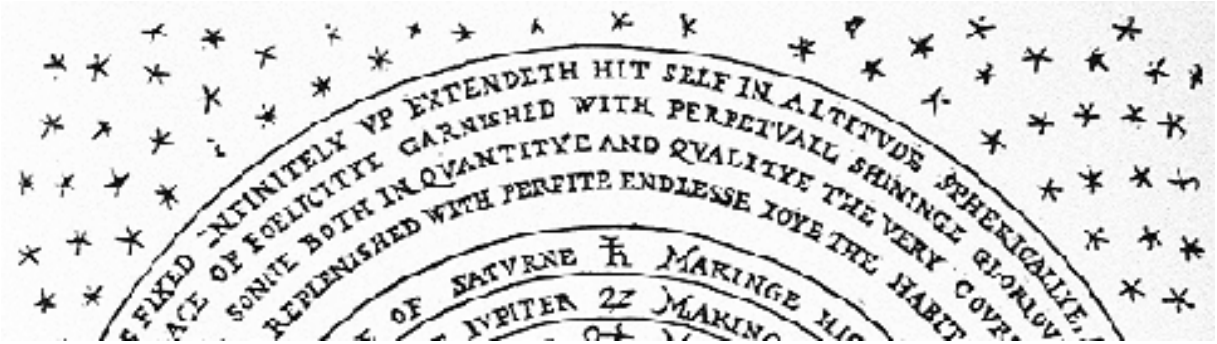


PHY1033C/HIS3931/IDH 3931 : Discovering Physics:

The Universe and Humanity's Place in It

Fall 2016

Prof. Peter Hirschfeld, Physics

Announcements

- HW 4 due Oct. 4
- Oct. 13 midterm exam
- Reading: Gregory, Chapter 5

Watch a portion of "Harmony of the Worlds," (from 24:28 to 54:28) on youtube:
https://www.youtube.com/watch?v=p9GAMHCsQTs
Equivalence of the Tychonic and Copernican systems
Kepler's 3 Laws

Public Lecture: "The Physics of Star Trek" Monday, Oct. 3, NPB 2205!
Dirk Morr, U. Illinois-Chicago

Last time

Tycho Brahe 1546-1601

- New Star of 1572 - Aristotle wrong
- Comet of 1577 - no crystalline spheres
- The Tychonic system: just the same as Copernican *relative to* Earth's position.
- All predictions for planetary positions identical.

Clicker question:

Tycho's famous astronomical data

a. were acquired with the aid of a telescope borrowed from Galileo

b. came from Ptolemy's notebooks

c. were forged to please the king of Denmark

d. came from Johannes Kepler's observations

e. were obtained with huge instruments to measure angles accurately

Clicker question:

