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## WHAT DID SHAKESPEARE KNOW ABOUT COPERNICANISM?

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*Abstract:* This contribution examines Shakespeare's knowledge of the cosmological theories of Nicolaus Copernicus (1473-1543) as well as recent claims that Shakespeare possessed specialized knowledge of technical astronomy.

*Keywords:* Shakespeare, William; Copernicus, Nicolaus; renaissance astronomy

### 1. Introduction

Although some of his near contemporaries lamented the coming of “The New Philosophy,” Shakespeare never made unambiguous or direct reference to the heliocentric theories of Nicolaus Copernicus (1473-1543) in his drama or poetry. Peter Usher, however, has recently argued in two books *Hamlet's Universe* (2006) and *Shakespeare and the Dawn of Modern Science* (2010) that *Hamlet* is an elaborate allegory of Copernicanism, which in addition heralds pre-Galilean telescopic observations carried out by Thomas Digges. Although many of Usher's arguments are excessively elaborate and speculative, he raises several interesting questions. Just why did Shakespeare, for example, choose the names of Rosenskrantz and Guildenstern for Hamlet's petard-hoisted companions, two historical relatives of Tycho Brahe (the foremost astronomer during Shakespeare's *floruit*)? What was Shakespeare's relationship to the spread of Copernican cosmology in late Elizabethan England? Was he impacted by such

Copernican-related currents of cosmological thought as the atomism of Thomas Harriot and Nicholas Hill, the Neoplatonism of Kepler, and the heliocentrism of John Dee and William Gilbert? Does the language of Shakespeare's plays support the idea that Shakespeare had an in-depth knowledge of technical astronomy on the order of Chaucer (who wrote an instruction manual for an astronomical instrument, the astrolabe), or that Shakespeare understood the implications of Copernican astronomy? The answers to these questions reveal important relationships between Shakespeare and science and technology, the subject of two recent monographs by Adam Cohen based on earlier work by Marjorie Hope Nicolson (Cohen 2006, 2009; Nicolson 1956).

## **2. Shakespeare and Copernicanism**

Shakespeare lived through an unprecedented age – the beginnings of England's imperial expansion, and the still unexplained confluence of printing, a new ethos of precision, standardization, and quantification, and the triumph of public over hermetic knowledge that would later fuel both the industrial and scientific revolutions. In retrospect, it is easy to apply modern categories to the period, specifically the 19<sup>th</sup> century idea of progress (positivism) found in Comte, Marx and Darwin; there is little evidence, however, to suggest that the Elizabethans believed themselves to be living in an extraordinary era of scientific or technological change and furthermore, the Victorian middle class ideal that a responsible citizen should keep abreast of modern scientific developments was not a feature of Elizabethan or Jacobean intellectual life. For the vast majority of the populace, specialized new knowledge in natural philosophy was out of their

reach as it first appeared in Latin monographs and only slowly filtered into the vernacular, primarily via almanacs.

The Elizabethan period was too early to have fully digested several continental insights and discoveries in physics and cosmology. Plattard has demonstrated that French Renaissance writers in the latter half of the 16<sup>th</sup> century—with the exception of Montaigne, Pontus de Tyard, and Jacques Peletier du Mans—generally either ignored or were ignorant of Copernicus’s theories (Plattard 1913; Ridgely 1962).

Similarly in England, Copernicanism is rarely discussed in popular English literature before 1630. As Nicolson points out, “so far as popular imagination was concerned, the theories of Copernicus had little or no effect until after the observations of Galileo’s telescope. They remained mere mathematical theories, important to the technical astronomer and mathematician, but neither disturbing nor enthralling to the lay mind” (Nicolson 1939:32-33; Hetherington 1975). Astronomer and literary scholar David Levy, the co-discoverer of Comet Shoemaker–Levy 9, makes the insightful comment: “at the time of most of Shakespeare’s writing, the real impact of Copernicus’ ideas had yet to be felt....had Shakespeare’s prime writing years ended a decade later, his plays might have reflected a vastly different situation” (Levy 2000:65-66). Respected and widely used astronomical textbooks based on Ptolemy such as Riccioli’s *Almagestum novum* were being published as late as 1651, and in 1680, James Bowker would seriously attempt to refute Copernicanism in a popular almanac (Bowker 1680).

