Lunar CRater Observation and Sensing Satellite

Kepler's Laws

By: Nicole Clazie, 12th grade AAE student

German mathematician and astronomer, Johannes Kepler, proposed three laws of planetary motion in the early 1600's. These three laws described the motion of planets from a heliocentric or Sun-centered perspective. He created these laws based on observations of Tycho Brache. Although today Kepler's explanation of these motions is not accepted, his laws still are.

Kepler's first law, also known as the law of ellipses, says that the orbit of every planet is an ellipse with the Sun at a focus. The planets' elliptical orbits are a result of the inverse square force of gravity, although Kepler did not know this. In this elliptical orbit, the Sun is not at the center. It is located at one of the foci. The planets then follow the elliptical orbit, and the distance between the planet and the Sun is constantly changing because of the geometric properties of an ellipse.

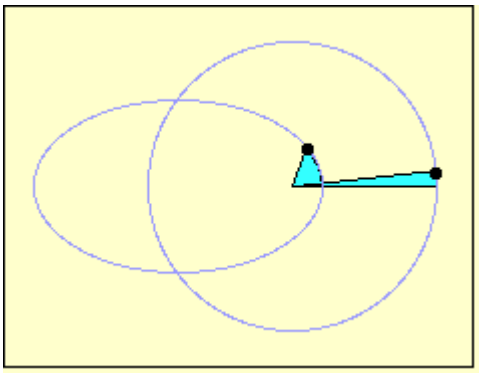

Photo courtesy NASA

Kepler's second law, also known as the law of equal area, says a line joining a planet and the Sun sweeps out equal areas during equal intervals of time. This law arises from conservation of angular momentum, but again, Kepler did not know this at the time. Planets, in their orbit, move faster when they are near the Sun. The point in the planet's elliptical orbit when it is closest to the Sun is called perihelion and the point farthest away is aphelion. So according to Kepler's second law, planets mover faster when they are near the perihelion and move slower when they are near the aphelion. This phenomena is related to what happens when a spinning ice skater brings their arms in close to their body (they spin faster) or throw their arms out (they spin slower).

Kepler's third law, also known as the law of harmonies, says the square of the orbital period of a planet is directly proportional to the third power of the semi-major axis of orbit. In other words, the relation between a planet's orbital period and its distance from the Sun has the same form for all planets. Kepler's third law implies that the greater the radius of a planet's orbit, the greater the amount of time the planet will take to complete its orbit. In other words, the innermost planets take less time to orbit the Sun than the outermost planets do, such as Mercury compared to Pluto. Mercury only takes 88 days to complete its orbit, but Pluto takes 248 years.

Kepler's laws have proven to be accurate. They provide the fundamentals to understand the movement of planets in the solar system. Although Kepler's laws are considered the laws of planetary motion, they also can be used to calculate the orbits of artificial satellites and other bodies orbiting the Sun.

It was not until 1687, roughly 80 years after Kepler presented his three "laws", that Sir Isaac Newton published his mathematical description of gravity which explained why Kepler's laws are valid.