Journal of Literature and Science
Volume 18, No. 2 (2025)
ISSN 1754-646X
Marleen Waffler, "Blazing Stars": 17-34

"The blazing Stars": Constellations of (Non-)Knowledge in the Changing Perception of Comets at the Turn of the Eighteenth Century

Marleen Waffler

In November 1680, German astronomer Gottfried Kirch spotted a comet of remarkable brightness in the sky, which remained visible even in daylight. In the years to follow, various different written accounts of this comet, in a wide variety of genres from pamphlets and almanacs to sermons and learned deliberations, appeared in print. As varied as the background of their composers were their interpretations of this cometary sighting, and the significance the individual texts attributed to different elements of this occurrence. This article aims to analyse a selection of these publications, and discuss their positioning within a pre-scientific, as well as a scientific system of knowledge and non-knowledge. The concept of non-knowledge, in this respect, is understood not as deliberate ignorance of knowledge, but as awareness of gaps of knowledge, the discovery of limits of knowledge and potential ensuing forays into unknown realms of thought in order to further knowledge. Declarations of knowledge and accusations of non-knowledge are further perceived as tool of dominance, power, and interconnected claims of truth within the interrelation of pre-scientific and scientific epistemologies of comets in particular. Tracing back to Enlightenment philosophers, the relationship between these two systems of knowledge has been portrayed as a clear, linear development and declaration of progress from the pre-scientific production, reception, and transmission of learning to the scientific epistemology. This theory was adopted and popularised by the History of Ideas, a branch of historical study founded by Arthur O. Lovejoy in the twentieth century. The teleological representation of this approach has received substantial criticism, such as by Michel Foucault, who in his *The Order of Things: An Archaeology of the Human Sciences* (1970), argued for the necessity to rather bring into view:

> the epistemological field, the *episteme* in which knowledge, envisaged apart from all criteria having reference to its rational value or to its objective forms, grounds its positivity and thereby manifests a history which is not that of its growing perfection, but rather that of its conditions of possibility (21).

As a result of his "archaeological inquiry" (21), Foucault arrived at the conclusion that there had been a break "in the *episteme* of Western culture" (21) over the course of the seventeenth century, in which the requirement for the possibility of knowledge changed from the Renaissance episteme of correspondence and resemblance, a notion that the "world is covered with signs that must be deciphered [to] reveal resemblances and affinities" (55), to a Classical episteme of comparison, in which resemblances "will not be accepted until [their] identity and the series of [their] differences have been discovered by means of measurement with a common or, more radically, by its position in an order" (78).

This episteme shift, and its induced change in knowledge production, reception, and transmission is exemplified in the shifting epistemology of comets at

the turn of the eighteenth century, particularly in response to the comet of late 1680. This will be shown by means of a literary analysis of four different works engaging with this comet sighting, which were published for the English market in the first decade of the eighteenth century. The article will first outline the pre-scientific, paradigmatic understanding of, and knowledge about, comets as divine harbingers of wrath as described in the English Quaker John Axford's text *Catastrophe Mundi: Or, the Various Alterations and Changes That Have Happened in the World since 46 Years after the Creation* (1704), as well as Thomas Fowle's almanac *Speculum Uranicum*: *Or, an Almanack and Prognostications for the Year of our Lord God 1712. Being the Bissextile or Leap-Year. And from the Creation of the World, According to Sacred Wit, 5660,* for the year 1712, in which he discusses this religious notion of comets in detail. It will then focus on the second Astronomer Royal Edmund Halley's *A Synopsis of the Astronomy of Comets* (1705), in which a different system of knowledge is evident, namely the perception of comets as objects of scientific enquiry, observation, and calculation. The article will conclude with a reading of French philosopher Pierre Bayle's work *Pensées Diverses Écrites à un Docteur de Sorbonne à l'Occasion de la Comète Qui Parut au Mois de Décembre 1680* (1683), translated into English as *Miscellaneous Reflections, Occasion'd by the Comet Which Appear'd in December 1680* in 1708, indicating the interest its perspective was met with in the British Isles. Bayle's understanding of comets was rooted in his sceptical approach to knowledge in general, objecting to subscribe to any theories which lacked evidence for their claims, such as, in his opinion, the reading of comets as divine signs of wrath and portents of retribution. In the Foucauldian tradition, this article argues that the epistemology of the knowledge of comets in Europe changes throughout the seventeenth and eighteenth centuries, from a pre-scientific to a scientific system of knowledge and non-knowledge. With the help of the specific example of the perception of comets around the turn of the eighteenth century, it aims to demonstrate that this process, however, was not teleological, and not, as Foucault had initially proposed, a sudden "essential rupture" (Foucault 73) between two succeeding systems of knowledge, but rather shows a process of gradual change, in which both systems co-existed, and were intertwined more deeply than commonly granted.

Comets as Harbingers of Divine Wrath

This "blazing star…" (Johnson "Comet") of 1680, as comets were commonly referred to, featured an exceptionally long tail, which "taken by one of *Bristol* was 62 d. in every degree is 60 Minutes, allowing a Minute for a Mile, as the Learned doth; the length of its stream was 3720 Miles" (Axford 16). English Quaker John Axford provided this calculation in his work *Catastrophe Mundi*. Yet Axford's interest in this, as well as in a variety of other comets discussed in his treatise, was not solely focussed on collecting and reproducing relatively objective, proto-scientific observations regarding the size, shape and length of these phenomena. Predominantly, and indicated in the title of his work, Axford, a self-proclaimed and self-taught "Student in Physick and Astrology, above Forty Years" (2), was interested in catastrophes, and the comets he believed – in accordance with the majority of his contemporaries in England (Jardine 11) – heralded them to humankind. The comets' portentous character could be gauged more precisely by studying their shape, length, and brightness; the bigger and brighter the 'blazing-star', the more severe the ensuing catastrophe was expected to be. The astounding visibility of the comet of 1680 consequently was of particular concern to Axford, because "as that Comet […] was

the greatest that ever was, so those Calamities and Afflictions signified by it, might exceed also" (Axford 16). Writing retrospectively, Axford found his apprehension justified. Upon recapitulating the roughly twenty years that had passed since the first sighting of this comet, he remarked on developments in the British Isles and abroad alike:

> [W]hat Translations of Monarchies, change of Laws, Government; what Wars, Calamities, Desolations, Destructions; hath happened since in divers parts of the World; as the dreadful Inundation which happened in *Holland*, about the beginning of 1682, […] Drowning […] many People and Cattle: Also the *Turks* besieged *Viena* in *Germany* [sic] […]. The King of *France* his cruel Persecution of his Protestant Subjects. […] [A]lso the Fire at *Wapping* and *Southwark* in *London*. […] And a terrible hard Winter, […] not known the like in the Age of Man. […] The Persecution of *Dissenters* in the Years 82, 83 and 84. The Death of the King [.] The coming in of the Prince of *Orange*, […] 1688. The departure of King *James*. […] Also in 1692, […] at *Port-Royal* in the Island of *Jamaica*, a most terrible Earthquake, which made a great Ruin of Buildings, Plantations and People (Axford 16-17).

