholarship, he is well acquainted with the catalogue of knowledge that humans have generated; however, when facing a phenomenon like the aurora borealis, all of that learning yields no definitive answers. When confronting anomalous events like the aurora, the human being, with all of its knowledge, seems quite insignificant in the grander scheme. C. Mather’s remarks almost suggest a type of anti-intellectualism as he points out how humans have made themselves “be admired for our Learned Jargon.” However, in this case, his distrust of the academic elite is justified: he recognizes how humans have been misled for many years in believing Aristotle’s version of the universe. For C. Mather, to not be skeptical of scholarship is dangerous. Instead of rallying against intellectualism, he appears to incorporate that skepticism and critique into the intellectual project.87 How C. Mather feels about being “left in the Dark” is unclear as he appears to both rejoice and lament humanity’s ignorance. On one hand, he relishes the mystery of existence as it corresponds with the

87 Another example of C. Mather’s skepticism of human knowledge:

I don’t see, that the Extent of our Atmosphere is hitherto well determined. For tho’ ‘tis pretended, That our Baroscope has fixed it, for less than Fifty Miles; yet Hartsoeker will persuade you that the Reports of that Mercury in this matter are no to be relied upon, but that our Atmosphere may extend some Hundred of Leagues; And, I confess, that for some Reasons, which at present I dont care to mention, I incline to that Opinion...But how poorly Qualify’d are we then to form a Judgment on many Things that are doing it may be up towards the Selvidge of this Atmosphere. (A Voice 6)
notion that humans cannot fully comprehend the workings of an infinite God. On the other hand, C. Mather’s own curiosity and will to know, evidenced by his life’s work, suggest a different desire: the desire to know the answers.\textsuperscript{88} Latent in C. Mather’s words is his struggle to reconcile the desire to know everything with the fact that, according to his beliefs, he should not and cannot know everything.

Science and religion never appear in all-out conflict for C. Mather, yet \textit{A Voice from Heaven} demonstrates how hard he must work to navigate and negotiate these belief systems. C. Mather clearly believes in the new science, yet he is also clearly unwilling to abandon certain beliefs even as they fall out of fashion among intellectuals. C. Mather carefully distances his views on divine interference from those who “are little enough tinged with Enthusiasm or Fanaticism” and resort to believing in “the Operations of Angels Good &Bad” (\textit{A Voice} 7). He reaffirms his belief in the “known Principles of Mechanism,” but accounts for the moments when these explanations fail. When answers are not forthcoming, turning to scriptural explanation may offer further insight:

\begin{quote}
Our Sacred Scriptures do sufficiently assure us, That the Angels both Good and Bad, are sometimes particularly concerned about the \textit{Meteors} in this \textit{Atmosphere}; the \textit{Tempests}, and the \textit{Thunders} raised there: yea, That the \textit{Heavens do Rule}, and the \textit{Invisible World}, has an astonishing share in the Government of \textit{Ours}. (\textit{A Voice} 7)
\end{quote}

\textsuperscript{88} Regarding C. Mather’s other scientific pursuits, one thinks particularly of his promotion of inoculation during the smallpox epidemic despite public disapproval. In his push to get the public to understand the benefits of inoculation, C. Mather literally put his life on the line. In one case, a grenade was thrown through C. Mather’s window containing the message: “‘COTTON MATHER, You Dog, Dam you: I’ll inoculate you with this, with a Pox to you’” (Silverman 350). After losing many of his children to the disease, his acceptance of inoculation suggests that he was not content to rely on prayer alone. While his worldview allowed there to be no conflict between this scientific development and God (i.e. God has permitted humans to discover something like inoculation), he was nevertheless relying on a type of human intervention in which God seems very much in the background.
C. Mather’s idea that God has full authority bears some resemblance to Thomas Prince’s conclusion that the aurora borealis is an act of God. But C. Mather provides a reasonable explanation for why God’s authority makes sense: there is no evidence proving that the universe is entirely mechanistic. In other words, while it may seem as though C. Mather is shirking the scientific method by allowing divinity to hold the reigns, his turn to religion is a logical progression. Rather than indulging in potentially misleading speculation, C. Mather is essentially admitting he does not know the answers, yet. The ability to admit that one does not know is an important scientific step because it leaves the door open for theory and eventually proof.

Portions of C. Mather’s sermon clearly demonstrate his interest in investigating the aurora borealis as a scientific phenomenon; however, figuring out the cause of the aurora is not his primary goal. His main task is to manage human emotional response and instruct his people appropriately so that they do not fear the future, whatever that future may bring. This task is crucial to the development of science, since the way a community reacts to unknown phenomenon can help or hinder a study of it. He writes, “it becomes not Serious Christians to be Dismayed at the Signs of Heaven...” (A Voice 8) and further explains: “People that know themselves Reconciled unto GOD, would never be so Terrified, as most People are, when they see any Fires kindling in the Welkin over them” (A Voice 9). Several times, C. Mather warns people about falling “under the prepossessions of a strong Imagination” as he refers to reports of people seeing “Phantasms of Swords & Spears, and Rivers of Blood, and Armies or Navies Engaging with one another, and the Canon with a roaring mouth vomiting out Fire upon one
another” (A Voice 13). In general, he chides his readers for allowing their behavior to be affected by negative emotional reactions to the aurora. He lists the ways people misbehave by preying on each other, abandoning their good education, ruining their finances, maltreating their friends, and most importantly:

Or, See a People Evidently near a dreadful Convulsion, & yet no Men of Sense Uniting to find out Methods for the Relief of the Publick Distress, but all generally Alienated from one another, broken into Factions, & Sacrificing all to Cursed Animosities…(A Voice 12)

It is this sad vision of society that leads C. Mather to deliver a powerful statement against prodigies:

If our Country have yet the Happiness, to have no such Symptoms in any Degree upon it, I should think, we may defy all the Prodigies in the World, for any Predilections of Evil, which they may give unto us. I hope therefore we shall Unanimously deprecate ’em! A reign of Piety, & Honest, & Charity, among us, would be such a Token for Good, that the People in the Wilderness could see no Tokens, that they should have cause to be Afraid of.” (A Voice 13)

In this way, C. Mather uses the aurora borealis to motivate society to unite and do good works. Thus, while A Voice from Heaven provides rational, scientific insight into the aurora borealis, it makes an even greater effort to address the non-rational emotive responses to this phenomenon.

C. Mather warns readers about the negative effects of reacting to the aurora borealis with fear and he guides them toward a different emotive relationship: he instructs them to embrace and celebrate the aurora along with the known and unknown universe. He asks:

What interpretation is to be made of the Aurora Borealis, that Heaven has lately shown unto us? I will say, That tho’ I can do very little by way of Prognostic; And I would not say that like the People of Gilead, when we see a Pillar of Smoke and a Flame ascending in Heaven, must we conclude, that Evil is coming upon us; Nor would I think the Meteor to be Signal Forerunner of whatever happens to Follow after it, Like the Honest Old Man upon Tenderton Steeple: Nevertheless,
no doubt the other *Meteors* of the heavens as well as the *Rainbow* are designed for Instructive ones. The glorious God who is their and our Creator (even He, who is also our Saviour) says of us, whom he calls to be Spectators of them, *Surely they will Receive instruction.* *(A Voice 13-14)*

What C. Mather proposes here is quite rational: rather than worrying about the portents of the aurora, allow it to be didactic. To further emphasize this point, he refers to the people of Greenland who allow the aurora to be “of incredible use to them in the Business of their Lives” *(15).* He then considers how New-Englanders might make use of the aurora:

> We may also render our Northern Light of some use unto us, in the Greatest Business of our Lives, it awaken in us the Right Thoughts of Righteousness. May not the Fiery Appearance make us Inquisitive [...] May not the Bloody Appearance, admonish us [...] May not *Rare Sights* calling us to look more than without them we should have done unto the *Heavens*, very well put us upon thinking, whether we are not so *Buried* in the Business of the *Earth*, as to need something that may call us off, to converse in a more Divine way, with more *Heavenly Objects.* *(A Voice 15)*

C. Mather encourages people to use the aurora for a purpose; he asks that they allow the aurora to awaken them, to make them inquisitive, and if necessary, to serve as a warning. He acknowledges the power of the aurora to call people away from their daily routines to confront something greater: it is a reminder of Divine mystery. Moreover, C. Mather wants his readers to be vigilant and analyze the uncommon occurrences in the clouds while keeping their imaginations in check.

The final paragraphs of C. Mather’s sermon take on a tone much different from these earlier sections. As *A Voice from Heaven* nears its end, it escalates in emotional urgency, transforming into a jeremiad. C. Mather ends with a reference to Judgement Day:

> Why should not this *Fiery & Bloody Appearance*, in the *Vapour of Smoke* lately before us, put us in mind of that *Great & Notable Day?* ... A Day that shall come as a Thief in the Night, and the Elements shall melt with fervent Heat; A Day, which, O Secure and Sleeping World, it is near, it is near, and it hasteth greatly!
‘Tis well for us if we are, and no little part of our Business to be Ready for it. (A Voice 16)

This apocalyptic turn is unsurprising for C. Mather, but it does seem out of place since he has presented, up to this point, a mostly rational approach to thinking about phenomena like the aurora borealis. While it may seem like fear-mongering, he has spent a significant portion of the sermon cautioning people against lapsing into wild interpretations and allowing themselves to be governed by irrational fear. Rather, this moment is as a call to action: he hopes that the aurora borealis will inspire people to take charge of their lives and make changes for the better. Furthermore, regardless of his personal desire to investigate the science of the aurora borealis, C. Mather needs to place phenomenon within a divine framework. This compulsion exposes his struggle to reconcile his inner passion for elite learning with his public role as God’s humble servant.

What is perhaps most interesting about A Voice from Heaven is that even though C. Mather perceives the growth and development of human knowledge within a divine framework, God is not at the forefront—humans are. In other words, God may have ultimate authority, but C. Mather has argued that God, in his ultimate authority, has authorized humans to look. Nothing they find can conflict with God because it is through God that the discovery has been made. In different ways, the works of Thomas Prince, Nathaniel Ames refers to the 1719 aurora in his 1731 almanac in both the calendar’s verse and the essay. In verse, he writes, “See how the Morning is mimic’d in the North/By strange and vaprous Lights that there spring forth...Unusual Lights by Night adorn the Skies./And the cold North is fill’d with Prodigies.” The essay offers an explanation similar to what Robie proposed; however, Ames does not endorse it. He is similarity reluctant to support the notion that the northern lights are portents. Despite his vague explanations, Ames offers an intriguing conception of God, describing him as “the Great God of Nature.” In this way, Ames suggests anomalies such as comets and the aurora are indeed natural occurrences, yet they do not appear by chance. Rather, God is the “one Architect above” and ultimate controller of the natural world.
Thomas Robie, and Cotton Mather suggest a type of humanism at work in the nascent period of science as a discipline. These texts may serve to remind us that science is filtered through our humanity; the important questions and goals do seem to be the same as they both emerge from and encircle the human condition, and our seemingly unique existence on this planet.

