From the Annals of the World History

Tycho Brahe

-- 14 December 1546 - 24 October 1601

Tycho Brahe, born in 1546, was the eldest son of a noble Danish family, and as such appeared destined for the natural aristocratic occupations of hunting and warfare. However, he had an uncle Joergen, a country squire and vice-admiral, who was more educated, and childless. Tycho's father had agreed with the uncle before Tycho was born that if Tycho was a boy, the uncle could adopt and raise him. He changed his mind and reneged. Then, when a younger brother was born, the uncle kidnapped Tycho. The father threatened to murder the uncle, but eventually calmed down, since Tycho stood to inherit a large estate from the uncle.

When Tycho was seven, his uncle insisted that he begin studying Latin. His parents objected, but the uncle said this would help Tycho become a lawyer. At age thirteen, Tycho entered the University of Copenhagen to study law and philosophy. At this impressionable age, an event took place that changed his life. There was a partial eclipse of the sun. This had been predicted, and took place on schedule. It struck Tycho as "something divine that men should know the motions of the stars so accurately that they were able a long time beforehand to predict their places and relative positions". Perhaps this predictability was especially appealing to one whose personal life was evolving in rather an uncertain way.

One of the advantages of being a rich kid was that he could immediately go out and buy a copy of Ptolemy's Almagest (in Latin), and some sets of astronomical tables, which showed the positions of the planets at any given time. Ptolemy himself had made such tables, and they had been revised in Spain by a group of fifty astronomers in 1252, brought together by Alfonso X of Castile. These were called the Alfonsine tables. Tycho also bought a recent set of tables based on Copernicus' theory.

At age sixteen, the uncle sent Tycho to Leipzig, in Germany, to continue his study of law. He was accompanied by a tutor, the twenty year old Anders Vedel, who himself later became famous as Denmark's first great historian. However, Tycho was obsessed with astronomy. He bought books and instruments, which he hid from his tutor, and stayed up much of each night observing the stars. When he was seventeen, he observed a special event---Jupiter and Saturn passed very close to each other. (This was on August 17, 1563.) He found on checking the tables that the Alfonsine tables were off by a month in predicting this event, and the Copernicus tables off by several days. Tycho decided this was a pathetic performance by the astronomers, and much better tables could be constructed just by more accurate observation of the exact positions of the planets over an extended period of time. He decided that this was what he was going to do.

Vedel realized Tycho was a hopeless case, and gave up trying to tutor him in law. The two remained good friends for life. Meanwhile, the uncle died of pneumonia after rescuing the king from drowning after the king had fallen off the bridge to his castle returning from a naval battle with the Swedes. When Tycho returned to Denmark, the rest of his family were quite unfriendly. They despised his stargazing, and blamed him for neglecting the law. He decided to return to Germany, and fell in with some rich amateur astronomers in Augsburg. He persuaded them that what was needed was accurate observation, and (as telescopes had not yet been invented) this meant rather large quadrants to get lines of sight on stars. They set up a large wooden quadrant, part of a circle with a nineteen foot radius that took twenty men to set up. It was graduated in sixtieths of a degree. This was the beginning of Tycho's accurate observations.

At the age of twenty-six, in 1570, Tycho returned to Denmark. He lived for a while with his family, then with an uncle, Steen Bille, who had founded the first paper mill and glassworks in Denmark. He was the only family member who approved of star gazing.

In 1572, another astronomical event took place that changed Tycho's life. On November 11, walking back from Steen's alchemy lab, Tycho noticed a new star in the sky that was brighter than Venus. He did not believe his eyes. He called some servants, then some peasants, to reassure him that it was really there.

The new star was so bright that it could be seen in daylight. It lasted eighteen months. It was what is now called a nova, a rare event. The crucial question from the astronomical and theological point of view was

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where exactly was this new star? Was it an event in the upper atmosphere, that is to say, below the moon, what was then termed in the sublunary region? If so, that would be o.k., because this region, below the moon, was where change and decay took place. On the other hand, if it was out there in the eighth sphere, the fixed stars, the edge of heaven, that contradicted Aristotelian and Christian dogma, because that sphere had remained unchanged since the day of creation, and was supposed to stay that way. Maestlin in Tubingen, and Thomas Diggs in England, leading astronomers, tried to detect movement in the new star by lining it up with known fixed stars, using stretched threads. They could see no movement. Tycho had just finished building a new sextant, with arms five and a half feet long, a massive bronze hinge, a metallic scale calibrated in minutes (sixtieths of a degree) and a table of corrections for the remaining tiny errors in the instrument he had detected. His technology was far ahead of the competition, and he was able to settle the argument. The new star did not move at all relative to the fixed stars. It was in the eighth sphere. Tycho published a detailed account of his methods and findings the next year. He hesitated some time before publishing, because book writing seemed a bit undignified for a nobleman. Similarly, when some of the other young nobles asked him to give a course on astronomy, he refused, and only changed his mind when the King told him to do it.

