Ptolemy's Almagest in Poetry and Collage

Sarah Glaz and Mark Sanders

The work presented here is a collaboration between the mathematician and poet Sarah Glaz and the collage and ceramic artist Mark Sanders. This poem–collage pair provides the artists' responses to the mathematics and history surrounding the influential treatise in astronomy by Claudius Ptolemy known as *Almagest*. As background, we include a brief discussion on the history and mathematics involved, and a reflection on several landmark images and concepts appearing in the poem and the collage.

The Poem and the Collage

''Ptolemy's Almagest: Book I'' is a found poem formed by Sarah Glaz from the introduction and table of contents of *Almagest: Book I*, translated into English by G. J. Toomer (1984) [13]. The collage, by the same title, made by Mark Sanders, reflects as well as extends the imagery and ideas appearing in the poem.

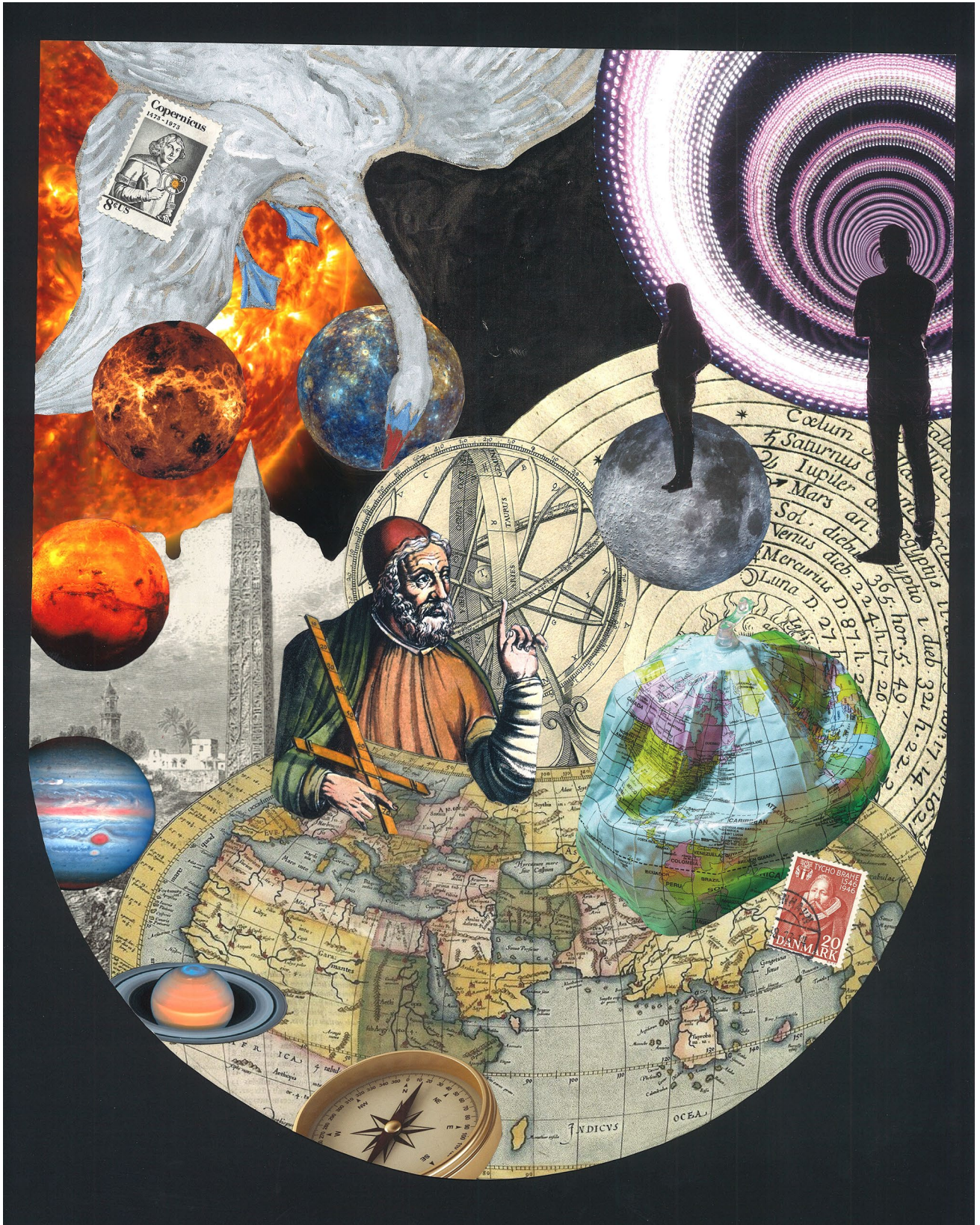**Ptolemy's Almagest: Book I**

a found poem

Only mathematics can make men see clearly, from the constancy,
order, symmetry and calm associated with the divine

    that the heavens move like a sphere,

    that the earth, too, taken as a whole, is sensibly spherical,

    that the earth is in the middle of the heavens,

    that the earth has the ratio of a point to the heavens,

    that the earth does not have any motion from place to place, either.

    that there are two different primary motions in the heavens.