Without omissions, this list of mostly chronologically arranged calamities experienced by Axford and his contemporaries in England, its Jamaican colony, and continental Europe in a time of political upheaval, extends over two pages, and continues still for another after. At the core of this extensive narrative of disasters of different severity and type woven together, including natural catastrophes such as earthquakes, floods, and fires, as well as war, persecution, and turbulent changes within the English monarchy and political system, lies the comet of 1680.

Axford's perception of this comet, as well as a variety of others he discusses in his *Catastrophe Mundi*, was deeply rooted in judicial astrology, which Bernard Capp defines as "the attempt to interpret [planetary] influences [on the Earth] in order to make predictions and give advice [in particular about potential warfare, diseases or other calamities]" (16). Axford himself describes his approach as follows: "*Astrology* is a most noble and sublime Art, which declareth the Reason or Fore-knowing things to come by the Stars, by observing and considering their Motions, Aspects, and Conjunctions" (Axford 4). His treatise, however, differed noticeably from the genre of the almanac widely popular throughout different social strata (Wardhaugh 2; Schechner 66-67), which used judicial astrology for annual predictions of occurrences its readers could expect to experience in the new year. Axford's endeavour looked backwards, and instead set out to show the usefulness and validity of employing judicial astrology *per se*. For this purpose, he collected what he considered successful predictions of future catastrophes by astrologers such as Nostradamus, John Holwell, and William Lilly. Based on the "Blazing-Star that appeared in the Sign *Gemini*, in 1652[,] which Sign is accounted the Ascendant of *London*, by the Learned in the Cœlestial Sciences" (Axford 7) Lilly was held to have foreseen, amongst other events described in his almanac *Mercurius Anglicus* for 1654, the plague and the great fire afflicting the city in 1665 and 1666, respectively.

At the turn of the eighteenth century, the judicial arm of astrology experienced resentment from religious quarters. The significance judicial astrologers like Lilly, and writers like Axford, put on "those stars which are under the Horizon, or in the Ascendant, [which] have greater Pre-eminence not only in the present state of things, but also over the Lives and Fortunes of Men, and Constitution of Weather" (Axford

4), proved problematic with respect to questions of moral responsibility for one's own actions, which thus could all too easily be blamed on those stars. More importantly still, this approach seemed to imply stars had inherent power, which – however implicitly – challenged the Christian doctrine of an omniscient, omnipotent God (Capp 131). Perhaps it is for this reason Axford put strong emphasis on his notion that God had created the stars as a means of communication, for the benefit of humankind: "Its [sic] a merciful Providence of Almighty God, that he hath given some Men the knowledge of Contingencies or future *Events*, by observing the various Aspects and Conjunctions of the Heavenly Bodies" (Axford 5). Axford's phrasing of this knowledge of the future being given to "some Men" is noteworthy, as it suggests he had specific conceptions about who is (and should be) given access to this information by God, namely judicial astrologers. This implies an understanding of knowledge as strategic asset connected to ideas of power. Because of their supposed superior knowledge of the future, this group is enabled to decide the degree of insight they wish to give other members of society, if any at all, and possibly the price at which this understanding may be obtained.

The desire to attain knowledge relating to individual or collective future(s), and to advise others accordingly, lay at the core of judicial astrology. Its innate principle of interpreting the stars an all-knowing and all-powerful God had so arranged to convey his messages, also indicates the limits of knowledge the discipline faced. Judicial astrologers, from Axford's perspective, could only ever understand as much as was made intelligible to them through observing the stars in the sky. Aside from those, they had no infallible way of verifying their claims made about, and insight inferred into, divine actions. Consequently, the predictions given by judicial astrologers in their almanacs and varied other works generally remained fairly vague (Wardhaugh 14), their writers seeking "shelter behind a screen of platitudes and cryptic ambiguity" (Capp 35). Others, such as William Lilly, who dared to be much more specific in their prophecies, faced accusations of involvement in political schemes, crimes, and blasphemy, hazarding potential imprisonment (Wardhaugh 8-9), or even execution. While John Axford's *Catastrophe Mundi* predominantly was concerned with recounting and lauding the capabilities of other judicial astrologers and the usefulness and success of their predictions, he could not help but include some of his personal prognostications. Interestingly, his outlook into the future included in his treatise is utterly positive, if – naturally – utopian to some degree:

> After many sad Years, a Chair [referencing the constellation Chair of Cassiopeia, in which this prediction was based] of Rest is promised, a firm Peace. Shall a Man, or Prince, or Men, appear into this World, or in *Europe*, with an Invincible Army shall he level Mountains, set *Europe* in Peace. He shall restore the lost or unforfeited Priviledges of Nations, and take off Oppressions from the Common People; and the Laws between Party and Party to be of quick dispatch, easie to be understood, and cheap (Axford 19).

The explanation for the lack of negative prophecies in Axford's treatise, at least in those reaching beyond 1704, the year of its publication, may be found in its declared purpose, the attempt to showcase the utility of judicial, or as Axford himself calls it, "true" (Axford 3) astrology. The public outcry and repercussions for a positive prediction of the future that does not come to pass will presumably be fairly sparse. The same reaction does not seem very likely in case of a negative prognostication failing to occur, as these involve provoking strong elements of fear and unease in their

readers. Because of this, however, negative prophecies may generally be remembered better. Ultimately, the employment of potentially unfulfilling negative predictions might lead to assumptions of incompetence on the part of their author, reflecting badly on the entire work and its intended goal of advocating for judicial astrology. This method further served as effective preventive measure against possible accusations of blasphemy.

Providence and the Image of the Great Chain of Being

Similar tactical considerations may be found in Axford's emphasis on divine Providence in the astrologer's process of arriving at their predictions. He argued, "Now, as it is certain God made nothing in vain, neither were those glorious Heavenly Bodies which the Lord God calleth all by their Name, made for Fashion[']s sake to be gazed on only" (Axford 4). While astrologers may be able to interpret the stars and translate their information for humanity and the future into words, God is the entity who positions the stars and thus the origin of their meaning. Axford shared this conviction of divine Providence, which superseded solely stellar elements and related to the entire universe, with the majority of his contemporaries living in the British Isles. It was defined as follows by Samuel Johnson in his seminal work *A Dictionary of the English Language* (1755):

> PROVIDENCE. n. s. [*providence*, Fr. *Providential*, Lat.]
> 1. Foresight; timely care; forecast; the act of providing. […]
> 2. The care of God over created beings; divine superintendence ("Providence").