By 1575, Tycho was famous throughout Europe, and he embarked on a grand tour, visiting astronomers in many cities. He decided it would be nice to move down to Basle, in Switzerland, a charming and civilized town. King Frederick II of Denmark (whose life had been saved by the uncle) was very upset at the thought of losing his best astronomer (and astrologer), and, after offering Tycho various castles, which didn't prove persuasive, offered him a whole island, flat with white cliffs, about three miles long, called Hveen, near Hamlet's castle of Elsinore. Denmark would bankroll building of an observatory and house, and the inhabitants of the island, who worked forty farms grouped around a small village, would become Tycho's subjects. The reason a king of a rather small country had quite so much wealth at his disposal was that the Protestant Reformation had placed the Church's lands and resources in his hands.

Tycho hired a German architect and built his Uraniborg (castle of the heavens). It was surrounded by a square wall 250 feet on a side. It had an onion dome, like the Kremlin, but an Italianate palace facade. It had rooms for huge precision instruments, fantastic murals, a paper mill and printing press, an alchemist's furnace, and a prison for tenants who caused problems. In the library, Tycho installed a brass globe five feet in diameter he had made for him in Augsburg. This was a highly polished accurate sphere, and the positions of the stars were engraved on it as they were measured over a twenty-five year period. In Tycho's study, a quadrant was built into the wall itself, with a mural of Tycho painted on to the wall.

The quadrant was centered on an open window through which the observations were made. Several clocks were used simultaneously to try to time the observations as precisely as possible--an observer and a timekeeper worked together. His very large staff and several sets of equipment permitted four independent measurements of the same thing simultaneously, greatly reducing the possibility of error. The precision of measurements, which had held at ten minutes of arc since Ptolemy, was reduced at Uraniborg to one minute of arc. The observatory was full of gadgets---statues turned by hidden mechanisms, and he had a system of bells he could ring in any room to summon assistants.

After disagreements with the new Danish king in 1597, he was invited by the Bohemian king and Holy Roman emperor Rudolph II to Prague, where he became the official imperial astronomer. He built the new observatory at BenátkynadJizerou. Here, from 1600 until his death in 1601, he was assisted by Johannes Kepler who later used Tycho's astronomical data to develop Kepler's laws of planetary motion.

Tycho was not a Copernican, but proposed a "geo-heliocentric" system in which the Sun and Moon orbited the Earth, while the other planets orbited the Sun. His system provided a safe position for astronomers who were dissatisfied with older models but were reluctant to accept the Earth's motion. It gained a considerable following after 1616 when Rome decided officially that the heliocentric model was contrary to both philosophy and Scripture, and could be discussed only as a computational convenience that had no connection to fact. His system also offered a major innovation: while both the purely geocentric model and the heliocentric model as set forth by Copernicus relied on the idea of transparent rotating crystalline spheres to carry the planets in their orbits, Tycho eliminated the spheres entirely. Kepler tried, but was unable, to persuade Tycho to adopt the heliocentric model of the solar system. Tycho advocated for a system with an unmoving Earth for reasons of physics, astronomical observations of stars, and religion.

Tycho's distinctive contributions to lunar theory include his discovery of the variation of the Moon's longitude. This represents the largest inequality of longitude after the equation of the center. He also discovered vibrations in the inclination of the plane of the lunar orbit, relative to the ecliptic (which is not a constant of about 5° as had been believed before him, but fluctuates through a range of over a quarter of a degree), and accompanying oscillations in the longitude of the lunar node. These represent perturbations in the Moon's ecliptic latitude. Tycho's lunar theory doubled the number of distinct lunar inequalities, relative to those anciently known, and reduced the discrepancies of lunar theory to about 1/5 of their previous amounts. It was published posthumously by Kepler in 1602, and Kepler's own derivative form appears in Kepler'sRudolphine Tables of 1627.

Legacy

Although Tycho's planetary model was soon discredited, his astronomical observations were an essential contribution to the scientific revolution. The traditional view of Tycho is that he was primarily an empiricist who set new standards for precise and objective measurements.Tycho considered astrology to be a subject of great importance. In addition to his contributions to astronomy, he was famous in his own time also for his contributions to medicine; his herbal medicines were in use as late as the 1900s.

Although the research community Tycho created in Uraniborg did not survive him, while it existed it was both a research center and an institution of education, functioning as a graduate school for Danish and foreign students in both astronomy and medicine. Tycho's success as a scientist also depended on his adroit political skills, to obtain patronage and funding for his work. The crater Tycho on the Moon is named after him, as is the crater Tycho Brahe on Mars.