Only mathematics can provide sure and unshakeable knowledge
to its devotees, provided one approaches it rigorously,

    on individual concepts

    on the size of chords,

    on the table of chords,

    on the arc between the solstices,

    on spherical proofs,

    on the arcs between the equator and the ecliptic,

    on the table of inclination,

    on rising-times at *sphaera recta*.

This science makes its followers lovers of divine beauty, accustoming
them and reforming their natures, to a similar spiritual state.

Mark Sanders—*Ptolemy's Almagest*: *Book I*
27.7 × 34.3 cm.
Cardboard, photographic paper, magazine clippings, postage stamps

Background

Claudius Ptolemy (ca. 100–170 CE) was a Greek mathematician, astronomer, astrologer, geographer, music theorist, and philosopher who lived and worked in Alexandria, Egypt.

Alexandria, a city situated at the mouth of the Nile, was founded by Alexander the Great following his conquest of Egypt in 332 BCE. After Alexander's death, the city prospered under the Ptolemaic rule, becoming a thriving multicultural metropolis, a major trading hub on the Mediterranean coast, and a center of Hellenistic intellectual life. Alexandria was home to the Museum (seat of the Muses), a forerunner of the modern university, and its library, the Great Library of Alexandria, which housed the largest collections of papyrus scrolls in the ancient world. The Museum was an institute of research and pursuit of learning, attracting a large number of scholars from the farthest reaches of the Hellenistic world. In particular, under royal patronage, science and mathematics flourished at the Museum as in very few other historical periods.

The school of mathematics at the Museum was founded by Euclid (323–285 BCE), initiating the Golden Age of Greek Mathematics, which lasted until the middle of the second century BCE. During its heyday, the Museum produced, in addition to Euclid himself, other distinguished scholars whose work determined the course of future mathematics: Archimedes, Eratosthenes, and Apollonius were all educated or otherwise affiliated with the Museum.

In 146 BCE, following a power struggle, Ptolemy VII banished from Egypt all scholars and scientists who had not demonstrated their loyalty to him. This event marked the end of the Golden Age of Greek Mathematics. Anarchic conditions brought on by further political strife and by frequent ethnic and religious clashes contributed to the decline of original scholarship at the Museum. A further blow was delivered by the Roman conquest of the city in 30 BCE and the establishment of a military regime, which effectively reduced Alexandria's status to that of a bread-basket province of the Roman Empire.

Claudius Ptolemy was one of the last mathematicians who produced lasting works at the Museum. Although he authored books on all the subjects of his interest, his fame rests mainly on his treatise on astronomy known as *Almagest*, and to a lesser degree on his treatise on geography, *Geographike Syntaxis*.

Almagest was an extensive compilation of astronomical information about the movement of the sun, moon, the five planets known in Ptolemy's time, and the fixed stars. It was originally titled *Syntaxis Mathematica* (Mathematical Compilation). The Greeks called it *Megale Syntaxis* (The Great Compilation). Later translators from Greek into Arabic combined the word *al* (the) with the word *majisti* (great) to form the title A*lmajisti*, When the treatise was translated into Latin, the word took the form *Almagest*, the title by which this compilation is known today.

Almagest advocated the geocentric model of the universe prevailing at that time, viewing Earth as the fixed and immovable center around which the planets rotate in concentric circles. It combines original work with a brilliant synthesis and exposition of known results. Not unlike Euclid's *Elements*, *Almagest* rendered all the works on the subject authored by Ptolemy's predecessors obsolete. It became the supreme authority on astronomy until Nicolaus Copernicus's 1543 work *De Revolutionibus* presented a heliocentric model of the universe, and its theory of planetary orbits was not abandoned and resolved until Johannes Kepler observed that planets' orbits are elliptical rather than circular (1609). In spite of its errors, *Almagest* set astronomy on a solid mathematical basis, which included the development of many mathematical tools, particularly trigonometry, used to this day by both astronomers and mathematicians.