There was significant interest in Copernicanism in England in the mid-16<sup>th</sup> century among a small coterie of learned mathematicians, many influenced by the same hermeticism, Stoic/alchemical materialism, and

Pythagoreanism which also may have led Copernicus to his original insight into the structure of the heavens (the Pythagorean astronomers Philolaus of Croton and Aristarchos of Samos had likewise identified the center of the universe as the sun or a 'central fire'). Robert Recorde's dialogue *The Castle of Knowledge* (1556) had cast doubt on Ptolemy's and Aristotle's arguments against the rotation of the earth, a central thesis of the Copernican system. Recorde promises to explain the Copernican system to the young scholar in his dialogue when he has become more advanced in his studies. Thomas Digges (1546-95) later translated the first book of Copernicus's *De revolutionibus orbium coelestium* in 1576 as an appendix to a reprint of his father Leonard Digges's *Prognostication Everlasting*. Also, Thomas Digges in his *Stratoticos* (1579) claimed to be writing a commentary on Copernicus which, however, never appeared. John Field (1520-87) published an *Ephemeris Anni 1557* revising the Prutenic tables of Rheinhold based on Copernican calculations. John Dee, another English Copernican, wrote a Latin preface to Field's work indicating his support for the mathematical superiority of the Copernican hypothesis (Russell 1972).

The road to acceptance of Copernicus's sun-centered universe in England, however, was uneven, since he had little physical data to support the superiority of his system over the Ptolemaic. As astronomer Owen Gingerich has demonstrated, the two world systems are virtually mathematically equivalent. In the past ten years, scholarship on the reception of Copernicus has revealed that truly committed supporters of heliocentrism were few before Galileo: "[earlier] scholars took statements made in praise of Copernicus to be implicit endorsements of his heliocentric cosmology. Gradually this view has been supplanted by the acknowledgement that many supposed partisans of Copernicus only

endorsed the use of his astronomical models for the calculation of apparent planetary positions, while rejecting or remaining silent on the reality of heliocentrism” (Tredwell 2004:143). Copernicanism did not come fully into the spotlight until Galileo published an astonishing illustrated monograph in 1610 called the *Siderius nuncius* or *Starry Messenger*, announcing the first telescopic discoveries of lunar mountains, the moons orbiting Jupiter, and the resolution of stellar nebulae into individual stars.

In two recent monographs *Hamlet's Universe* (2006) and *Shakespeare and the Dawn of Modern Science* (2010), and series of articles, Peter Usher, Emeritus Professor of Astronomy at The Pennsylvania State University, has claimed to have uncovered in *Hamlet* an elaborate allegory of the competing world systems of Shakespeare's day – Tychonic, Ptolemaic, and Copernican. He has also argued for similar structural patterns in *King John* (Usher 1995). Henry Janowitz also finds Copernican references throughout Shakespeare (Janowitz 2001). Usher is not without precedent since elaborate cosmic symbolism has been clearly demonstrated by John North in Chaucer's poetry (particularly the *Compleynt of Mars*), a source for several of Shakespeare's plays. Also, Weber has demonstrated how the context of alchemy and Neostoicism can inform our understanding of *Antony and Cleopatra* as a meditation on the nature of the universe (Weber 1996). Usher further proposes that through his friendship with Thomas Digges, who along with his father Leonard possibly built a working telescope long before Galileo and made astronomical observations with it, Shakespeare alludes to such phenomenon as Jupiter's red spot, the milky way (resolution of its galaxies), and craters on the moon.