Observation of the aurora borealis is more than a data gathering mission, and discussing it is more than dictating a series of facts to an audience. The appearance aurora borealis in early America tells an important story about human curiosity and the power that curiosity has over daily life. It is an event that has the potential to bring people together in ways they may have previously thought to be impossible. Celestial events such as the aurora borealis remind us of our smallness in the universe, our susceptibility, and our general inability to defend ourselves against it if threatened; they also show us something about ourselves, as we experience wonder and awe at their majestic and sublime beauty. And, lastly, these events force us to think about the planet on which we live, the planet that we share with all other life, our home.

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90 In the eighteenth century, scientists were just beginning to realize the association between the northern lights and magnetism. These theories were beginning to replace notions of sulfurous or other gaseous compounds emanating from the earth. As explorers ventured into the polar regions in the early nineteenth century, they learned even more about auroral phenomena. This new research revealed an auroral zone at the poles.
CHAPTER 5: THE RAINBOW UNWOVEN: THE SIGNIFICANCE OF THE RAINBOW IN COLONIAL AMERICA

In the seventeenth and eighteenth centuries most meteorological phenomena were approached with trepidation. Rainbows, however, were an exception. Scientifically, the rainbow raised pressing questions about the behavior of light; in terms of religion, it symbolized a covenant between God and Noah (and humanity generally) that God would not flood the world again. Whereas comets, stars, and the aurora borealis evoked a fraught sense of the relationship between heaven and earth, the rainbow marked a more mutual one, acting like a bridge between the divine and the human. For early Americans such as Samuel Sewall, William Williams, Cotton Mather, and Jonathan Edwards rainbows were a source of both scientific and godly wonder. This chapter traces the significance of the rainbow in texts by these four authors as it pays close attention to emotionality and the experience of the observer. The chapter takes on the following questions: How do interpretations of the rainbow differ from interpretations of other forms of celestial/meteorological phenomena? How does the absence of fear change the way people respond, in terms of wonder, to the phenomenon? How did colonial Americans navigate or reconcile their religious understanding of the phenomenon with the developing scientific explanation of it (are they compatible or mutually exclusive)? Does a scientific understanding of the rainbow destroy or alter its significance in the religious sense?

For colonial Americans in the seventeenth century, rainbows were understood in two main forms: the religious and the scientific. For both theologians and scientists in the seventeenth and early eighteenth centuries, these discursive modes were not mutually
exclusive and often compatible. The writings of William Williams, Cotton Mather, and
Jonathan Edwards demonstrate this almost seamless transition between the rainbow’s
scientific data and its theological significance. Rainbows, unlike other forms of celestial
or meteorological phenomena, were considered signs of divine favor consistent with their
role in the Bible. As indicated in the Book of Genesis, the rainbow is “the sign of God’s
promise, meaning that he would not flood the earth again” (Gen 9:14). This promise is
the covenant between God and Noah, Noah’s descendants, and the animals:

And my covenant will I establish with you, that from henceforth all flesh shall not
be rooted out by the waters of the flood, neither shall there be a flood to destroy
the earth anymore. Then God said, This is the token of the covenant which I make
between me and you, and between every living thing that is with you unto
perpetual generations. I have set my bow in the cloud, and it shall be for a sign of
the covenant between me and earth. And when I shall cover the earth with a
cloud, and the bow shall be seen in the cloud…Therefore the bow shall be in the
cloud, that I may see it, and remember the everlasting covenant between God and
every living thing, in all flesh that is upon the earth. (Genesis 9:11-16)

As a “token,” the rainbow is the visible sign of the contract that God makes with
humankind. Moreover, as a covenant, the rainbow symbolizes a mutual agreement
between God and man, thus connecting heaven and earth in a reciprocity that does not
exist with other celestial and meteorological phenomena.

The bow that God sets in the sky is an assurance and a sign of peace, yet its
meaning is indelibly tied to catastrophe and the violence inflicted by God in the flood.
The image of the “bow” is both a sign of war and a sign of peace: it is God’s divine
weapon, yet it is a weapon being laid to rest (Serafini). For New England Puritans

91 This explanation is contested by other scholars who interpret this passage as simply a
reference to the rainbow as a natural phenomenon, which was also “a divine intervention”
that ended the flood. In this case, there is no association with a violent act (Serafini).
Filippo Serafini also remarks on the interesting usage of the rainbow as a “sign”: “The
particularly, natural disasters were often, if not always, interpreted as signs of God’s anger at the sinfulness of humankind. The rainbow was a welcome respite from dreadful thoughts elicited by most meteorological or celestial phenomena. Moreover, the rainbow represented more than one isolated good sign: it encompassed a positive view of existence and the entire world. As Filippo Serafini explains in “The Bow in the Clouds: the Biblical Symbolism of the Rainbow”:

The symbolic structure of the account allows for the affirmation that an essentially positive view of the world, typical of the Old Testament, cannot be blurred by either natural disasters or wickedness on the part of humans; this is because creation always manifests God’s will to care for and favor life.

Thus, the rainbow reminds people that despite frequent manifestations of God’s displeasure, he has not abandoned “his creatures” (Serafini). Moreover, as a natural phenomenon, the rainbow often marks the end of the storm, signaling a period of calm after turbulence.

In addition to Genesis, the rainbow appears in several other sections of the Bible, notably in the Old Testament in Ezekiel 27-29 and in the New Testament in Revelations 4:3 and 10:1:

And above the firmament that was over their heads, And I saw as the appearance of amber, and as the similitude of fire round about within it to look too, even from his loins upward: and to look too, even from his loins downward, I saw as a likeness of fire, and brightness round about it. 28. As the likeness of the bow, that is in the cloud in the day of rain, so was the appearance of the light round about 29. This was the appearance of the similitude of the glory of the Lord: and when I saw it, I fell upon my face, and I heard a voice of one that spake. (Ezekiel 27-29 Geneva Bible)
And he that sat, was to look upon, like unto a Jasper stone, and a sardine, and there was a rainbow round about the throne, in sight like to an emerald (Revelation 4:3 Geneva Bible)

And I saw another mighty Angel come down from heaven, clothed with a cloud, and the rainbow upon his head, and his face was as the sun, and his feet as pillars of fire. (Revelation 10:1 Geneva Bible)

In these instances, the rainbow appears like a halo, different from the covenant rainbow of Genesis, but similarly suggests something magnificent and wonderful. 92

In seventeenth-century Europe and colonial America, theories about the rainbow, like most meteorological and celestial phenomena, were derived from Aristotle’s work. Meteorologica (c. 340 BCE) posits that rainbows are the result of a relationship between the sun, a cloud, and the human eye. Aristotle believed that the cloud was composed of droplets of water and air; because of their small size, these droplets could not reflect the entire sun, but by making up a single surface, they could reflect its colors (Dales 81). 93 In Meteorologica, Aristotle groups rainbows together with halos, “mock suns and rods” because he believes these phenomena are caused by reflection (245). One of the key differences between the rainbow and the halo is color: the rainbow shows many colors while the halo appears white or lacking color. In an attempt to provide a reason for this difference, Aristotle writes:

We must refer to what has been demonstrated by the science of optics as our ground for believing that our vision is reflected from the air and other substances which have a smooth surface just as it is from water and to the fact that in some

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92 Serafini points out that “rainbow” is sometimes translated interchangeably with “halo.” He further notes some of the differences in translating from the Greek and Hebrew: toxón, or “bow,” in Hebrew qešet. Whereas, in Revelations, the author uses ĭris (Serafini).

93 Aristotle did not investigate what a single droplet might reflect (Dales 81). For a technical summary of Aristotle’s mathematical explanation of the bow’s shape, see Richard C. Dales, The Scientific Achievement of the Middle Ages (1973).
mirrors shapes are reflected, in others colours only…The colour of bright objects sometimes appears bright in the reflection, but sometimes, either owing to the feebleness of our sight, produces an appearance of another colour. (245)

According to Aristotle, the rainbow holds color because its source of reflection comes from the water, which is “dark,” whereas the halo is colorless because its source of reflection is the air. Furthermore, Aristotle suggests that the colors of the rainbow may change as a result of our inhibited eyesight and, in effect, the colors of the rainbow are what we see with imperfect vision. As one’s vision grows weaker, one sees different colors. To demonstrate how vision works as a filter of reality, Aristotle provides the following example:

An example of this is what used to happen to a man whose sight was weak and unclear: he always used to see an image going before him as he walked, and facing towards him. And the reason why this used to happen to him was that his vision was reflected back to him; for its enfeebled state made it so weak and faint that even the neighboring air became a mirror and it was unable to thrust it aside. (253)

Although Aristotle is conducting a scientific investigation, his theory noticeably lacks any sort of experiment to demonstrate the physics of the rainbow. Likewise, Aristotle’s explanation of the rainbow’s colors lacks empirical evidence:

Bright light shining through a dark medium or reflected in a dark surface (it makes no difference which) looks red. Thus one can see how the flames of a fire made of green wood are red, because the fire-light which is bright and clear is missed with a great deal of smoke; and the sun looks red when seen through mist or smoke. (257)

Aristotle uses familiar examples to explain reflection and color and while these examples approach a scientific explanation, it is clear that some specific connection to the rainbow is required. He also attempts to explain the timing of rainbow appearances, for instance, in the autumn they can “occur at any time of the day” but when the days are longer, “no
rainbow occurs midday” (Aristotle 281). These conclusions are based on astronomy, but rely on a model in which the sun is in orbit around the earth.

Although Aristotle’s theories had been around for a long time, they were not well known in Europe until the twelfth century. Part of the reason for their unpopularity was because they remained in their original Greek, which few people could read (Lee and Fraser 139). However, Aristotle’s theories were being studied in other parts of the world, particularly by Arabic scholars. The rise of Islam in the seventh century led to a renewed interest in the science of the rainbow, which led to the study of Aristotle’s works and their eventual translation into Latin. Scholars such as Job of Edessa (c.640-708), Alhazen (c. 965-c.1040), and Avicenna (980-1037) built on Aristotle’s theory of the rainbow. For instance, Job, who placed greater value on observation than Aristotle, offered a descriptive explanation of the rainbow’s shape in favor of Aristotle’s geometric one. He also claimed that the colors of the rainbow appear when the sun shines through the residual humidity after a rain. Later Arabic scholars, such as Avicenna, continued to interrogate the claim that rainbows are associated with reflecting clouds. Avicenna, who used sprays of water as an example, suggested that the small drops of water illuminated by sunlight are an essential quality of the rainbow and not coincidental. Avicenna offered some breakthrough ideas, but he retained portions of Aristotle’s theory when he could find no better answer. Alhazen, Avicenna’s contemporary and the first person to recognize that light travels from a seen object to the eye of the observer, also pursued the problem of the rainbow by positing the idea of refraction (Fitzpatrick). While he did not make the connection to the formation of the rainbow, he produced one of the first correct models of raindrops being lit by the sun (Lee and Fraser 143). It is from this model that
others were able to construct correct geometric explanations of the rainbow in the fourteenth century (Lee and Fraser 143).