This bipartite definition explores first the literal meaning of the term, "to foresee", which, in Johnson's words, explains the ability "to see beforehand; to see what has not yet happened; to have prescience; to foreknow" ("To foresee"). Subsequently to the etymological explanation of the notion follows a second description, forming a connection to the word's religious connotation, the concept of the omnipotent, omniscient, and omnipresent divine creator and ruler of the world, or, to the Quaker John Axford, the one "in [whose] hands are we, and our Words, and all Wisdom, and the knowledge of the Works" (3). This understanding of divine Providence as representation of "the holder of ultimate power, the one who determined the initial conditions from which the universe could develop its lawlike behaviour" (Jackelén 141) derives from Thomas Aquinas' fundamental *Summa Theologica* (published posthumously in 1485). Thinking about the connection and interaction of God, humans, and creation, Aquinas employed the Aristotelian idea of primary causes and secondary, or natural, causes (Jackelén 139-40). In this ontological work, Aquinas argued every cause is moved by a previous cause to achieve a desired effect. This theory, perhaps best imagined as a chain reaction, needs a starting point, an "unmoved" (Dvořák 619) cause, which, for Aquinas was evident in God. From this followed that "all beings apart from God are not their own being, but are beings by participation. Therefore, it must be that all things which are diversified by the diverse participation of being, so as to be more or less perfect, are caused by one First Being, Who is most perfect" (Aquinas 238). God, as most perfect being, is the origin of all existence; accordingly, he must also be viewed as creator of the secondary causes, which he furnishes with power to execute tasks and achieve effects he directs them to. Thereby, they operate "in virtue of the divine power as its instrument[s]" (Dvořák

618). As primary mover, God, for Aquinas, can act both as primary cause as well as via the secondary, natural causes.

Central for the paradigmatic perception of divine and human interconnection at the turn of the eighteenth century, this idea was firmly intertwined with the image of the Great Chain of Being, as discussed by Arthur O. Lovejoy in his eponymous work (183). This text served as foundational text for the history of ideas, a historiographic approach that perceives ideas as independent units, which, due to their timeless nature, can be traced unchanged in various different thinkers' theories throughout the entire Western history of thought. This implied a teleological progress of this history from antiquity to Lovejoy's present, which historians and literary scholars could then expose in their analyses. This essentialist approach, however, did not take into consideration contextual factors of texts, and disregarded changing cultural and semantic connotations these unit ideas may have experienced, as well as any dissonances within their development over time. For this it has been severely criticised by scholars such as Michel Foucault and Quentin Skinner, who in his essay "Meaning and Understanding in the History of Ideas" (1969) pointed out that such a concept of history may expose historical and literary analyses to the "perpetual danger" (7) of an "unconscious application of paradigms whose familiarity to the historian disguises an essential incapability to the past" (7), thus not so much producing historiographic accounts, but rather "*mythologies*" (7). Similar methodological criticism may also be found in Jaakko Hintikka's "Gaps in the Great Chain of Being: An Exercise in the Methodology of the History of Ideas" (6). Still very recently, academic publications have read Lovejoy's influential theory critically in respect to questions of feminism, environmentalism, antisemitism, and racism, such as, for the latter, Vanita Seth's "The Origins of Racism" (2020), in which she identifies and criticises the prevalent Lovejoyian essentialism in the discussion of the origins of racism (349, 368).

The term 'the Great Chain of Being' describes an anthropogenic ordering concept of the universe, which remained relevant throughout the eighteenth century and beyond, as it was a concept that "had a mental existence outside language and could travel as autonomous, hypostasized unit […] from period to period" (Kenny 24). Derived from third-century Neoplatonist philosopher Plotinus, and adapted by Saint Augustine of Hippo a century later, this notion portrayed the existence of all elements of creation in ranked succession. Like a chain, it was comprised of "an infinite […] number of links ranging in hierarchical order from the meagerest kind of existents, which barely escape nonexistence, through 'every possible' grade up […] to the highest possible kind of creature" (Lovejoy 59). Every component of this chain was assigned a specified place in it, from minerals at the very bottom, via plants, animals, humans (with subdivisions within this group, which gave royals their own category), and angels to God at the very top. This concept not only showed each member of the chain its designated spot, but also emphasised the interdependence of all its parts on each other. This was of particular importance, as this structure only worked when – and if – its individual links complied to its given hierarchical order. Just one lapse by one of its members, therefore, would lead to the break, and ultimate collapse of the entire chain, leaving chaos and mayhem in its wake. Particularly, this picture suggested a memorable moral message for humankind, explored by a number of philosophers and writers throughout the seventeenth and eighteenth centuries (Lovejoy 183-84). The evocation of exorbitant apocalyptic consequences for the entire chain of existence by just one misstep taken by one of its elements may seem slightly disproportionate. However, within the system of the Great Chain of Being, it

poses the sole appropriate answer to such a severe offence, for every single one element belonged to the same one overarching element, expressed in the concept of the macrocosm and the microcosm. Ignoring one's designated position in the chain therefore not only endangered all other parts of it, but also openly challenged divine Providence. More specifically with regard to humans, this suggested the blasphemous notion of equality with, or even superiority to, God, the soul and very head of the chain. At the very least, it hinted at implicit criticism of this universal divine system of existence, created as "the best (*optimum*) among all possible worlds" (128), as polymath Gottfried Wilhelm Leibniz famously stated in his work *Theodicy: Essays on the Goodness of God, the Freedom of Man, and the Origin of Evil* (1710). On the much smaller level of a country's society, the structure and order of which the Great Chain of Being both entailed and represented, misdemeanour against its hierarchically assigned places was considered to endanger this society at large.

