



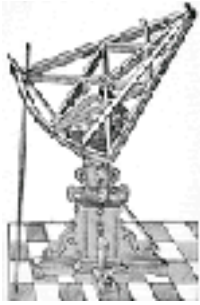
Tycho Brahe (1546-1601)

Tyge (Latinized as Tycho) Brahe was born on 14 December 1546 in Skane, then in Denmark, now in Sweden. He was the eldest son of Otto Brahe and Beatte Bille, both from families in the high nobility of Denmark. He was brought up by his paternal uncle Jørgen Brahe and became his heir. He attended the universities of Copenhagen and Leipzig, and then traveled through the German region, studying further at the universities of Wittenberg, Rostock, and Basel. During this period his interest in alchemy and astronomy was aroused, and he bought several astronomical instruments. In a duel with another student, in Wittenberg in 1566, Tycho lost part of his nose. For the rest of his life he wore a [metal insert](#) over the missing part. He returned to Denmark in 1570.

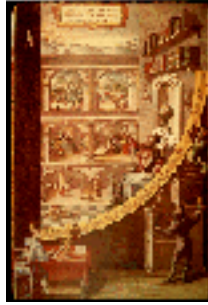
In 1572 Tycho observed the new star in Cassiopeia and published a brief tract about it the following year. In 1574 he gave a course of lectures on astronomy at the University of Copenhagen. He was now convinced that the improvement of astronomy hinged on accurate observations. After another tour of Germany, where he visited astronomers, Tycho accepted an offer from the King Frederick II to fund an observatory. He was given the little island of Hven in the Sont near Copenhagen, and there he built his observatory, [Uraniburg](#), which became the finest observatory in Europe.



[Uraniburg](#)



Sextant



Mural Quadrant

Tycho designed and built new instruments, calibrated them, and instituted nightly observations. He also ran his own printing press. The observatory was visited by many scholars, and Tycho trained a generation of young astronomers there in the art of observing. After a falling out with King Christian IV, Tycho packed up his instruments and books in 1597 and left Denmark. After traveling several years, he settled in Prague in 1599 as the Imperial Mathematician at the court of Emperor Rudolph II. He died there in 1601. His instruments were stored and eventually lost.

Tycho's major works include *De Nova et Nullius Aevi Memoria Prius Visa Stella* ("On the New and Never Previously Seen Star") (Copenhagen, 1573); *De Mundi Aetherei Recentioribus Phaenomenis* ("Concerning the New Phenomena in the Ethereal World") (Uraniburg, 1588); *Astronomiae Instauratae Mechanica* ("Instruments for the Restored Astronomy") (Wandsbeck, 1598; English tr. Copenhagen, 1946); *Astronomiae Instauratae Progymnasmata* ("Introductory Exercises Toward a Restored Astronomy") (Prague 1602). His observations were not published during his lifetime. [Johannes Kepler](#) used them but they remained the property of his heirs. Several copies in manuscript circulated in Europe for many years, and a very faulty version was printed in 1666. At Prague, Tycho hired Johannes Kepler as an assistant to calculate planetary orbits from his observations. Kepler published the *Tabulae Rudolphinae* in 1627.

Because of Tycho's accurate observations and Kepler's elliptical astronomy, these tables were much more accurate than any previous tables.

Tycho Brahe's contributions to astronomy were enormous. He not only designed and built instruments, he also calibrated them and checked their accuracy periodically. He thus revolutionized astronomical instrumentation. He also changed observational practice profoundly.

Whereas earlier astronomers had been content to observe the positions of planets and the Moon at certain important points of their orbits (e.g., opposition*, quadrature*, station), Tycho and his cast of assistants observed these bodies throughout their orbits. As a result, a number of orbital anomalies never before noticed were made explicit by Tycho.

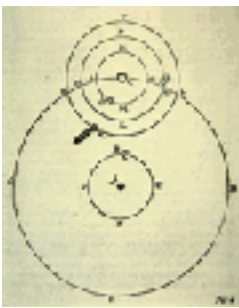
Without these complete series of observations of unprecedented accuracy, Kepler could not have discovered that planets move in elliptical orbits. Tycho was also the first astronomer to make corrections for atmospheric refraction*. In general, whereas previous astronomers made observations accurate to perhaps 15 arc minutes, those of Tycho were accurate to perhaps 2 arc minutes, and it has been shown that his best observations were accurate to about half an arc minute.