One intersection between the Arab and European world comes from the seizing of the Arabic library of Toledo during the city’s fall in 1085 (Lee and Fraser 147). After this event, scholars began translating the library’s texts from Arabic to Latin (Ptolemy’s Almagest and Aristotle’s Meteorologica were among them). These newly available texts had a major impact on European universities in the medieval era.\textsuperscript{94} Aristotle’s texts, which authoritatively and definitively covered a range of subjects, became central to the curriculum. These new ideas replaced works by Isidore, Bede, and Rabanus Maurus, which garnered their authority from ecclesiastical sources (Lee and Fraser 147). In the former educational model, the teacher was considered a “conduit for received truth” (Lee and Fraser 148) and his ability to teach with authority “was guaranteed by Scripture and the Church Fathers” (Lee and Fraser 147). With the advent of Aristotelian ideology, a “new educational elite” emerged (Lee and Fraser 148). While faculty members were still considered clerics, “many of them had a new and quite different self-image as independent-minded students of the classical texts” (Lee and Fraser 148). This new era brought an end to one type of dogmatism, but led to scholasticism, another dogmatic structure of learning.

Between the twelfth and seventeenth centuries scientific thinkers continued to study the rainbow as they debated the process of its formation. The works of Robert Grosseteste, Roger Bacon, and Theodoric of Freiberg stand out as turning points in the

\textsuperscript{94} Most universities had a similar academic structure consisting of the superior and inferior faculties. The superior ones were “theology, law, and medicine” and the inferior one were the arts: “the trivium of grammar, logic, rhetoric, the quadrivium of arithmetic, geometry, astronomy, and music” (Lee and Fraser 147).
quest to solving the complicated and difficult problem of the rainbow. In the early thirteenth century Robert Grosseteste (c.1175-1253), a graduate of Oxford who studied geometry, optics and astronomy, challenged the current theory by considering refraction, rather than reflection alone, as a cause.\textsuperscript{95} In the latter portion of the thirteenth century, Roger Bacon (1219-1292) advanced the scientific process by turning to mathematics as a “final step” for any scientific pursuit (Lee and Fraser 156).\textsuperscript{96} Like Aristotle, R. Bacon still relied on sensory input as a “first step” toward acquiring knowledge, yet he championed experimentation, inductive reasoning, and observation (Lee and Fraser 155).\textsuperscript{97} R. Bacon placed a greater focus on measurement and introduced the need for appropriate instruments such as an astrolabe (Lee and Fraser 156). However, even with these new ideas in play, he was unable to completely abandon the Aristotelian explanation and admitted well into his study that the rainbow still perplexed him (Lee and Fraser 139).\textsuperscript{98}

\textsuperscript{95} Dales makes note of scholars’ disagreement on Grosseteste’s ideas as they argue over his ambiguous language; however, Dales makes a strong case for Grosseteste as an important contributor to scientific theory by laying out Grosseteste’s refraction theory (84).

\textsuperscript{96} Another noteworthy contributor to rainbow theory was Theodoric of Frieberg (see \textit{De iride}, 1310) who moved away from dodgy theories about clouds, reflection, and refraction. Instead, he was able to offer a geometry of reflection and refraction. Although his “quantitative details” were often incorrect, his “qualitative insights” were not (Lee and Fraser 166).

\textsuperscript{97} Lee and Fraser note that R. Bacon did not describe individual experiments but wrote about the process of experimenting. However, notes about the cost of books and instruments suggest that he did conduct experiments (Lee and Fraser 155).

\textsuperscript{98} R. Bacon does not abandon all of Aristotle; rather, he reintroduces reflection and contests Grosseteste’s suggestion that it is all refraction: “Whatever R. Bacon’s stumbles, he was an astute observer who advanced the idea that objective measurements of the rainbow would ultimately reveal its secrets” (Lee and Fraser 159).
While thinkers like R. Bacon continued to pick away at Aristotle’s rainbow theory, several of Aristotle’s core ideas remained intact until the seventeenth century.  

Leading up to the groundbreaking work of René Descartes and Isaac Newton, thinkers such as Tycho Brahe and Johannes Kepler continued the quest for decoding the rainbow phenomenon. Kepler, who advanced the work of Tycho Brahe, made discoveries foundational for Newton’s gravitational theory (Lee and Fraser 177). Kepler also advanced the science of optics by investigating aspects of human vision, the camera obscura, and refracting telescopes (Lee and Fraser 177). However, while Kepler discussed the rainbow in *Mysterium Cosmographicum* (1596/1621), he failed to produce a satisfactory explanation (Lee and Fraser 181). Seven years after Kepler’s death in 1630, Descartes offered what modern scientists consider the first real theory of the rainbow in *De l’arc-en-ceil* or “On the Rainbow” (1637) (Lee and Fraser 192). Some of Descartes contemporaries, such as Pierre Gassendi (1592-1655), recognized the merit and authority of Descartes’s rainbow theory, which valued mathematics more than Aristotelian sensory information (Lee and Fraser 193). However, despite the magnitude of Descartes theory, it was generally unpopular among seventeenth-century scholars.  

99 For sixteenth-century texts on the rainbow, see Leonard Digges’s (1520-c.1559) *A Prognostication of Right Good Effect*, which discusses the natural yet predictive power of the rainbow: “The Rainbow is the shining and rebounding of beames of light, that turne to the contrarie vapour againe in the cloude. It declareth sometime rain, and many times fayre weather: when the one, and how the other, is before opened” (13).  

100 Descartes rainbow theory was essentially the same as Theodoric’s, although it is thought that Descartes discovered this theory independently. For a technical explanation of rainbow theory and Descartes’s contributions, see Moysés Nussenzveig, “The Theory of the Rainbow” (1977). For a more skeptical view of Descartes contributions to rainbow theory, see Carl B. Boyer, “Descartes and the Radius of the Rainbow” (1952).
Descartes’s ideas, and the ideas of those who followed him such as Christian Huygens and Sir Isaac Newton, began to supplant the clunky, worn-out method of scholasticism that dominated scientific learning in the previous centuries. While Descartes was able to successfully overwrite many portions of Aristotle’s theory, the rainbow’s colors still confounded him. Following in Descartes’s footsteps Huygens continued to work on the theory of the rainbow, with a particular focus on the rainbow’s colors. However, a suitable theory was not proposed until Newton’s theory of optics, which he first explained in *Optical Lectures* and later presented to Henry Oldenburg, the secretary of the Royal Society, in a letter, which was eventually published. Newton’s ideas on color were considered radical as they challenged the very core of Aristotelian color theory (Lee and Fraser 200). While some of these ideas were derived from previous scholarship, Newton offered a set of original principals on the nature and behavior of light colors.

Newton demonstrated that the colors of the spectrum are fundamental and cannot be further reduced to other colors or changed with reflection or refraction. Establishing that prismatic colors do not change with reflection was significant because it contradicted the scholastic theory that color is an intrinsic property of the object. Newton also proposed that white light (sunlight) is composed of spectrum colors, which remain invisible until they are refracted. Newton supported his ideas with descriptions of experiments and he was confident that he was correct; however, his contemporaries remained skeptical and considered his ideas as just one of several potential working theories for solving the problem of light color. Newton was surprised, annoyed, and
ultimately discouraged by what he considered a poor reception of his theory (Lee and Fraiser 202).\footnote{Newton was after a science of color that was mathematical, yet he did not arrive a formula for dispersion or an explanation of the mathematics of color and refraction (Lee and Fraiser 202).}

The Royal Society was dedicated to gathering scientific information on various phenomena; however, this mission was more than simply collecting data as their contributors apprehended most subjects with a degree of scientific wonder. For instance, in a letter to the Royal Society from August 6, 1698 regarding rainbows Edmund Halley writes:

in the evening, between 6 and 7 o’clock, walking on the walls of Chester, I went to take the Air upon the Walls of Chester, when I was surprised by a sudden Shower, which forced me to take Shelter in a Nich that afforded me a Seat in the Wall…As I sat there, I observed an iris, exceedingly vivid, as to its colours…; and soon after, the beams of the sun being very strong, there appeared a secondary iris [rainbow], whose colours were more than ordinary bright…But what appeared most remarkable was, that with these two concentric arches, there appeared a third arch, nearly as bright as the secondary iris, but coloured in the order of the primary, which took its rise from the intersection of the horizon and primary iris, and went across the space between the two, and intersected the secondary…This uncommon Sight entertained me for about Twenty Minutes, when the Clouds blowing away, the whole Vanished. I was at first amazed with the Sight, but afterwards, recollecting that the Sun shone along the River Dee…I concluded, this Secondary Arch…was produced by the Beams of the Sun reflected from that Water… (193-195)

The appearance of the rainbow causes Halley to pause and take notice. He is clearly impressed by the vision and his impulse is to investigate what he is seeing instead of simply being awestruck. As demonstrated in his note, the sight of the rainbow prompts a thoughtful analysis of the phenomenon as he attempts to decode the complex function of light and the human ability to perceive it. Moreover, Halley presents these observational details in the form of a personal narrative: it is his experience. This type of experiential
confrontation with the phenomenon elicits an emotional reaction from the observer, which intimately links the observer to the phenomena in a unique way, different from learning about it indirectly. Additionally, like the aurora borealis, the rainbow required no instrument for viewing. Although its physics proved to be relatively complex, any person looking at the sky could participate in the observational act.

During the seventeenth and eighteenth centuries, the rainbow was observed, documented, and studied by several American colonists such as Charles Morton, Samuel Sewall, William Williams, and Cotton Mather, and Jonathan Edwards. University students would have also learned about rainbows as part of the curriculum. For instance, seventeenth-century Harvard students based their knowledge on Morton’s *Compendium*. His textbook highlights the dualistic manner by which colonial Americans understood the rainbow as both a light phenomenon and a sign from God. Furthermore, Morton’s textbook also demonstrates the ways in which folk-belief is woven into the beginnings of modern science.

Morton discusses the rainbow in the sixteenth chapter of *Compendium*, “of Appea[r]ing Meteors.” In this chapter, scientific explanation is interspersed with biblical exegesis and folk-belief, providing a multifaceted approach to learning about the rainbow while accommodating students’ preexisting belief structures. Morton begins his discussion of solar and lunar rainbows by referencing the flood and God’s covenant: “Solar that is the most notable of [all] these kinds as being dignifyed to become a seal of Gods covenant not again to distroy the World by water…” (109). He returns to the biblical rainbow event later in the chapter, claiming: “Besides this natural signification it has also another instituted to assure us of Gods Engagement, and purpose to moderate
rain for the Use of man, and not to distroy again the Earth thereby” (Morton 111). The inclusion of this perspective indicates that there is a real fear of the flood returning. However, Morton dispels this fear by offering a mnemonic couplet highlighting the intrinsic beauty of the rainbow and further suggesting that its aesthetic is amplified by its representation of God’s covenant. Morton also takes on the popular question of the rainbow’s origin and whether it existed in nature (pre-flood) before its mention in the Bible. To answer this question, Morton forgoes scientific reasoning and instead relies on a close-reading of the Bible to argue that the rainbow did exist before the flood: “Therefore the Words (I will put my bow in the Clouds) signifyes I will put it as a sign of my covenant, and not add a new creature to the nature of things” (111).

