Final Exam Study Guide

Black Holes

43:

- What do astronomers look for to detect a stellar black hole, and why?
  - Look for a companion object for the black hole to suck in and form an accretion disk. The accretion disk emits x-rays that are detectable by orbiting telescopes.
- Name of the first one discovered, in what decade it was discovered, the orbiting telescope directly involved in the discovery and what part of the spectrum it observed?
  - Cygnus X-1, 1970, Uhuru Satellite, x-ray spectrum

Galaxies and Quasars

44:

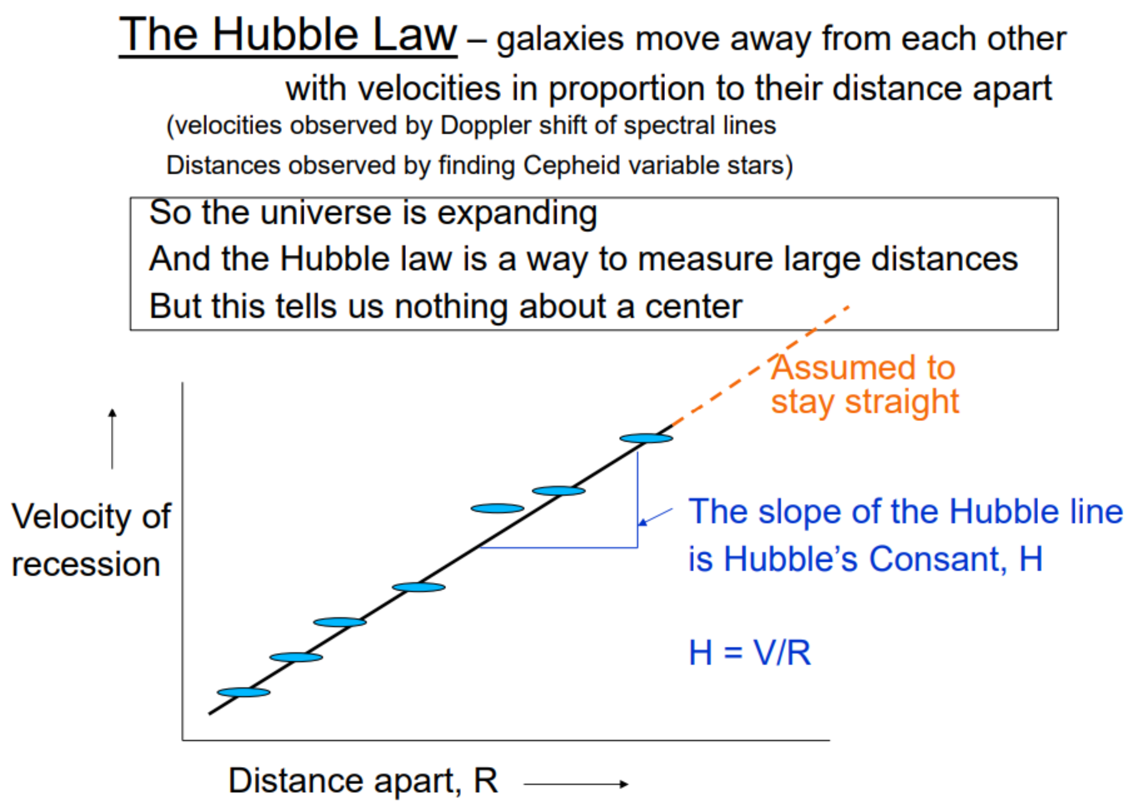
- In one short sentence, explain why we think quasars are very far away.
  - Spectral lines received by them are red shifted massively into a completely different spectrum. If they obey the Hubble Law they must be massively far away.
- In another sentence, why do those distances present a problem?
  - Their massive distance would result in a dim object, but they are far more bright than we would assume for something of that distance.

45:

- What might galactic spiral arms have to do with star formation?
  - Low density gas clouds are compressed by the shock front of the perturbations of a galactic spiral arm. Star formation is triggered from this compression.
- It has been shown that spiral arms will maintain their density due to their own gravity. In a sentence or two, what do we think is necessary to create them in the first place?
  - Density waves eminate out from the galactic center. These density waves impose a perturbation force on their surrounding particles. The small "perturbation force" causes particles to pile up in the spiral arms, keeping them dense.

46:

- Draw a graph of the Hubble Law, with the parameters of the axes labeled (you don't have to include the numerical values).



–

- How did astronomers gather the information needed to establish the Hubble Law?
  - Hubble combined his measurements of galaxy distances with measurements of the doppler shifts associated with the galaxies. Hubble discovered a proportionality between redshift of an object and its distance.

