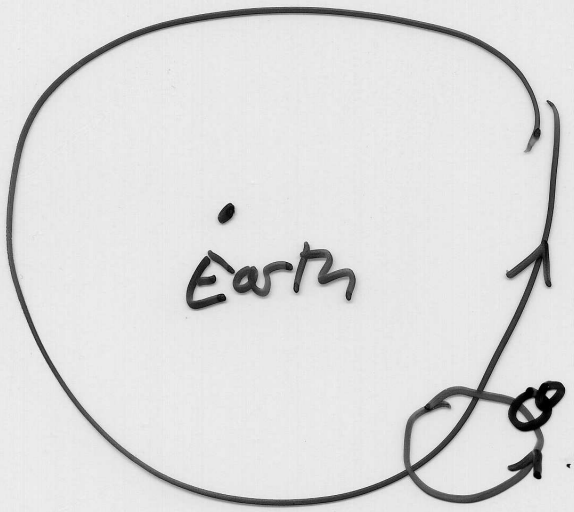
welcome to

ASTR 160b

- For NON-SCIENCE MAJORS
  (scientists: check out ASTR 210)
- NOT a survey course - 3 topics in-depth
  - extra-solar planets
  - black holes.
  - Dark Energy
- math level: high-school algebra/geometry
  (ASTR 120 has similar level, but better for math/science phobic)
- preference for fresh/soph
- grading:
  10% sections
  30% problem sets
  30% 2 midterms
  30% final
  (15% optional paper)
- see classesV2 for more details!

PLANETARY ORBITS



circles around Earth

geocentric

Ptolemy

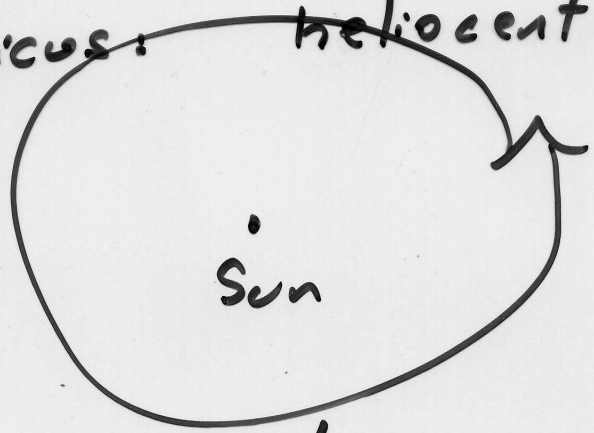
doesn't fit observation

add "epicycles"

FABLE: Ptolemaic Epicycles

MORAL: simple theories are better

Copernicus: heliocentric



circles

still needed epicycle

Kepler:

3 Laws of Planetary Motion

ellipses around Sun

excellent descriptive power

NOT an explanation

Newton: 3 Laws of Motion

$F = ma$

force ↑ mass ↑ ← acceleration

Law of gravity: F_{grav}

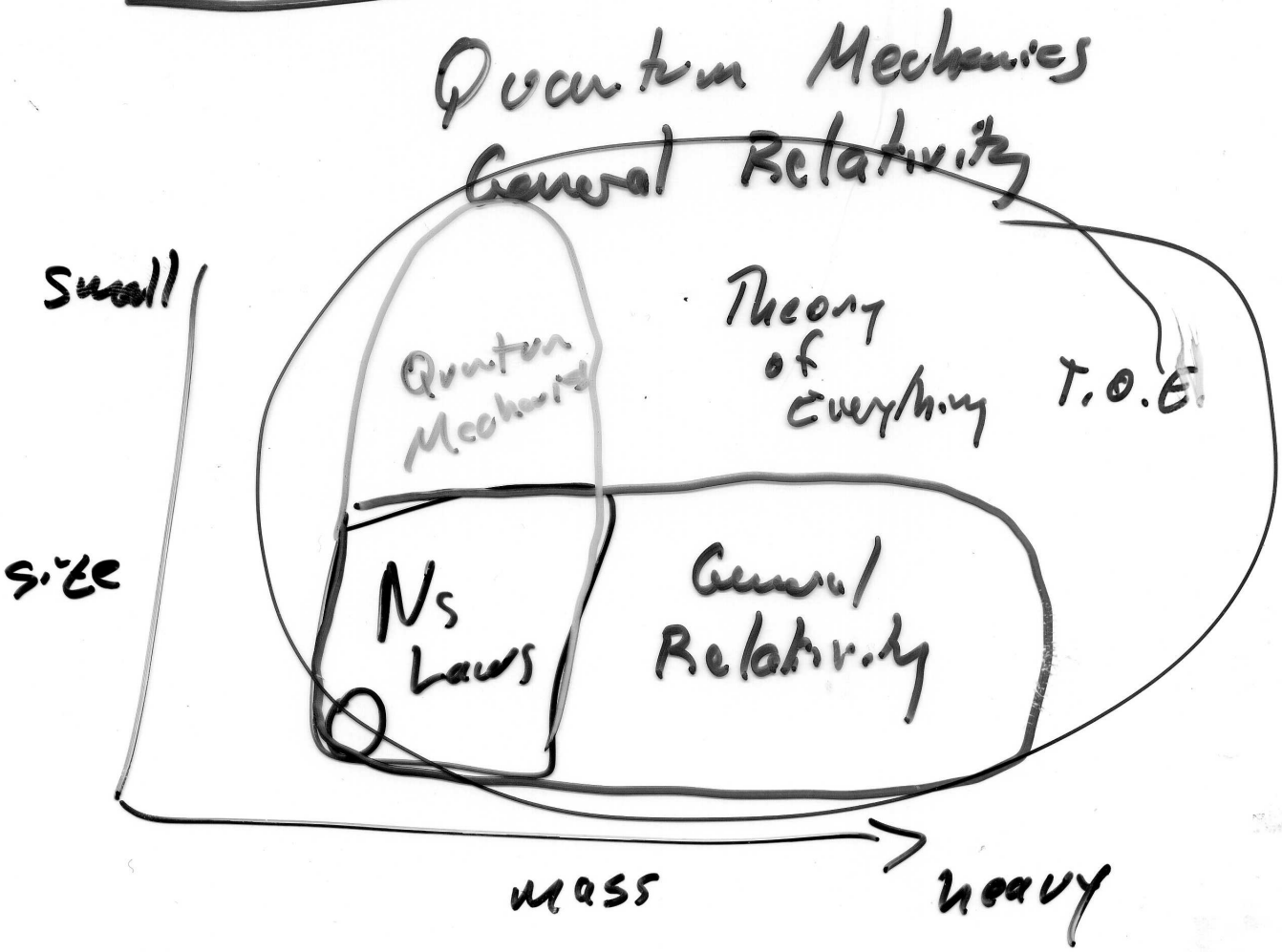
derives Kepler's Law

START OF SCIENCE:

- universe is governed by universal Laws
- these are mathematical

end of 19th century
problems w/ Newtonian Physics

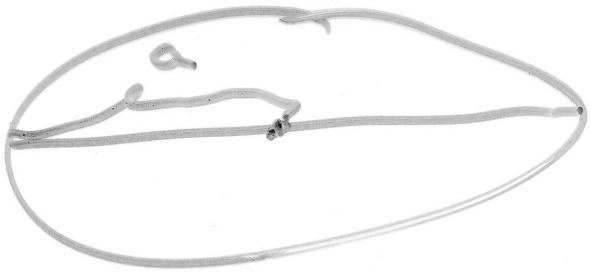
early 20th:



Newtonian modification of Kepler's 3rd Law

$$a^3 = \frac{G M P^2}{4\pi^2}$$

- G: constant of nature
- P: orbital period
- M: total mass of orbiting bodies
- a: semi-major axis of elliptical orbit



Earth around Sun

semi-major of Earth's orbit

"astronomical unit" AU

mass of Sun: $M_\odot$

period of Earth: 1 yr

$$(1\,A.U.)^3 = \frac{G M_\odot (1\,yr)^2}{4\pi^2}$$

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take general eqn divide by specific eq

$$a^3 = P^2 \cancel{G M / 4\pi^2}$$

$$(1AU)^3 = (1\,yr)^2 \cancel{G M_\odot / 4\pi^2}$$

$$\left(\frac{a}{1AU}\right)^3 = \left(\frac{P}{1yr}\right)^2 \left(\frac{M}{M_\odot}\right)$$

$a^3 = P^2 M$ → units of mass of Sun

→ units: 1 yr

↑ units of AU

Orbit of Jupiter

$a_{Jupiter} \approx 5 \cdot a_{Earth} = 5\ AU$

1 solar mass

$5^3 = P^2$

$125 = P^2$ $\quad P = \sqrt{125}$

11

$121 = P^2$ $\quad P = 11$ years