Tycho Brahe's discovery of the new star of 1572 and the comet of 1577

a. had been predicted by Ptolemy

b. were made using his new telescope

c. showed that both objects moved on circular orbits around the earth

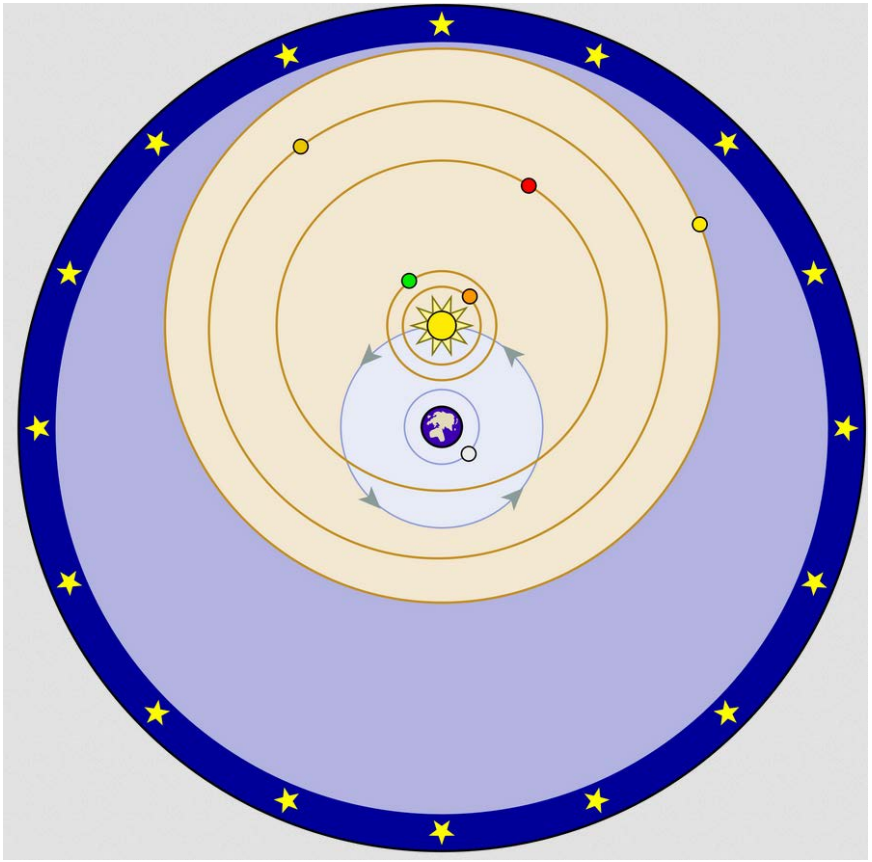
d. showed that both objects moved on circular orbits around the sun

e. were important because they showed change beyond the orb of the moon

Tychonian system

1) Sun & Moon orbit Earth

2) All planets orbit Sun



Completely equivalent to the Copernican system in terms of planetary positions!

https://people.sc.fsu.edu/~dduke/ntycho.html

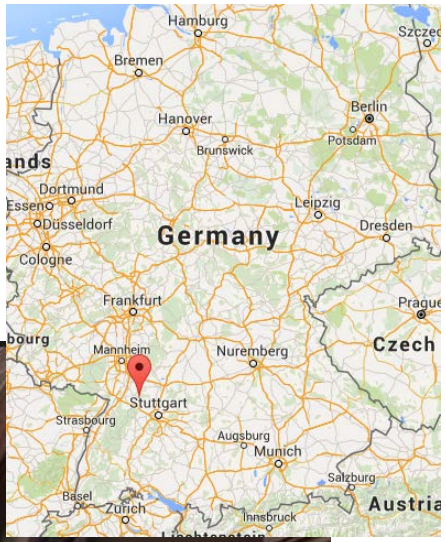
Kepler

- Early researches on mathematics of Copernican orbits
- Can the radii of orbits be an accident? No –

  Kepler felt they must reflect God's design.
- Teaching math class in Graz (catholic Austria), realized orbital radii are close to those of spheres containing *nested platonic solids*