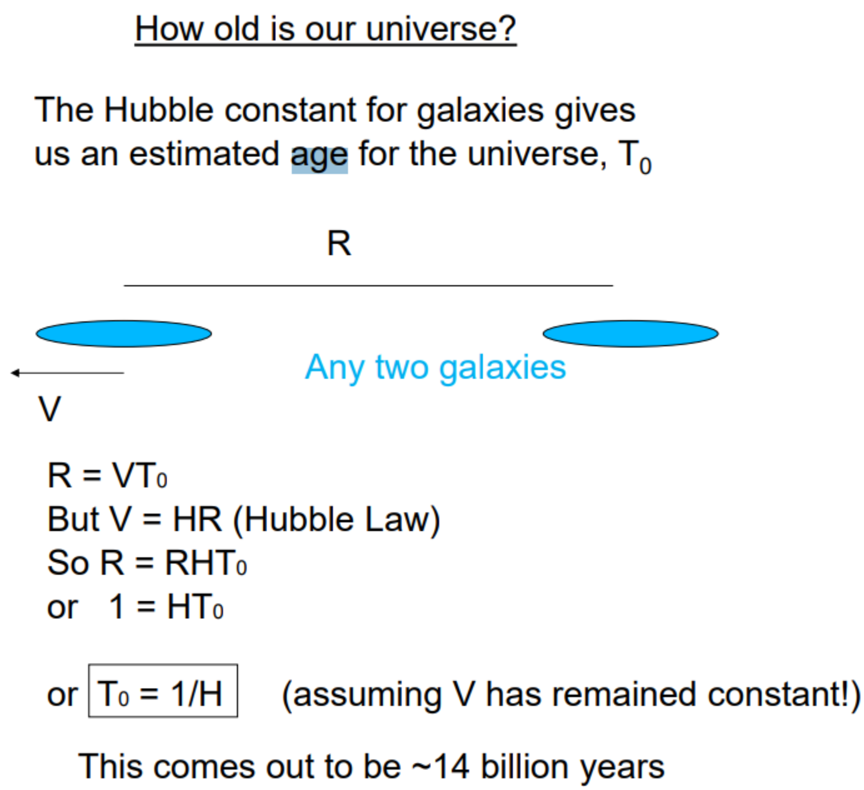
Cosmology

47:

- THERE IS NO 47! ONLY ZOOL!!!

48:

- With a diagram and a few sentences or equations, derive the expression for the approximate age of the universe in terms of the Hubble constant.

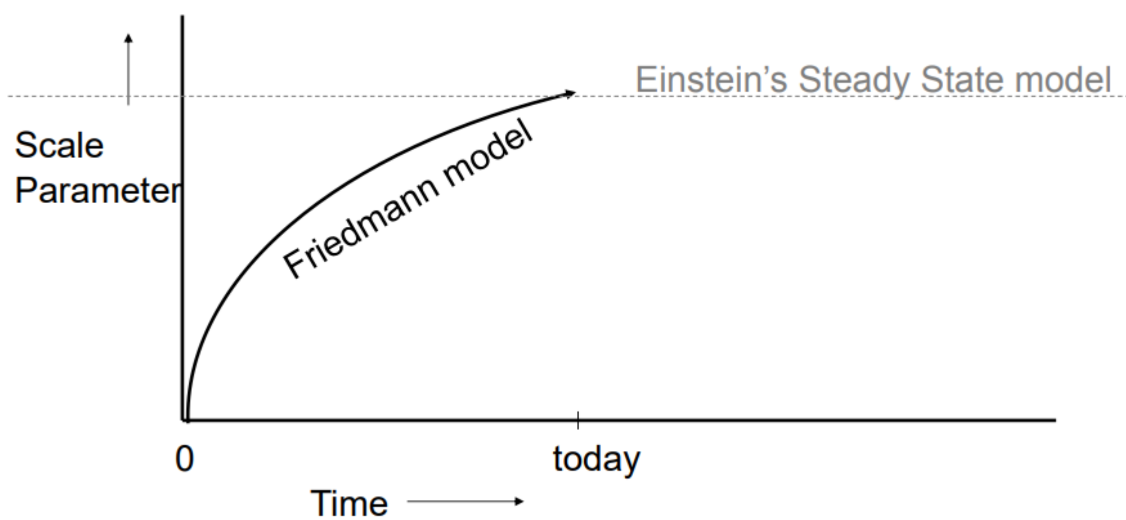


–

- What can you say about the estimated age if gravity has always been the strongest force over long distances?
  - Velocity is a pulling force on the universe over time. $\frac{1}{H}$ would then be the maximum age of the universe if velocity has been slowing things over time. If something has been speeding up the velocity of recession then $\frac{1}{H}$ would be the minimum age of the universe.

49:

- Draw the Friedmann and Steady State models of the universe on a graph of scale parameter vs. time. Indicate where the present time is on the graph.



