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Elizabeth A. Spiller
University of North Texas

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Sighting Utopia in the Lens: 
Reading Praxis in Johannes Kepler and Margaret Cavendish 

Elizabeth A. Spiller

Elizabeth Spiller teaches Renaissance literature at the University of North Texas. She has articles forthcoming in Modern Language Quarterly, Studies in Philology, and Studies in English Literature. She is currently completing a book on science and imaginative literature in the early modern period. 

All is possible, but all is in doubt. All things have lost their concert. In the very dawn of his humanist affirmation, the individual is assailed by the very doubts, the very criticisms, the very questioning with which Copernicus and Galileo set free the dormant forces of the universe, expanding it to a degree such that the dwarfed individual, in response, must gigantically display his unleashed passions, his unbridled pride, the cruel uses of his political power, the Utopian dream of a new city of the sun, the hunger for a new human space with which to confront the new, mute space of the universe. —Carlos Fuentes

In 1610 Galileo fascinated and shocked Europe with the publication in The Starry Messenger of the observations he made using the telescope. The consequences of this small volume were more far-ranging than probably even Galileo anticipated. While his claims about new stars and new satellites were of considerable interest in scientific circles, his book also altered not just what people knew but how they knew it. In her classic treatment of this subject, Marjorie Nicolson argues that of all the developments associated with the “New Science” it was the telescope that most profoundly changed how people understood the world (“Telescope” 234-5). Although Galileo’s Starry Messenger may be a somewhat unusu-
al case, its example nonetheless represents a significant conflict between reading and observation as ways of acquiring knowledge. Galileo's text reveals the extent to which many of the new methods of science depended increasingly on observation rather than on textual authority. Thus, Galileo documents his findings through illustration and description, rather than through a textual authority such as Ptolemy. Moreover, transforming telescopic vision to textual representation is the only means by which Galileo can share his findings since he obviously cannot furnish the reader with a telescope. Reading therefore becomes the medium through which the instrument of the telescope initially becomes known. If what is seen through the telescope is inevitably not the same when seen on the page, then neither is what is seen on the page the same when read through the cultural changes produced by the telescope.

A well known incident in Part II of Don Quixote (1614), published four years after The Starry Messenger, exemplifies the tension between reading and observation produced by the invention of the telescope. Without considering the possible impact that the telescope may have had on Cervantes' conception of Don Quixote, Edward Dudley has recently argued that Cervantes confronts through Quixote a world full of "new modes of knowing" such that the novel "becomes a response to the questions that the New Science posed about the possibilities of knowing." 2 As a text that theorizes more rigorously perhaps than any other how reading changes the way you see, Don Quixote explores in the adventure with Clavileño how the telescope alters what you see. This episode can be understood as a fantasy that enacts the conflict that the new ways of seeing exemplified by the telescope brought to older practices of reading. Although Sancho, being illiterate, is of course one of the remarkably few characters in Quixote who is not a reader, it is on this fact that the episode with Clavileño turns. In this adventure, Sancho Panza takes what he thinks is a voyage into space on the magical wooden horse Clavileño. As if he were using a telescope, Sancho's simulated ride on the horse becomes the means by which he is able to explore starry distances without ever leaving the ground. As someone who insists that what he sees is true, Sancho becomes a figure here for philosophers of the New Science who wanted to rely not on texts but instead on personal observation as a means of learning the truth about the world. Himself not a follower of textual authority, Sancho thus aligns himself with the practices of the New Science when he suggests that it was curiosity — his desire "to know what is forbidden and denied me" — that made him, he says, take off his blindfold mid-flight (Cervantes 731). 2

When Sancho gives his account of his "observations" of and from the moon, he invokes contemporary reaction to what scientists such as Galileo reported having seen through their telescopes. Listening to Sancho's completely unexpected account of how he "discovered the whole globe" in the sky, Sancho's audience responds with many of the objections that contemporaries had to the equally startling reports of Galileo's discoveries with the telescope.

Claiming that he took off his blindfold upon reaching the region of fire, Sancho first insists that he looked down to see an earth the size of a mustard seed peopled by men the size of hazel nuts. The duchess challenges his account: "it is clear that if the earth appeared to you like a grain of mustard seed and each
man like a hazel nut, one man alone would have covered the whole earth” (734). As the duchess's complaint implicitly recognizes, the telescope shows objects at a great distance only through a kind of distortion. Despite his protests, Sancho concurs with the duchess since he acknowledges that his view cannot determine how a part (hazel-nut men) is related to a larger whole (a mustard-seed planet).

Understanding this episode from the perspective of the telescope depends on recognizing that Sancho's experience occurs because, unlike Quixote, he is not a reader. Arranged by the duke and the duchess, this “adventure” begins as an elaborate re-enactment of their readings in romance. The horse of brass from Cleomadés, the hippogriff in Orlando furioso, the fantastic voyages in the Arabian Nights, perhaps Lucian's True History — these are among the romance subtexts that inform the way that the duke and duchess construct this adventure. Where Quixote knows such literary subtexts intimately, Sancho responds to the “experience” that the duke and duchess create by insisting on the truth of his personal observations as he has experienced them through the medium of Clavileño. Sancho thus describes how after passing the moon he left the horse to play with the goats of the “Cabrillas” constellation (nanny goat, Pleiades). Upon being challenged by Quixote as to the impossibility of having played with these starry goats, Sancho substantiates his claims by describing the colors of the goats. He avers that he saw colors in the stars — red, green, and blue goats — that were invisible to everyone else. As if in response to those who questioned whether the telescope would work the same way in the supralunar realm as it did in the sublunar one, Sancho transforms this challenge to his experience's observational validity into an improbable if irrefutable defense of his fantastic story.

