**Johannes Kepler** researched by Deborah Von der Lage

1571-1630

**Claim of Fame**

**Kepler's Laws**

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.

There is also a third Law, which Kepler found by analyzing the orbits of all the known planets:

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

**A List of Kepler's Firsts**

- First to correctly explain planetary motion, thereby, becoming founder of celestial mechanics and the first "natural laws" in the modern sense; being universal, verifiable, precise.

In his book Astronomia Pars Optica, for which he earned the title of founder of modern optics he was the:

- First to investigate the formation of pictures with a pin hole camera;
- First to explain the process of vision by refraction within the eye;
- First to formulate eyeglass designing for nearsightedness and farsightedness;
- First to explain the use of both eyes for depth perception.

In his book Dioptrice (a term coined by Kepler and still used today) he was the:

- First to describe: real, virtual, upright and inverted images and magnification;
- First to explain the principles of how a telescope works;
- First to discover and describe the properties of total internal reflection.

His book Stereometrica Doliorum formed the basis of integral calculus.

- First to explain that the tides are caused by the Moon (Galileo reproved him for this).
- Tried to use stellar parallax caused by the Earth's orbit to measure the distance to the stars; the same principle as depth perception. Today this branch of research is called astrometry.
- First to suggest that the Sun rotates about its axis in Astronomia Nova
- First to derive the birth year of Christ, that is now universally accepted.
- First to derive logarithms purely based on mathematics, independent of Napier's tables published in 1614.
- He coined the word "satellite" in his pamphlet Narratio de Observatis a se quatuor Iovis sattelitibus erroribus
Early Life

- Born: December 27, 1571
  Weil, Swabia, Germany
- Died: November 15, 1630
  Regensburg, Bavaria, Germany
- Premature child -224 days 9 hours 53 minutes
- 1st of 7 children – 3 died in infancy
- Family dysfunctional
- Grandfather-Sebald- mayor of Weil grandmother- devoted to religion, mean, lying, restless
- Father-Henrick- mercenary soldier-vicious, inflexible-tried to sell his youngest son
- Mother- Catherine-small, thin, bad disposition, collected herbs and made potions she thought had magical powers, raised by aunt who was burned at the stake as a witch. Mother barely escaped same fate. K had to hire several lawyers to defend his 70 year old mother

Education

- 5 years to go thru 4 grades
- 12- convent school Adelburg-Lutheran pastor
- University at Tuebingen – theology, philosophy, math and astronomy – Dukes of Wuerttenberg provided scholarships to train pastors to be able to defend the Lutheran faith.
- 1594-offered professorship of astronomy Fraz, Styria (Austria) – duty to make astrological predictions-successful
- 1598-all Lutheran schools closed – heresy –“embrace the catholic faith of be expelled from Austria”
- Tyco invites to Prague impressed with “Mysterium Cosmographian”-1-1-1600

Adult Life –

- Met Tyco Brahe at age 28, Feb. 4, 1600 in Benatky, six hours outside of Prague.
- Year before wrote, “My opinion of Tyco is this: he is superlatively rich, but he knows not how to make proper use of it as is the case with most rich people. Therefore, one must try to wrest his riches from him.”
- Kepler was envious of Tyco’s 30 years of collected precise and accurate data.
- Once Tyco died he “stole” it from the heirs and took 9 years to use it to modify his own beliefs.
- Felt Tyco treated him “like a dog.”
- Summer 1600- Tyco is recalled by the Emperor Rudolph II. Kepler learns of conflict against Lutherans and realizes he cannot return home to Graz to try to reclaim his families land and his job as schoolteacher and provincial mathematician.
- August 1601 – Tyco makes a deal with Emperor Rudolph II to publish his planetary theories. Kepler is recognized as his official assistant.
- Tyco dies – Oct. 24, 1601
- Kepler is appointed two weeks later as imperial mathematician.
- Kept Tyco’s data and used it.
- Focused on Mars. Tried to explain why Mars appears to be stationary or move slower and faster at various times. “He faced the challenge of choosing appropriate geometries for the two orbits so that a line joining Mars and Earth projected to the stars would correctly mark its position.”
Using Tyco’s data, he had to change his previous beliefs.

**Late Life**

- 1611- wife, Barbara, becomes ill with Hungarian fever and dies later that summer, all 3 children get smallpox –Fredrick dies,
- Tried to return to Tubingen but denied
- Tried to replace Galileo in Rome
- Moved to Linz to teach provincial math
- 1613-remarried- Susanna (24), 7 children, 3 died in infancy
- 1615- mother's witch trial
- 1619- “Harmonica Mundi” – 5 volume set
- Prolific writer
- Wrote science fiction book – “Somniun” – story about a trip to the moon
- 1625 –“Tabulae Rudolphinae” corrected errors in the tables of Planetary motion”
- 1628 – private math tutor-Dutchy of Sagan - $ issues
- 1630- tried to collect an old debt, became hungry and exhausted from trip and became ill in Regensburg and died – Nov. 15,1630 age 59

**Career highlights**

- 1596 – Published- *Mysterium cosmographicum* (The secret of the universe). Copies ended up in the hands of Galileo Galilei, Ursus (Tyco’s rival) and Tyco. Sun had to play major role in planetary movement.
- 1602 – Published – *De fundamentis astrologiae centioribus* (On the more certain foundations of astrology). Presented predictions and his attempt to reform classic doctrine. He did not support astrology.
- 1609 – Published – *Astronomia nova, aitiologetos seu physica coelestis* (A new astronomy, causally explained, or celestial physics). His effort to bring harmony to his planetary motion work.
- Kepler’s First and Second Laws are in this book.
- Kepler did some work on optics, and came up with the first correct mathematical theory of the *camera obscura* and the first correct explanation of the working of the human eye, with an upside-down picture formed on the retina. These results were published in *Supplements to Witelo, on the optical part of astronomy* (*Ad Vitellionem paralipomena, quibus astronomiae pars optica traditur*, Frankfurt, 1604). He also wrote about the New Star of 1604, now usually called 'Kepler's supernova',
- Kepler wrote a study of the properties of lenses (the first such work on optics) in which he presented a new design of telescope, using two convex lenses (*Dioptrice*, Prague, 1611).
- A difference between his theory and Brahe's data could be explained only if the orbit of Mars was not circular but elliptical (oval-shaped). This meant that the orbits of all planets were elliptical (Kepler's first law). This helped prove another of his statements. It is known as Kepler's second law, according to which the line joining a planet to the sun sweeps over equal areas in equal times in its elliptical orbit.
- There is also a third Law, which Kepler found by analyzing the orbits of all the known planets: The squares of the times to complete one orbit are proportional to the cubes of the average distances from the sun.
Sources

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There is a play on Kepler and Tycho "Reading The Mind of God" by Patrick Gabridge