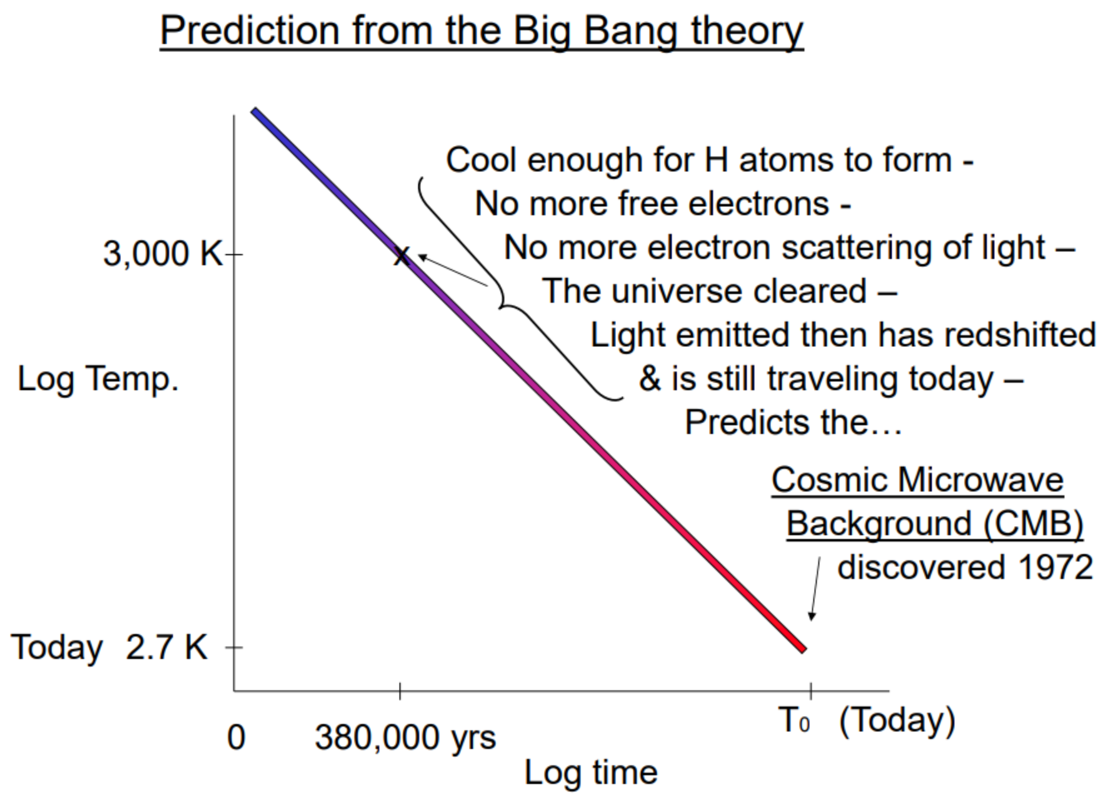
–

- What does the Steady State model require, that is not required for the Friedmann model, and was not

known to exist when both models were considered possible?
  - Steady State requires a cosmological constant that acted as a repulsive force to avoid physical singularity of the Big Bang. Cosmic Microwave Background Radiation (CMB) was not known to exist when both models were considered possible.

50:

- Why does the cosmic microwave background (CMB) favor the Friedmann model over the steady state model? Explain how the CMB originated and when, using a graph and a few sentences.
  - Cosmic microwave background radiation favors the Friedmann model because it originates shortly after the Big Bang (380,000 years). Light from when universe initially began to cool has been stretched with the expansion of space into the microwave spectrum.

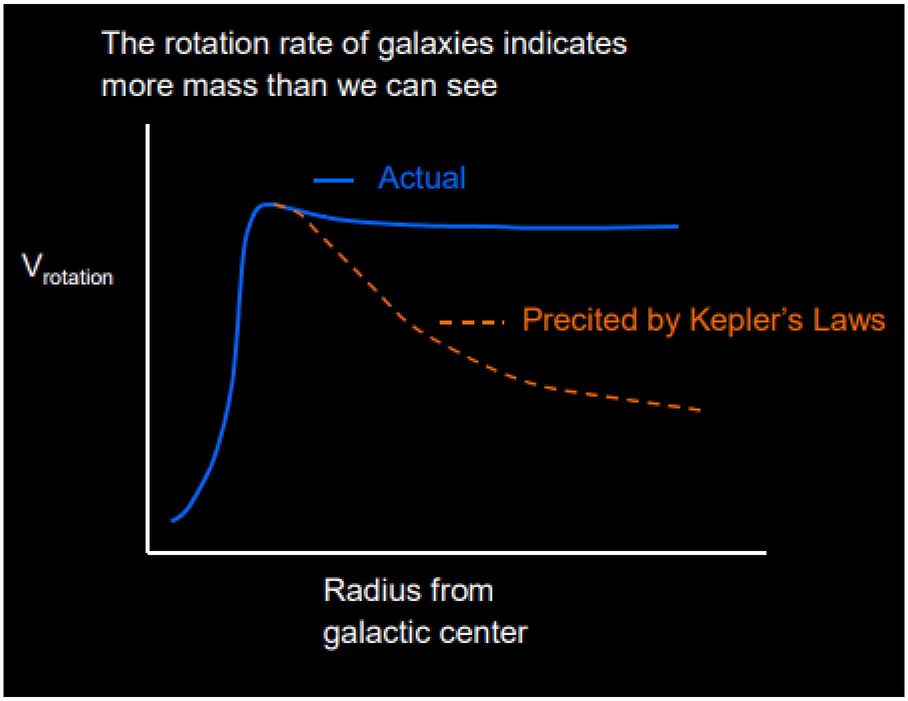


  -
- Name another piece of observational evidence that favors the Friedmann model, and why it does.
  - The Hubble Law verifies the increasing scale factor of the universe.