In this episode Cervantes ultimately refuses to resolve the conflict between observation and reading brought about by the new technology of the telescope. Although this story invokes the telescope only as a subtext, it is consistent with how the telescope entered the European imagination. Seizing upon its fantastic qualities, both critics and admirers of the telescope imagined its power in texts that dramatized the utopian possibilities it seemed to represent. As with Sancho's magical ride, the telescope was associated with the “Utopian dream” that Carlos Fuentes describes in his introduction to Don Quixote, because it was an instrument of distant vision. Insofar as the telescope was often credited with remarkable powers, it is unsurprising that it would be incorporated into a genre that in some sense made it possible better to see this world by refracting it through images of a distant world: the utopia. What the telescope and the utopia share is not simply a powerfully distorted image of the world, since what the utopia attempts as a genre is significantly more than just a fantastic imagining of the unattainable. As Fredric Jameson has demonstrated, utopias are structured to put two conflicting possibilities in relation to one another as a way of working out otherwise unresolvable cultural problems. If critics have noticed the prominence of utopia as a genre in works that deal topically with the invention of the telescope, then it is because these utopian fictions themselves constitute what Jameson identifies as a “process” that explores the conflict between reading and experience associated with the telescope as a new way of seeing (81).
In a provocative reassessment of the way that the early modern utopia develops, Marina Leslie has recently argued that utopias are neither “straightforward social blueprint” nor fixed literary genre but rather “a complex textual practice enmeshed in a web of historical contingencies” (1). She thus argues for the need “to consider utopia as a kind of edgy, multiple, and palimpsestic way of reading” (2; emphasis added).7 In this essay I would like to extend Leslie’s argument by in some sense inverting it. As recent work in textual studies and the history of the book has begun to make clear, reading is a contested activity in this period and, as such, reading as a means to knowledge comes at times to be perceived as an almost unrealizable ideal. Though not usually seen as linked texts, Johannes Kepler’s Dream (1634) and Margaret Cavendish’s Description of a New World Called the Blazing World (1666) represent two compelling examples of how an emphasis on observation and experimentation makes reading problematic in the context of early modern scientific practices. These two utopias do not just give readers images of the new technology; they also make the methods of the new technology a part of the reader’s experience of the text. Kepler’s Dream is a description of how the earth is perceived from the perspective of the moon. This alternative view of earth is then set inside an elaborate fairy tale frame narrative and annotated with hundreds of footnotes. Cavendish’s Blazing World describes the voyages of a protagonist who somehow escapes into an alternative realm where her experiences with scientific observation become a means for looking back at the earth. Kepler and Cavendish follow the practice of earlier utopias in using an elaborate frame narrative as a structure that separates the reader from whatever ideal world is being imagined. Both texts thus show how the frame is therefore both a means of access to an imagined ideal and a barrier to ever realizing it.

Reading is in most early modern utopias not unlike the bridge across the river Andrydes in Thomas More’s Utopia: although we may never know how long it is or precisely how it gets us closer to Utopia, it nonetheless allows us to reach, however tentatively, impossible ideals through imaginative self-projection (Marin, “Toward a Semiotic” 266; More 5). It is in this context that Peter Ruppert thus speaks of utopias as “tentative and provisional explorations” that only achieve a “dynamic process of discovery” through the active engagement of the reader (23–4). The insistence on texts as physical artifacts (see, for instance, the Aldine Press editions in the Utopia) thus emphasizes how reading provides key access to these otherwise unapproachable imaginative territories. For Kepler and Cavendish, reading is considerably more important and yet also considerably more vexed, since in their texts the frame narrative becomes a kind of meditation on the act of reading in which we are engaged. Depicting reading as instances of distortion, delusion, and dream through an association with the telescope, the frame in these utopias becomes a narrative realization of the act of reading. Understanding the ways in which reading involves a kind of distortion comparable to that of the telescope, Kepler and Cavendish construct their utopias as a way of creating, albeit in fictional form, a site/sight where reading theory and observational practice can be imagined if not realized. Augmenting recent work in the history of early modern reading practices, this essay considers these practices as they were theorized by Kepler and Cavendish.
themselves. For Kepler and Cavendish, reading is not so much the way to an utopian ideal as it is that ideal.

The manner in which these two texts are utopias about reading can be seen in how they were published. Kepler's *Dream* was published jointly with his translation into Latin of Plutarch's *De facie in orbe lunae.* Cavendish's *Blazing World* was likewise published jointly with her *Observations Upon Experimental Philosophy.* Kepler translates — and sometimes mistranslates — Plutarch as part of an ongoing attempt to reconcile a traditional understanding of reading with new practices in science. Kepler rereads the most self-consciously fictive parts of his classical sources to transform them into scientifically relevant documents. The *Dream* uses the utopia as a genre to integrate the ways of reading that Kepler associates with Plutarch, Cicero, and Lucian into the new kinds of knowledge being discovered through the telescope. If Kepler used the *Dream* to reconcile humanistic reading practices with his scientific work, Margaret Cavendish sought in the *Blazing World* to accommodate her readings of recent scientific texts to an understanding of herself as a writer. Cavendish's utopia examines what it means to read contemporary works in natural philosophy — and in particular those that claim to exemplify the “New Philosophy” that she associated with experimentalism. By publishing these texts together with their utopias, Kepler and Cavendish depict how the practice of reading becomes complicated by new visual technologies.

Johannes Kepler's *Dream* was the first fictional work to see the earth from a specifically Copernican perspective. Kepler did not conceive of the *Dream* as "proof" of the Copernican hypothesis, since he never seems to have truly doubted it. Rather, the *Dream* is an argument for the Copernican hypothesis that nostalgically projects a utopian world in which seeing and knowing were joined as they apparently had been in the pre-Copernican world. Despite the fact that Kepler claimed that the purpose of the *Dream* was "to use the example of the moon, to build up an argument in favor of the motion of the earth" (36), the work was of comparatively little scientific importance. Critical discussions of the *Dream* have generally separated Kepler's presentation of his scientific ideas at the center of the text from the complex textual apparatus that surrounds it. Kepler's readers have thus emphasized the scientific accuracy of his representation of what the earth would look like without recognizing that Kepler is also indulging in a fantasy world in which mediation and distortion would not interfere with what we see and know (Nicolson, "Kepler" 276-7; Manuel and Manuel 212; Lane vii). Understood in this context, Kepler's fantasy about unproblematic knowledge works as a kind of solution to the challenges set out in the frame narrative.

Kepler seeks this solution not only as a scientist but as a reader. As has often been observed, the final form of the *Dream* stands as a correction to mis-readings of earlier versions of the text that had led to witchcraft charges being brought against Kepler's mother. Actually, though, Kepler's attempt to amend earlier readings of his text became over the course of a number of years part of a larger attempt to develop a theory that reflected upon the reading practices that informed his scientific work. For if Kepler is best known for his
use of observational data to construct new star charts and tables, it should also be remembered that it was Tycho Brahe, not Kepler, who did the observing. As a scientific observer, therefore, Kepler was also a reader. As Anthony Grafton points out, Kepler relied on written descriptions from other astronomers as a kind of visual aid for his observational work. He thus used Cardano’s “crisp, well-chosen adjectives to compensate for weakness of his own eyesight . . . [in seeing] what a comet’s tail actually looked like” (“Kepler” 563). More generally, Kepler’s work testifies to an active and wide-ranging use of classical sources. J. V. Field demonstrates in this context how the importance that reading had for Kepler has become an impediment to subsequent attempts to understand his work. Kepler’s commentaries on his own work thus reread both classical authorities and his own earlier writings (Field 163–7, 172–6). As Grafton concludes, while new scientific practices may have changed the way in which reading was discussed, it nonetheless remained the model for “all complex forms of learning” (“Kepler” 565). Kepler’s work as a whole demonstrates in this context “how much the act of reading meant to him” (563). 11 Kepler theorizes in the Dream the interest in reading that Grafton identifies as being characteristic of the early modern period as a whole. The questions about reading and observing that structure Kepler’s more strictly scientific works become the narrative subject of the Dream. Kepler keeps returning to this otherwise intellectually insignificant text — revising, restructuring, explaining, adding notes to the notes — because it gives him a way to think through in narrative form his own scientific practices.