Within this understanding of the world, its organisation, and processes, where everything had its fixed position, any unusual, and – in the literal sense of the word – extraordinary, occurrence proved a severe threat to the status quo. Precisely for this reason, comets could represent an alarming sight to some of their onlookers in the late seventeenth century. In comparison to planets and their orbits, comets and their paths were more difficult to spot and trace, even with the possibility of observation by means of a telescope. To those who did not engage in regular observation of the skies, the comets' palpably vagrant nature made their advent seem sudden, and the duration of their sighting uncertain. Thus, they were a constant reminder of the disruptive danger they exposed the Great Chain of Being to. Since comets were commonly attributed a peripatetic character within the otherwise static order of the Great Chain of Being, they were explained as prodigies, meaning "out of the ordinary process of nature, from which omens are drawn; portent[s]" (Johnson "Prodigy"). The act of ascribing to comets the function of harbingers was thus a solution to account for their vagrant presence in this orderly world. Within the context of the Great Chain of Being, God, the primary cause of creation at the helm of the chain, was the only one powerful enough to send such heavenly portents. These were exclusively of a scolding, warning nature, as underlined by Samuel Johnson's second definition of the word 'prodigy', which he gave as "monster" ("Prodigy"). While monsters had been studied as objects of natural philosophical interest since the late sixteenth century (Krämer 227), a more general contemporary reading perceived them as (warning) signs (Daston and Park 173-214), providing the context for Johnson's interpretation. References found in various places in the Bible, such as in Revelation, Exodus, and Joel informed and solidified this portrayal of comets as "monsters warning the public of the Lord's intentions" (Schechner 27). The Gospel of Luke cautions: "And great earthquakes shall be in divers places, and famines, and pestilences; and fearful sights and great signs shall there be from heaven" (1233, chapter 21, verse 11). The 'blazing-star' of 1680, central element of John Axford's *Catastrophe Mundi*, "signif[ied] Future Events" (23) as the writer argued, by foreshadowing the conglomerate of catastrophes listed at the beginning of this paper, as all "Changes and Alterations happen[ing] in the World [were made known to humans by] Comets or Blazing Stars" (15). However, further, and rather more significantly, they served as divine "warning of future Calamities, that People may Repent and turn from the *Evil* of their Ways" (Axford 5). With this claim, Axford was in accordance with a religious knowledge formation of comets widely acknowledged by his contemporaries at the end of the seventeenth century. In this system of knowledge, the celestial phenomena were regarded not only as an expression of God's disapproval of individuals' or

groups' behaviour and his ire over humankind's foibles and sins, but also as harbingers of imminent catastrophic punishment.

In order to learn more about the nature of a potential impending catastrophe, a comet's features could be analysed. The comet's size could give information about the extent of the ensuing disaster, while the direction of its tail served as helpful means to localise it. Particular attention had to be paid to the comet's colour, its shape and form, as these all offered valuable knowledge in evaluating the type of calamity to expect. Brooms and torches were attributed more general, vague meanings, and could signify both the idea of cleaning up or setting on fire a sinful world, as well as represent light, indicating hope for the future. Other comet outlines were much more specific, with diverse tiers of adversity connected to them. In the seventeenth and early eighteenth centuries, a notable portion of comet shapes committed to paper for this purpose were related to fighting, warfare and bloodshed, such as arrow-shaped comets, ones that looked like lances and spears, and ones that resembled sabres and swords (Schechner 58). Their colour was another important indicator of events to come. Connected to their ruling planet, which could change throughout the course of a planet's visibility on Earth, the comets' colours were interpreted according to those associated with the planets. The comet of 1680 disquieting John Axford was reported to have taken on a total of three different colours, beginning as a pale specimen, then gaining brightness, and ultimately turning "a Martial red" (Schechner 52). This colour, apart from its evident connotation to blood, further was seen to announce "excessive hot weather, pestiferous winds, terrible thunder and lightning, and tempests. Rivers and fountains would dry up, and agricultural products would become scarce" (Schechner 52). These efforts to categorise comets and the catastrophic punishments they appeared to reveal to humanity allowed for a chance to expand knowledge while actively diminishing an area of non-knowledge, hereby obtaining a sense of control over subsequent adversities.

Comets were not only regarded as divine messengers of looming doom for humankind but also as forces capable of influencing planet Earth's seasons, weather, agriculture, and health. Rooted in the Aristotelian understanding of comets, this view was expressed in Thomas Fowle's *Speculum Uranicum*. Upon publication of the 1712 issue of his almanac, the self-proclaimed Gentleman had run his annual, collecting "the Eclipses, Lunations, Conjunctions, and Aspects of the Planets and Meteorological Observations" (Fowle 1) successfully for a little over thirty years.[1] Similar to other almanacs (Wardhaugh 11), Fowle attached an appendix which supplied, amongst other things, a "compendious Chronology of divers memorable Things since the Birth of our Blessed Saviour Jesus Christ, to this present Year, 1712" (19), and various prognostications for the year based on different star and planetary constellations. As a final note to his endeavour for that year, he aimed to provide his readers with an explanation of "the Physical Reasons of the Portents of Blazing stars or Comets" (39). In order to do so, he relied heavily on his readership's paradigmatic knowledge of comets originated with Aristotle in ancient Greece. Attempting to understand the latter's theory on comets requires familiarity with his concept of the creation of the universe as laid out in his work *Meteorology* (350 BC), which he held to encompass different spheres; the heavens, a celestial sphere above the moon, divided by the sphere of the moon from the terrestrial sphere, earth, below the moon. The celestial sphere, which contained stars and planets, consisted of only one element, ether, while the terrestrial sphere was "made up of four elements (earth, water, air, and fire)" (Heidarzadeh 3), positioned according to their lightness, with earth as the heaviest at the bottom. When the sun shone onto the Earth and warmed it, exhalations

kept within it were released, and, depending on their qualities, rose into different layers. Because of their heaviness, moist and cold exhalations only ascended into the layer of air, where they turned into clouds and winds, while dry and warm exhalations rose into the layer of fire. This combination then developed into "a form of fuel" (Heidarzadeh 6), which reacted with the heat of the eternal motion of the celestial sphere it bordered on, resulting in comets. Thomas Fowle thus maintained to his readers that comets were "the Cause of inordinate Heat, by their ardent burning in the Air, and their Matter of which they are made" (39). This was problematic for life on Earth, as it meant "the [e]arth [was] left dry" (Fowle 39), causing "the Moisture by which it fructified all things growing therein [to be] dry'd up by excessive Heat, and so render'd barren; whence there must of Necessity follow Famine" (Fowle 39-40). In addition, the hot and dry air comets were thought to create was believed to generate "Winds, and Winds trouble the Sea, whence come Inundations and overflowing of Rivers" (Fowle 40).