51:

- Dark matter and dark energy are still mysteries in our universe. What is the evidence for dark matter? Include as much as you can, and use diagrams where appropriate to explain it.
  - Light from distant galaxies is lensed around invisible compact masses in the "halo" of our galaxy (MACHO's).

  - Rotation rate of galaxies is faster than Kepler's Laws would imply, indicating that they contain more mass than is readily apparent.



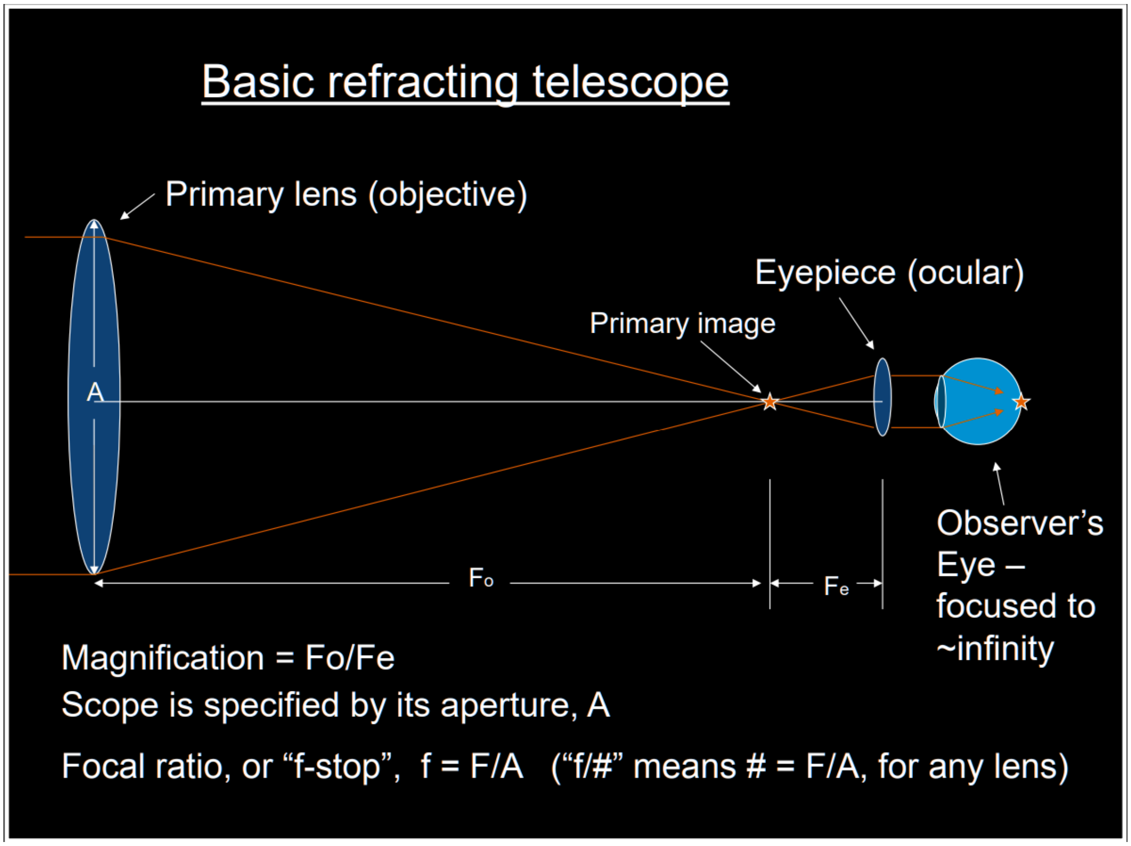
–

- What is the evidence for dark energy?
  - Quantum Theory predicts equal number of particles and anti-particles.
  - very far type1A supernovae don't recede fast enough, but we assume they have accelerated since they exploded.
    * Acceleration implies repulsive force implies an unknown energy in space.

Cumulative Questions

3: You plan to build a 6-inch, f/8 Newtonian telescope, with a 1-inch focal length eyepiece located 1 inch outside the tube.

- State the focal length of the objective and the magnifying power of the scope.
  - Focal length ("F"):
    * $F =$ Aperture x $f = 48$
    * (Focal ratio: f)
  - Magnifying power:
    * $M =$ Focal length of objective/Focal length of eyepiece
    * $M = 48/1 = 48$
- Draw a detailed diagram of the scope, showing the positions of all mirror(s), the eyepiece, your eye, the primary image and the image formed on your retina. Label all the dimensions involved, and include 2 light rays passing all the way through the telescope to your retina.