Morton references popular folk-beliefs in his text as he describes the rainbow’s “Prognostication” or the notion that one could predict the weather based on the rainbow’s appearance at certain times of the day. Morton seems to base this ability to predict the weather on folk-knowledge and includes “an old saying”: “A Rainbow in the Eve, put thine head in a Sheave, A rainbow in the morrow; go take thy bow, and arrow” (110). These rhyming couplets, interspersed throughout Compendium, are also serve as pedagogical tools to help students remember information (Cohen “The Compendium” 665). Similarly, in Morton’s discussion of lunar rainbows or halos, Morton’s explanation is a layered combination of observation and folk-knowledge. He explains that because the moonlight shines through a thin cloud, “the Colours of it do scarce at all appear but only as a Whittish Circle sometimes edged with a pale purple” (Morton 112). He follows this observation with another prognostic saying: “if more pale tis rain, If more redish tis a
stormy wind, but if a more bright white; it commonly preceeds good weather” (Morton 112).

Between these sections of biblical reference and folk-belief, Morton provides a scientific account of the rainbow. He explains, “the rainbow therefore is nothing but a multiplyed reflection of the Sun from a dewy Cloud, or [a] gently falling rain” (109). Although Morton mentions refraction of light in other sections of the book, he does not propose this theory for the rainbow. If Morton was aware of Newton’s ideas about the nature of light, then it is likely that he did not fully grasp their import (Cohen “The Compendium” 663). Morton emphasizes the position of the observer and the shape of the rainbow, noting that “the rainbow tis from every part that on all sides stand at the Dew angles with our Eye; and therefore if the Earth were transparent, we should see it a whole Circle and not a bow” (110). Morton’s science, regarding the rainbow as a full circle, is correct here, yet it runs the risk of contradicting the biblical interpretation of the rainbow as a bow. Morton’s also offers his experience observing rainbows. He includes a personal anecdote as he recounts seeing a particularly amazing rainbow. He writes, “Once I will remember I have seen such an Entire Circle standing on a Convenient ground for the purpose” (Morton 110). Morton’s inclusion of personal experience hints at

102 Morton’s chapter also covers double rainbows and the rainbow’s colors.

103 In the event of a rainbow, light enters a waterdrop and slows down as bends or refracts. The light then reflects within the droplet and then bends again when it moves out of the raindrop. Different types of light bend differently. The longer the wavelength the less it will bend. This is why the colors appear in their respective order in the rainbow (e.g. red light bends at a 42 degree and angle whereas violet light, being shorter, bends at a 40 degree angle). The rainbow typically appears as an arc because, as Morton astutely points out, the earth is in the way. The rainbow is actually a circle of light that is centered on the “antisolar point,” which is a point directly opposite from the sun that is relative to each observer (Waldstreicher).
the potential excitement of experiential learning, which may have influenced his readers or students, prompting them to use their experiences as motivation for scientific inquiry.

One first generation early American who documented his personal experience seeing the rainbow was Samuel Sewall. Sewall was a minister, a businessman, and a magistrate. He was no natural philosopher; however, his interest in meteorological phenomenon, as he recounts in his diary, points to a community of amateur observers in colonial America. An entry from 16 July 1697 highlights the communication between persons regarding the appearance of sights like the rainbow: “Rains sweetly at night, is a Rainbow in the morn as Mr. Goose tells me” (Sewall 457). While Sewall made plenty of firsthand observations, this entry suggests his desire to know about rainbows that he missed and, moreover, that others felt it worthwhile to share their experiences. Sewall’s diary (1674-1729) contains a vast amount of day-to-day information about life in the colonies. His notes on the rainbow are relatively straightforward and mundane: he does not speculate or attempt to explain any of the meteorological or celestial phenomena he encounters, yet the diary does suggest a preoccupation with the rainbow as he diligently notes when and where rainbows appear. His vigilant tracking of the rainbow suggests its appearance was always a significant event. If Sewall felt any particular emotion at the sight of the rainbow, it is absent in his entries; however, that he made repeated notations of the rainbow’s appearance suggests his keen interest in the phenomenon.

In most sections of Sewall’s diary, instances of the rainbow are short and unelaborate, appearing between commonplace moments. For instance on 31 October 1685, Sewall records: “Mrs. Prout, the Mother, is buried…Rainbow seen. Note, Little Hull had a sore Convulsion Fit this day about Noon, so that I was sent for home from
Court: had another near Sunset” (101). The rainbow appears among another series of seemingly commonplace event on June 3, “The widow of Gemaliel Wait buried. Thunder Shower took us at the Grave, the mourners went into the Schoolhouse; I to Mr. Chiever’s. When broke up a Rainbow appeared: was great Thunder in the night. All my married Cousins were in Town yesterday” (Sewall 179). Similarly, on December 1686, Sewall writes:

Going to Cambridge-Lecture, a little beyond Daniel Champney’s I saw a Rainbow to the North, being just about Noon: only Here. Simons with me just then; but Capt. Eliot and Mr. Tho. Oliver saw it, with whom rid over the Causeys. Mr. Oliver said he had not before noted a Rainbow in the North. Cloud rose suddenly very black and hail’d afterward. Ministers pray together at Boston this day. (158)

The juxtaposition of events (the rainbow, the inclement weather, and the prayer) may suggest Sewall considered a link between them, yet any clear understanding of their relationship is troubled by his lack of elaboration. Nevertheless, Sewall’s diligent record of the rainbow suggests that it was significant to him.

Two entries from Sewall’s diary indicate his understanding of the rainbow as a phenomenon of religious and scientific significance. Regarding the biblical interpretation of the rainbow, in an entry on 20 January 1687, he writes:

Mr. Lee preaches the Lecture. Eccles 7.13. From whence exhort ed to quietness under God’s hand: about middle of Sermon fire was cry’d, which made a great disturbance, by many rushing out. ‘Twas only a chimney I think. Spake of the inverted Rainbow, God shooting at somebody. And that our Time better than the former, and expected better still… (Sewall 165)

Although this is not a rainbow sighting, Sewall’s mention of the “inverted Rainbow” and “God shooting at somebody” indicates his familiarity with the biblical interpretation of
Sewall’s interest in the rainbow as a scientific phenomenon appears in a later entry on 15 February, 1697: “Remarkable Sun-dogs and a Rainbow were seen” (471). Although Sewall asks no further questions, his entry suggests his wonder at the appearance of both a sun-dog (an optical phenomenon that shows bright spots around the sun like a halo) and a rainbow. Like other entries, his mention of the rainbow is brief, yet the descriptive language seems to hint at a growing awe of the rainbow (Sewall 471).

Sewall’s diary offers a personal, private account of the rainbow’s impact, yet published sources, such as the almanac, suggest a general interest in the rainbow among colonial American readers. Almanacs were a form of popular literature as well as a key source of meteorological information. In addition to their monthly calendars, almanacs often contained at least one essay dedicated to some form of celestial or meteorological phenomena. In his 1685 Cambridge Ephemeris, William Williams includes an essay on the rainbow. The content of this essay demonstrates the multivalent thinking of seventeenth-century colonists, as Williams discusses the rainbow in scientific and theological terms. What is intriguing about Williams’s essay is the way he treats biblical information: he interrogates this information and treats it in a rational, scientific manner. Williams makes no transition between scientific and biblical information because his mode of interrogation is the same for both sets of data. He states: “There is a

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104 The inverted rainbow is known as a circumzenithal arc; it is like a rainbow, yet it is more closely associated with halos, and it is produced during the refraction of sunlight through ice crystals, forming in cirrus clouds, rather than water (rain).

105 An ephemeris is a chart or calendar that includes the positions and motion of predictable astronomical objects and events such as the stars, moon, and planets. This chart was often included in an almanac, or the work was called an ephemeris.

106 Williams relies on the Aristotelian assumption that the rainbow is the product of a favorable relationship between the sun and clouds.
twofold cause of Rainbows, Natural and Supernatural” (Williams 15). Regarding the natural, he writes:

The natural is twofold 1. It is a sign of Rain víz. when it appears in a very watry cloud, that it is ready to fall into drops, or when the colors of the bow grow little and little till at the last they are buryed in a black cloud; this is rarer then the contrary but when it happens is almost an infallible token of Rain ensuing. 2. It is a token of fair weather, when the colours of the bow gradually grow clearer and clearer till at length they vanish away. (Williams 15)

Regarding the supernatural, Williams refers to the Book of Genesis: “The Supernatural end of the Rainbow is to be a sign or symbole of Gods mercy to the world in never destroying it again by a deluge Genesis 9” (15). The rainbow’s appearance in the Bible also prompts the following historical, yet scientific question: “Whether or no there was any existence of Rainbows before the Flood is a Question?” (Williams 15). Williams points out that there is not a clear answer to this question as some disagree about when the rainbow came into existence. Williams seems to agree with “the Affirmative voice,” which he considers “to be the most clear and rational” (15). He further explains:

For since these bows are grounded on nature…we must either assert that nature was Supernaturally hindered in its operations (in that respect) till after the flood which is unreasonable, or else must maintain that a suitable cloud never opposed the sun and give occasion for a Rainbow till after the Flood, which would be “very strange” (Williams 15). While his question is based on a biblical event, its interrogation of the origin of the rainbow and the state of nature in the past is ultimately scientific.

The latter portion of Williams’s essay addresses the more theologically-based question of why God chose the rainbow as the sign of his covenant:

And if it should be asked why the Allmighty chose the Rainbow and not any other Celestial appearance. (If a reason might be attempted) we should say…because most proper for the signification intended thereby: Thunder and Lightning had too much terror, to have been tokens of mercy; Comets appeared too seldom to put us
in mind of a Covenant to be remembered oft: and might rather signifiye that the
world should be once destroyed by fire then never again by water… (15)

Williams reasoning makes use of empirical observation as he takes into account the
infrequency of certain phenomena such as the comet. Williams is also conscious of the
emotions elicited by sky-phenomena such as the terror generated by thunder and
lightning. He calls attention to the unique quality of the rainbow as a positive
meteorological sign, which may also prompt readers to consider the aesthetic allure of the
rainbow. Genesis provides assurance that it is a peaceful sign, but even without this
knowledge, the rainbow seems to possess an intrinsic beauty that makes people
experience emotions such as joy, happiness, and peace instead of sheer terror. Williams
ends his essay with a note of joy, calling people to “Look upon the Rainbow, and praise
him that made it” (15).

Cotton Mather’s Thoughts for the Day of Rain (1711/12) takes up some of the
same questions that Williams posed almost thirty years prior. A significant portion of C.
Mather’s essay highlights the rainbow’s significance in Genesis and provides an extended
commentary on how people should respond to the rainbow as a beautiful sign from God.
However, C. Mather also writes excitedly about the rainbow as a meteorological
phenomenon. C. Mather’s purpose is to explore the full meaning of the rainbow by
addressing it from several perspectives, all of which are intertwined.\footnote{Some sections from Thoughts are reprinted in The Christian Philosopher.} He interweaves
the theological, scientific, and aesthetic dimensions of the rainbow by shifting back and
forth between theological and scientific explanation: the theological version of the
rainbow leads to the scientific one and vice versa. For C. Mather, physics and theology
serve as epistemological vehicles for the pursuit of knowledge and meaning, which make
up the broader framework in which C. Mather operates. In other words, his goal is to uncover the meaning behind phenomena like the rainbow through various modes of inquiry such as natural philosophy or theology. Moreover, these modes of inquiry are not mutually exclusive; rather, they pair with one another in a complementary manner. Part of what makes C. Mather’s study of the rainbow so intriguing is what he actually uncovers: he discovers the depth of emotion elicited by the rainbow. The rainbow is a phenomenon that C. Mather considers “neglect[ed]” and “too much disregarded & overlooked in a World which owes more pious Regards unto it” (Thoughts 2). Unlike most other meteorological and celestial phenomena, the emotions associated with the rainbow are overwhelmingly joyous and beauty-filled.