Although Usher does not make it entirely clear what the motivation for such an overarching cosmological allegory would be or how it fits with

the other obvious themes of the play, he has assembled several interesting observations. In addition, at least one commentator and three textual editors have also detected a Copernican reference in Hamlet's piece of doggerel to Ophelia: "Doubt that the sun doth move" (Bevington 2009:2.2.117). The line seems to entertain the possibility that the sun may not move, remaining fixed in a heliocentric cosmos. A.J. Meadows believes it to be "an oblique reference to heliocentric ideas" (Meadows 1969). T.J.B. Spencer calls it "a clever epitome of some of the poetical tendencies of the 1590s: cosmological imagery, the Copernican revolution, moral paradoxes, all illustrating amorous responses" (Spencer 1980:249). Ann Thompson and Neil Taylor in the Arden *Hamlet* of 2006 have annotated the passage more boldly – "The second line [Doubt that the sun doth move] has given editors trouble since it refers to the Ptolemaic belief that the sun moved around the earth – a belief that Shakespeare (if not Hamlet) knew to be outmoded" (2006:246). Thompson and Taylor, however, offer no explanation for why Shakespeare would have known or believed the Ptolemaic system to be outmoded, since reputable astronomers, theologians and poets in England, as established above, continued to cogently defend Ptolemy well into the late 17<sup>th</sup> century.

Christopher Marlow (born in the same year as Shakespeare), who as a Cambridge undergraduate would have studied basic astronomy, demonstrates no acquaintance with the Copernican system in his drama. Very few of the astronomy textbooks in use in 1580 at Corpus Christi college attended by Marlowe – Apian, Frisius, Sacrobosco, Finé, Giuntini, Clavius and Maestlin – mention Copernicus even in passing (Johnson 1946:243). Marlowe's devil catechises Faustus on the structure of the heavens and the devil responds to Faustus's questions by expounding an

idiosyncratic and non-conventional geocentric theory (8 sphere system versus the traditional 10) which Marlowe had read about in either Ricius' *De motu octave sphaerae* (1513), or in works by Finé and Agrippa. Thus, if a Cambridge graduate and exact contemporary of Shakespeare in a play about the boundaries of knowledge does not employ Copernicanism to represent theological or natural philosophical unorthodoxy, then clearly the Copernican system was not being widely debated outside of a small handful of mathematicians and astronomers.

Another possible allusion to a Copernican cosmic allegory is Hamlet's studies at the University of Wittenberg, which became a center of Copernican learning. Copernicus's pupil Georg Joachim Rheticus (1514-74) was professor of astronomy and mathematics at Wittenberg. In 1540, he published *Narratio prima de libris revolutionum Copernici*, an epitome of Copernicus's *De revolutionibus*. Why did Shakespeare have Hamlet study at Wittenberg along with Rosencrantz and Guildenstern, the names of two important relatives of Tycho Brahe?

A portrait of Tycho with names of his current relatives and ancestors, including Rosencrantz and Guildenstern, appears in *Tycho's Epistolae* (1596) – did Shakespeare possibly see an advance copy in possession of Thomas Digges, as astronomer Owen Gringerich has suggested (Ashbrook 1984:395)? Digges was certainly known to Tycho. A Dec. 1, 1590 letter to English astronomer Thomas Savile from Tycho offers greetings to Dee and Digges, and included two copies of Tycho's *De recentioribus phaenomenis* (1588); and with typical Tychonic narcissism, 4 engraved portraits of himself (surrounded by family crests). Among the crests are those of 'Rosenkrans' and 'Guldensteren'.

Shakespeare may have learned of the visit to England in 1592 of Frederik Rosenkrantz (1569-1602) and Knud Gyldenstierne (1575-1627), two cousins of Tycho, who had both studied at Wittenberg (Srigley 2002:178-80; Simpson 1926:28). A later descendent of Rosenkrantz, author Palle Rosenkrantz, indicates that the pair of cousins were almost inseparable and frequently found in each other's company in public. They may have therefore had a reputation among the small circle of courtiers who met them as the archetypal 'tweedle-dum' and 'tweedle-dee,' which is their role in *Hamlet*. Thus the use of their names should not necessarily invoke Tycho Brahe or his world system (Rosenkrantz 1910; Swank 2003:12-15). Although the possibility exists that Shakespeare was well aware of the emerging new world systems, his references to cosmological systems often refer to his known reading in Greek and Roman Stoic texts and Neopythagorean concepts such as the music of the spheres: above all, Shakespeare was always interested in the relationship between man and cosmos and how this relationship impacted ethos and behavior, and human motivation.