– 

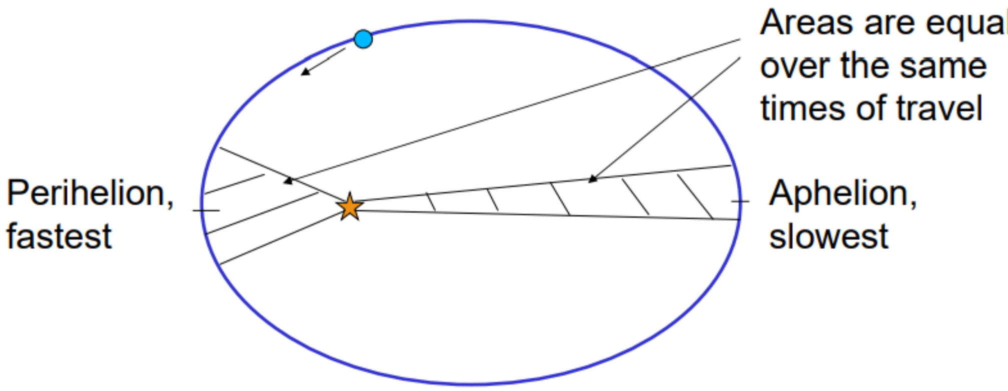
5:

- Why are radio telescopes sometimes linked together to form an "interferometer"? In other words, state what problem this helps to solve.
  - Creating an interferometer can reduce the beamwidth of the radio telescope resulting in more accurate measurements.
- Discuss why "adaptive optics" are used in modern optical telescopes, and basically how that technology works.
  - Adaptive optics correct for atmospheric turbulence by "tuning" the reflective panels which make up the primary mirror.

6:

- State Kepler's 3 laws of planetary motion. Your own words are ok, as long as they're accurate.
  1. All planets move around the Sun in elliptical orbits. having the Sun as one of the foci.
  2. A line joining any planet to the sun sweeps out equal areas in equal lengths of time.
  3. The squares of the sidereal periods of the planets are directional proportional to the cubes of their mean distances from the sun.
     - $(M + m)p^2 = a3$ (m in solar mass, p in years, a in AU)
- Draw at least one orbital diagram to illustrate the first two, showing the sun, perihelion and aphelion, and where the planet moves slowest and fastest. Show the definition of eccentricity on the diagram, and state what $e = 0$ and $e = 1$ mean.

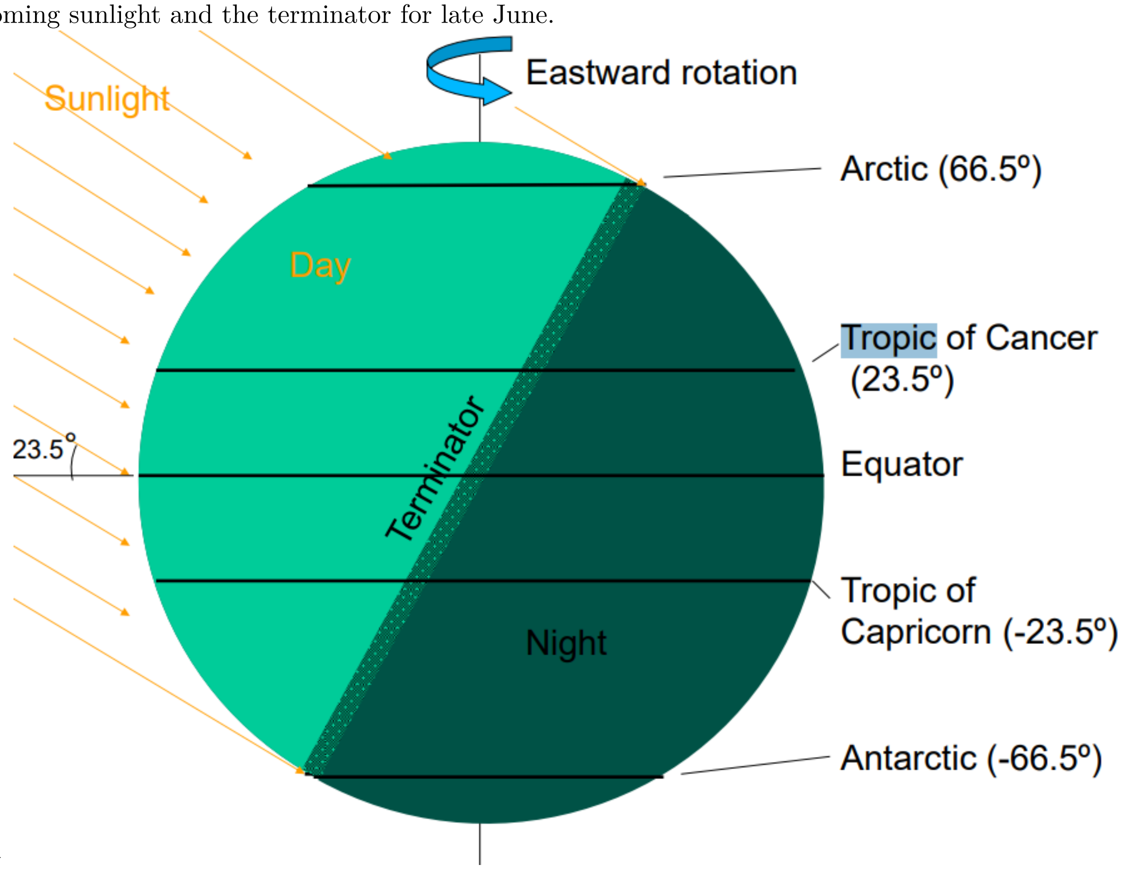
.