C. Mather provides readers with a brief history of rainbow science, beginning with the work of Antonius De Dominis (1560-1624) who used mathematics to explain how the inner bow of the iris is formed in rain droplets in his book De Radijs Visus et Lucis. C. Mather’s inclusion of Antonius De Dominis demonstrates his extensive knowledge of the rainbow’s history as De Dominis, according to Newton, is thought to have come up with the first correct theory of the rainbow, although Descartes is usually credited with the first accurate model. C. Mather summarizes De Dominis’s theory, which argues that the interior bow of the rainbow “is made in Round Drops of Rain, by a Refraction of the Suns Light, and One Reflection between them; and the Exterior, by Two Refractions, and Two sorts of Reflections between them, in each Drop of Water” (Thoughts ii).108 C. Mather then moves on to Descartes’s discovery, which was derived

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108 The idea of refraction dates back to the work of Claudius Ptolemy (100-170 AD); however, his theory was inaccurate. Nevertheless, scholars such as Robert Grosseteste applied a refraction theory to the occurrence of the rainbow (see De iride). For further
from the work of De Dominis. In both cases, C. Mather emphasizes mathematical demonstration, particularly in Descartes’s work, which results in a sound rainbow theory:

He [Descartes] clearly demonstrated the primary Iris, to be only, The Suns Image, reflected from the Concave Surfaces, of an Innumerable Quantity of small Sphaerical Drops of falling Rain, with this Necessary Circumstance, that those Rays which fell on the Objects, parallel to each other, should not after One Reflection, and Two Refractions, (viz. At going into the Drop and coming out again) be Dispersed, or made to diverge, but come back again also to the Eye, parallel to each other. The Secondary Iris he supposes produced by those Rays of Sun, which fall more obliquely, but after the same manner as before, only in these there are Two Reflections before the Suns Rays refracted a second time, and tending towards his Eye, in a parallel Position can get out from the Aqueous Globules. (Thoughts ii)

C. Mather rehearses the technical details of Descartes’s work, yet in summarizing these new, rather difficult to grasp ideas, he makes the theory intelligible for his intended audience.

C. Mather praises contemporary scientists such as Edmund Halley and Isaac Newton, describing Halley as “the Acute and Accurate Mr. Halley,” who “shows how the Cartesian Problems were more easily solved than the Author himself imagined” (Thoughts iii). He has even greater acclaim for Newton, who he calls “The Perpetual Dictator of the Learned World in the Principles of Natural Philosophy; and the most Sagacious Reasoner upon the Laws of Nature” (Thoughts iv). C. Mather has every reason reading on how refraction was applied to rainbow studies before the seventeenth century, see Carl B. Boyer, “Refraction and the Rainbow in Antiquity” (1956). A corrected law of refraction is typically attributed to Willebrord Snellius, a Dutch astronomer. Thomas Harriot also knew of refraction, but did not publish his findings. While this law was known by a few men prior to Descartes’s discovery of it, Descartes was the first to publish it in 1637. Descartes claimed he discovered the law independently of Snell. Twenty years later, Pierre de Fermat proposed that light travels at a slower speed in media than air. Although Fermat was ultimately correct, he was challenged by other well-respected scientists who asserted that light travels at a faster rate in media than air. Fermat’s theory remained unsubstantiated until the mid-nineteenth century when wave theory was introduced (Young). See also Richard Fitzpatrick, “Geometric Optics”(2007).
to champion Newton, since Newtonian physics were construed as validating God’s presence and work upon nature. He further describes Newton as “The most Victorious Assertor of an Infinite GOD, that hath appeared in the bright Army of them that have driven the baffled Herd of Atheists away from the Tents of Humanity” (*Thoughts* iv). He goes on to summarize what Newton has accomplished in *Opticks* regarding the “*Phaenomena* of the Rainbow,” yet remarks on the limitations of understanding the complexity of this work:

But if all my Countrymen could Read *Oughtreds* Characters, or ken the Terms & Rules of *Trigonometry*, with the Doctrine of *Fluxions*; yet my Printer could not easily accommodate us, with the *Schemes* that would be needful for *Dilucidation*. The very few that would be gratified with such things, I leave to Consult the Authors themselves, & shall proceed unto more *Theological* and *Agreeable* Contemplations. (*Thoughts* iv)

C. Mather blames the printer for being unable to produce the characters necessary for these types of explanations, yet he also hints that even with the appropriate characters, only a few of his readers would be able to appreciate a mathematical explanation. In an earlier passage, C. Mather identifies his audience as he justifies the content of his essay:

The Readers for whose Edification these *Essayes* are chiefly Calculated, are for the most part Plain men, *Dwelling in Tents*. It would rather puzzle such Readers than *Instruct* them, to give them a Lecture on the *Mathematicks* of the Rainbow Nor does the Author profess himself to be so much of a *Mathematician*, as to do it with the Exactness, wherewith it ought to be done, or to be any more than a *Wellwiler to such Mathematicks*” (*Thoughts* ii).

While C. Mather grasped the basic principles of Newtonian physics, he was aware of his limitations (particularly in mathematics) and clearly unafraid to make it known to his audience. Despite his lack of mathematical prowess, C. Mather demonstrates that his strength lies in being a communicator and an interpreter of scientific accomplishments. He remarks on science’s missteps:
the Modern Corrections of ancient Errors, proceed unto the Differences between the Solar Iris, and the Lunar: and between the Iris and the Halo; so little progress have we yet made in real and certain Knowledge, that I should Leave you after all, with the Subject of my Discourse, but in the Clouds. (Thoughts 3)

In this section, C. Mather also reveals his genuine curiosity to know more about the rainbow, suggesting his commitment to a level of understanding beyond speculation and theory.

C. Mather uses the appearance of the rainbow in the Book of Genesis as a basis for scientific inquiry as well as emotional response. In response to the biblical event of the rainbow, he writes:

This is the COVENANT, which our God has made with the Earth; and the Rainbow is the Sign and Seal to the Covenant. We should thankfully Remember it, as often as we see the Rainbow, and Say; Blessed be our Gracious and Merciful and Long-suffering Lord, who hath Sworn, that the Waters of Noah shall over the Earth no more! (Thoughts 16)

Rather than generating a theology-based question, the question this biblical moment elicits is ultimately a scientific one. C. Mather asks rhetorically: Whether there were any Rainbow before the Flood? And, in response, he states:

There is nothing in Scripture, no, nor Nature neither, to assure us, that there was. We are not sure, that the Constitution of the Air, and the Clouds, before the Flood, was the same, that it was afterwards. We are sure, that the Flood brought a Marvellous Alteration on the World; probably on the Air, as well as on the Earth. (Thoughts 16)

C. Mather’s reasoning here is entirely rational as it reveals his allegiance to empiricism. Since no theological or scientific evidence exists to support the presence of rainbows appearing before the flood, one cannot draw a conclusion. Additionally, he explores the possibility that nature was entirely different and perhaps the familiar laws of physics did not apply. C. Mather cites Dr. Jackson, who suggests that the air was different and lacked the “peculiar Disposition, which is required unto the Production of the Rainbow”
(Thoughts 16). He also notes that others share this view, acknowledging that “many Christians also deny the Antediluvian Existence of it” (Thoughts 17). This investigation into the scientific origins of the rainbow leads C. Mather back to theology. By closely analyzing biblical text, C. Mather challenges the view that rainbows did not exist before the flood while offering a different way of thinking about its origins:

The Lord speaks not of the Rainbow as a New Thing; He seems to speak of it, as a Thing that had been already placed in the Clouds; I have set my Bow the Cloud. He invites us rather to Look on the New Use which He assigns unto it. (Thoughts 17)

Thus, for C. Mather, it is less important to argue over whether the rainbow was there or not there, but to focus on how one might use the rainbow in daily life: “My Readers, will you give me leave to teach you the Use of the Bow?” (Thoughts 66).

C. Mather characterizes the rainbow as having several different use-values, all of which are emotional and piety-invoking. The rainbow is an “Admirable Spectacle,” a source of beauty and “good thoughts,” an inspiration for poetry, and a reminder of terror (Thoughts 5).109 As a spectacle, the rainbow evokes wonder:

[It is] the Wonderment wherein we behold it; It is to us, we would rather say, The Mother of Wonderment. But the Wonders which it raises in our Minds, ought to be tuned into Praises of the Great God, whose Strength is in the Clouds... (Thoughts 6)

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109 C. Mather emphasizes that the rainbow should inspire genuine “Good Thoughts,” for this way of thinking, according to C. Mather, is enriching for the mind. He writes, “Whenever a Rainbow is Exhibited, there is a Sett of Good Thoughts, with which it should always be Look’d upon” (Thoughts 5). He even places a positive spin on God’s bow, which may be interpreted as a weapon, by suggesting: “my Design is, now to fit some Arrows for the Bow of God, and make ready a Quiver of Good Thoughts, Which are to be shot from that Bow into the Minds of the Faithful, as often as it appears unto us” (Thoughts 5). C. Mather’s emphasis on “good thoughts” recalls his Bonifacius (1710) or his “Book of Essayes to do Good.”
C. Mather’s rhetoric is celebratory as he champions the sentiment of wonder as long as it leads one’s mind to God. In this way, the rainbow also evokes a type of beauty: “Look upon the Rainbow, and praise Him that made it; very beautiful it is in the brightness thereof” (Thoughts 6). C. Mather promotes the rainbow’s beauty as long as it is wedded to piety. He writes, “But we may not, we will not flop here. We will go on to such an Useful Contemplation of the Rainbow as may render it a noble Instrument of Piety” (Thoughts 6).110

C. Mather further emphasizes the rainbow’s pious beauty and the role of spectator in the second section of his essay, “The Savior and his Rainbow.” This portion of C. Mather’s text, informed by an emotive aesthetics, lapses into a completely metaphorical state. In effect, rational and non-rational thought processes become confused, leading to ambiguity regarding what is scientific and what is religious. For instance, he writes:

Perhaps, there is nothing in all the Meteorous Kingdom so very Beautiful. Such is the Beauty of the Meteor...That which it becomes us most of all to Ponder, is, That the Sovereign Creator of the World, has in His Wisdom Stamp’d a Sacramental Character on the Rainbow; He has Instituted the Rainbow, for a Sign, and Seal, of His Covenant with the World. (Thoughts 39)

Here C. Mather appears to encourage his readers to indulge in the beauty of the rainbow, but with the following caveat: this indulgence must lead to holy contemplation. He even chides those who look upon the rainbow without considering its heavenly implications: “It is a real Fault in the People of God, that they can be Spectators of the Rainbow; with no more Proper, Holy, Heavenly Thoughts, produced in their Souls” (Thoughts 46).

