SHAKESPEARE'S SUPPORT FOR THE NEW ASTRONOMY

Peter Usher

The time is out of joint. O cursed spite!
That ever I was born to set it right.

Hamlet*: Act I, scene 5*

RENAISSANCE cosmology prior to the year 1543 was based almost entirely on concepts established by Plato and his student Aristotle, that the physical universe comprises an immobile Earth about which move the seven ancient planets and the stars. This geocentric model was eminently plausible for it agreed in its basic form with what was obvious to the naked eye, that all heavenly bodies circled the earth, albeit at different rates and in slightly different ways.

The geocentric model was brought to a high level of sophistication by the last of the Greco-Roman astronomers, Claudius Ptolemy (fl. 140 AD), yet notwithstanding the ingenuity of its mathematics, the Ptolemaic model suffered from a major defect—it failed to predict planetary motions for any extended period of time. Informally Plato had assigned to his students the task of explaining the apparent movements of the planets (Pannekoek 102), but neither his simple model nor the more sophisticated one of Ptolemy were up to the task. In fact, the assigned problem remained unanswered for well-nigh two millennia, until the advent of Newtonian mechanics in the last half of the seventeenth century.

A major step in predicting planetary positions occurred in 1543 with the publication of the book *De Revolutionibus*. This seminal work by the Polish mathematician Nicholas Copernicus (1473-1543) advanced the revolutionary idea that the Sun was at the center of all motion in the planetary system. Initially the heliocentric model was not superior in its predictive power to the old, but it spurred Renaissance thinkers to view the physical universe in a new light. Unfortunately, through the labors of Thomas Aquinas, Christianity had become committed to Aristotelian and Platonic ideals and in particular to the doctrine of geocentricity, and so Christian leaders, both Catholic and Protestant, opposed the Copernican model. Centuries of thought were at risk of being toppled as Copernicus subjected the planetary system to a major transformation—one that placed the Sun at the center instead of the earth. As a result, those who were early to see the truth in heliocentricism had to proceed with caution for fear of persecution.

Dissemination of heliocentricism in England began with Robert Recorde (c. 1510-1558) whose *Castle of Knowledge* of 1556 regarded the doctrines of Copernicus with favor even if he did not fully believe in them (Berry 127). In the same year John Field (c. 1525-1587) published *Ephemeris Anni 1557* which contained predictions of planetary positions for 1557 based on the Copernican system. Field calculated these ephemerides at the urging of John Dee (1527-1608), but Dee had a far greater impact on astronomy through his pupil Thomas Digges (c.1546-1595). In 1573 Digges published a treatise on the "New Star" of 1572, *Alae seu Scalae Mathematicae*, which contained warm praise for the Copernican hypothesis. This work was dedicated to the chief minister to Queen Elizabeth, William Cecil, Lord Burghley. In 1576 Digges followed this publication with *A Perfit Description*, which clearly described and depicted a heliocentric planetary system.

Digges published his *Perfit Description* as an appendix to the almanac, *A Prognostication Everlasting*, which his father Leonard Digges (c. 1521 - c. 1574) had begun. Thomas Digges edited and updated the almanac following his father's death. In a recent paper we have examined the circumstances surrounding the publication of *A Perfit Description* from the time of the 1576 edition of the almanac to the final edition that appeared more than a decade after the death of its author (Best et al). We concluded that Thomas Digges was able to advance the cause of heliocentricism by unobtrusively tucking away the details in an appendix to an almanac that was already quite popular and that was superficially based on politically correct geocentricism, thereby succeeding in disguising not only Copernican theory, but also his own seminal advance—a physically infinite universe filled with stars like the Sun. In fact he may have succeeded so well in disguising his advocacy of the New Astronomy (as it came to be known) that not only did it go unnoticed by censors and potential inquisitors at the time but the full impact of the shattering of the sphere of the stars has not been fully appreciated even to this day (see Best et al.)