–
– $e = 0$ is a circular orbit
– $e = 1$ is a parabolic orbit

9:

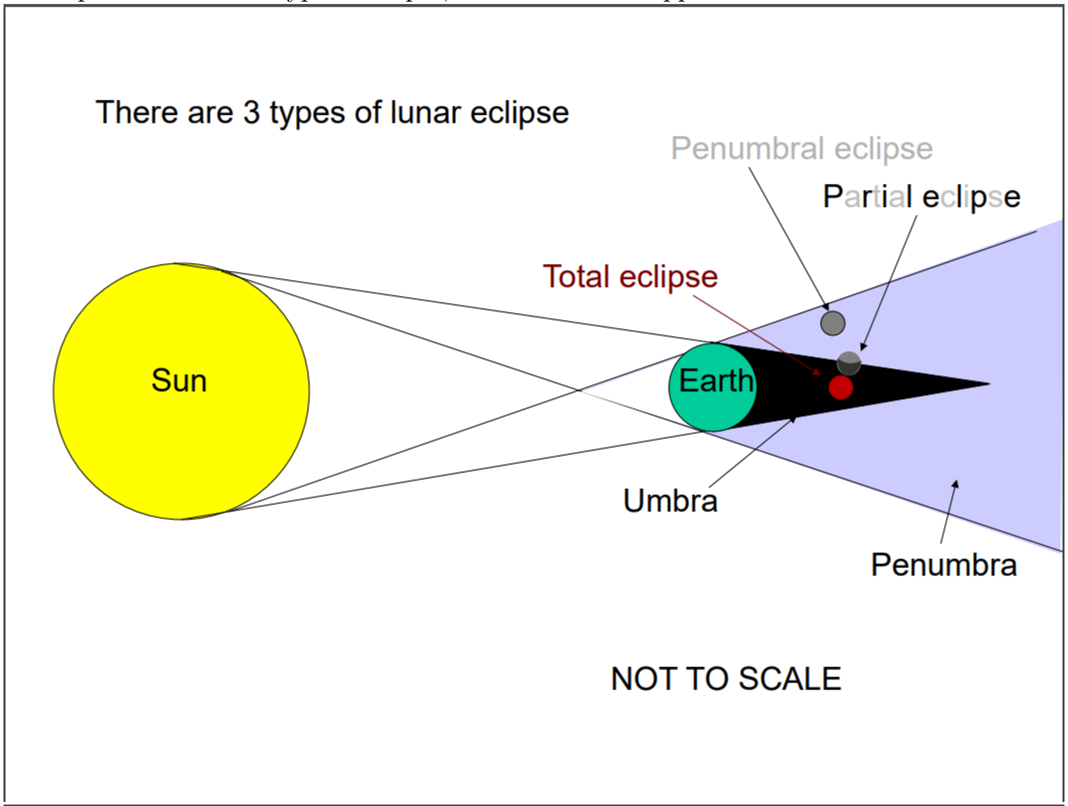
- In a few words, name 2 reasons we have three seasons on Earth.
  - Earth is tilted on its axis leading to the sun hitting certain parts of the earth more directly and some more indirectly and this changes as the Earth orbits the Sun.
  - The changing length of the days also means that the surface of the earth is exposed to more sunlight
- Include an Earth diagram, showing the Tropics, Arctic and Antarctic circles with their latitudes, plus incoming sunlight and the terminator for late June.