110 Thoughts also demonstrates how the rainbow inspires poetry as C. Mather includes some of his own verse along with the words of Richard Blackmore. C. Mather writes: “Who sees bright Meteors in the Liquid Skies,/The wonderous works of the Eternal spies” (Thoughts Title Page).
In “The Savior and his Rainbow,” C. Mather’s rhetoric shifts back and forth between emotive states as he invokes the jeremiad while reinforcing the generosity of God’s covenant. C. Mather addresses his audience specifically by speaking directly to his fellow New Englanders: “But must my poor NEW-ENGLAND, have no part in the Rainbow, about Him, that has hitherto been the Hope of NEW-ENGLAND, and the Saviour thereof in the Time of Trouble!...Yea, there are some very Base People among us” (Thoughts 63). Despite this woeful lament, C. Mather emphasizes the rainbow as a harbinger of God’s good will towards humans as he confidently states: “The Rainbow is Naturally a Token, that the Rains will not be Great, nor Long: and that Fair Weather is anon to be Look’d for” (Thoughts 19). The rainbow and the covenant it represents provides people with a sense of God not as a destroyer of earth and humanity but as a “preserver”: the “Preservation of the World” is “promised with the Rainbow” (Thoughts 19). C. Mather ends his essay on a positive note by acknowledging the rainbow as a clear signal of a better world: “This, This is the Voice of the Rainbow unto us, Be Encouraged, O People of God: Let things Look never so dismally...” (Thoughts 21).111 However, even though the rainbow is ultimately a positive sign from heaven, it is still a reminder of the “Woful” and “Fearful Desolation” that the flood brought upon the “Wicked World” (Thoughts 7). C. Mather also takes this opportunity to point out that while humanity may not drown, they can still burn: “Tho’ a Watery Food that may drown the World, is no more to be fear’d, yet there is a Fiery Flood, for the depredations whereof a miserable

111 By providing the various names for it in Hebrew, Greek, Latin, French, Italian, Spanish, German, and Native American (“our Indians call it by some such Name, as Ukqumogquoanuh”), C. Mather highlights the global witnessing of the rainbow even though different rainbows are seen at different times and in different locations (Thoughts 3).
World is growing horribly combustible” (Thoughts 25). Likewise, although C. Mather interprets God’s bow as “without Arrows,” he cautions people that God has a “Quiver full of them” (Thoughts 31). C. Mather dwells on the loss of life that presumably occurred with the flood; however, this loss is tempered by the belief that the world was “Ill-peopled” and “The World of the Ungodly” (Thoughts 14).

In addition to discussing the nature of rainbows, C. Mather is further interested in the flood for scientific reasons since he believes that science can provide historical proof of biblical events. As scholars have pointed out, the new science offered Puritanism an opportunity to prove biblical happenings as well as the existence of that which occupied an invisible realm. Regarding this proof, C. Mather writes,

The Water poured out from these direful Orifices, upon the Earth, must needs overflow it; until the Omnipotent God restored the former Center of the World. Finally; The Incomparable Sir Isaac Newton, judges the Universal Flood, cannot have better, and fairer Account given of it, than this, To Suppose the Center of Gravitation removed for a Time, towards the Middle of the then inhabited Parts of the World: And a change of its Place, but the Two Thousandth parts of the Radius of this Globe, were enough to bury the Tops of the Highest Mountains under Water. But we have notorious Proofs, in our Subterraneous Occurrences, that the Flood reached unto America too. (Thoughts 12)

Whereas previously the Bible was a source of information for the truth of certain events, C. Mather’s interest in using empirical evidence to support biblical events suggests an interesting reversal of this thought. By initiating a search for evidence in nature, C. Mather runs the risk of disproving the word of the Bible. Additionally, he risks his own faith in the truth of these events by investigating them. Kenneth Silverman explains how this shift in thinking is potentially problematic to C. Mather’s faith, “…the very piety evident in such thinking—widespread among Christian scientists of the eighteenth

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112 C. Mather also sent these details in a letter to John Woodward of the Royal Society. See Chapter 1.
century—obscured its dangerous implications, and unwittingly led Mather close to irreligion…” (250). However, Silverman suggests that “Mather shared unawares in some of this subversive shift in emphasis” (250). C. Mather’s potential subversion of the traditional tenets of his faith appears in his confident and excited response to the news that bones, allegedly of a giant, were found in New York:

The Ruines and Reliques every where found in the Subterraneous World, which could proceed from nothing but the Flood, (as our Accomplished and Victorious Woodward among the rest, & beyond the all, had rendered incontestable,)…Among the rest, the Undisputed Skeleton of an Humane Body, of about Seventy Foot Long, and his Teeth, some above Two Pounds, and other more than Four Pounds in Weight, lately dug up in our Neighbourhood at Albany, at such a Distance from the Sea, that it could be no Animal of the Sea: This can be no other, than a Lively Proof, brought from America. [How it came hither, Heaven knows!] (Thoughts 8)

C. Mather’s exuberance at the possibility that proof has been found that “There were Giants in the Earth in those Dayes” suggests that the Bible’s word is not enough—it cannot offer confirmation like science can (Thoughts 9). However, as Silverman suggests, it is unlikely that C. Mather’s conscious mind would not have thought of it that way. For C. Mather, science or natural philosophy served as a means to a theological end. Furthermore, his emphasis on the value of finding these fossils in America works to affirm the original errand into the wilderness and typology. In this way, the Puritan mission, their journey to America, was exactly what God had intended.

C. Mather shares this desire for empirical evidence with Jonathan Edwards (1703-1758). Like C. Mather, Edwards is also willing to risk the possibility of being wrong in order to have scientific proof stand as a buttress to his religion. Edwards believed that historical meaning was a required “foundation for the typological interpretation, even if the typology is ultimately more important for what it reveals about Christ” (Kreider 99).
As a later figure, the works of Jonathan Edwards represent some of the ways in which science continued to impact theology in the eighteenth century. What appears as a latent struggle regarding the limits of human knowledge in the works of Cotton Mather is at the forefront of Edwards’s approach to science and religion. In *The Science of the Soul*, Sarah Rivett explains the plight of eighteenth-century ministers (Edwards included):

Repeatedly and collectively, philosophers and ministers grappled with the problem of uncertainty, a deep and ensconced awareness that their techniques of observation could extend to a world just beyond the natural but that the divine knowledge produced therein might also extend beyond revealed truths and scriptural law. This dangerous and uncharted territory meant that new knowledge carried with it the threat of repeating original sin. (288)

Rivett addresses the anxiety that ministers faced as they searched more deeply for answers to nature’s mysteries. There was a concern about discovering too much and worsening their fallen state, thus repeating original sin. Rivett further explicates Edwards’s confrontation with the limits of knowledge as she focuses on his preoccupation with the invisible world and the fallibility of the human senses. By employing “whimsical—even sentimental—images from nature” in his writing, Edwards attempted to form “a bridge” between his “theological and natural philosophical endeavors, between the human soul as microcosm of the divine and the natural world as a macrocosmic map of God’s omnipotent presence” (Rivett 296). However, eighteenth-century philosophy presented a significant challenge to this “bridge” as it called sensory data into question. Rivett summarizes Edwards’s struggle in navigating the disparate philosophies of Spinoza and Locke. Spinoza argued for the elimination of sensory data and championed reason alone while Locke remained loyal to sensory information. Locke confronted the question of how the senses might lead one to “larger rational structures” (Rivett 296). Like Spinoza, Newton argued for structures of reason in the natural world
even if scope was limited: “the world reflected the causal effects of divine existence but could not lead to knowledge beyond that” (Rivett 296). While aware of its fallibility and limitations, Edwards believed in the power of human sensory information. His proposed solution for dealing with their shortcomings was by tapping into “an indwelling principle.” Rivett explains,

The indwelling light of Christ constituted an ontological as well as theological shift in which divine essence opened the mind to “divine consciousness,” which gathered knowledge of religious mystery from the innermost recesses of the self. In place of a universe of signs, the soul became the space where divinity resided. Edwards looked to the soul for a solution to the mechanical philosophical limits of nature. If decoupled from the nominalistic tendency of natural philosophy and observed as spiritual entity unto itself, the “indwelling principle” might provide empirical access to the divine. (291)

The indwelling principle lifted the restrictions placed on the human capacity to know as it “transformed the limited scope of human capacity from a fallen to a redeemed condition of rational comprehension” (Rivett 296). By way of the indwelling principle, Edwards promoted the human senses with the idea that they could offer a more profound type of knowledge than reason alone.

While the characteristics that Rivett identifies appear in many of Edwards’s well-known works such as Sinners in the Hands of an Angry God (1741), his personal writings on the rainbow appear to lack that philosophical complexity and seriousness; however, what they offer instead is a sense of the curiosity and joy that meteorological phenomena like the rainbow inspires. Throughout his life, Edwards produced several different discussions of the rainbow: “Notes on Scripture” focuses on the rainbow as it appears in the Bible as the covenant while his short essay, “Of the Rainbow,” is purely scientific,
describing the physical properties of the rainbow.\textsuperscript{113} Both of these texts are lesser known works of Edwards, and they pose a series of challenges for historians and interpreters of his work because their precise historical details, such as when Edwards wrote them, are unknown.

Edwards’s scientific investigation of the rainbow, “Of the Rainbow,” offers no poeticisms or theological rationale, but it does reveal Edwards’s scientific curiosity.\textsuperscript{114} Edwards explains his purpose: “We shall endeavor to give a full account of the rainbow; and such an one as we think…will be satisfactory to anybody, if they are fully satisfied of Sir Isaac Newton’s different reflexibility and refrangibility of the rays of light” (“Of the Rainbow” 298). Edwards puts forth an example of how the rainbow effect might be achieved in daily life:

And [I] can convince any man by ocular demonstration in two minutes on a fair day that the reflection is from drops, by only taking a little water into my mouth, and standing between the sun and something that looks a little darkish, and spiriting of it into the air so as to disperse all into fine drops; and there will appear as complete and plain a rainbow, with all the colors, as ever was seen in the heavens. (“Of the Rainbow” 298)

\textsuperscript{113} Edwards also commented on the rainbow’s appearance in Revelation 4:3 in No. 270 from “Notes on Scripture (1737/8) and, publicly, in a sermon series from 1738 “Charity and Its Fruits.” The rainbow also appears Edwards’s notes on no. 370 of “Miscellanies,” and in “An Unpublished Essay on the Trinity” (see also Kreider 94). As Glenn Kreider notes in \textit{Jonathan Edwards’s Interpretation of Revelation 4:1-8:1} (2004):

Edwards’s use of the rainbow in these various sources indicates that one sign can have a number of significances…Thus, the symbol of the rainbow is multifaceted. It has a number of typological references, all of which find their common center in the person and work of Christ. (98)

\textsuperscript{114} Stephen J. Stein comments on Edwards’s curiosity:

Even before 1737, more than ten years earlier while at Yale College, Edwards had paused to observe the rainbow. Then his principal interest had been scientific, not theological. The rainbow attracted him as an inherently curious phenomenon which he was confident the new science of the day could explain…He wanted to discover the relationship between Newton’s ideas and certain natural phenomena as rain, clouds, dew, lightning, and thunder. (445)
This example is significant as Edwards sets out to show that the fine drops of water are the source of the rainbow. Moreover, “Of the Rainbow” grasps the idea that the rainbow is generated from refraction rather than reflection alone.