Apart from droughts, storms, and floods, Fowle further perceived a direct influence of comets on the human body. He claimed comets "infected [the air] through hot, thick Exhalations, which being drawn into the Mouths of Living Creatures, does infect and kill them, causing Pestilential Diseases" (40). The threat of the plague perhaps even surpassed another danger of the heat, namely, that "the radical Moisture of Living Creatures (whereby they subsist) is dry'd up, whereby they become little better than dead Carcasses" (40). For Fowle, comets proved perilous to humans not only through provoking external causes affecting the safety and possibility of life on Earth, but also via internal causes doing so. Fowle's insight into processes of the human body was guided by the Aristotelian analogy of the macrocosm, representing the world, being mirrored in the microcosm, the human body, and the prevalent Hippocratic notion of body humours. The latter suggested that the four humours (black bile, yellow bile, phlegm, and blood) corresponded to the four temperaments melancholic, choleric, phlegmatic, and sanguine. Different combinations of those were considered to define a person's character traits. When a human was in good health, all four humours were distributed evenly throughout all parts of the body; illnesses were thus interpreted as either excess or lack of a humour in a body part. The theory of the four humours, symbolising Aristotle's microcosm, was intrinsically connected to the four seasons of the year, the four primary qualities hot, dry, cold, and moist, and the four elements of the terrestrial sphere, earth, water, air, and fire, depicting the macrocosm (Porter 57-58). Thomas Fowle was therefore convinced the appearance of comets affected the human body from the inside. He worried that comets "dry up the Humours in Men and increase Choler, which excites to Quarrels, then follow Blows, Wars and Bloodshed; and so by Consequence [this] produces Alterations in States, Law, Government" (40). Fowle furnished his readers with advice on ways in which to face such forceful portents: "I would not have any one to fear, tho' they be never so horrid or terrible to behold, but rather take Courage thereby to call earnestly upon God for Mercy, that he may avert his Judgments, whereof he does so fairly warn us by these his Messengers" (40).

Comets as Objects of Scientific Examination

Within this pre-scientific episteme of comets, they served as expressions of divine anger over human sins, and harbingers of ensuing punishment sent from heaven down to Earth. From this argumentation, the perception of comets as causes of natural catastrophes, wreaking havoc and leading to illness and death, developed. However, this conviction coexisted with a different system of knowledge and non-knowledge,

by which it was gradually superseded in importance throughout the latter half of the seventeenth century. This system was centred around the scientific perception of terrestrial and celestial phenomena, through their observation by eye, as well as by means of scientific instruments such as the telescope and the microscope. It was propagated by a "process of change and displacement among and within competing *systems of natural philosophy*" (Schuster 224), that is systems of enquiry into the natural world. This process, which laid the foundation for modern science (Daston 12), is commonly referred to as the Scientific Revolution. It thus is given the appearance of one homogenous development, when it actually spanned a roughly two-hundred-year time period, from 1500 to 1700. The term describes the gradual shift from the Ptolemaic geocentric worldview and the scholastic Aristotelian learning dominant in the European continent and the British Isles throughout the Middle Ages, to the Copernican heliocentric perspective and an "experimentally-oriented corpuscular-mechanical natural philosophy" (Schuster 238). The latter fostered a system of knowledge which put strong emphasis on Baconian and Lockean empiricism, on experience gained through own experiments and observation, and on providing a platform for their discussion, as well as for theoretical considerations and exchanges, in newly founded societies such as the Royal Society (1662). This epistemological shift to a curiosity for specific, individual objects (Daston 18-20) and their elements, and their analysis along the parameters of new knowledge did not signify a complete replacement of their scholastic understanding, and the connected worldview. Rather, these two may be argued to have occasionally been attempted to be merged together, as Roger Ariew has demonstrated in his paper on learning taught about "astronomical novelties, especially comets" (358) around Paris throughout the seventeenth century.

At the turn of the eighteenth century, one of the main proponents of the early scientific epistemes of knowledge in the British Isles was Edmund Halley, the second Astronomer Royal (1720-1742). Just like the aforementioned John Axford, he had observed the comet making its way across the sky in late 1680. His reaction to this sight, compiled only a year after Axford's text, clearly showcased Halley's confidence in a different system of knowledge to the Quaker and self-proclaimed student of astrology, John Axford. While the latter retrospectively remembered and listed this spectacle as the precursor of various natural, economic, and political catastrophes afflicting England in the next twenty or so years, Halley was not worried about any impending divine signs of retribution for human misconduct. Instead, having worked at first Astronomer Royal John Flamsteed's Greenwich observatory previously, and just returned from his successful venture of charting stars of the Southern hemisphere under the sponsorship of the East India Company, he was fascinated by the experience, as it provided him with an opportunity for personal astronomic observation of a comet (Jardine 32). Over the course of the next few years, Halley and his fellows at the Royal Society, Robert Hooke and Christopher Wren, deliberated on the orbits of comets, and the possible method of their calculation. The solution to these puzzles, famously, was provided by Isaac Newton with the publication of his *Philosophiæ Naturalis Principia Mathematica* (*The Mathematical Principles of Natural Philosophy*), commonly referred to as *Principia* (1687). In this tripartite work, Newton presented the theoretical, mathematical groundwork for the calculation of planetary and cometary movement in elliptical orbits, first suggested through practical observations by Johannes Kepler (Wardhaugh 34), and the connected issue of gravitation, by means of the inverse square law (Moore and Mason 36). This law allowed for the calculation of the "Sun's pull"

(Moore and Mason 36) on two planets by squaring their respective distances from the sun, which, as the law states, was then inversely proportional to the sun's respective gravitational force on them. Halley had undertaken the laborious and tedious task of "extract[ing] the manuscript in sections from its author, wheedling, flattering, reassuring and chastising him, to get him to give up the pages for printing" (Jardine 36), and had financed the endeavour "out of his own pocket" (Moore and Mason 36), after the Royal Society withdrew as funding party on the grounds of the slow progress of the project.

As a result of his interest in this undertaking, Halley further became personally involved in reviewing and (re-)calculating data employed in determining cometary trajectories in the *Principia*, in an effort to facilitate Newton's momentous task, and accelerate its prospective publication. Decades later, he published some of the results concerning "this most difficult Part of the Astronomical Science" (2), which had before "[lain] altogether neglected; for no Body thought it worthwhile to take Notice of, or write about, […] the Motion of Comets" (2), in his treatise *A Synopsis of the Astronomy of Comets* (1705). This claim of knowledge not as yet uncovered conveniently provided Halley with legitimation for his approach, with which he was now able to create new knowledge. Organised in a "General Table for Calculating the Motions of Comets in a Parabolical Orbit" (8), as well as one listing the "Astronomical Elements of the Motions in a Parabolick Orb of all the Comets that have been hitherto duly observ'd" (7), Halley hereby equipped his readers with information necessary to conduct their own calculations, helped along by his detailed instructions on their practical implementation included in his *Synopsis*. Within the text, Halley also reflected on his own findings, such as regarding "that prodigious Comet of the Year 1680" (5). While working on revisions for "that *Great Geometrician*, the *Illustrious Newton*['s]" (Halley 5) *Principia*, he had noted the similarity of the orbits of this blazing star with one to follow in early 1681, from which he concluded these two had in fact to have belonged to the same comet, seen on its elliptical path both before and after perihelion, the closest point of a comet's orbit to the sun. This discovery, as Halley claimed in 1705:

> induced [him] to construct [the tables of cometary movement], That whenever a new Comet shall appear, we may be able to know, by comparing together the Elements, whether it be any of those which has appear'd before, and consequently to determine its Period, and the *Axis* of its Orbit, and to foretell its Return (21).