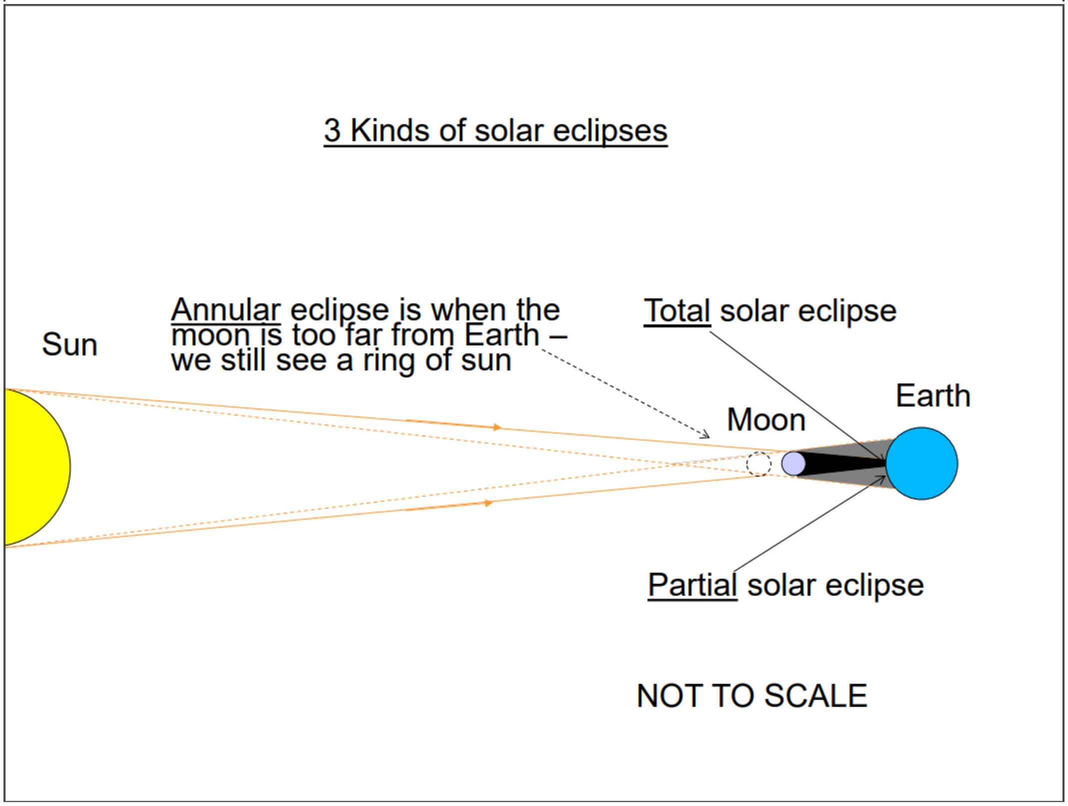


–

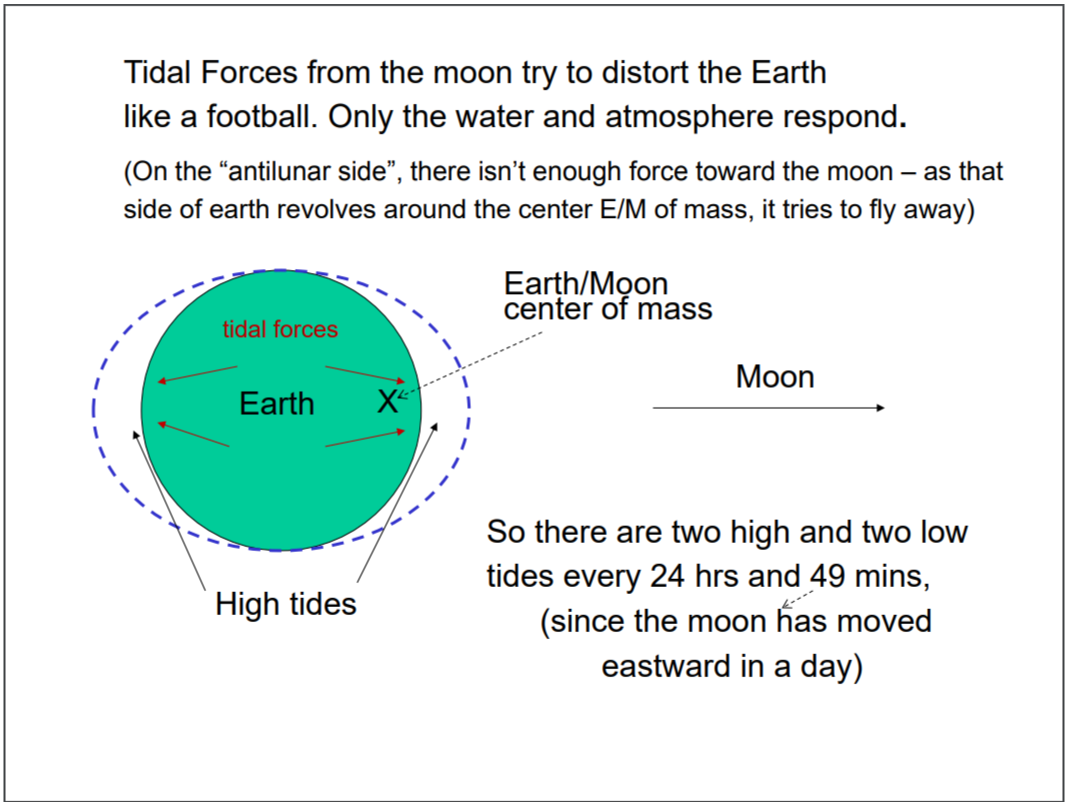
14:

- Use 2 diagrams of sun, earth and moon to show: 1- the three types of lunar eclipses; 2- the three types of solar eclipses. Label each type of eclipse, and describe its appearance.