All we know about Ptolemy's life is that he was a native of Alexandria and that his astronomical observations were carried out between 127 and 151 at the Museum. It is unclear to what extent his writings were based on his own observations. Some historians claim that he used Hipparchus's (190–120 BCE) observations and work in his treatise. Others criticize him for both his great error of assuming Earth's centrality and the more minor, but still significant, errors in his own observations.

A found poem is a literary collage. The poem "Ptolemy's Almagest: Book I" was formed from the cited English translation of Claudius Ptolemy's writings with minimal changes, mostly reordering or combining phrases, and introducing line and stanza breaks. The power of his words is undeniable. As is his passion for mathematics.

The six lines of the second stanza of the poem describe his geocentric model of the universe and require no clarifying comments beyond the explanation of the last line. The "two different primary motions in the heaven" refers to the system of planetary motion that Ptolemy attributed to Apollonius of Perga (262–190 BCE). To reconcile the data obtained through observations with the hypotheses of circular orbits, Apollonius devised an ingenious explanation of planetary motion consisting of two circular movements: each planet moves in small circular orbits, or epicycles, whose centers lie on the circumference of a larger circular orbit. This complicated system of planetary movement was called the epicycle system.

In the fourth stanza of the poem, several mathematical and astronomical notions are mentioned. To cite Heath's description of Book I's table of contents [11], the second stanza lists the following contents:

> propositions required for the preparation of Tables of Chords [equivalent to tables of sine values], the Table itself, some propositions [with proofs] of spherical geometry leading to trigonometric calculations of the relation of arcs of the equator, ecliptic, horizon, and meridian, a Table of Obliquity [Inclination] for calculating declinations for each degree-point on the ecliptic, and finally, a method of finding the right ascensions for arcs of the ecliptic equal to one third of a sign or 10 degrees.

Much of the collage imagery relates to Ptolemy's work in *Almagest,* but it also touches on his treatise in geography, *Geographike Syntaxis*.

The figure in the center of the collage is a portrait of Ptolemy by the sixteenth-century French priest and explorer André Thévet. Central are also the images of the astrolabe/armillary sphere (whose construction is described in *Almagest*), and of the sixteenth-century representation

of Ptolemy's geocentric model of the universe in Peter Apian's *Cosmographia* (1524). The planets themselves spiral out from the central Earth position, following Ptolemy's theorized sequence: Moon, Mercury, Venus, Sun (behind the swan), Mars, Jupiter, Saturn. The presence of the Divine is represented by Zeus, in the form of the swan from the Greek myth about the seduction of Leda, presiding over the fiery spheres of Ptolemy's orbiting planets

The two commemorative postage stamps depict, on the top left, the Polish astronomer Nicolaus Copernicus (1473–1543), and on the bottom right, the Danish astronomer Tycho Brahe (1546–1601). Tycho Brahe was the first to notice that the solar observations Ptolemy claimed to have made in 141 are not genuine and that there is a strong reason for doubting that Ptolemy carried out his own observations of the more than one thousand stars listed in his star catalog.

Earth, having lost its central position in the universe, appears, humorously, as a deflated beach ball on top of the map of the world from Ptolemy's *Geographike Syntaxis*. *Geographike Syntaxis* represents a compilation of geographical knowledge as it was known in Ptolemy's time. Like *Almagest,* it added, to a summary of known facts, Ptolemy's own touch of genius by introducing a new mathematical method for representing curved surfaces of Earth on a plane surface. And like *Almagest*, it offered more than had been offered by any previous geographical treatise, although it suffered from both inaccuracies and borrowed observations. The compass appearing at the bottom of the collage is a reference to Ptolemy's depiction of north at the top of the page and south at the bottom, which became the norm for future generations, who stand at the top right looking skeptically at the concentric circles appearing in the collage. The deflated beach ball rising from Ptolemy's map forms a visual link between the depiction of the world on a flat surface and Earth's spherical form, which, having assumed its correct position in space, carries the future generations around the Sun, feet firmly planted on the ground. Alexandria is represented by one of the two obelisks called Cleopatra's Needle, seen on the left, and it is no coincidence that the needle points northward on the map that is this collage.

Unless otherwise noted, the sources for the historical information presented here are references [1, 2, 11, 12], and [13]. For interested readers, additional poem–collage pairs on which Sarah Glaz and Mark Sanders have collaborated, as well as other works by both poet and artist, can be found in references [3–10, 14], and [15].

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