The tables, "in the making of which I spar'd no Labour" (6) as Halley remarked, so that they "might come forth perfect, as a Thing consecrated to Posterity, and to last as long as *Astronomy* it self" (6), had proven useful to him in his own thinking already, when he observed that the comet which he witnessed in 1682 may not have been a new comet, after all:

> And, indeed, there are many Things which make me believe that the Comet which *Apian* observ'd in the Year 1531[,] was the same with that *Kepler* and *Longomontanus* took Notice of and describ'd in the Year 1607[,] and which I my self have seen return, and observ'd in the Year 1682 (21).

Aware of potential perturbances caused by "giant planets such as Jupiter and Saturn" (Moore and Mason 42), Halley did account for some occasional "Inequality of the

Periodick Revolutions" (21), which only served to reinforce his argument, as this made the comet of 1456 eligible as a return of this comet as well. Based on this knowledge and Halley's own computations, he felt bold enough to "venture to foretell, That [this comet] will return again in the Year 1758" (22). Although Halley died too early to bear witness personally, his prediction was verified, when the comet named after him today, was next sighted seventy-six years after he had been able to spot it in the sky himself in 1682 (Wilson 342-43).

Halley's observation of the reality of cometary returns inevitably implied this to be a possibility for most, if not all other comets:

> [W]e shall have no Reason to doubt but the rest must return too: Therefore Astronomers have a large Field to exercise themselves in for many Ages, before they will be able to know the Number of these many and great Bodies revolving around the common Center of the Sun (Halley 22).

As promising as this notion may have sounded to astronomers, at first glance it appears to be opposed to the paradigmatic religious interpretation of comets as harbingers of divine wrath and punishment. In that function, their essential feature was precisely their singular, sudden occurrence, which interrupted the otherwise perfectly organised divine creation, in which every element was attributed its fixed place. Halley's claims, read in this system of early scientific knowledge, suggested that comets were indeed a permanent, regular part of this system, which significantly threatened their recognized nature as omens specifically employed by an omniscient, omnipotent God in individual circumstances in order to chastise errant humanity. Further, Halley's practical application of Newton's theoretical principles of determining the orbit of a comet, impugned their unpredictability and incalculability, another central motive consolidating their perception as divine portents. Simultaneously, considering this new knowledge and learning in the pre-scientific system of knowledge put the Great Chain of Being at potential risk of unrest. It evoked the idea that cometary arrivals and their orbits could be comprehended and even forecast by mere mortals, who, in doing so, attempted to rise above their station. Halley's own beliefs in this respect remain unclear, as he did not comment on them in this work. It might be argued that this was due to strategic reasoning on Halley's part, as accusations of perceived atheism expressed in his presentations and publications negatively impacted and threatened his career repeatedly (Schaffer 17-19). In the 1690s, these allegations centred around the claim that he had argued for the possibility of eternal existence of planet Earth (Schechner 173). This belief was in direct opposition to the orthodox Christian dogma of the conflagration of the planet, an all-consuming fire, which was followed by the Last Day of Judgment, and after which Earth would turn into a star. According to Simon Schaffer, these charges against Halley seem to have prevented him from obtaining the vacant Savilian Chair of Astronomy at Oxford University in 1691/1692, which was instead given to the Scot David Gregory (17-18), despite Halley's recommendation for the position issued by the Royal Society.

However, as Simon Schaffer has shown in the context of theological responses to Halley's papers throughout the 1690s, only a few short years before the publication of his *A Synopsis of the Astronomy of Comets* (1705) discussed above, Halley's emphasis lay "on the universal applicability of scientific criteria to any and all data recoverable from the historical record" (Schaffer 29). This is the criterion according to which, in his *Synopsis*, he examined works on the topic of comets by a variety of

scholars from Greek and Roman antiquity to his present, from Aristotle (1) and Seneca (2) via Tycho Brahe (3), Johannes Kepler and Hevelius (4), to Giovanni Cassini, John Flamsteed, and Isaac Newton (5). The declared goal of the *Synopsis* was then to be the "collect[ion of] all the Observations of Comets I could, [and combining them into a mathematical table], the Result of a prodigious deal of Calculation, which, tho' but small in Bulk, will be no unacceptable Present to Astronomers" (6). What mattered to Halley was the scientific congruence of processes and matters, such as, with his *Synopsis*, providing astronomical observers with data of recorded comets in order to help them determine the elliptical trajectories of new comet sightings. His focus was not primarily on arguing or even attempting to represent their precise coherence with orthodox theological dogmas, but rather on the "unrelenting pursuit of scientific consistency" (Schaffer 29). Halley thus subscribed to a scientific system of knowledge, which, while coexisting with the religious system of knowledge Thomas Fowle and John Axford endorsed, did not necessarily share the same foci, objectives, and convictions. In Halley's understanding, the religious discourse of knowledge deriving from Scripture was to be read as allegorical learning, rather than literal information suggesting God's direct (inter-)action with the world. Yet, this does not inevitably imply Halley's naturalistic concept of the universe to be devoid of divine presence, but rather meant that to him, God acted through natural causes, which could be measured and calculated with new scientific methods (Schechner 162).

Epistemological Doubt and the Interconnection of Systems of Knowledge

The French philosopher Pierre Bayle may be argued to have coexisted in both systems of knowledge. While his treatise *Pensées Diverses* appeared in comparatively short temporal succession to the 1680 comet it discusses, its English translation twenty-five years later indicates the interest its perspective was met with in the British Isles. Directly in the subtitle, Bayle gave his intended goal for this work, "to explode Popular Superstitions" (ii). As a proponent of philosophical scepticism, he held that all judgment must be withheld on any beliefs and claims that could not be backed up with sufficient evidence, or when the evidence available was inept. He strongly opposed the "Errors of the common People, who will needs have it, that the Comets threaten this World of ours with all kind of Misery and Desolation" (3). However, in Bayle's view, this opinion was also frequently found among the learned, such as the fictive scholar at the Sorbonne to whom he had addressed his work: "I can't comprehend how so great a Doctor as you are, shou'd yet be carried away with the Stream, and imagine with the common Herd, […] That Comets are in the nature of Heralds sent forth to declare War with Human kind on the part of Almighty God" (3-4). Bayle's voluminous book approached this episteme from a variety of angles in its effort to logically contradict this claim, and show its unfounded nature. Thus, Bayle contested the belief comets themselves could bring doom over planet Earth and its inhabitants, as he considered it "very uncertain at least, whether Bodys at such a distance […] can send forth such a Quantity of matter as is capable of a considerable Action here" (15). Additionally, Bayle argued, even if this were the case, "there's no more reason to conclude they shou'd cause a Pestilence, a War, or a Famine, than that they shou'd bring Health, Peace and Plenty, because no body knows the nature of these minute Bodys, the Figure, Motion or Texture of their Parts" (25). The comet of 1680, at the core of Bayle's undertaking, was the ideal exemplary proof of his reasoning:

> [I]s there any better sense in maintaining, that the present Comet, which prevents not an excessive cold Season while in its full appearance, shall cause a War three years hence when it self is no more, because, by overheating the Mass of Blood, it will render Mankind more enterprising; than in maintaining it will preserve a good understanding and peace in the World, because by cooling the Mass of Blood it will render Mankind very wise and moderate (25)?