Thomas Digges escaped persecution from the time of the publication of his revolutionary ideas to the end of his life in 1595. This was an extraordinary feat in an age of political and religious intolerance, when the House of Tudor was in constant dread of Catholicism and war with Spain, when Sir Walter Raleigh and his cohorts in the so-called School of Night fell under suspicion of atheism, and when one of England's leading mathematicians, Thomas Harriot, was imprisoned simply because his work was sponsored by Raleigh. It would not have gone unnoticed in England in the final years of the writing of *Hamlet* that the Italian philosopher Giordano Bruno (1548-1600), who had lectured extensively there and on the Continent and had been captured by the Inquisition, was consigned to the flames for assorted impieties, including his advocacy in 1584 of an Infinite Universe.

The turn of the seventeenth century was a time when heliocentricism was upsetting centuries of geocentric tradition, when the accustomed order of the heavens was turned

topsy-turvy. Shakespeare noted that the new cosmic order might presage a new order in the affairs of the earth as well. In the "degree" speech in *Troilus and Cressida*, Ulysses says that the heavens show humanity the merits of an harmonious geocentric order: "The Heavens themselves, the planets, and this center [the earth], observe degree, priority, and place." Ulysses goes on to warn that when the planets "in evil mixture to disorder wander" then the hierarchy on earth is imperiled. Later in the play, Troilus states that this has indeed occurred: "The bonds of heaven are slipped, dissolved, and loosed." Elsewhere I have suggested that the concerns that Rosencrantz and Guildenstern express to Claudius concerning the collapse of geocentricity may be seen in analogous human terms: "Most holy and religious fear it is, to keep those many many bodies safe that live and feed upon Your Majesty."

Stability in politics is a constant theme in the Shakespeare canon. In *Hamlet* it manifests itself through the plight of a king who, allegorically speaking, is falsely placed at the center of an hierarchy of planets, including the Sun, that stretches out to the stars, and whose position is threatened by Hamlet, the rightful heir to the throne and so, the rightful Sun and the rightful center.

Shakespeare and Optics

Shakespeare showed great sensitivity to the need for burying the New Astronomy in an allegory that only his inner circle could appreciate. These privileged few would no doubt have included Lord Burghley, who made it his business to develop intelligence in defense of the realm. In the 1570s Burghley consigned to William Bourne the task of writing a treatise on a new-fangled device known as a "perspective glass" or "perspective trunk" (Johnson 176-7). In 1578, Bourne reported that the device enabled a letter to be read at a quarter mile (van Helden *Transactions* 30).

Leonard Digges was a keen experimentalist who is regarded as the inventor of the perspective trunk, a unique design comprising a plano-convex lens with a spherical mirror for an eyepiece (Ronan). These devices were in use at least by 1570, as reported by John Dee in that year and by Leonard and Thomas Digges in 1571 in *Pantometria*. In the Preface, Thomas

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Digges refers to his father's "continual" use of "proportional Glasses." It should be significant that Leonard Digges was the grandfather of another Leonard Digges, one of four writers who contributed dedicatory poems to Shakespeare's Folio of 1623 (see Whalen).

No doubt perspective trunks were quite useful at the time of the Spanish Armada in 1588, amply validating Cecil's interest. The use of optics in warfare would not be surprising given the peacetime use of lenses by artists in Northern Europe by the middle of the sixteenth century. In the fifteenth century, artists graduated from a straightforward pinhole "camera obscura" to use of a "mirror-lens" (i.e. a spherical concave mirror like a shaving mirror). Shaving mirrors are easier to make than plane mirrors and have all the qualities of a lens because they can project images. By this means the image of a subject seen through a hole in the door of a darkened room was projected onto paper pinned up next to the hole. Thus they can be used in lieu of an eyepiece to view images formed by convex lenses. Unlike mirror-lenses, use of convex lenses results in reversed images as evidenced in late sixteenth-century portraiture by a sudden excess of left-handed drinkers (Hockney 74, 118).