In contrast to the scientific texts that Steven Shapin and Simon Schaffer have described as transforming early modern readers into vicarious observers, readers of the Dream are not observers. 12 Kepler initially uses the fictional form precisely because he wants to describe something that no one — no matter how good the telescope — could see from earth. The literal separation of reader from observer is prominent in a letter that Kepler wrote to Paul Guldin, which is included in a “selenographical appendix” at the end of the published version of the Dream. Kepler’s letter thanks Guldin for giving him a telescope and presents him with a copy of the Dream, suggesting that the text will be a compensation for the telescope. Kepler is not simply employing the rhetoric of courtly patronage; he intends his remarks literally, saying that

Since you are the first from whom I hear that this treasure [the telescope] is to pass into my possession, you are also the first to whom I think I should offer some fruit of literary enjoyment. . . . If you direct your mind to the towns on the moon, I shall prove to you that I see them. (150–1)

Having just given Kepler the astronomical tool that would have allowed him to “direct” his eyes to find proof of these new observations, Guldin can only see through his imagination. What is true for Guldin is also true for other contemporary readers of the Dream: they must use their imaginations since it is not possible for anyone — with or without a telescope — to see what the earth looks like from the moon.

Kepler therefore constructs this text so that it is in some sense a dream about reading and observation. One day, after reading about the legendary his-
tory of Bohemia, the narrator falls asleep and dreams that he is reading a book about a man named Duracotus. A fictional version of Kepler, Duracotus is able to learn about the moon and stars through the discoveries and revelations of a daemon spirit who shows him a vision of Levania (the moon) that comprises the central part of the text. If Kepler is reading at the outset of the narrative, he is also involved in “watching the stars and the moon” (11). Yet, even as Kepler invokes these two methods of acquiring knowledge, he rejects them as insufficient insofar as it is through a dream that he has his vision of the moon. His dream in turn replicates these conflicting acts of observation and reading. In dreaming that he is reading yet another book — one obtained at the Frankfurt book fair — Kepler reminds his readers that this book fair was the best source for new scientific books that were innovative, controversial, or even censored. Yet, at the same time, this dream about reading is itself presented as a kind of astronomical observation: the dream begins with the drowsiness brought on by a late night watching stars and ends with a storm that would have made astronomical observations as well as astronomical dreams impossible (11, 28).

Like Kepler’s narrative, Duracotus is associated with forms of reading and observation that define contemporary scientific practice. Duracotus learns not just Danish but modern methods of science when he studies with the astronomer Tycho Brahe at his observatory complex on Hven. In the Dream, Uraniborg is represented as a place that combines modern observational techniques with modern reading practices. As Kepler knew from having served as Brahe’s assistant at Uraniborg, Brahe had an enormous, room-sized brass quadrant affixed to the wall that became a key tool in the “highly precise method of observation” with which Brahe “fought against the very nature of human vision and emerged victorious” (47 n. 25). Yet, as Kepler suggests, studies at Uraniborg also emphasized reading along with observation: Brahe had an extensive library collection, a paper mill, and a printing press. Duracotus has thus learned both by using new observational tools and by reading books: “things which you saw with your own eyes or learned by hearsay or absorbed from books” (14). Uraniborg appears in the frame narrative as the best attempt to bring together reading and observation as the two dominant means of acquiring new scientific knowledge. Kepler suggests in this reflection on Uraniborg that even Brahe’s dream could not, in this world, be fully achieved: despite his training, Duracotus does not “acquire new knowledge” through the methods taught at Uraniborg but through the vision from the daemon, whom Kepler associates with knowledge. The purpose of Kepler’s elaborate frame narrative, then, is to portray the acts of reading and observation as important but finally never adequate means of acquiring knowledge.

In his copious footnotes, Kepler addresses his remarks to different kinds of readers. He names particular individuals; he addresses readers of his earlier works; he imagines that spectators who had observed his astronomical demonstrations are now reading this work (39 n. 8; 108 n. 154; 57 nn. 44, 46, 47). Often employing the imperative, Kepler repeatedly gives his readers instructions on how to read his Dream: “Interpret this physically” (64 n. 57); “Refer back to Note 28” (49 n. 31); “You who are annoyed, forgive me” (65 n. 59).
so doing, Kepler's footnotes inscribe the figure of the reader into the text as he both anticipates and tries to script the responses of his readers. At the same time, Kepler is in the notes also his own best reader. As a record of Kepler's different and changing interpretations of his own work, the notes exemplify the range of his reading practices. Kepler at times reads his Dream as an allegory in a manner in keeping with the hermeneutics of medieval theology; he demonstrates his familiarity with the reading practices of humanist philology by glossing his text with notes on relevant scholarly literature; elsewhere he provides scientific explanation and interpretation more characteristic of the New Science. In this context, Kepler's notes to the text likewise problematize the relationship between reading and observing. When he discusses the origin of the Dream, Kepler insists that his work preceded both observational studies and his reading in classical sources. Thus, at the outset, Kepler describes how "exceedingly amazed" he was that his ideas corresponded so closely with Plutarch's "because they did not at all come to me from reading this book" (32 n. 2). In discussing the mountains on the moon — one of the most famous conclusions of The Starry Messenger — Kepler similarly insists that "this detail of the Dream is older than the Dutch telescope" (125 n. 207). At these moments Kepler seems to participate in a positivistic view of his own scientific practice. Yet, Kepler's text elsewhere gives other, conflicting accounts for the sources of his ideas. What is important is finally not where Kepler got his ideas but that his notes reproduce the structure of the Dream in suggesting that knowledge does not come from either reading or observing.

As the frame narrative to the Dream suggests, Kepler shares with Cavendish a recognition of the limitations to both reading and observation in the practice of science. Since Copernicanism makes it clear that man is not the measure of his universe, Kepler imagines in Levania a world and a people who are the measure of their universe. Kepler thus depicts the inhabitants of Levania as a fantastic consequence of the physical reality of their world: having both a "monstrous size" and a "short lifespan," the physical being of these creatures is in keeping with the astronomical circumstances of their world (27). Kepler emphasizes how man is neither the measure of his world nor physically suited to apprehend other worlds. With a darkness uncharacteristic of imaginary voyages during this period, Kepler describes in detail how those who investigate this world will suffer pain until they are almost "torn to pieces" (71 n. 68). The Levanians by contrast realize a relationship to their physical environment that allows them direct and unmediated access to knowledge. They need neither books nor telescopes to know their world. Even as Kepler purports to be demonstrating the Copernican theory, he represents the Levanian world through a pre-Copernican understanding of man.