Outside of astrology, which Bayle scathingly called "a Scandal upon human Nature" (27), he did not consider there to be sufficient evidence regarding the true nature of comets; therefore, it was impossible to allocate them negative or positive qualities. Concomitantly, comets could not be charged with responsibility for either good or bad developments on Earth. While Bayle readily admitted "that tho in fact no Comet did ever appear which was not follow'd by a great many Calamitys" (47), he reasoned that "this proceeds intirely from the Nature of the things of this World, which renders 'em subject to an infinite variety of Changes" (47). Hence, the amount of evil and good happening in the world did not depend on the sighting of a comet. On the contrary, "the Years we suppose poison'd by the Influence of Comets, are remarkable for as great Blessings to some parts of the World, as any other Years in the account of time" (49), whilst the "most tragical Adventures, and terrible Desolations, have been preceded by no Comet at all, whereas the most memorable Prosperitys have" (49). Bayle's own logical thinking and empirical observation led him to recognise a limit of understanding, an area of non-knowledge, within the pre-scientific system of knowledge. This limit restricted the possibility to fully comprehend comets and their influence and interaction with Earth in general, and humankind in particular, an observation which led him to reject the paradigm of the foreboding character of comets. Instead, he read them as symbolising a different divine intention, serving as means to "convince the World of a Providence, which dispenses Good and Evil, loves Mankind, won't see 'em perish without calling 'em to Repentance; and who therefore merits their utmost Love and Gratitude" (217).

Conclusion

At the turn of the eighteenth century, the understanding of comets in Europe was not unanimous, but embedded in two main systems of knowledge, as the reading of the four works discussing their perception and interpretation of the comet of late 1680 investigated above has shown. The longstanding pre-scientific episteme comprehended comets as vagrant elements in the universal organisational concept of the Great Chain of Being. As such, they served as portents of a providential God's wrath over human sin and misdemeanour, his last warning to repent, and, when humans neglected or failed to do so, the announcement of ensuing punishment expressed by means of catastrophes. The Quaker John Axford reads comets in this respect in his *Catastrophe Mundi*. This system of knowledge places all power with God, who accordingly is in charge of who has access to (which degree of) knowledge, effectively ruling over human limits of knowledge, and non-knowledge. In this context, for John Axford, judicial astrologers, a group of persons he considered himself part of, if only as a self-proclaimed student, held a special position, as they were granted (deeper) insight into the providential God's universe, and could thus foretell, meaning fore-know, the future for others. It is this profession in particular, however, which then also demonstrates the limits of this system of knowledge and its areas of non-knowledge for all its participants, when prognostications made, often

with comets as heralding element, did not occur. This implied the astrologers had not correctly observed and understood the knowledge shown to them by God by means of the stars, and was thus punishable, as other members of this system of knowledge depended on the astrologers in this respect. When almanac-maker Thomas Fowle, in his annual endeavour entitled *Speculum Uranicum*, in 1712 set out to discuss the physical nature and influence of comets on humans, he relied on his readers' paradigmatic Aristotelian knowledge of the fixed, permanent celestial sphere and the terrestrial sphere, the interaction of which was held to create comets. In his account, comets are natural causes used by God to communicate with humanity. True to Foucault's Renaissance episteme, they are perceived as interconnected and can interfere with every realm of life, their appearance in the sky able to cause storms, floods and plagues without, in the macrocosm, as well as choleric temper inciting humans to war within, in the microcosm of the human body. Living in a time of great political, religious and societal upheaval, the possibility of identifying its origin and cause may have presented some notion of knowledge and control, as well as suggested direction on how to move into more peaceful times.

In opposition to Axford and Fowle, second Astronomer Royal Edmund Halley, who, from a temporal perspective, published his 1705 *Synopsis* in between Axford's and Fowle's works, must be assigned to Foucault's Classical episteme of comparison, measurement, and order. His engagement with the 1680 comet was of a scientific nature. He treated the comet as an object of scientific interest, observation, and calculation, by means of which he could enhance his knowledge of comet trajectories, a subject he alleged had not been considered from a mathematical perspective. With the comet's data gained and tabled with that of other comets, in his *Synopsis* he thus claimed to aim at making this knowledge more accessible to other cometary observers as well, in order to facilitate their future calculations of such comet trajectories. Halley's endeavour contributed to the expansion of his own limits of knowledge, as he realised that certain trajectories of historical comets were identical to that of the 1680 comet, thus concluding their potential periodic return. This notion, on paper, was diametrically opposed to the singular portentous concept of comets and the fixed hierarchical image of the 'Great Chain of Being' held in the pre-scientific system of knowledge. However, it may be argued that these two systems did not have the same foci and objectives, and therefore did not need to, and could never have agreed completely (thereby making one of the two redundant). Pierre Bayle's understanding of comets, as given in his *Pensées Diverses* (1683; *Miscellaneous Reflections* (1708)) was rooted in his sceptical approach to knowledge in general, objecting to subscribe to any theories which lacked evidence for their claims, such as, in his opinion, the reading of comets as divine signs of wrath and portents of retribution. Bayle shows the limits thus perceived in the pre-scientific system of knowledge by employing the scientific episteme, observing and comparing comets and their perceived consequences and aftermath on Earth to prove that the portentous nature of comets could not be verified.

Knowledge newly established and propagated may be suspected to have enabled the labelling of already existing, especially contradicting knowledge, as non-knowledge. This strategic move could, in turn, perhaps be hoped to contribute to the expansion of the interpretive dominance of one's own system of knowledge. For Axford and Halley, disregarding their existence in different epistemological systems, this may be observed in their explicitly Eurocentric understanding of astrological and astronomical learning, which they both, in their respective works, portray as universal truths unquestionably applicable to the context of the contemporary English colony of

Jamaica, in Axford's text, and the East India Company in Halley's case. Despite, or rather precisely because of their obvious differences, both the pre-scientific and the scientific system of knowledge are integral for a comprehensive understanding of the epistemological perception of, and the discourse on, comets at the turn of the eighteenth century. Therefore they need to be represented not as two insular epistemes following in linear succession, but as co-existing and to some degree intertwined.