Leonard Digges's *Pantometria* (1571) edited by his son Thomas, claims that Leonard had experimented with 'perspective glasses,' possibly an early telescope; William Bourne in *A treatise on Properties* also asserts that Leonard had built perspective glasses and further claims were made in Bourne's *Inventions or Devises* (1578). Unfortunately, the word 'perspective' can refer to mirrors, simple convex magnifying lenses, or early telescopes ('perspective trunks' or 'perspective cylinders'). These scattered references indicate that mathematicians in England were attempting to work out the details, either theoretically or practically, of a telescope, probably for military and navigation purposes. But some of the claims for the devices



made by Thomas Digges of the power of magnification were clearly extravagant exaggerations, and the absence of high quality optical glass in England makes it highly unlikely that telescopes of sufficient power, clarity and field of view to observe the heavens were present before Hans Lipperhey's (1608) and Harriot's and Galileo's models (1609). And given that none of the English authors ever considered combinations of two or more lenses, neglected concave lenses that would have served their purposes, in addition to the technical difficulties of obtaining optical grade glass and adequate mirror coatings (not to mention the extreme difficulties of grinding the lenses and mirrors), their claims must be taken as hypotheses and speculation (Van Helden 1977:12-15; Turner 1991).

The two references to "perspectives" in Shakespeare are clearly not to "perspective glasses" (telescopes) as Usher has claimed, but to paintings created with oblique anamorphosis, i.e. containing distorted images unless viewed from a particular angle (*All's Well*:5.3.48; *Richard II*:2.2.18). Usher, however, believes that either Leonard or Thomas Digges had invented a telescope almost 30 years before Galileo's *Siderius nuncius* and that Digges had trained it on the heavens. He cites a number of celestial objects and phenomena alluded to in *Hamlet* that could only have been resolved with a telescope. For example, Horatio mentions the 'disasters in the Sun' that appeared before Caesar's death. But these are undoubtedly naked-eye sunspots which can be seen without a telescope when the sun is veiled by clouds or through a camera obscura, and therefore do not imply the discovery of the telescope. Chinese astronomer Gan De had commented on naked-eye sunspots in 364 BC.

Also, was Digges able to resolve with his alleged telescope the Great Red Spot (GRS) of Jupiter (Jove) before Hooke's and Cassini's reports of

1664-65 and did he pass this information on to Shakespeare? Hamlet describes his father as possessing “the front of Jove himself,/ An eye like Mars, to threaten and command” (*Hamlet*:3.4.57-58). At times the colors and apparent sizes of Mars and the GRS are similar at 3-10 arc seconds. Usher lists several other tantalizing possible references to telescopically resolved solar and stellar features and objects such as lunar craters (a blemished moon, which he links to Ophelia, *aphelion* or opposite to the ‘sun’ Hamlet), the individual stars of the milky way, and the phases of Venus. However, Usher does not provide convincing explanations for why these phenomena were first introduced into a play by an English dramatist. It is highly improbable that the Diggeses would not have immediately published their telescopic observations as did Galileo who obviously feared competitors, since shortly after the publication of *Siderius nuncius* other astronomers began feverishly building telescopes.

Leslie Hotson and A.L. Rowse have demonstrated several links between Shakespeare and the Digges family and it seems likely that he crossed paths with at least one of the Digges family. Leonard Digges the Younger (son of Thomas Digges, grandson of Leonard Digges the Elder) wrote prefatory verses to the *First Folio* and Shakespeare lived near the Diggeses in London. Thomas Digges’s widow Anne married Thomas Russell, one of the overseers of Shakespeare’s will. Richard Whalen cautions, however, from the Oxfordian viewpoint, that there is no recorded evidence of Shakespeare knowing any of the Diggeses (Whalen 2001).