Where the frame narrative identifies a conflict between observation and reading as the key problem of modern knowledge, the utopia at the heart of the narrative imagines a world that reconciles this conflict through its physical reality. The utopian central section inverts the normal situation in which we make claims about the earth based on our observations of the moon. Kepler asks us instead to imagine being on the moon while looking back at the earth. In trying to portray what the earth looks like from the moon, Kepler renames these
celestial bodies to accord with the way this change in perspective also alters how they appear to observers. The moon that we see primarily as white (lebhana, luna, selene, selas) becomes Levania, while the earth that they perceive as rotating is the Volva (volare) (78 nn. 89, 90). As we have seen, Levania’s lunar world is one where knowledge is derived from evidence that is clearly and continually visible to an eye unaided by the telescope: seeing is knowing. The most remarkable feature of the Levanian landscape is that the earth — four times as large as the moon — can always be seen in the sky. It is, the daemon says, “always visible . . . fixed in place, then, as though it were attached to the heavens with a nail” (22). Because the Volva appears to Levanians as if it were four times the size of their own globe, the Volva’s “size and brilliance . . . is practically never hidden, even at new Volva.” As a result, this world has a natural solution to two of the most pressing epistemological problems of the seventeenth century: telling time and determining the longitude. The Volva thus becomes a visible celestial manifestation of the truth.

Consequently, Kepler’s *Dream* can describe a world in which knowledge is based on direct observation in a way that is not physically possible on earth. The constancy of the Volva allows the Levanians to determine both the hour and their location simply by looking up at the sky. What Kepler’s original readers would have recognized immediately is that the Levanian world solves the problem of how to keep time and determine longitude. As the work of David Landes suggests, this was a serious problem in the seventeenth century (Landes 84, 132, 145; Howse 2-54). In his *Learned Treatise of Globes* (1639), Robert Hues complained that through sailors’ ignorance of how to calculate latitude

there have been many errors committed in navigation, and many whole countries also removed out of their owne proper situation, and translated into places of others. (169)

Although the miscalculations of ships on such north–south passages were relatively few in comparison to those made on east–west voyages, errors occurred because there was no reliable way to make such calculations. Since at least the time of Ptolemy’s *Geography* it had been known that calculating longitude entailed comparing the time in different parts of the globe. The different proposals for doing this were all predicated upon one of two assumptions about the earth’s position in the universe or, more particularly, about man’s ability to find some fixed point of reference to the universe. The first group sought to find or create a reference point inside the boundaries of the planet. Peter and Phillip Apian, Guillaume de Nautonier, and even the mad Mathematician of Cervantes’s *El coloquio de los perros* located this standard of measure within the earth itself when they looked for declination from the magnetic pole. After it was realized that the ore content of mountains and other large land masses made standard declination impossible, two British mathematicians suggested that a series of “fixed points” be artificially constructed on the surface of the earth. In this proposal lamented by Dr. Arbuthnot as having “spoiled one of my papers of Scriblerus, which was a proposal for the longitude not very unlike,” William Whiston and Humphrey Ditton suggested that vessels moored at
Intervals along travel routes should shoot off flares each night at midnight, according to Peak of Tenerife time. Gemma Frisius, William Cunningham, and proponents of the chronometer method gave man the power to create such a point of reference with what Cunningham calls the "parfaite clocke artificial-ly made" — a perfectly sound plan that was just not yet feasible (110).

Each of these methods essentially sought to dissociate time-telling from reliance on non- or supra-terrestrial phenomena and, in doing so, to create a self-contained, self-referential earth. The second, more popular solution to the longitude question sought a point of reference outside the boundaries of the earth in the form of predictable celestial phenomena that could be observed and recorded at different points on the globe simultaneously. In this model, the skies themselves became a kind of clock. These methods calculated longitude by observing the relative positions of different celestial bodies: the moon to the sun (Ptolemy's lunar eclipse method), Jupiter's satellites to Jupiter (Galileo's planetary eclipse method), or the moon to the fixed stars (Johann Werner's lunar distance method). In relying on phenomena that were in some way difficult to observe, such methods were, as Kepler concludes, "very laborious and uncertain" (98).

Kepler's utopia circumvents the impediments to knowledge on earth because the monstrous size of Volva ensures that for the Levanians time is always known. Where most observers after Galileo looked at the moon's spots as evidence of its changing nature, Kepler directs his readers' attention to a comparable progression of spots visible on the earth itself. Not indications of inconstancy, these spots instead mark the passing of time.

Volva itself also distinguishes the hours for them. For even though it does not seem to have any motion in space, nevertheless, unlike our moon, it rotates in its place and displays in turn a wonderful variety of spots. . . . This is the only uniform measure of time. (23)

The panoramic succession of images produced by the Volva's rotation is plainly visible to the naked eye — a man (Africa) seems repeatedly to be kissing a girl (Europe) in a long dress (eastern Europe, the Baltic regions), who stretches back her hand (England) to catch a leaping cat (Scandinavia). No special knowledge of star movements or calculations is necessary: most simply, each new attempt by the man to kiss the girl marks the passage of another hour. The story that the Levanians see in the sky makes the same demand of its viewers that Sancho Panza makes on his audience when he tells Don Quixote his goat story: you must keep count for the story to work (Cervantes 152-4). Unlike the progression of the fixed stars across the sky, the spots mark intervals, not sequence. The dial, the fixed point behind the moving hands, is not in some distant sphere. In contrast to seventeenth-century solutions to the longitude problem, Kepler's watching Levanians themselves take the place of the fixed dial. Neither a rigorous prerequisite to observation nor a laborious calculation to be drawn from it, knowledge depends upon the presence of a viewer to keep count of the passing hours. Requiring neither telescopes nor books to know their world, the Levanians enjoy the "measure" no longer possible in Kepler's post-Copernican astronomy.
Although Kepler’s description of Levania appears in many ways to be objectively and scientifically accurate, he suppresses details that do not support his fantasy. For instance, facts that do not support a radical connection between seeing and knowing are never mentioned. The text does not acknowledge that finding the latitude on Levania would be nearly as difficult as finding the longitude is on earth. Kepler obscures the latitude problem by mentioning it only in the context of the “convenience” of determining longitude on Levania:

they indicate the longitude of places with reference to their motionless Volva, and the latitude with reference both to Volva and to the poles, whereas for longitudes we have nothing but the lowly declination of the magnet. (22)

Although the comparison between the earth’s longitude and Levania’s latitude goes unremarked in this passage, the opposite connection between the earth’s latitude and Levania’s longitude is insisted upon elsewhere in the Dream precisely because it can be assimilated into the model of visible knowledge. In this respect, Kepler compares the Volva’s presence on the horizon to “the greater and smaller altitudes of the pole, even though we do not see the pole with our own eyes.” For a sailor or astronomer, the most logical terrestrial analogue to the Volva’s “always visible” presence on the Levanian horizon would be the star Polaris at the North Pole. Since Polaris is a real and visible natural body, it provides information about location to the inhabitants of earth in much the same way that the Volva would on the moon. Instead of discussing the Pole star, however, Kepler’s narrative emphasizes the Pole, an abstract (and invisible) concept. In making this choice, the Dream again suggests that the Levanian world can be apprehended immediately and intuitively in ways that the sublunar one cannot. Ultimately, the Dream is a utopia that admits the physically necessary limitations to human knowledge in order to project a world and place that does not have such limitations.