Notes

1. The 1712 edition of Fowle's almanac gives the author's surname as "Fowles". However, this is the exception to all other annual publications of *Speculum Uranicum* available for consideration for this article (1680-1707), which on their title pages all declare to be written by a "Thomas Fowle". Since Thomas Wright's *The History of Almanacs* (1863) also supplies the name "Thomas Fowle" (181) for this almanac, this version of the surname is employed in this article.

Works Cited

Aquinas, Thomas. *The Summa Theologica of Saint Thomas Aquinas*. Great Books of the Western World, vol. 19, edited by Robert Maynard Hutchins and Mortimer J. Adler. Encyclopædia Britannica, 1952.

Ariew, Roger. "Ariew, Roger. "Theory of Comets at Paris During the Seventeenth Century." *Journal of the History of Ideas,* vol. 53, no. 3, 1992, pp. 355–72, https://doi.org/10.2307/2709882.

Axford, John. *Catastrophe Mundi: Or, the Various Alterations and Changes That Have Happened in the World since 46 Years after the Creation, … By John Axford, Student in Physick and Astrology, above Forty Years*. J. Nutt, 1704.

Bayle, Pierre. *Miscellaneous Reflection, Occasion'd by the Comet Which Appear'd in December 1680. Chiefly Tending to Explode Popular Superstitions*, translated by unknown. J. Morphew, 1708, https://doi.org/10.1037/13880-000

"Book 42: Luke". *King James Bible*, edited by Derek Andrew. 2nd version, 10th ed., 1992, pp. 1193-1241.

Capp, Bernard. *Astrology and the Popular Press: English Almanacs 1500-1800*. Faber and Faber, 1979.

Daston, Lorraine. *Eine kurze Geschichte der wissenschaftlichen Aufmerksamkeit* [A Short History of Scientific Attention], vol. 71, edited by Heinrich Meier. Carl Friedrich von Siemens Stiftung, 2000.

Daston, Lorraine and Katharine Park. *Wonders and the Order of Nature, 1150-1750*. Zone Books, 1998.

Dvořák, Petr. "The Concurrentism of Thomas Aquinas: Divine Causation and Human Freedom". *Philosophia*, vol. 41, no. 3, 2013, pp. 617-634. https://doi.org/10.1007/s11406-013-9483-9

Foucault, Michel. *The Order of Things. An Archaeology of the Human Sciences*. Pantheon Books, 1970.

Fowles, Thomas. *Speculum Uranicum: Or, an Almanack and Prognostications for the Year of our Lord God 1712. Being the Bissextile or Leap Year. And from the Creation of the World, According to Sacred Wit, 5660.* E. Everingham, 1712.

Halley, Edmund. *A Synopsis of the Astronomy of Comets*. John Senex, 1705. https://doi.org/10.5479/sil.271675.39088015653660

Heidarzadeh, Tofigh. *A History of Physical Theories of Comets, From Aristotle to Whipple*. Springer Science + Business Media, 2008, https://doi.org/10.1007/978-1-4020-8323-5

Hintikka, Jaakko. "Gaps in the Great Chain of Being: An Exercise in the Methodology of the History of Ideas". *Reforging the Great Chain of Being. Studies of the History of Modal Theories*, edited by Simo Knuuttila. D. Reidel, 1981, pp. 1-17, https://doi.org/10.1007/978-94-015-7662-8_1

Jackelén, Antje. "Cosmology and Theology". *The Routledge Companion to Religion and Science*, edited by James W. Haag, Gregory R. Peterson, and Michael L. Spezio. Routledge, 2012, pp. 135-144.

Jardine, Lisa. *Ingenious Pursuits: Building the Scientific Revolution*. Little, Brown and Company, 1999.

Johnson, Samuel. *A Dictionary of the English Language*. Times Books, 1983.

Kenny, Neil. *Curiosity in Early Modern Europe*: *Word Histories*. Harrassowitz, 1998.

Krämer, Fabian. *Ein Zentaur in London*. *Lektüre und Beobachtung in der frühneuzeitlichen Naturforschung* [A Centaur in London. Reading and Observation in Early Modern Science]. Didymos, 2014.

Leibniz, Gottfried Wilhelm. *Theodicy: Essays on the Goodness of God, the Freedom of Man, and the Origin of Evil*, translated by E.M. Huggard, edited by Austin Farrer. 2nd ed., Open Court Publishing Company, 1990.

Lovejoy, Arthur O. *The Great Chain of Being. A Study of the History of an Idea*. Harper Torchbooks, 1960.

Methuen, Charlotte. "On the Threshold of a New Age: Expanding Horizons as the Broader Context of Scriptural Interpretation". *Hebrew Bible/Old Testament: The History of Its Interpretation*, vol. 2: From the Renaissance to the Enlightenment, edited by Magne Sæbø. Vandenhoeck & Ruprecht, 2008, pp. 665-690, https://doi.org/10.13109/9783666539824.665

Moore, Patrick, and John Mason. *The Return of Halley's Comet*. W.W. Norton, 1984.

Porter, Roy. *The Greatest Benefit to Mankind*: *A Medical History of Humanity from Antiquity to the Present*. HarperCollins, 1997.

Schaffer, Simon. "Halley's Atheism and the End of the World". *Notes and Records. The Royal Society Journal of the History of Science*, vol. 32, no. 1, 1977, pp. 17-40, https://doi.org/10.1098/rsnr.1977.0004.

Schechner, Sara. *Comets, Popular Culture, and the Birth of Modern Cosmology*. Princeton UP, 1997, https://doi.org/10.1515/9780691227672

Schuster, John A. "The Scientific Revolution". *Companion to the History of Modern Science,* Paperback, eds. Robert C. Olby, Geoffrey N. Cantor, John R. R. Christie, and M. J. S. Hodge. Routledge, 1997, pp. 217-242.

Seth, Vanita. "The Origins of Racism". *History and Theory*, vol. 59, no. 3, 2020, pp. 343-368, https://doi.org/10.1111/hith.12163.

Skinner, Quentin. "Meaning and Understanding in the History of Ideas". *History and Theory,* vol. 8, no. 1, 1969, pp. 3-53, https://doi.org/10.2307/2504188

Wardhaugh, Benjamin. *Poor Robin's Prophecies. A Curious Almanac, and the Everyday Mathematics of Georgian Britain*. Oxford UP, 2012.

Wilson, Curtis. "Astronomy and Cosmology". *The Cambridge History of Science*, vol. 4: Eighteenth-Century Science, edited by Roy Porter. Cambridge UP, 2003, pp. 328-353, https://doi.org/10.1017/CHOL9780521572439.015

Wright, Thomas. "The History of Almanacs". *MacMillan's Magazine*, vol. 7, no. 39, 1863, 173-185.