Tycho's observations of the new star of 1572 and [comet](#) of 1577, and his publications on these phenomena, were instrumental in establishing the fact that these bodies were above the Moon and that therefore the heavens were not immutable as Aristotle had argued and philosophers still believed. The heavens were changeable and therefore the Aristotelian division between the heavenly and earthly regions came under attack (see, for instance, Galileo's *Dialogue*) and was eventually dropped. Further, if comets were in the heavens, they moved through the heavens. Up to now it had been believed that planets were carried on material spheres (spherical shells) that fit tightly around each other. Tycho's



observations showed that this arrangement was impossible because comets moved through these spheres. Celestial spheres faded out of existence between 1575 and 1625.

If Tycho destroyed the dichotomy between the corrupt and ever changing sublunary world and the perfect and immutable heavens, then the new universe was clearly more hospitable for the heliocentric planetary arrangement proposed by Nicholas Copernicus in 1543. Was Tycho therefore a follower of Copernicus? He was not. Tycho gave various reasons for not accepting the heliocentric theory, but it appears that he could not abandon Aristotelian physics which is predicated on an absolute notion of place. Heavy bodies fall to their natural place, the Earth, which is the center of the universe. If the Earth were not the center of the universe, physics, as it was then known, was utterly undermined. On the other hand, the [Copernican system](#) had a number of advantages, some technical (such as a better lunar theory and smaller epicycles), and others more based on harmony (an obvious explanation of retrograde planetary motion *, a strict demonstration of the order and heliocentric distances of the planets). Tycho developed a system that combined the best of both worlds. He kept the Earth in the center of the universe, so that he could retain Aristotelian physics (the only physics available). The Moon and Sun revolved about the Earth, and the shell of the fixed stars was centered on the Earth. But Mercury, Venus, Mars, Jupiter, and Saturn revolved about the Sun. He put the (circular) path of the comet of 1577 between Venus and Mars. This Tychonic world system became popular early in the seventeenth century among those who felt forced to reject the [Ptolemaic arrangement](#) of the planets (in which the Earth was the center of all motions) but who, for various reasons, could not accept the Copernican alternative.



The Tychonic Universe. [High-resolution image](#) also available.

Sources

The standard biography of Tycho Brahe is Victor E. Thoren, *The Lord of Uraniborg: A Biography of Tycho Brahe* (Cambridge: Cambridge University Press, 1990). Still useful is the more technical treatment by J. L. E. Dreyer, *Tycho Brahe: A Picture of Scientific Life and Work in the Sixteenth Century* (Edinburgh: Adam & Charles Black, 1890; 2d ed. New York: Dover, 1963). C. Doris Hellman's article in the *Dictionary of Scientific Biography* is also useful. Tycho's works and correspondence have been collected in *Tychonis Brahe Dani Opera omnia*, ed. J. L. E. Dreyer, 15 vols. (Copenhagen 1913-1929;

reprinted Amsterdam: Swets & Zeitlinger, 1972). See also John Christianson, "The Celestial Palace of Tycho Brahe," *Scientific American*, 204, no. 2 (1961):118-128; Charles D. Humbert, "Tycho Brahe's Island," *Popular Astronomy*, 45 (1937):118-125; Joseph Ashbrook, "Tycho Brahe's Nose," *Sky and Telescope*, 29, no. 6 (1965):353, 358; C. Doris Hellman, "Was Tycho Brahe as Influential as He Thought?" *British Journal for the History of Science*, 1 (1963):295-324; Ann Blair, "Tycho Brahe's Critique of Copernicus and the Copernican System," *Journal for the History of Ideas*, 51 (1990): 355-77.

Glossary terms

[opposition](#) -- The situation of two heavenly bodies when their longitudes or right ascensions differ by 180 degrees. The moon is in opposition to the sun when the earth is directly between them.

[quadrature](#) -- Those points or moments at which a half moon is visible. More generally, it is the situation of two heavenly bodies when their longitudes differ by 90 degrees.

[atmospheric refraction](#) -- The change in direction of a ray of light as it passes from space into the atmosphere. This causes celestial objects to appear to be in a location different from their actual ones.

[retrograde planetary motion](#) -- At times, the planets appear to be moving opposite to their normal direction of motion. This is an effect caused by the annual motion of the Earth around the Sun which is superimposed on the motion of the planet.

Click here to go directly to the [Glossary](#).

Images:

Sextant: From *Tycho Brahe's Description of his Instruments and Scientific Work*, tr. Hans Ræder et al, Copenhagen: Munksgaard, 1946), p. 72.



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