

Kepler's Laws—8 Sept

- The discovery of the laws of motion, the first science.
 - *De Revolutionibus Orbium Coelestium*, Copernicus, 1543
 - *Astronomia Nova*, Kepler, 1609
 - *Philosophiae Naturalis Principia Mathematica*, Newton, 1687
- How Kepler figured out the path of Mars from Tycho's observations. Discovery of his three laws.



Kepler at 39, Sternwarte Kremsmünster
<http://members.nextra.at/stewar/>

Copernicus	1473–1543
Columbus sails	1492
Tycho Brahe	1546–1601
Shakespeare	1564–1616
Johannes Kepler	1571–1630
Jamestown	1607
King James Bible	1611
Harvard College	1636
Isaac Newton	1642–1727

8 Sept

- Pick up a protractor to share.
- For Friday, read assignment in Galileo's *Siderius Nuncius* on the discovery of moons orbiting Jupiter with his newly invented telescope.
 - Click the link on the syllabus
 - Then go to “Preview this book”

Kepler & Tycho

Their meeting at Benatek (in Chechoslovakia): ...on 4 February 1600, Tycho de Brahe and Johannes Keplerus, co-founders of a new universe, met face to face, silver nose to scabby cheek. Tycho was fifty-three, Kepler, twenty-nine. Tycho was an aristocrat, Kepler a plebian. —Koestler, *The Sleepwalkers*, p302

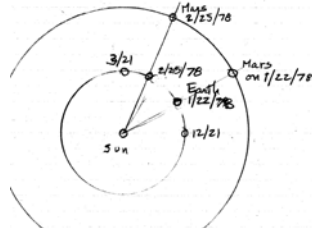


How did Kepler figure out the orbit of Mars from Tycho's observations?

- Tycho's observations are 2 dimensional
 - Declination: angle from celestial equator
 - Right ascension: angle from location of sun on vernal equinox
- Orbit is 3 dimensional
- Period of Mars
 - Opposition occurred on 22 January 1978
 - Next opposition: 25 February 1980 (56th day)
- Path of Mars

- Observations
 - Opposition occurred on 22 January 1978
 - Next opposition: 25 February 1980 (56th day of the year)
- For there not to be an opposition in between,
 - Mars has traveled $360 + (56 - 22)360/364 = 394^\circ$
 - in $364 + 364 + (56 - 22) = 762$ days
- Period of Mars is how long to move 360°
 - $762 \times 360 / 394 = 696$ days.
 - Actual period is 687 days.

Period of Mars



Path of Mars

- Observations
 - On 21 March 1978, the right ascension of Mars is 7hr 46min (116.5° from the sun on the vernal equinox).
 - On 5 February 1980 (one Martian year later), Mars is at 11hr 03min (165.8°).
- Where is Mars? Pretend to be Kepler in 1600