In contrast to “Of the Rainbow,” Edwards’s commentary on Genesis appears in No. 348 in his “Notes on Scripture.” In this text, he begins with a reference to the rainbow as a symbol of God’s promise not to flood the earth again.

This Beutifull pleasant Light appears after darkness after the Heavens have been covered with blackness & have poured out Rain on the Earth Seeming to threaten its destruction by a deluge. So it is a fit Symbol of his mercy after his Anger the turning away of his Anger his mercy appearing in the forgiveness of Sins. (Edwards quoted in Stein 450)

However, the commentary that ensues deviates from this initial biblical reference and takes the form of a poetic rumination about the rainbow. Edwards writes,

Tis Light manifested in all the variety of its beutifull colours which Represent as has been elsewhere Shewn the Beauties & Sweetness of the Divine Spirit of Love and those amiable Sweet Graces & happy Influences… (Edwards quoted in Stein 448)

When compared with C. Mather’s Thoughts for the Day of Rain, Edwards’s text shares some similarities in that both authors shift back and forth between theology and science as they indulge in musing about the rainbow’s beauty and its representation of goodness. Both C. Mather and Edwards discuss the rainbow in terms of its divine power; however, unlike C. Mather’s text, Edwards’s No. 348 does not speak to any potential readers or offer them instruction on how to think about the rainbow. As a private reflection, Edwards’s text ruminates on the rainbow’s loveliness. Moreover, while that loveliness is

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inherently attached to God or religion, Edwards appears to revel in the aesthetics of the rainbow, and subsequently produces a commentary that bears its own aesthetics in its poetics. There is a loveliness to Edwards’s prose and he clearly selects each word with care:

Tis a pleasant Light in the Bosom of a dissolving Cloud that is wearied with watering and is Spending it Self from the Sake of men & in order to Shed down its fatness, its Nourishing, benign, Refreshing Influences on the Earth and So fitly represents the Beauty & Love & Excellent fullness of Christ as it is manifested in his Dying for men… (Edwards quoted in Stein 449)

In “wearing with watering” and “Spending it Self from the Sake of men & in order to Shed” employs consonance that gives this text a particular poetic resonance. Likewise, Edwards combines personification with sensuous yet somewhat visceral bodily imagery as he depicts the cloud as weary from shedding its watery fatness from its Bosom. Although Edwards associates this image with the “fullness of Christ as it manifested in his dying for his men,” his description of the cloud is almost maternal as the cloud’s fat bosom provides “Nourishing, benign, Refreshing Influences on the Earth” just as mother might feed her infant.

Edwards’s commentary in No. 348 is clearly motivated by the flood in Genesis, yet much of the text is dedicated to a discussion of the rainbow as representative or symbolic. For instance, Edwards highlights the unity of the rainbow as each drop is required to make up the whole:

The Whole Rainbow Composed of Innumerable Shining beutifull drops all united in one ranged in Such Excellent order Some parts higher & others Lower the Different Colours one above another in Such exact order. Beautifully Represents the Church of Saints of different degrees Gifts & offices Each with its proper Place & Each with its peculiar beuty each drop very beutifull in it Self but the whole as united together much more beutifull… (Edwards quoted in Stein 450)
Edwards continues this line of thought by further suggesting: “a Drop of Rain fitly represents man it is a very Small thing of little value…Rain sinks into the earth like man sinks into the grave” (Edwards quoted in Stein 452). However, the sun shining through those drops represents the saints: “for in them fire & water are mixed together which fitly Represents the Contrary principles that are in the Saints flesh & Spirit” (Edwards quoted in Stein 452). In these sections, Edwards indulges his imagination as his perceptions of the rainbow are informed by aesthetics and poetics. His use of language demonstrates the ways that non-rational thought processes informed his science and, likewise, the ways that rational thought processes, such as science, informed his imaginative poetics.

Stephen J. Stein comments on the apparent exceptionality of Edwards’s poetics in “Jonathan Edwards and the Rainbow: Biblical Exegesis and Poetic Imagination,” noting that although “New England did not condition him to write poetry, Edwards’s flights of exegetical fancy fulfilled some part of the universal drive to be poetic” (Stein 440). In certain ways, Edwards poetics may seem antithetical to his Protestantism, nevertheless, his writing reads poetically. Stein points out a similar oddity in Edwards’s use of his imagination: “His imagination carried him in unpredictable directions as he pondered upon the texts of Scripture. His powers of association and analogy were not restricted by a tight hermeneutic” (456). Edwards’s apparent use of his imagination went against what Stein describes as “that Protestant distaste for imaginative interpretation” as Edwards “did not restrict his own reflections to the literal sense of the text” (454). Rather than focusing on the rainbow’s effect on Noah, Edwards launches into a more figurative

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116 Edwards focuses on the colors of the rainbow in his other commentaries. Both Stein and Kreider note Edwards’s fixation on the color green as being “the most pleasing [or pleasant] color,” as the rainbow is described “in sight like unto an emerald” in Revelations 4:3 (Kreider 92).
consideration of the “union of God and man in Christ” from the Genesis passage (Stein 454). Stein further characterizes Edwards’s imaginative and allegorical writing found in No. 348 as “theological musings” (456). Unlike some of his more “rigorous endeavors,” No. 348 was “a kind of theological play” that Edwards engaged in for “amusement and relaxation” (Stein 456). Similarly, Glenn Kreider comments on Edwards’s imagination: “Edwards expects that some will criticize him for having an unbridled imagination, finding types where none should be found” (99).

Both of Edwards’s rainbow texts, No. 348 and “Of the Rainbow,” are undated, which has made it difficult for historians to place Edwards’s writings in any certain historical context. While Stein suggests that No. 348 was likely written in the early 1740s, another editor of Edwards’s work, Wallace E. Anderson, attributes “Of the Rainbow” to Edwards’s second year of graduate study. Sereno Dwight and Egbert Smyth, biographers and editors of Edwards’s work, ascribe “Of the Rainbow” an earlier period in Edwards’s life, before he entered college (Anderson 5). However, Anderson disagrees, arguing that Edwards would have received little training in natural science and logic, as these disciplines were reserved for college and not typically found in the grammar school curriculum. Accepting an earlier date for “Of the Rainbow” also brings up the question of how Edwards accessed Newton’s work on optics if he was living remotely. Anderson makes a case for accurate dating and correcting erroneous dating of these works since it leads to “a distorted picture of his intellectual development…” (2-3). He identifies Edwards’s work in “Of the Rainbow” as belonging “decidedly to the modern rather than the medieval age” and argues that even though Edwards lacked the mathematical skills
and ignored the necessity of experimentation, his thinking never retreated to scholasticism (Anderson 47).

Regarding Edwards’s combining or reconciling theology and science, Stephen J. Stein argues that Edwards’s discussion of the rainbow in “Notes on Scripture” is “an excellent illustration of his combination of science and theology” as the text moves “back and forth…from meteorology to theology” (447). Glenn Kreider further explains Edwards’s combining theology with science:

In addition, Jonathan Edwards was convinced that what he could learn about the rainbow through studying nature and science would aid his interpretation of this symbol. Edwards believed that God’s revelation in nature is consistent with his revelation in Scripture. Of course, Scripture takes priority. God’s word interprets God’s world. (98)

However, what Stein describes as Edwards’s unconventional style or unusual biblical exegesis might be better appreciated as something altogether different. Rather, No. 348 seems to elude classification as it is neither wholly scientific nor religious. In certain ways, Jonathan Edwards, like Cotton Mather, stands as a representative of the early American, Protestant mind. However, in other ways, these figures are outliers of their respective generations, religions, and communities. However, if we view their texts as representative, these works do appear to reveal a change in colonial American perceptions of celestial and meteorological events as they demonstrate how what was once a seamless transition from scripture to science or nature requires, by the eighteenth century, a more compelling argument regarding the authority of scripture over the authority of nature. Moreover, it is perhaps because of the rainbow’s perceived benevolence, as opposed to the extreme fear elicited by other celestial and meteorological
light events, that makes it easier to explain as a natural phenomenon instead of a wholly divine occurrence.
CHAPTER 6: CONCLUSION

Although Cotton Mather was a privileged member of elite New England society, his writings offer us some of the best insight into the changes taking place within the New England mind. Since C. Mather wrote avidly and so much of his work survived, he is a rather obvious figure for scholars of early American history and literature. However, in addition to the fact that we have access to his texts, the value of C. Mather’s work lies in the way that he writes: by writing candidly, in some instances, C. Mather reveals his psychological state to his readers. While C. Mather’s thoughts do not necessarily reflect those of the laity, the shifts in his writing do provide an ideal example of how intellectual and emotive states were transforming during the late seventeenth and early eighteenth centuries.

As many scholars have already pointed out, C. Mather appears to stand on the precipice of a new era and his writing exposes a self-consciousness about his liminal position between the old and the new. Michael Winship aptly characterizes C. Mather’s intellectual stance:

Mather could be in this sense both a Newtonian and a Puritan. But he was painfully aware that the natural philosophers whose good opinion he craved were contemptuous of such a combination. It that awareness lay the source of his anxiety about science. (“Prodigies” 105)

Winship further points out, C. Mather was more concerned with “what constituted correct speech for a learned person” than he was about his belief in the validity of prodigies. If we allow C. Mather to be representative of the New England intellect during this period, we recognize a significant shift from the perspectives espoused in Wonders of the Invisible World to the perspective that The Christian Philosopher endorses. As I have
argued in this project, this shift is not a simple one. It involves more than a turn away from religion toward a secular scientific rationality. Rather, as the texts discussed in this project demonstrate, there is a complex intellectual and emotional overhaul taking place in this period. Moreover, the exploration into these intellectual and affective shifts prompts the following questions: Do new forms of rational thinking (e.g. new science) precipitate changes in humans’ emotive posture toward nature or the celestial realm? Or do changes in humans’ emotional relationship to their surroundings pave the way for new, rational intellectual postures such as the new science?

By looking at a figure such as Cotton Mather, what becomes clear is that the answers to these questions are not at all straightforward. However, these difficult questions lead us to consider the ways in which non-rational processes such as emotion bleed into our rational, intellectual or empirical thought processes, leading us to an awareness that they are not separable. It is this inseparability and confusion between the intellectual and the emotional that complicate the way we classify these texts as scientific and/or religious. The destabilization of these categories also affects the way historical frameworks such as “The Enlightenment,” “The Scientific Revolution,” or even “Puritanism” inform these texts. I am not suggesting that these frameworks should necessarily be dissolved or that they are not useful, but I have taken a skeptical approach to using these movements’ parameters in my analyses as each one comes with a set of criteria that seem consistently in-flux.

While religion, particularly the rigidness of the Puritan faith, might seem antithetical to scientific thinking, colonial Puritan writers often demonstrated otherwise: rather than acting as a barrier, Puritanism embraced new science as its representatives
found ways to present modern astronomy as complementary to biblical exegesis. Without supplanting biblical explanation, the Puritan writers that I have discussed in this project have generally presented both science and religion as viable philosophical modes of thinking. Their texts offer readers an intersection between science and art, as they expose the ways in which science is channeled through the human capacity to imagine and feel.