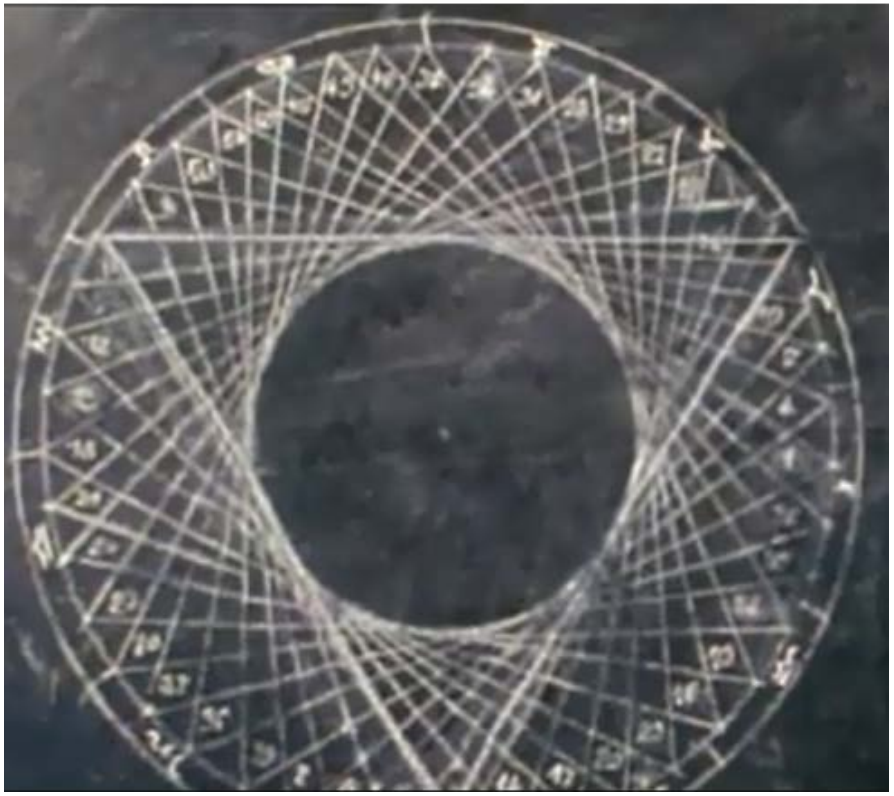
Maulbronn Monastery

(Protestant seminary in Kepler's time)

