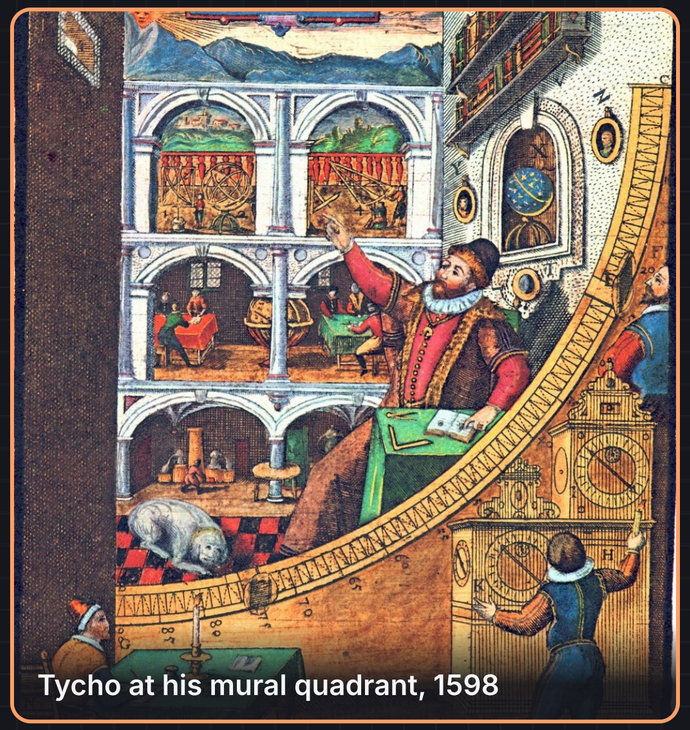
Pi & Planck

HISTORY OF SCIENCE

Tycho's Data, Kepler's Laws

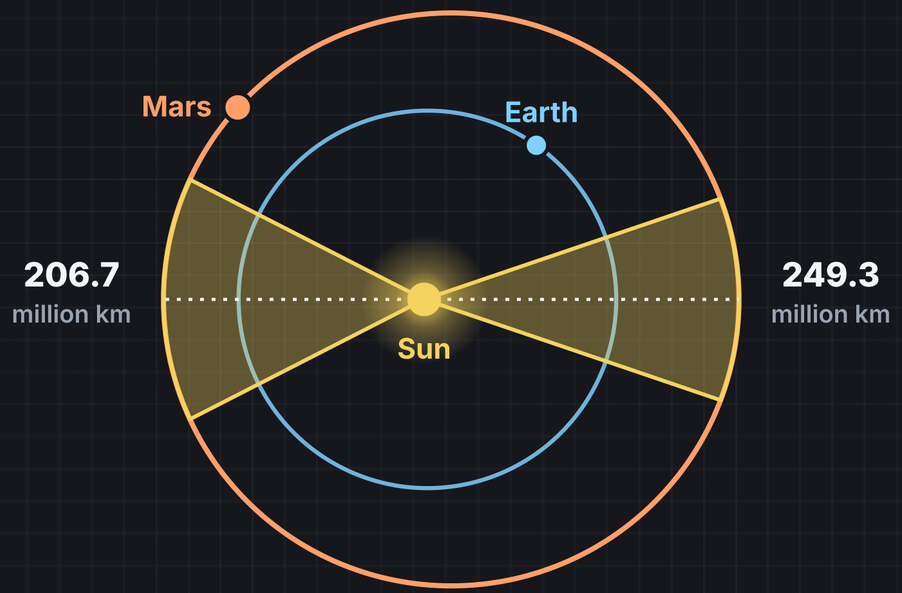
Tycho Brahe died on 24 October 1601. His Mars data, good to about an arcminute, showed Kepler the orbits are ellipses.

TYCHO'S EYE



Tycho at his mural quadrant, 1598

MARS, TO TRUE SCALE



Equal times (86 days each) sweep equal areas

True scale: Mars's orbit is only 0.4% narrower than a circle

KEPLER'S THREE LAWS

1 (1609) Planets move on ellipses, with the Sun at one focus. $r = \frac{a(1-e^2)}{1+e\cos\theta}$

2 (1609) A line from the Sun to a planet sweeps equal areas in equal times. $\frac{dA}{dt} = \text{constant}$

3 (1619) The square of a planet's year is proportional to the cube of its distance. $T^2 \propto a^3$

PLANET	a (AU)	T (yr)	$T^2 \div a^3$
Mercury	0.39	0.24	1.00
Venus	0.72	0.62	1.00
Earth	1.00	1.00	1.00
Mars	1.52	1.88	1.00
Jupiter	5.20	11.86	1.00
Saturn	9.57	29.43	0.99

24 Oct 1601 — Tycho Brahe dies in Prague. Kepler goes on to analyse his Mars observations.

≈ 1′ — Tycho's typical error was 0.5′ to 1.0′. One arcminute is 1/60 of a degree.

1609 1619 — Laws 1 and 2 appear in Astronomia Nova (1609), law 3 in Harmonices Mundi (1619).

Sources: MacTutor (Brahe; Kepler) · NASA NSSDCA Planetary Fact Sheet · Kepler, *Astronomia Nova* (1609) · Image: Tycho Brahe, *Astronomiae instauratae mechanica* (1598), public domain

@piandplanck