In her Observations upon Experimental Philosophy (1666), Margaret Cavendish takes up the philosophical problem raised in the Dream by arguing that telescopes, microscopes and other tools of observation constitute only “deluding Glasses” and “Experiments.” She asserts that “[s]ense deludes more than it gives a true Information, and an exterior inspection through an Optick glass, is so deceiving, that it cannot be relied upon” (sig. d1). Where a text with this title might in this period ordinarily be expected to document trials, demonstrations, or “experiences,” Cavendish’s Observations is instead a rejection of the scientific practices exemplified by such work. The full force of Cavendish’s critique of experimental and observational science only becomes apparent when read through her utopian rethinking of contemporary scientific practice in the Blazing World. Cavendish chooses to append the Observations to the Blazing World to establish experimentalism as the context for her fictional work. Rejecting the science of observation in favor of the imagination of readers, the Blazing World makes experimentalism the site for its utopia about fiction and the nature of reading.
In this respect, Cavendish’s utopia is the culmination of a line of inquiry begun with her first scientific work, Philosophical Fancies (1653). She subsequently revised this work as the Philosophical and Physical Opinions (1655, 1663), a much more fully realized response to her reading in recent works in natural philosophy. In these subsequent editions, Cavendish responds to what she has been reading in Hobbes, Descartes, More, and Van Helmont. The somewhat ironically entitled Observations Upon Experimental Philosophy offers a critique of the scientific practices that she associated with Robert Hooke’s Micrographia (1665), Hobbes’s work on optics, and Robert Boyle’s Experiments Touching Colours (1664). Although it is difficult in many respects to delineate the development of Cavendish’s intellectual opinions in these works, it is clear that her attitude towards the practice of science in this period changes as a result of her experiences as a reader of science. Speaking of her husband as her “only tutor” and herself as “unlearned,” Cavendish describes how after the publication of her first works she “applied [her] self to the reading of Philosophical Authors, of purpose to learn those names and words of Art that are used in Schools” (Cavendish, Life sig. a3r). She became a reader so that she could become part of the ongoing intellectual debates that interested her. Presenting herself as one who wrote as a reader, Cavendish in the early editions of the Philosophical and Physical Opinions used her status as a reader of recent works by Hobbes, Descartes, and van Helmont to authorize her writing. In the Observations and the Blazing World, Cavendish’s rejection of recent work in experimentalism and optics is predicated in part upon her earlier attempt to take part, if only as a reader, in contemporary scientific debate. Here she writes as someone who will not be read in order to reject reading as it was being defined in the works of experimental philosophers.

As a fictional response to her readings in the New Science, the Blazing World might be understood as telling in small the history of reading as a contested activity in early modern science. Seeing Cavendish in this way contrasts with the more familiar view of her as one who did not read. As Cavendish recognizes, experimental philosophy was the type of science that most excluded readers like her. The problem with the New Science, for Cavendish, is not just that it depends on “arts” — such as the telescope — that involve distortion and delusion. Equally important, the methodology of experimentalism limits the reader’s access to new forms of knowledge. Thus, in her joint publication of the Observations and the utopian Blazing World, Cavendish rejects contemporary scientific practice in favor of a utopian fantasy in which readers get to make their own worlds. On the other hand, Cavendish’s decision to write a utopia should not suggest that she was primarily frustrated in her isolation from contemporary scientific thought. As recent studies demonstrate, many of Margaret Cavendish’s scientific opinions were in themselves not that far from the mainstream of contemporary intellectual thought.21 Cavendish’s philosophical writing, as she herself recognizes, is in many ways no more strange than Descartes’s vortices, Hobbes’s materialism, or Charleton’s atomism. As Eve Keller concludes, it is important that we not ignore “the contemporary viability of her own attempts at natural philosophy” (450).22 In suggesting that what distinguishes Cavendish is thus not so much what she read, knew, or even under-
stood, recent discussions have focused on how as a woman Cavendish lacked the authority to write on these subjects.

This argument might be extended, however, by recognizing as a more fundamental problem that Cavendish’s works were not read because she herself lacked the preliminary qualifications to be accepted even as a reader of scientific texts. As Shapin and Schaffer suggest, the reader became a key figure in the development and dissemination of seventeenth-century science. Although observations and experiments would ordinarily be considered merely “probable,” affirmation from distinguished witnesses could transform what was only a “probable” into an “accepted” truth. Readers were important in this process as a way of multiplying witnesses to create greater consensus (Shapin and Schaffer 60). In this regard, Cavendish’s case demonstrates that just as there were limitations on who qualified as an observer, there were, in ways that have not been fully recognized, also comparable limitations on who qualified as a reader. Margaret Cavendish is not qualified to be a true reader of these texts to the extent that she would not have been accepted as a valid witness at the demonstrations held by the Royal Society and other learned groups. Cavendish was implicitly not accepted as capable of truly assenting to — let alone “confuting” — work in contemporary science. This sense in which she was thus not recognized as a reader more fully explains why Cavendish’s published work received no serious attention during the seventeenth century. While this claim is a logical extension of what has been identified as Cavendish’s position in general, it becomes important because Cavendish’s works — and the Blazing World in particular — respond to her own recognition that she was not read.

Although Cavendish claimed that she did not write to be read, she was clearly deeply concerned with readers’ responses to her work. Cavendish’s sense of herself primarily as a reader can be seen in her attitude towards her own readers. Her insistence that she wrote “to please myself rather than to please such Crabbed Readers” who might criticize her works does not obviously come out of an indifference to what readers thought. Cavendish’s works almost all include elaborate prefatory epistles that seek to direct the terms under which her work is read. The Philosophical and Physical Opinions (1663), for instance, includes a letter from the duke of Newcastle to his wife, a second from her to him, a letter to her “Noble Readers,” another simply “To the Reader,” “An Epistle to the Reader,” and finally “Another Epistle to the Reader.” The earliest version of this text, The Philosophical Fancies (1653), begins with three different versions directed to three different kinds of readers. Even the Observations Upon Experimental Philosophy, although more restrained in many ways, nonetheless contains letters to the duke, to the “Most Noble, and Eminent-Learned” readers of Cambridge University, and to the “Courteous Reader.”