Lenses in turn had been known since early times. In the first century AD, Ptolemy is reputed to have had a spectacle glass that enabled him to descry ships from afar, and Roger Bacon (c. 1214-1292) reported that magnifying glasses enabled the stars to "shine in what places you please" (van Helden *Transactions* 28). Bacon also reports examining the Moon through two lenses, and Leonardo da Vinci (1452-1519) noted that it was possible to "make glasses for the eyes to see the Moon large" (Rienitz 7). Thus the perspective trunk made use of two technologies known in the latter half of the sixteenth century: the mirror-lens and the plano-convex lens. It it our belief that the device that combined these optical devices was trained upon the heavens by the Digges father and son and that the results were reported in *Hamlet*.

Hamlet and the New Astronomy

Science historians continue to wonder whether or not the Digges model of 1576 was no more than a great imaginative leap to a physical infinity (Johnson & Larkey 117; Johnson 175; McLean 150). The history of science informs us that it wasn't until Galileo (1564-1642) that data were acquired through actual telescopic observations, data he published in 1610. Galileo showed among other things that the Moon is blemished, that at least one planet —Venus—has phases consistent with motion around the Sun, and that the Milky Way can be resolved into a myriad of stars. But was Galileo actually the first to see them? That these phenomena had been seen before Galileo now seems certain.

I propose that the text of *Hamlet* contains descriptions of solar system objects and the Milky Way, and that these data could not have been gleaned without optical aid. I will fur-

ther suggest, based in large part on the substantial hints in *Hamlet*, both those described here and in my previous articles (see Works Cited), that telescopic observations occurred in England, probably in the interval 1563-1576, at least thirty-three years before Galileo first pointed his spyglass at the heavens and that it is likely that such observations were made with the help of the "perspective trunk" of Leonard Digges.

Omens, Sun and Moon

Shakespeare frequently blends images and ideas of the heavens from classical mythology with what appear to be images derived from direct observation. Among these classical ideas is that events in the heavens portend disasters on earth.

To the ancient Greeks, Phoebus Apollo was god of the Sun and his sister Diana goddess of chastity and the Moon (Bullfinch 6). The Sun-chariot was the symbol of royalty (Graves 109.2), an idea that carried over into Elizabethan iconography, where kings were customarily associated with the Sun (Fleischer 33). It seems reasonable to suppose therefore that Hamlet, heir to the throne, should be associated with the Sun, and that his beloved Ophelia be associated with the Moon. Together the Sun and the Moon rule the sky, for they are the most prominent of the ancient planets. Shakespeare calls the Moon the "moist star" because of her tidal influence upon "Neptune's empire," viz. upon the world's oceans (1.1.118-9, 1.1.118n). I also suggest that Ophelia's name, used, it seems, for the first time ever in *Hamlet*, may have been coined from the prefix *ob-* (or *op-*) as in "opposite," and *helios*, the Sun, since she and Hamlet are destined to rule just as the Moon and Sun dominate the heavens—unless of course something goes awry. In the first scene (1.1.117-20) Horatio says:

> As stars with trains of fire, and dews of blood,
>
> Disasters in the Sun; and the moist star,
>
> Upon whose influence Neptune's empire stands,
>
> Was sick almost to doomsday with eclipse.

Whereupon Horatio says that these events in the heavens are actually omens foretelling disasters pending on earth (1.1.121-5):

> And even the like precurse of feared events,
>
> As harbingers preceding still the fates
>
> And prologue to the omen coming on,
>
> Have heaven and earth together demonstrated
>
> Unto our climatures and countrymen.

Unfortunately lines 1.1.117-8 cannot be analyzed unambiguously, if only because they include an incomplete sentence, but according to Edwards, "dews of blood" does immediately precede and belong with "disasters in the Sun." "Disasters" is a plural noun that suggests to me the wounds mutually inflicted on the two claimants to the throne, Hamlet and Claudius.