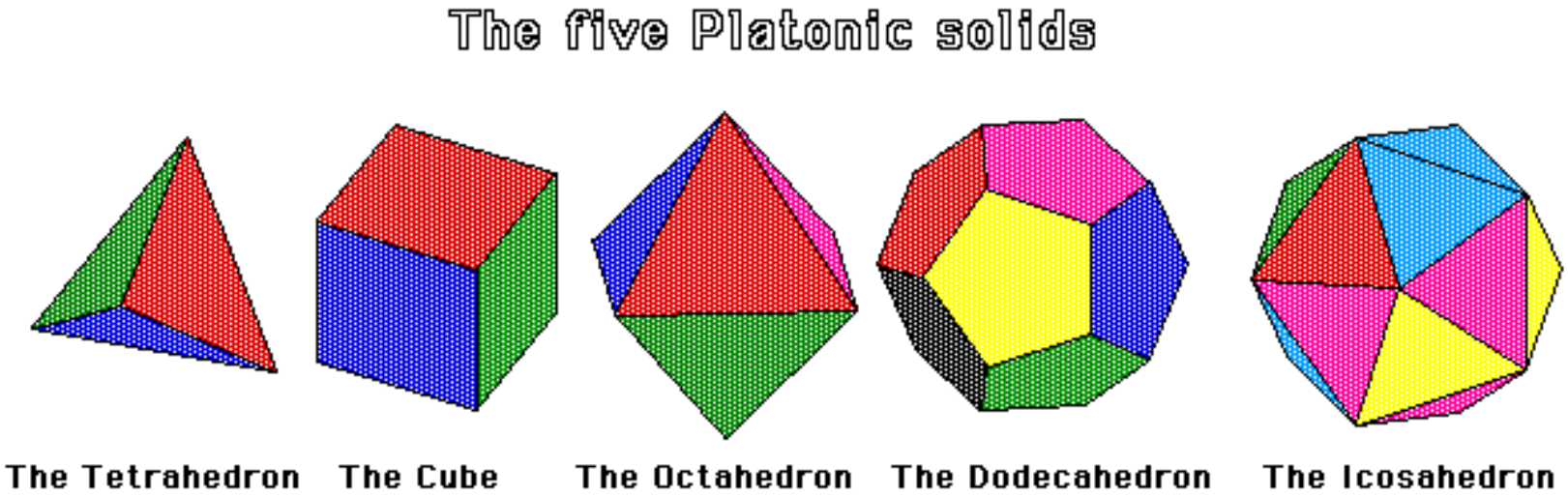


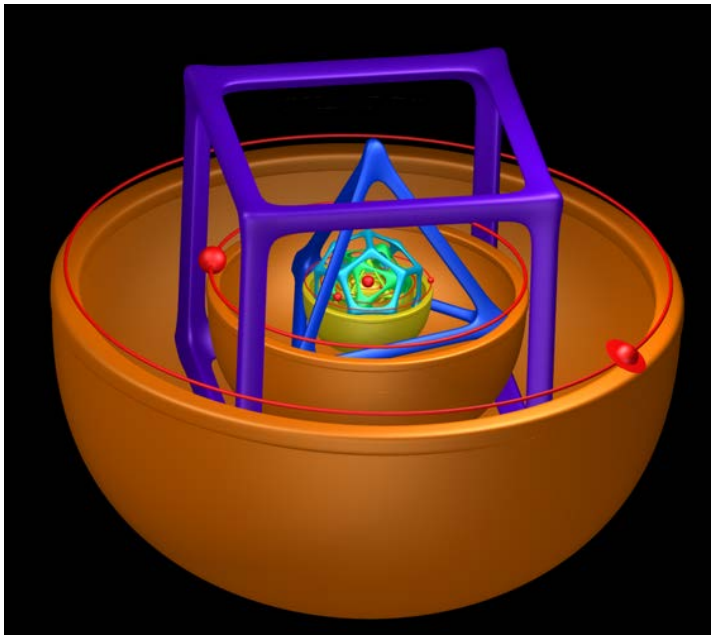
Kepler’s epiphany

(Carl Sagan’s imagination)