Cavendish relies on this elaborate textual apparatus not out of an ignorance of contemporary conventions in publishing. Rather, she is also imagining, somewhat idealistically, the possibility that her readers would in some sense rewrite her books through their responses. Thus, in the CCXI. Sociable Letters (1664), she responds to a writer who condemns the practice of printing letters praising a work. She disagrees by saying that she wishes that “whereas I have
One Friend to Praise my Works, although Partially, I had a Thousand, or rather Ten thousand Millions, nay, that their number were Infinite, that the Issue of my Brain, Fame, and Name, might live to Eternity if it were possible” (163).

Cavendish is here indirectly defending her practice — which she began after critics suggested of her early works that they must have been written by someone else — of including such a letter of praise from her husband in almost every book she published. At the same time, Cavendish is also supposing that she might have “infinite” millions of readers who would write to praise her works. Even as she imagines that she will be able to create readers through her writing, she also hopes that such readers would be able to create her through their reading. Thus, Cavendish’s interest in reaching readers is not so much the expression of an egocentric desire for fame as it is a recognition of how central her own experiences as a reader were in defining — as well as limiting — her understanding of the world.

Where Kepler writes from the perspective of a scientist trying to communicate a kind of imaginative observational experience to readers, Cavendish responds as a reader who was unable to obtain the “truth” from the observational accounts of writers such as Robert Hooke. Understood from Cavendish’s perspective, a text such as Hooke’s *Micrographia* limited the reader in the sense that a reader could only ever see as much as the illustrations showed. The very elaborateness — the microscopic realism — of the engravings merely emphasizes that the text becomes a substitute for, rather than an encouragement to, experience itself. Thus, Cavendish constructs the *Blazing World* to redefine the access that her readers have to the “truth” of her text.

Cavendish employs a frame narrative to create a transition into a world in which her autobiographical character is allowed to reign over the scientific society from which the author was excluded. The *Blazing World* therefore begins in a romance world with a young man “travelling into a foreign Country,” and falling “extremely in Love with a young Lady” (1). The young man determines to pursue his love by kidnapping her, but his boat is lost in a storm. When the boat passes through the North Pole into another world called the Blazing World, only the lady survives. The lady’s marriage to the emperor of this new world allows her to establish a group of learned societies, which become the vehicle for both a critique of experimental science and a demonstration of the methodological superiority of what Cavendish referred to as “rational thought.”

In debates that ironize proceedings at the Royal Society, representatives of different societies are repeatedly forced to admit that they cannot answer the empress’s questions because they cannot see something. Astronomers cannot determine what air is because they cannot see it (22); chemists do not know whether all animals have circulatory systems because these interior motions are not visible “neither of themselves, nor by the help of any optic instrument” (35); natural philosophers are unable to observe “the interior, corporeal motions” of vegetables and minerals (41). In the same way that Cavendish addresses her *Observations upon Experimental Philosophy* to what she refers to as “Modern Experimental and Dioptical Writers,” Cavendish here mentions the experimental philosophers and the astronomers both first and at greatest length. Together, these two methods of scientific inquiry epitomize what is for
Cavendish the greatest weakness of contemporary science: reliance upon visual evidence.

In establishing the boundaries of her fictional world, Cavendish thus uses astronomy in ways that challenge its reliance upon unverifiable visual evidence. In particular, reading into the frame of her narrative world evokes the act of looking through a telescope. At the beginning of the narrative when the lady first crosses from her world into the Blazing World, Cavendish addresses the reader directly for the first and only time to explain the peculiar twinned planets and their relationship to our world:

least you should scruple at it, and think, if it were thus, those that live at the Poles would either see two Suns at one time, or else they would never want the Suns light for six months together, as it is commonly believed; You must know, that each of these Worlds having its own Sun to enlighten it, they move each one in their peculiar circles; which motion is so just and exact, that neither can hinder or obstruct the other; for they do not exceed their Tropicks, and although they should meet, yet we in this world cannot so well perceive them, by reason of the brightness of our Sun, which being nearer to us, obstructs the splendor of the Suns of the other Worlds, they being too far off to be discerned by our optic perception, except we use very good Telescopes, by which skilful Astronomers have often observed two or three Suns at once. (3; emphasis added)

It is precisely at this point that a new world opens up in Cavendish’s text. This new world is not the Blazing World, an alternative realm that readers would have anticipated from Cavendish’s title. Instead, the unexpectedly new world in Cavendish’s text is the lady’s native world: before this point there is nothing in the text to indicate that her world is not our world. Prior to this, the term “world” is only used once in the opening pages and is preceded by a definite article. Here, suddenly, the text moves directly from the expected, generic romance alternation between actual and ideal to a more complicated division that now includes the Blazing World as a third realm.

Cavendish’s description of the complicated physical relationships between the three planets is ostensibly an assertion of the plausibility of her narrative world. Yet, it is not improbable planetary motions that are a problem; at issue rather is our ability to know anything about such a world. Cavendish’s suggestion that the worlds she describes are real but not visible “except we use very good Telescopes” initially situates this utopia just beyond the range of unaided vision. Science — the knowledge of “skilful Astronomers” — appears to provide the most certain access to and confirmation of her fictional realm. The conclusion that these astronomers may see these worlds in the same way that they see “two or three suns at once,” however, reduces their claims to the status of optical illusion. What science can attest to is no more than a disappearing parahelion. Even as the frame narrative models reading on the act of looking through the telescope, Cavendish insists that it is not astronomers with telescopes but instead “skillful” readers with texts who will be able to discover this strange new world.
Like Kepler, Cavendish intends the reader to see things which would not be visible in any lens. This contrasts with most literary writers who responded to the new visual technology by using their texts to show readers — if often parodically — what you could see through the telescope. John Donne thus imagines that Galileo is able to bring the moon to the earth in *Ignatius, his Conclave* (1611), while Francis Godwin’s *Man in the Moone* (1638) depicts a world of people ten, twenty, and thirty times larger than life. Where Donne and Godwin mimic the function of the telescope, Cavendish uses her narrative to show readers worlds that the telescope’s augmented vision occludes. Cavendish’s intention of showing readers a world that exceeds new technologies of vision can be seen in the inhabitants of this world:

the men . . . were of several Complexions: not white, black, tawny, olive- or ash-coloured; but some appear’d of an Azure, some of a deep Purple, some of a Grass-green, some of a Scarlet, some of an Orange-colour, & c. (14-15)

Vividly and visibly outside the monochrome range of “white, black, tawny, olive- or ash-coloured,” the people of this world are truly a people of color. Tempting as it may be, however, it would be a mistake to understand Cavendish’s depiction of the “several complexions” of this world as an attempt to reconceptualize contemporary understandings of racial identity, or even, as Rosemary Kegel suggests, as evidence of “the flexibility of race as a category during the seventeenth century” (135).