The available textual data seem also to contain a second omen which, together with the first, reflect the suffering experienced by Hamlet and Ophelia, presaging their deaths. The solar disasters identify circumstances surrounding Hamlet's death, while the eclipse of the Moon foretells the death of Ophelia by drowning (4.7.164). Both omens are associated with excess: in Act IV, Ophelia will meet her demise because she has "too much of water" while in Hamlet's case (1.2.67) he is "too much in the Sun." Hamlet's being too much in the Sun may be a pun on his being "too much" the "son" of Old Hamlet (1.2.67n) and may also refer to his alleged "madness," (as in: "mad dogs and Englishmen go out in the noonday Sun.")

It may also connect his troubles with Sunspots.

Large Sunspots are visible to the naked eye and in pre-telescopic times were attributed to transiting foreground objects. Galileo thought of them as clouds, but with ever-improving optical resolution, it was believed by the eighteenth century that they were actual holes in the surface of the Sun (Berry Sections 124-5, 268). If Shakespeare means "in the Sun" to be taken literally, he would have to have had optical evidence. Taken literally, "disasters in the Sun" imply breaks in the skin of Sun. Since both Hamlet and Claudius vie for the crown, both have the right to a mythological identification with the royal Sun and, in the final act, both suffer"disasters" in the form of puncture wounds.

Ophelia and Venus

Laertes advises his sister not to take matters of the heart too seriously. He states his reasons for caution, first in the context of love (1.3.5-28) and then of chastity (1.3.29-44). The context of love pertains to the goddess of love, Venus, while the context of chastity pertains to the goddess of chastity, the Moon.

In 1.3.11-4 Laertes introduces the subject of love with the words:

> . . . nature crescent does not grow alone
>
> In thews and bulk, but as this temple waxes
>
> The inward service of the mind and soul
>
> Grows wide withal.

The word "crescent" pertained originally to the waxing Moon in any phase—crescent

or gibbous—since it derives from the Latin *crescere* meaning to increase in size, regardless of the size itself (OED). This meaning probably obtains here since "crescent" and "waxes" precede "grows wide withal," i.e. tends toward the Full phase.

Thus we learn that the Moon is not the only object that waxes, since the issue in question here is love (Venus) and not chastity (the Moon). It would be disjunctive if the description of crescent and gibbous phases of the Moon were to apply to Venus, unless of course that was what Shakespeare intended. If so, the phases of Venus can be detected with certainty only telescopically, as when Galileo trained his spyglass on Venus in 1610 and reported his finding in a letter to the Tuscan ambassador (van Helden *Sidereus* 107). Only if Venus circles the Sun can it show the full range of phases from new to full and back to new again. In 1610 this finding was hailed as a great piece of evidence in favor of heliocentricism. However, since, as we have shown in previous articles, so much of cutting edge astronomy is to be found in a subtext in *Hamlet*, we feel justified in suggesting that the newly discovered phases of Venus, as hinted at by Laertes, may also be intended.

Ophelia and the Moon

Laertes then warns Ophelia of dire outcomes if she does not protect her virginity, arguing that she might be dishonored if she were to entertain Hamlet's advances. The passage (1.3.33-44) in question begins and ends with Laertes urging her to remain a virgin. Laertes instills fear with the help of three metaphors whose common theme is physical impact:

(i) The first is a purely military metaphor that urges Ophelia to stay out of the "shot and danger of desire" (1.3.34-5).

(ii) Next, Laertes cites two adages: the first (1.3.36-7) states that a maiden would go far enough if she were merely to reveal her beauty to the chaste Moon, and immediately upon uttering the word "moon," he uses a second commonplace to describe the threat to her virtue (1.3.38): "Virtue itself scapes not calumnious strokes." If the chaste Moon herself can be impugned, so too can anyone's reputation.