Platonic (regular) solids



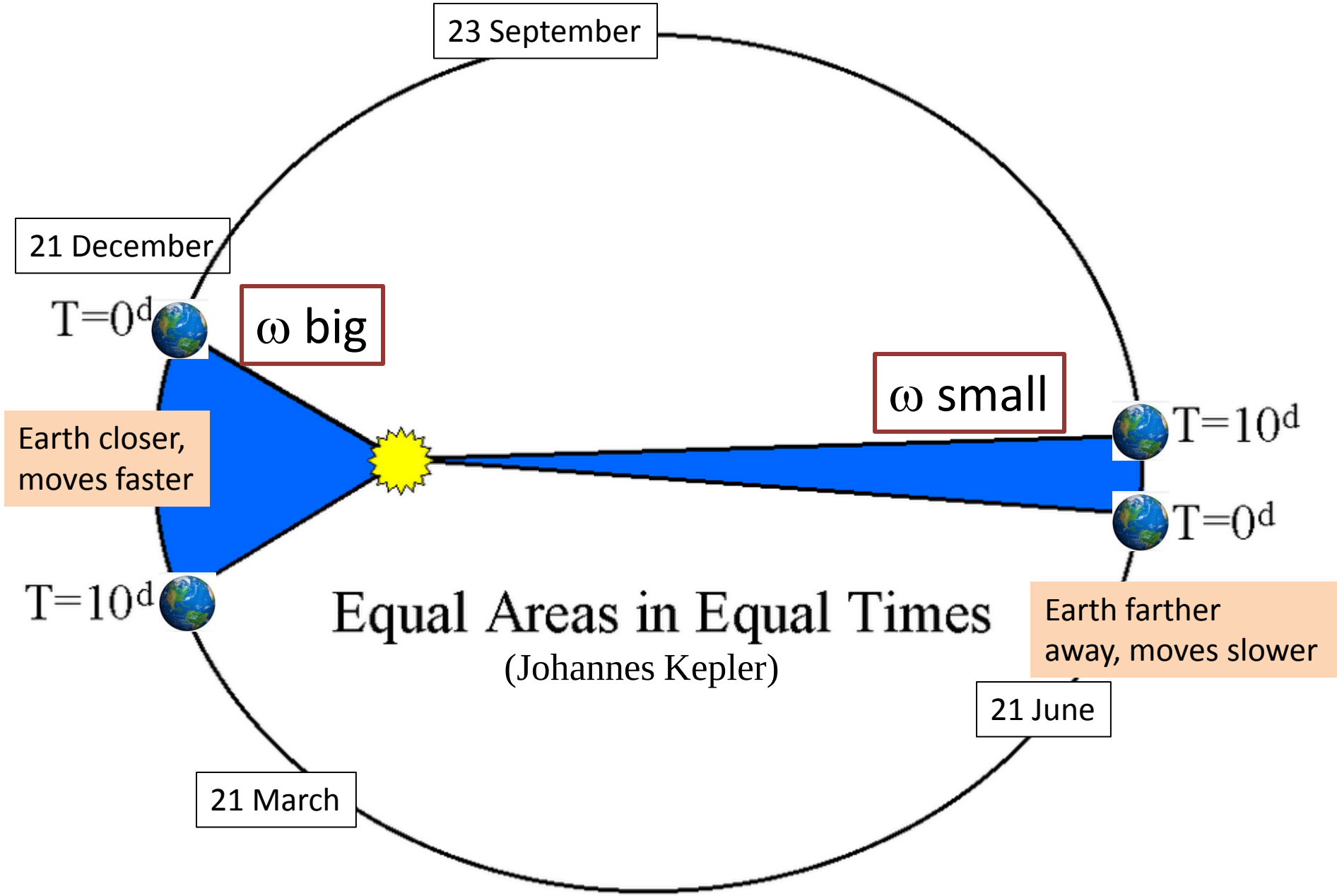


For Kepler, it was very important that there were exactly 5 such solids, so if you put one orbit inside and one outside each, you accommodate 6 planets – that's all there were (so they thought then)! Also radii of spheres were not *so* different from planetary radii, so this false geometrical argument convinced him.

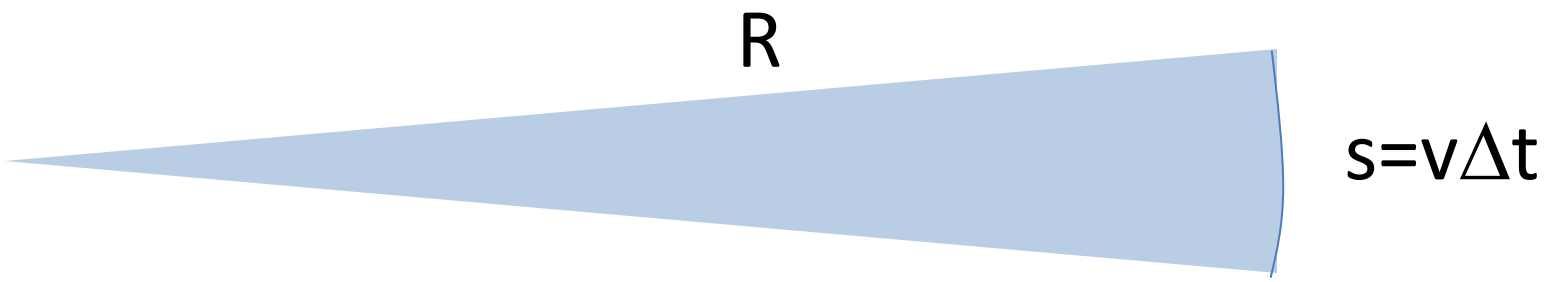
Kepler's 3 laws

1. planets move around the sun in elliptical orbits, with the sun at one focus.
2. as planet moves around its orbit, it sweeps out equal areas in equal times.
3. the period and average radius of the planets' orbits are related to each other by $T^2 \propto R^3$

Angular speed changes on Earth's orbit!



Slice of Earth's orbit swept out in time Δt



Area $\approx$ Rs = RvΔt

Rv const.$\Rightarrow$ equal areas in equal times!