In this description of the people of the Blazing World, Cavendish is rereading her own fiction through an understanding of discovery provided by her rejection of the telescope. In Cavendish’s early prose romance, “Assaulted and Pursued Chastity” (1656), the heroine Travellia/Affectionata finds herself in a distant and strange land:

they in the boat never saw such complexioned men, for they were not black like Negroes, nor tawny, nor olive, nor ash-coloured, as many are, but of a deep purple; their hair as white as milk, and like wool; their lips thin, their ears long, their noses flat, yet sharp, their teeth and nails as black as jet and as shining . . . All those of royal blood were of a perfect orange colour, their hair coal black, their teeth and nails as white as milk. (63, 68)

In this earlier story, a contemporary fascination with ethnography informs Cavendish’s belief in natural hierarchy. As someone who supported sumptuary laws that would make social standing physically visible to all, Cavendish here postulates a race in which class would be marked not by clothing but by skin color. When Cavendish rewrites this passage in the *Blazing World*, however, a different understanding of what it means to be able to know things by seeing them leads her to imagine not two colors of people but a whole rainbow: azure, purple, green, scarlet, and orange. More spectacular than anything produced in Boyle’s *Experiments Touching Colours*, the people of this world refract the full spectrum of visible light.
Throughout the Blazing World the power and majesty of the realm derive from the range of color in the people and the whole colored world itself. Thus, a special sort of diamonds that sparkle with the spectrum of light becomes an icon of the empress’s power over her subjects: the Imperial State room is made of diamonds that “seem’d just like so many Rainbows” (12) and her buckler of office “shewed like a Rainbow” (14). For Cavendish, these colors are produced by natural vision; although optic devices such as the telescope might augment vision in some respects, they limit the range of visible color to a monochrome. Where earlier telescopes allow astronomers to see the Blazing World only as an illusory parhelion, now in its inability to show more than a monochrome, the telescope misses the magnitude and power of this “Blazing” world. In its very vividness, the Blazing World becomes something that cannot be seen through the artificial, and hence limited, means of the telescope.

Towards the end of the fiction, Cavendish herself recognizes the ways in which she is rejecting not just experimental and observational science but the ways of reading that they imply. In an episode involving the empress’s choice of scribes, Cavendish reimagines the events that led to the writing of this book. The empress decides that she needs a scribe to assist with her intellectual projects. She first hopes to enlist “the Soul of some ancient famous Writer; either of Aristotle, Pythagoras, Plato, Epicurus, or the like” (89). In order to suggest that these philosophers are no longer relevant to the New Science, Cavendish has the empress’s guiding spirits inform her that these “learned, subtle, and ingenious Writers” were too sure of their own opinions to “have the patience to be Scribes.” From the ancients she then turns to “one of the most famous modern Writers, as either of Galileo, Gassendus, Des Cartes, Helmont, Hobbes, H. More, & c.” If the classical philosophers have been excluded because of their ancient opinions, the empress is excluded because of these “fine ingenious writers” are so “self-conceited that they would scorn to be scribes to a woman.” In this moment Cavendish asks us to think about what it would mean if Galileo or Hobbes, for instance, had not been too “self-conceited” to write for a woman. If other scientists had been willing to write to and for her, Cavendish implies, then she would not have had to write the Blazing World. These authorities are invoked only to be rejected as possible characters because this is the point at which Margaret Cavendish enters her own text as a character: she becomes the self-writing character. Although critics have noted how Cavendish’s fictional works almost always include some autobiographical version of herself, the Blazing World is distinctive in having two different autobiographical versions of Cavendish. Where the empress constitutes an autobiographical reflection of Cavendish as a reader of science, Cavendish introduces herself under her own name in this moment as the writer of an utopian science.

While Cavendish rejects the science that she associated with the Royal Society as the basis for knowledge at the outset of the Blazing World, she subsequently suggests that it can play a role in society. In the Observations, Cavendish characterizes the work of experimentalists and others not as science but as forms of art. By relying on telescopes, microscopes, “and the like inspections,” this type of science produces illusions (sig. b2). After rejecting science as the basis of knowledge at the beginning of the Blazing World, Cavendish
subsequently suggests in the central section of the text that the “arts” of science can be important in theology and politics, an assertion that is needless to say in direct contradiction to the claims of the Royal Society to remove itself from any involvement in either of those areas.29 After first reforming and then dissolving her scientific societies, Cavendish’s empress turns her attention to the social circumstances of the state. Although she has rejected the scientists’ claim to knowledge, the empress now uses their assistance to create two central chapels, one representing heaven and the other hell. In these temples, the “art” that made science an inadequate means of knowledge in the Observations is exploited to create spectacles “so artificially contrived” to delude the ignorant people (62). Science cannot produce truth for Cavendish, but it can create “deluding” shows that are powerful enough to create “a constant belief” (63).

By setting the Blazing World in opposition to the new worlds being discovered by natural philosophers, Cavendish seems to present a radical choice between being a reader and being a scientist. Kepler, however, wants to integrate old reading practices with new observational methods. His utopian gesture is to recognize the conflict in that desire and thus to imagine a world in which neither reading nor observation is necessary. Even as Kepler’s utopia looks back to a pre-Copernican certainty, Cavendish’s Blazing World imagines a realm in which anyone can create her own theory of how the world works. In this respect, she embraces uncertainty by rejecting the dogmatism and institutionalization that she associates with scientific authority. In the end, though, Cavendish likewise imagines a world in which there would be no need to justify empirically one’s scientific visions. If neither of these utopias solve the conflict between reading and observation that each identifies, their failures are not of the imagination. Rather, Kepler and Cavendish attest the need to produce a theory of knowledge that could also produce new theories of reading.

Notes

1. In his elegant and consistently illuminating introduction to Don Quixote, Fuentes makes a similar point when he discusses how Sancho’s “empiricism” cannot overcome Quixote’s unwavering belief in the truth of what and how he reads (xviii–xix).

2. Contemporary thought was, at best, ambivalent about the moral and theological dangers attached to scientific curiosity. For a discussion of how astronomy and knowledge of the stars is transformed from a subject of revelation outside the “ken” of man into a matter of scientific inquiry, see Lewalski 46–50. Sancho’s curiosity does indeed seem to have given him significant new ambitions in the ways that Milton’s Raphael predicts: as a result of having seen, as he says, the comparative insignificance of the earth, Sancho declares after his investigation into the stars that he would rather “rule the sky” than have his long-promised island (Cervantes 736).