(iii) Lastly, Laertes launches into a botanical conceit, likening the possible outcome of Ophelia's relationship with Hamlet to the cankers that afflict young plants (1.3.39-42):

> The canker galls the infants of the spring
>
> Too oft before their buttons be disclosed,
>
> And in the morn and liquid dew of youth
>
> Contagious blastments are most imminent.

These few lines hold a wealth of meaning.

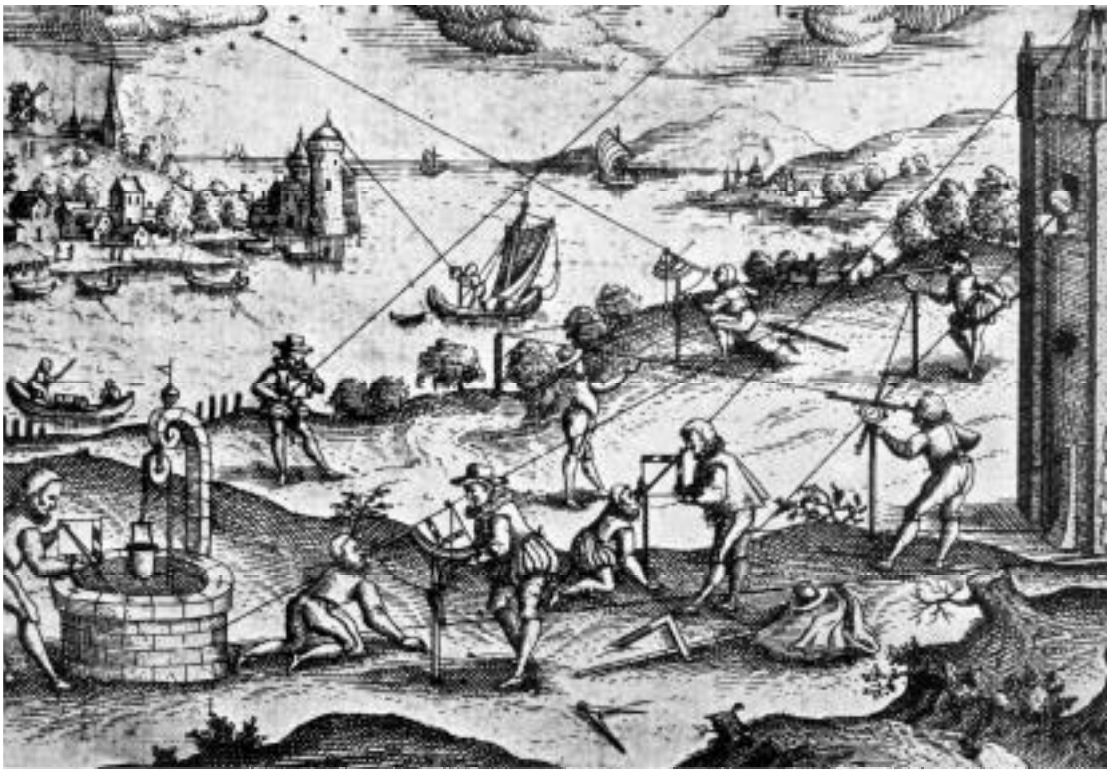
Cankers on the Moon

It has been known since antiquity that cankers can result from wounds to plants (Orlob 99-107). The cankers that attack plants are roundish spots and lesions that result when leaves, stems, thorns, and fruits are injured, allowing fungi and bacteria to assail the tissue. These lesions are like small sunken craters, closely resembling the craters that can be seen on the surface of the Moon through a telescope: a central depression encircled by a raised ridge where the plant resists the infection (Barnes 175-6). The disease is contagious and young plants are particularly susceptible (Carefoot & Sprott 176).