Usher takes his arguments concerning the Diggeses too far, although Thomas Digges’s primary contribution to astronomy, his promotion of the idea in *A Perfit Description* (1576) that Copernicanism necessarily implied infinite space in the heavens, may have stimulated Shakespeare’s interest in

infinity, nothingness and void, and even atomism. The ancient atomists as well as Aristarchos had proposed an infinite void which appears as an explicit theme in *King Lear* (i.e. the repetition of the word ‘nothing’).

Hamlet attempts to dream of infinite space: “O God, I could be bounded in a nutshell and count myself a king of infinite space...” (2.2.55-56). Copernicus knew that no one had yet been able to detect stellar parallax, which to him implied two hypotheses: either the stars are immensely far away from the earth, or that the earth does not move. He concluded that the earth moved. He left it to the philosophers to determine if the universe was actually infinite.

Although the infinity of the universe was a classical idea discussed by the ancient atomist school, the concept was first firmly linked to the Copernican system in English thought by Digges in the *Prognostication everlasting* (Johnson 1934). Also, Bruno had been in England from 1583-85 espousing the infinity of worlds and published *De l’infinito universo e mondi* in 1584. The concept of infinity is also expressed in Spenser’s *Hymn of Heavenly Beauty*:

Far above these heavens which here we see,  
Be others far exceeding these in light,  
Not bounded, not corrupt, as these same be,  
But infinite in largeness and in height,  
Unmoving, incorrupt and spotless bright. (64-70)

Scholastics had split hairs and spilled many pots of ink over the materiality or non-materiality of the world and heavens, and whether or not they were distinct, divided entities, and sources such as Spenser quoted above could be read as support for an infinite cosmos. So Hamlet’s dream of

infinite space does appear to arise from the resurgence of this idea in both technical astronomy and literature during Shakespeare's career.

In the end, however, Usher's arguments, though interesting, are based on circumstantial evidence and ultimately represent variations of the old view of bardolatry: i.e. Shakespeare was the most advanced, knowledgeable and modern of the Elizabethans, therefore he would have possessed the most advanced knowledge of cosmology, even secret and unpublished scientific data only known to a few.

A quick glance at the use of Copernicanism in John Donne provides an important point of reference. In the "First Anniversarie," his traducian meditation on the death of Elizabeth Drury, Donne writes:

And new Philosophy calls all in doubt,  
The Element of fire is quite put out;  
The Sun is lost, and th'earth, and no man's wit  
Can well direct him where to looke for it. (205-208)

In the poem, Donne never confirms or denies Copernicanism, but Donne's lament that the sun is lost in the New astronomy simply reveals for him the old imperfection of the world, since men are forced to look for new worlds in the firmament because new arguments for heliocentrism have cast old cosmological arguments in doubt. This passage underscores the infirmity of human reason, as do many of the other laments in the poem, expressing the *contemptus mundi* philosophy that can be found throughout Donne's poetry and sermons. Instead of a new *organon* to comprehend nature, Donne thus views the new developments in cosmology as a confirmation that human knowledge is unable ultimately to understand the

heavens without divine guidance. In his view, new science breeds confusion and skepticism – a far cry from the later modernist view of progress.

So we are left to ponder Shakespeare's relationship to Copernicanism. But we must accept the possibility that it had little impact on his imagination, since Copernicanism's later role in ultimately dismantling the Aristotelian-based Catholic theology of natural phenomena was probably not fully appreciated in England until the very end of Shakespeare's career, as it was Galileo who ultimately and finally dismantled Aristotelian physics between 1610-1630.

### **3. Conclusion**

Copernicanism did not sweep Europe by storm after the publication of *De revolutionibus orbium coelestium* in 1543; knowledge of it was restricted to a few academics, and it did not come into the spotlight until near the end of Shakespeare's life when Galileo refuted several tenets of Aristotelian physics such as the natural place of the elements. Ironically, non-Copernicans such as Tycho Brahe had further demonstrated that related Ptolemaic-Aristotelian concepts such as the crystalline spheres were physically impossible. But technical astronomy aside, Shakespeare's later plays are certainly permeated with the philosophical ideas that were indirectly generated by newly emergent theories of cosmology: void, nothingness, infinity, new worlds, and most importantly, man's relationship to the cosmos.

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