Astro Notes

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1 Class overview

Office hours tues and thurs 11-12 astro 237
ta office hours
wed 3:30:530 astro 2367
hw due wed
hw posted week before

- solar system
- steller evo
- compact objects
- galaxy quasi darkmatter
- cosmic web
- big bang

course goals

- apply pys to universe
- understand foundations of modern astro, astrophys, and cosmology
- conceptual understanding of the uni based on physical principles

2 Early Astronomy

2.0.1 Greek

- Aristotle
  - earth is spherical
  - partial lunar eclipses
  - some stars visible from southern locations but not northern and vice versa

    - had ideas regarding perfect geo influenced by Pythagoras and Plato
- Aristarchus (310-230 BC):
    - unpreceded heliocentric framework
    - trig distances earth-moon-sun system
    - angular diameters $\theta_{sun} \approx \theta_{moon} \therefore \frac{A}{C} = \frac{D_{moon}}{D_{moon}}$
    - diameters from lunar eclipses $D_{moon} < D_{earth}$
- Eratoshs (176-195 BC):
    - Determined radius of spherical earth R_E
    - Sun at zenith at noon on summer solstice at Aswan
    - But further north in Alexandria, Egypt, the sun is south of the zenith by angle α
- Hipparchus (190-120 BC):
    - Discover precession of the equinoxes from examination of star catalogs over centuries
    - established the magnitude system
- Copernicus (1473-1543):
    - heliocentric
    - earth rotates
    - still assumed uniform circular celestial motion
    - inferior planets: orbit smaller than earths
    - superior planets: orbits larger than earths

2.1 Emergence of modern Astro

Inferior planets

- B/C = sin θ_E
- B=C Sin θ_E
- C is AU
- Early astronomers didnt know C, so they could only infer rations of B/C. Ie. Orbital radii measured in AU

Superior Planets

- Measure time between opposition and eastern quadrature
- want angle θ between opp and east quad

- $\theta = (\omega_E - \omega_p)$ and $C/B = cos\theta$
- measure τ and synodic period, calculate sidereal period and ω_p; know ω_E and infer C/B

Galilean Revolution

- Galileo Galilei (1564 -1642)
- - improved and used a basic refracting telescoping
- def publication of early results 1610 *"starry messenger"*
- - Moon is cratered; not a perfect Sphere
  - milkyway is made out of stars
  - Jupiter has moons (or as he thought, stars)
  - measured phases of Venus

Phases of Venus

- direct confrontation with Ptolemaic geocentric models
- in Ptolemaic models you only see crescent phases

Tycho Brahe (1546-1601)

- Denmark, later Prague
- Given island by king Fredrick (and staff)
- made a accurate and vast database of celestial motion
- had a lead nose?
- Threw giant ragers
- supernova named after him

Johannes Kepler (1571–1630, Prague)

- 'Inherited' (maybe stole) Brahe's data
- also has a SN
- Kepler fit a new empirical model of heliocentric orbits, abandoning perfect circles
  - "*It was as if I awoke from sleep and saw a new light*" (Kepler, New astronomy)

Kepler's Laws

First law

- The planets travel on elliptical orbits with the sun at one focus
- Semimajor axis, half the major axis
- eccentricity: how elliptical (stretched) an orbit is - distance between foci divided by major axis.

second law

- A line drawn from the sun to a planet sweeps out equal areas in equal time intervals'
- perihelion: orbital point closet to the sun
- aphelion: furthest orbital point from the sun

third law

Def: *The square of the sidereal orbital periods of the planets are prop to the cubes of the Semimajor axis of their orbits*

$$p^2 = Ka^3$$

P = planets sidereal period
a= length of semimajor axis
K = constant

Consequences of heliocentric model

- retrograde motion of outer planets
- positions of outer and inner planets wrt sun
- annual parallax
- aberration of starlight
- Coriolis effect

Parallax

- annual parallax: change in the apparent position when seen from two diff locations due to earth revolving around the sun. First measured by Bessel in 1838

Aberration of starlight

- deflection of apparent stellar positions in the direction of the observers motion
- analog: running throw rain and getting wet in the front and not in the back
- detected (Picard, 1680); explained (Bradley, 1729)

- telescope is moving along orbital vector around the sun; translation along orbit cannot exceed transit time of light through telescope

Corilois effect: evidence of erath rotation

- coriolis acceleration is perp to the direction of motion
-
$$\vec{a_{cor}} = s\vec{v} \times \vec{\omega}$$
- can be deduced from a pendulum
- and in hurricanes!

3 Glossary

Synodic period

- time elapsed between success conjunctions or oppositions
- this is the period we observe from earth, which is moving

Sidereal Period

- elapsed time of full orbit relative to the fixed stars (inertial ref frame)
- This is the one we will want to put in keplers laws