The noun "gall" in 1.3.39 has been in use since 1398 to mean an excrescence produced on trees, while the verb "to gall" has been in use since 1548, not only to signify injury to trees by contact, but also to "harass or annoy in warfare," especially by "arrows or shot." In early use the word "gall" means also a "breach" as in "gaules made by the artillerie" (OED). Thus a botanical image is connected with a military image similar to the previous two, the word-play conflating two sorts of defenses; the botanical one being apt because of the remarkable similarity in appearance of plant cankers and lunar craters, despite their immense disparity in size. Here also the Bard uses for the first time the word "blastments," which Edwards interprets as "blightings," but the frequent wedding of biological and military metaphors suggests that Shakespeare still has the Moon in mind, and is thinking of some surface defects that appear to have been caused by being struck by something hard, as buildings or city walls have craters "blasted" in them by cannon balls.

Laertes repeatedly invokes "fear": "Fear it Ophelia, fear it my dear sister" (1.3.33) and ". . . best safety lies in fear" (1.3.43). This suggests that Shakespeare knew full well the consequences if these explosions were to occur on earth. In fact, the "blastments are most imminent." The word "imminent" connotes something that is "impending threateningly" and "hanging over one's head" (OED) which is where the Moon is seen a lot of the time. "Imminent" also means "close at hand in its incidence" and indeed lunar features are astronomically "most imminent" since the Moon is the closest of the ancient planets under discussion here. Even the meanings of "projecting or leaning forward" (OED) might apply, for the Moon peeks over the horizon as she rises and peers back as she sets.

In 1988 Maurice Charney devoted a full chapter to the largely neglected subject of skin disease in Hamlet, stating that this imagery is among the most distinctive of the play (120-30). We support this interpretation because it appears that Shakespeare is conflating plant cankers with lunar blemishes. Since even with a telescope, all we can ever see of the planets are their surfaces, we must trust to the information the surface conveys about the health of the organism, whether plant or planet.[2] Thus we learn that the Moon's Platonic perfection is sullied. But what of the real-life counterpart?



Amateur astronomers of the late sixteenth century at some unknown location, probably in Germany or the low countries (the engraving is from the Deutches Museum in Munich). Although no details of time and place accompany this engraving, art historians can infer the date—"late sixteenth century" —from the costumes. The instruments depicted are obviously a variety of tools for measuring distance and examining objects at a distance, while several appear to be telescopes. The numerous figures attest to the excitement and popularity surrounding the new vistas that such instruments were opening at this time.

When Ophelia tries to return letters supposedly written to her by Hamlet, he denies having done so, cruelly questioning her honesty and fairness (3.1.103-8). In the sixteenth century, "honest" and "fair" meant "without blemish." Many have seen Ophelia as a dissembler like her father, both of whom in their own way undermine her budding relationship with Hamlet, but about one interpretation there can be little doubt: in sharp contrast to Desdemona and Juliet, she always obeys her father, allows herself to be manipulated by him, and is wholly uncritical of his scurrility. These character flaws endanger the potential harmony of a Sun/Moon relationship with Hamlet. Hamlet then owns up to flaws of his own, calling himself "proud, revengeful, ambitious" and an "arrant knave" (3.1.122-5). So it is that Ophelia's dishonesty and Hamlet's self-styled "indifferent honesty" are paralleled by the existence of blemishes in their celestial counterparts. It seems that something is "rotten," not only in "the State of Denmark," but in the entire universe, from plant to planet.

Old Hamlet and the Great Red Spot

In his mother's chambers, Prince Hamlet describes his father's image as it appears in a miniature portrait: "the front of Jove himself, an eye like Mars, to threaten and command…" (3.4.56-7); words that require careful analysis. The phrase "an eye like Mars" is sandwiched between "Jove" (Jupiter) and his capacity "to threaten and command," this latter attribute alluding to his role as God of Laws maintaining order among the residents of Mount Olympus.

