Tycho Brahe and Johannes Kepler

(Condensed Version: see below for links to fuller version)

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These two colorful characters made crucial contributions to our understanding of the universe: Tycho's observations were accurate enough for Kepler to discover that the planets moved in elliptic orbits, and his other laws, which gave Newton the clues he needed to establish universal inverse-square gravitation.

What you should know:

Tycho Brahe (1546-1601), from a rich Danish noble family, was fascinated by astronomy, but disappointed with the accuracy of tables of planetary motion at the time. He decided to dedicate his life and considerable resources to recording planetary positions ten times more accurately than the best previous work. After some early successes, and in gratitude for having his life saved by Tycho's uncle, the king of Denmark gave Tycho tremendous resources: an island with many families on it, and money to build an observatory. (One estimate is that this was 10% of the gross national product at the time!) Tycho built vast instruments to set accurate sights on the stars, and used multiple clocks and timekeepers.

He achieved his goal of measuring to one minute of arc. This was a tremendous feat before the invention of the telescope. His aim was to confirm his own picture of the universe, which was that the earth was at rest, the sun went around the earth and the planets all went around the sun - an intermediate picture between Ptolemy and Copernicus.

Johannes Kepler (1571-1630) believed in Copernicus' picture. Having been raised in the Greek geometric tradition, he believed God must have had some geometric reason for placing the six planets at the particular distances from the sun that they occupied. He thought of their orbits as being on spheres, one inside the other. One day, he suddenly remembered that there were just five perfect Platonic solids, and this gave a reason for there being six planets - the orbit spheres were maybe just such that between two successive ones a perfect solid would just fit. He convinced himself that, given the uncertainties of observation at the time, this picture might be the right one. However, that was before Tycho's results were used. Kepler realized that Tycho's work could settle the question one way or the other, so he went to work with Tycho in 1600. Tycho died the next year, Kepler stole the data, and worked with it for nine years.

He reluctantly concluded that his geometric scheme was wrong. In its place, he found his three laws of planetary motion:

I *The planets move in elliptical orbits with the sun at a focus.*

II *In their orbits around the sun, the planets sweep out equal areas in equal times.*

III *The squares of the times to complete one orbit are proportional to the cubes of the average distances from the sun.*

These are the laws that Newton was able to use to establish universal gravitation.

Kepler was the first to state clearly that the way to understand the motion of the planets was in terms of some kind of force from the sun. However, in contrast to Galileo, Kepler thought that a continuous force was necessary to maintain motion, so he visualized the force from the sun like a rotating spoke pushing the planet around its orbit.

On the other hand, Kepler did get right that the tides were caused by the moon's gravity. Galileo mocked him for this suggestion.

A much ***fuller treatment*** of Tycho Brahe and Johannes Kepler can be found in my 1995 notes:

Links to: ***Tycho Brahe*** ***Kepler*** ***More Kepler***

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