3. As always in Don Quixote, Cervantes is reworking a variety of texts and topics. Sancho’s “ride” is also modelled, as he himself suggests, on the voyages that Eugenio Torralba claimed to have taken.
4. On the key importance that the telescope had as an informing metaphor in the early modern period, see Blumenberg 617-74; Reiss 31-3, 54; Rorty 11-13, 38-51.

5. Indeed, Thomas More himself seems anticipate the telescope as a utopian instrument in Hythlodaeus’s description of the “most expert” astronomical knowledge of the Utopian scholars: “they have ingeniously devised instruments in different shapes, by which they have most exactly comprehended the movements and the positions of the sun and moon and all the other stars which are visible in their horizon” (More 91). Before its invention, a version of the telescope can of course be imagined by More as a tool of “exact” knowledge. Afterward, the telescope generally moves out of the central section of the utopia and into the framing narrative in a way that emphasizes the problematics of the knowledge it seems to bring. See my discussion of John Donne and Francis Godwin below in this context; one key exception is Saloman’s House in the New Atlantis (1627).

6. Discussions of the historical development of the utopia in this period that connect this genre to science as well as politics include, among others, Manuel and Manuel, Reiss, Boesky, Founding Fictions, and Leslie.

7. Leslie rightly emphasizes that even aside from historical considerations utopias are hard to fix as a literary genre because the philosophical commitment to reform that characterizes utopian writing has as a narrative consequence a self-conscious need to revise and rewrite earlier utopias. Nonetheless, early modern utopias after More do seem to share certain identifying narrative features; see Boesky, Founding Fictions 14-17.

8. Although the Dream was published posthumously, Kepler left instructions that these two texts were to be published together. A letter to Matthias Bernegger suggests that he originally hoped to include with them an edition of Lucian’s True History. See Romm 101.

9. On the impact that Kepler’s work had on literary figures such as John Donne, Francis Godwin, John Wilkins, Cyrano de Bergerac, and John Milton, see Nicolson, “Kepler” and “Cosmic Voyages.”

10. Originally written as a set of propositions while Kepler was a student at Tübingen, the work subsequently was circulated in manuscript around 1608. References to the witch Fiolkhilde resulted in witchcraft charges against his mother. Over the next twenty five years Kepler continued to rework his manuscript in order to correct the terrible misreading of the original manuscript: “I therefore decided to avenge this dream of mine for the affair just cited [concerning his mother] by publishing the book, which will be another punishment for my adversaries” (41 n. 8). See Nicolson, “Kepler” 260-67.

11. For two excellent accounts, from different perspectives, of the importance of reading as a practice in the development of early modern science, see Grafton, Defenders, and Sherman 29-52, 79-100.


13. Galileo’s Starry Messenger, for example, was immediately published in a Frankfurt edition and would almost certainly have been available at the 1611 book fair. On Kepler’s participation in the literary culture that helped define this new visual sensibility, see Grafton, “Humanism.”
14. An illustration of the famous mural quadrant is included in Brahe's *Astronomiae instauratae mechanica* (1598). Kepler's representation of Uraniborg as a model of modern scientific practice differs significantly from that of Andreas Libavius, who associated it with dark, arcane forms of knowledge. See Hannay and the reassessment by Shakelford.

15. See, for example, 124 n. 202; 129 n. 211, 54 n. 43.

16. Although Kepler describes early versions of his work as having associated these physical characteristics of Levania and its inhabitants with its political structure, the revised text is careful to eliminate such potentially topical comments (129-30 n. 213).

17. In an influential argument about the changing attitudes toward visual perception in this period, Svetlana Alpers identifies Kepler as someone who recognizes that distortion is inherent in any lens, whether it be the lens of the eye or of various observational tools like the telescope. Alpers thus concludes that Kepler defends the use of optical tools not so much by arguing for their integrity as by demonstrating that natural vision is characterized by a similar distortion, the "deception of vision." As a utopia the *Dream* does not need to reconcile natural and artificial observation since it imagines a world without the falleness of man (Alpers 34-5). For two excellent accounts of the visual culture that Kepler was influential in redefining in Northern Europe, see Kaufmann and Ruestow.

18. The earth rotates 360 degrees/24 hours (15 degrees/hour); a time difference of, say, 3 hours and 5 minutes translates into 45 degrees, 60 minutes of longitude.

19. Letter to Swift, 17 July 1714; quoted in Howse 49.

20. On the impact of Galileo's claim in the *Starry Messenger* that he could see that the moon was "not smooth, uniform, and precisely spherical" but rather spotted, "full of cavities and prominences," see Boesky, "Milton" 24.

21. For excellent rethinking of Cavendish's science in its contemporary context, see Stevenson; Rogers 177-211; and Sarasohn.

22. In making this argument, Keller recognizes a key implication of Shapin and Schaffer's assertion that the "losers" in the history of cognition are often as significant as the "winners."

23. What women were expected to read was not Galileo, for instance, but popularizations such as John Wilkins's *The Discovery of a World in the Moone* (1638). The affiliation between women readers and such popularizations is suggested by the fact that Cavendish herself seems to have been transformed into a central character in de Fontenelle's *A Discovery of New Worlds*, which was both widely read in France and quickly translated into English by Aphra Behn.

24. Cavendish's famed visit to the Royal Society in 1667 merely proves this point. Although she did attend the society, it was only once and only as a spectator who herself became a spectacle for Society members such as Pepys. For accounts of this visit, see Mintz; and Grant 15-26.

25. James Fitzmaurice's research is especially suggestive on this point: he reports that many of the presentation copies of Cavendish's books appear never to have been read at all ("Margaret Cavendish" 302).

26. In important ways, Cavendish is her own first reader. Although she claimed — and her critics have often repeated this assertion — that she never
read her own works, the evidence suggests otherwise. Fitzmaurice suggests that Cavendish read her works with care and attention when she hand-corrected the published volumes of her work with a clear sense of the kinds of readers she was addressing in the different texts (see “Margaret Cavendish” and “Some Problems”).

27. Cavendish, “To the Readers of my Works” in Orationes, quoted in Bowerbank 405.

28. The duke’s first letter was initially written, according to Cavendish, to counter the rumor that someone else—a man—was the true author of her books. William Cavendish’s letter is of course an imprimatur that relies not just on his class or gender but more importantly on his position as the husband who had what society recognized as a legal responsibility over his wife. As such, William Cavendish’s letter ironically can assert that she wrote these books only by itself claiming “authority” of and over them.

29. See, for instance, Sprat.

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