Bullough (34) takes the last line above at face value to mean that Hamlet's "father had 'An eye like Mars,'" etc. There are a number of arguments that support the interpretation that it is Old Hamlet's eye that is "like Mars," and not that Old Hamlet himself is like Mars. Bullough (34, 174-6) refers to a poem by Antonio Francesco Rainieri appended to a book "Eulogies of Men Famous for Warlike Virtue" by Paolo Giovio. This poem compares the Duke of Urbino, Francesco Maria della Rovere (1490-1538), to Hercules in the words: "The mace from Hercules, from Mars the sword." Bullough's suggestion is that in line 3.4.57 Hamlet "indirectly compares his father to Hercules." Bullough does *not* say that Hamlet is comparing his father to Mars as well; he merely states that Hamlet's father *had an eye like Mars* (just as the *Hamlet* text says), not that Hamlet's father was like *both* Hercules and Mars.

The planet Mars, however, is not known for an "eye," only for its red color. What Shakespeare means is that Jupiter has an *eye* that is red; in short, it seems most reasonable that Shakespeare is describing Old Hamlet's face as like that of Jupiter with an "eye" that is red like Mars, in other words, a reference to the planet Jupiter's Great Red Spot.

At the turn of the seventeenth century it was not generally known that the planet Jupiter has an "eye like Mars" for this feature too can be discerned only telescopically. The history of science claims that the Great Red Spot was first observed in 1664-5 by Robert Hooke (1635-1703) and Jean Dominique Cassini (1625-1712). But if Hamlet's creator had seen the planets by means of Leonard Digges's perspective trunk, or had heard tell of it from them or someone who had seen them, it seems perfectly reasonable that he would have seen the Great Red Spot as well.[3]

Resolution of the Milky Way

The Milky Way is aptly named, for it appears to the naked eye as a pearly band that stretches across the sky from horizon to horizon. When examined under magnification with the help of a telescope, much of the nebulosity resolves into a vast number of separate and distinct stars. The resolution of the Milky Way into discrete stars is one of the first sights that amateurs observe with a new telescope, a fact that Shakespeare relates in his usual subtle way.

In 2.2, Player I recites a passage begun by Hamlet about the savagery of Pyrrhus, a

passage so moving as to engender sympathy in the gods. Such sympathy, says Hamlet, would "make milch the burning eyes of heaven" (2.2.475) and evoke the passion of the gods (2.2.476). Apparently the recounting of the brutality of Pyrrhus is so heart-rending that Player I has no trouble bringing tears to his own eyes. Polonius's comment on the actor's tears suggest the meaning of the preceding line 2.2.475; viz. that if the gods were to have seen this brutality then they too would have become bleary-eyed. But why use the term "milch" or "milk" if the subject is passion and tears?

If, as Philip Edwards suggests, "milch" here refers to the Milky Way (2.2.475n), then Shakespeare, in a sort of connection by opposition, may have invoked the image of the resolution of the Milky Way into discrete stars when seen through a telescope, something that for him is connected with an opposite phenomenon, the blurring of lights caused by tears.

Resolution of the Milky Way into discrete stars revives the interpretation of the ancient Greek philosopher, Democritus, of the nature of the Milky Way, viz. that it was "the luminescence due to the coalition of many small stars which shine together because of their closeness to one another" (Jaki 8-10), a theory that was itself in the process of resolving into the present solid reality of an infinite universe, thanks in large part to the perspective trunk of Leonard Digges.

"Demonstrations grounded upon Observations"

Taken singly, any one of the items above might be overlooked, but collectively the evidence for sixteenth-century advances in astronomy due to telescopy merits close examination. There is evidence that the interpretations presented here do not exist in a vacuum. In his *Pantometria* of 1571, Thomas Digges makes a point of referring to his father's discovery of "things farre off," though he omits identifying them or stating how remote they are. But we can guess what they might be, for in a preface to *Stratioticus* of 1579, Thomas states that he had begun writing several books including one on the Copernican theory. This book, he writes, was intended to "ratifye and confirme" the theories and hypotheses of Copernicus by "evidente Demonstrations grounded upon late Observations." I take this to mean that he was intending to report and analyze observational data recently acquired in support of the hypothesis advanced by Copernicus in his *De Revolutionibus* of 1543. Unfortunately this was one of several of the books by Thomas Digges that never appeared.