Some of the questions this project tackles might be applied to other forms of scientific inquiry such as geology or medicine; however, my reason for investigating sky phenomena echoes Samuel Eliot Morison’s sentiment that “Of all innovations, the astronomical were the most spectacular, the most disturbing, and the most contrary to common sense” (“The Harvard School” 4) as well as Theodore Hornberger’s claim that “By far the most lyrical passages in what may be called the religio-scientific literature of the time are those that deal with the solar-system (“The Date” 417). The import of the astronomical continued well beyond the eighteenth century as it turns up the literature of the nineteenth century and beyond. For example, Edgar Allan Poe’s *Eureka: A Prose Poem* (1848), composed at the end of his career, reads as treatise on the spirit and the universe, championing speculation and favoring intuition or ratiocination over scientific analysis and proof.117 Although *Eureka* ignores and openly resists certain aspects of scientific study, it ultimately promotes the use of the scientific imagination. For instance, the narrator writes:

> It will now be understood that, in using the phrase, ‘Infinity of Space’, I make no call upon the reader to entertain the impossible conception of an *absolute* infinity. I refer simply to the ‘*utmost conceivable expanse*’ of space—a shadowy and

117 Scholars debate the seriousness of *Eureka* because Poe seems to be poking fun at science, like Jonathan Swift in *Gulliver’s Travels* (1726); however, even when *Eureka* is read as part hoax, there is a development of a philosophy regarding scientific and artistic pursuit.
fluctuating domain, now shrinking, now swelling, with the vacillating energies of
the imagination. (Poe 225)

Poe asks his readers to consider the mathematical principle of infinity as both real space
and imaginative space, for it is only through the imagination that such a concept can be
entertained by the mind. Moreover, he highlights how the human imagination is
unbounded or its bounds are not intelligible, like the expanse of the universe. Poe’s
scientific vision is also his poetic vision, and in this vision science and art are wedded: “It
is the poetical essence of the Universe—of the Universe which, in the supreneness of its
symmetry, is but the most sublime of poems, Now symmetry and consistency are
convertible terms: --thus Poetry and Truth are one” (300). For Poe, science must involve
the imaginative, emotional mind; it must be more than factual information alone.

Nathaniel Hawthorne’s The Scarlet Letter (1850) also offers an intersection
between art and science as Hawthorne portrays the emotionality of Arthur Dimmesdale’s
bearing witness to astronomical phenomena. After seeing

one of those meteors, which the night-watcher may so often observe burning out
to waste, in the vacant regions of the atmosphere…Mr. Dimmesdale was
overcome with a great horror of mind, as if the universe were gazing at a scarlet
token on his naked breast, right over his heart. (Hawthorne 105)

Witnessing this odd celestial light evokes an emotional, imaginative response:
Dimmesdale can only turn his thoughts inward as he experiences shame and imagines
this invisible emotion becoming visible as a scarlet letter branded on his chest.
Hawthorne’s narrator is antagonistic toward Dimmesdale and criticizes his indulgence in
self-centered imaginative fancy. Rather than fearing that the light apparition signals
calamity for the community, Dimmesdale vainly believes the meteor signifies doom for
him alone. Moreover, the narrator expresses a general skepticism of the lone observer
“who beheld the wonder through the coloured, magnifying and distorted medium of his imagination, and shaped it more distinctly in his after-thought” (Hawthorne 106).

If we fast-forward to the twenty-first century, narratives featuring apocalyptic aspects of astronomy maintain their appeal in Western literature as well as popular culture. Films such as Lars Von Trier’s Melancholia (2011) and Christopher Nolan’s Interstellar (2014) begin with disastrous forecasts for Earth. In Melancholia, another planet on a collision course threatens Earth while in Interstellar, the planet is dying and can no longer support life. These films capture our two core fears regarding the destruction of our planet: in one scenario, the threat is outside and in the other scenario, the threat comes from within. Interstellar’s narrative offers the possibility of hope for current and future humans as its protagonists find a way to transport humans off of the planet and successfully establish a new home on another planet capable of sustaining human life. By leaving an old world to travel to a “new” world meant to be found, the mission central to Interstellar’s narrative can be read as secularized iteration of the Puritan errand into the wilderness. In Melancholia, the apocalyptic narrative plays out as it allows the planets to collide. The destruction is ultimate: there are no heroes, there is no hope.118 In essence, Melancholia depicts a secularized Judgement Day. In both films,

118 Deep Impact (1998) and Armageddon (1998) are two other popular twentieth-century films in which a celestial body (comet/asteroid) threatens to collide with Earth. In Armageddon, disaster is thwarted. Deep Impact has a different premise yet a similar outcome as a team of astronauts are able to break up a comet before it hits earth, thus dodging a complete catastrophe. Deep Impact also plays out the story of Noah’s ark as a lottery is put in place to save people and animals that are young and healthy for preservation and recolonization purposes. Even Disney-Pixar makes use of the apocalyptic storyline in Wall-E (2008). In this animated film, humans have managed to destroy their atmosphere, forcing them into space for many years. The narrative begins post-apocalypse and features a lone robot, Wall-E, as its protagonist. Although disaster
outer-space is mysterious, incredibly beautiful, and terrifying, but in *Interstellar* it is also place of hope. Conversely, *Melancholia* portrays the dangers of being unprepared for the threats that the universe presents. However, *Melancholia* ultimately portrays the apocalypse as an aesthetic moment in which the film’s central characters, with the exception of John (Kiefer Sutherland), embrace the end of Earth.

Our knowledge about the universe has grown vastly between the seventeenth century and the twenty-first century. While people once contemplated sailing to a new continent with trepidation, we now consider interplanetary travel with the same apprehension. However, our science continues to reveal how little we actually understand about our universe. Even celestial events witnessed in the seventeenth century are not fully understood and are being reinvestigated by astronomers and astrophysicists. For instance, in 2014 researchers revised their conclusions regarding the nova of 1670, CK Vulpeculae. This celestial event was documented by French astronomer and monk Père Dom Anthelme, Johannes Hevelius and Domenico Cassini. Between 1670 and 1672, observers could see a new bright light in the sky until its eventual disappearance in 1672. For many years this event was thought to be a nova; however, in 2014 astronomers labeled the phenomenon a red transient, which is an extra-violent collision between stars. Using the APEX (Atacama Pathfinder EXperiment) telescope, researchers noticed “a strange chemical fingerprint” and theorized that it was caused by the merging of two stars comparable to our sun (Drake). After comparing these new telescopic observations with historical descriptions of the nova, they concluded that the event was more specular than

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has already ensued, the storyline is a hopeful one as Wall-E discovers evidence that Earth is regenerating and ready for human re-colonization.

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a regular nova, but not quite as magnificent as a supernova. While the phenomenon fit some criteria of a red transient, Tomasz Kamiński (Harvard-Smithsonian Center for Astrophysics, Cambridge, USA) remained skeptical since it did not “match more recently observed explosions” (Drake). Even more recently in 2018, researchers have revised their theory again as new data from the ALMA (Atacama Large Millimeter/submillimeter Array) telescope, which is powerful enough to detect debris from the 1670 event, suggests that it may have been a collision between a white dwarf and brown dwarf star (“ALMA Discovers New Type of Stellar Collison”).

Similar historical investigations are pursued by research-scientists attempting to gain insight into the aurora borealis, sunspots, and the earth’s magnetic fields. In a paper from 2015, “Recurrent Auroral Activity in the Twelfth and Seventeenth Centuries,” derived from a conference talk on historical applied astronomy, authors David M. Willis and Chris J. Davis explore evidence of recurrent auroral activity and the correlation between sunspot activity and the aurora borealis in the twelfth and seventeenth centuries.119 Their method follows the work of F. Richard Stephenson, who is considered the “founding father’ of applied historical astronomy,” a field that uses historical records to gather data relevant to current questions in astrophysics and geophysics (vii). Although Willis and Davis’s study contains data predominantly from East Asian records rather than data collected from Europe/the Americas, their methods and goals demonstrate the

119 Sunspots are the product of knots in the sun’s magnetic fields. When these magnetic fields become entangled, they burst as sunspots. They usually occur in pairs and are quite large (a few times larger than the earth in diameter). As the temperature of the sun’s surface fluctuates, particles can get away from the star at the areas where sunspots occur on its surface. This results in particles of plasma entering into space, which is known as solar wind. Within approximately 40 hours, these winds reach planet earth; this event is can result in the auroral display (“What are Sunspots?”).
importance and necessity of accessing historical astronomical records. By mining these records, the authors were able to extract data supporting the possibility of patterns in auroral behavior, which may provide valuable insight into future auroral activity.

Early American scientific texts are an integral part of the history of literature, religion, and science; they are versatile texts that can be read in different ways. Throughout this dissertation, I have frequently identified these texts as scientific, yet in many ways these texts seem to elude modern forms of classification and resist genre: they contain scientific elements, but fall short of science by modern standards. Likewise, they contain imaginative or fictive elements, yet they are not fictional texts. Many of these texts also contained some theological component; however, the biblical message does not necessarily trump the scientific one. Modern categories, which typically position science and mathematics as distinct from the arts and humanities, seem unable to accurately support the complexity of these early texts, which bridge both the sciences and humanities. They provide readers with more than quantifiable material; they also reveal what people imagined and felt when they observed the heavens. While quantification offers an objective way of probing nature, it does not obviate human emotion since humans are the ultimate interpreters of any information. By offering a glimpse at what Western science was at its beginnings, these texts highlight how science is a human invention and a “cultural product” (Iwaniszewski 3). It is the medium through which we make sense of our world.

120 In “Historical evidence concerning the Sun: interpretation of sunspot records during the telescopic and pretelescopic eras” (1990), F.R. Stephenson discusses the poor quality of the sunspot record from before 1750. Stephenson explains the different use-values between a record of sunspots and a record of the aurora borealis. Despite the poor quality of earlier records, pretelescopic data would be valuable.
In “Sonnet—To Science,” Edgar Allan Poe lamented how scientific knowledge threatened the destruction of poetry by obliterating the mystery of nature. Poe characterizes science as a “vulture” that “preyest…upon the poet’s heart” (3-4) and suggests a type of beauty in remaining a wanderer searching “for treasure in the jewelled skies” (7). John Keats expressed a similar lament in *Lamia* (1819):

> There was an awful rainbow once in heaven:  
> We know her woof, her texture; she is given  
> In the dull catalogue of common things.  
> Philosophy will clip an Angel’s wings,  
> Conquer all mysteries by the rule and line,  
> Empty the haunted air, and gnomed mine—  
> Unweave a rainbow, as it erewhile made  
> The tender-person’d Lamia melt into a shade. (232-238)

In certain ways, Poe’s and Keats’s fears are actualizing in the twenty-first century as curriculums appear to favor STEM learning over the arts. This model is a peculiar one since, in essence, science is an art: it is an expression of human imagination and creativity. Moreover, as foundational scientific texts demonstrate, science is catalyzed by human emotion and subsequently the answers it produces impact human emotionality (e.g. wonder, anxiety). Science is a “vulture” preying upon the poet or that which “clip[s] an Angel’s wings” only if we allow it to be.


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