In previous papers I suggest that the "trick" in Hamlet's remark: "Here's fine revolution an' we had the trick to see't" (5.1.75-6), refers to the device by which Thomas Digges and his father may have observed the stars. I suggest that the Digges, father and son, made observations with an early telescope, thereby supporting a new world view that became known as the

New Astronomy. That they were able thereby to see the details, not only of stars, but of planets as well, the "blastments" on the Moon, the Great Red Spot on Mars, the discrete stars in the Milky Way, requires nothing more than common sense. I suggest that such observations were probably made sometime between 1563, when Leonard Digges' estate was restored following his conviction for supporting Wyatt's Rebellion in 1554, and 1571 when *Pantometria* was published and the elder Digges died; but certainly before the publication of *A Perfit Description in* 1576.

In conclusion

Shakespeare's knowledge of astronomical results prior to their formal announcement would not be unprecedented, because a similar condition obtains in anatomy. Knowledge of the circulation of the blood was formally announced by William Harvey in 1616 but Shakespeare incorporates this knowledge into at least nine plays written prior to 1608 (Davis). Fear of persecution probably delayed announcement of the advance in anatomy, and a similar foreboding may have convinced Thomas Digges to withhold a formal presentation of his proofs of the truth of the New Astronomy, while quietly slipping reference to an Infinite Universe into an appendix of his father's best-selling almanac.

Copernicus lived his life in fear of ridicule and persecution. Andreas Osiander (1498-1552) endeavored to protect Copernicus by penning a Preface and changing the title of this work, but these ploys didn't fool Thomas Digges. It seems reasonable to expect therefore that he would have known the risk, both in shattering the outermost sphere of the stars, because this was what shielded our gaze from the abode of the gods, and in displacing the center of the planetary system, lest this be interpreted as undermining the monarchy. Shakespeare, who may have adopted an allegorical pen name to protect his own identity, may have acted in a similar fashion to protect the Digges family by using an allegory to disguise the empirical evidence for the New Astronomy. Indeed when Hamlet is viewed in the light of this cosmic allegory, we may see him withholding information even from his best friend: "There are more things in heaven and earth, Horatio, than are dreamt of in your philosophy."

NOTES

1 According to this interpretation, Prince Hamlet personifies the New Astronomy which comprises the heliocentric model of Copernicus, and the Infinite Universe of stars of Thomas Digges. Claudius personifies the bounded geocentric model of his namesake Claudius Ptolemy, while Rosencrantz and Guildenstern personify the bounded model of the Danish astronomer Tycho Brahe (1546-1601). The allegory recounts the struggle to distinguish physical reality from appearances, a struggle well-known to astronomers as they strive to convert images on the sky to the reality of three- and four-dimensional space.

2 This fact would seem significant to astronomers and geophysicists interested in planetary and stellar structure, for generally speaking, information on the interiors of these objects can only be gleaned from observations of the outer skin, which must then be used in theoretical models.

This print portrays the sense of a system on the verge of collapse. The ancient astronomy, represented by aging columns labelled Ptolemy and Hipparchus, is weakened, but the roof (the Heavens) continues to be supported by new columns labelled Copernicus and Tycho Brahe, astronomers who incorporated recently discovered phenomena into the old finite universe.

3 If we take the long axis of the Great Red Spot (GRS) to be 30,000 km and the diameter of Mars to be 6,800 km then as seen from the Earth at the time of Opposition, the angular diameter of Mars is about 19 arcseconds, or roughly twice that of the GRS. Thus even though the long axis of the GRS is physically about 4.5 times greater than the diameter of Mars, the two appear to be of comparable angular size because the distance of Jupiter at Opposition (5.2 - 1 = 4.2 astronomical units) is about 8.4 times greater than that of Mars at Opposition (1.5 -1 = 0.5 astronomical units). The similarity of these values suggests that “an eye like Mars” refers both to angular sizes and colors.

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