1. 

2. 

- Draw a diagram showing the forces that cause the tides on Earth.



–

21:

- Name 2 major features on the surface of Mars, and compare each in size to a familiar feature on Earth.
  1. Olympus Mons - 3x the size of Mt. Everest
  2. Valles Marineris - Length of the USA
- Why are we sure that Mars once had a much higher pressure atmosphere? One or two sentences are enough.
  – Mars's current atmosphere is too thin to support liquid water; however, there is evidence of previous water flows and islands.

23:

- Astronomers are particularly interested in Io, Europa, Titan and Enceladus.
- With one sentence for each, what make each so interesting and what planet does each one orbit?

	Io	Europa	Titan	Enceladus
Interesting Property	Volcanic	Subterranean Ocean	Dense Atmosphere	Icy Surface Cryo Volcanoes
Orbits	Jupiter	Jupiter	Saturn	Saturn

- Of these moons, which one(s) is(are) bigger than Mercury?
  – Titan is bigger than Mercury.

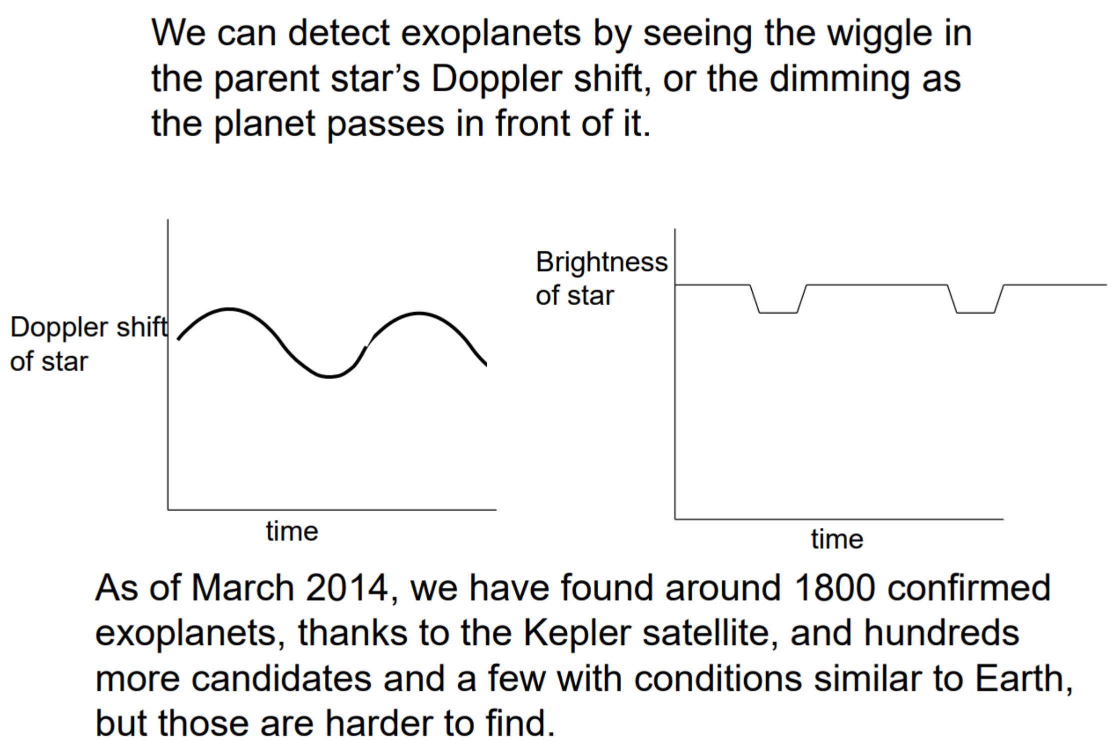
25:

- Why do we have meteor showers? Two sentences are plenty.
  – These meteors are caused by streams of cosmic debris called meteoroids entering Earth's atmosphere at extremely high speeds on parallel trajectories.
- Why isn't Eris called a planet, and why isn't Sedna called a planet?
  – In order for a body to be considered a planet, three criteria must be met:

    1. It orbits the sun.
    2. It has enough mass to achieve hydrostatic equilibrium (a nearly round shape)
    3. It has to have cleared its orbit of other bodies
  - Eris has not cleared its orbit of other bodies, so it is not considered a planet.
  - Sedna is not spherical, so it is not considered a planet.

28:

- Briefly describe the Doppler Method for finding exoplanets, with a diagram.
  - Astronomers identify oscillations in doppler shift of a star, indicating a second source of mass (i.e. an exoplanet).

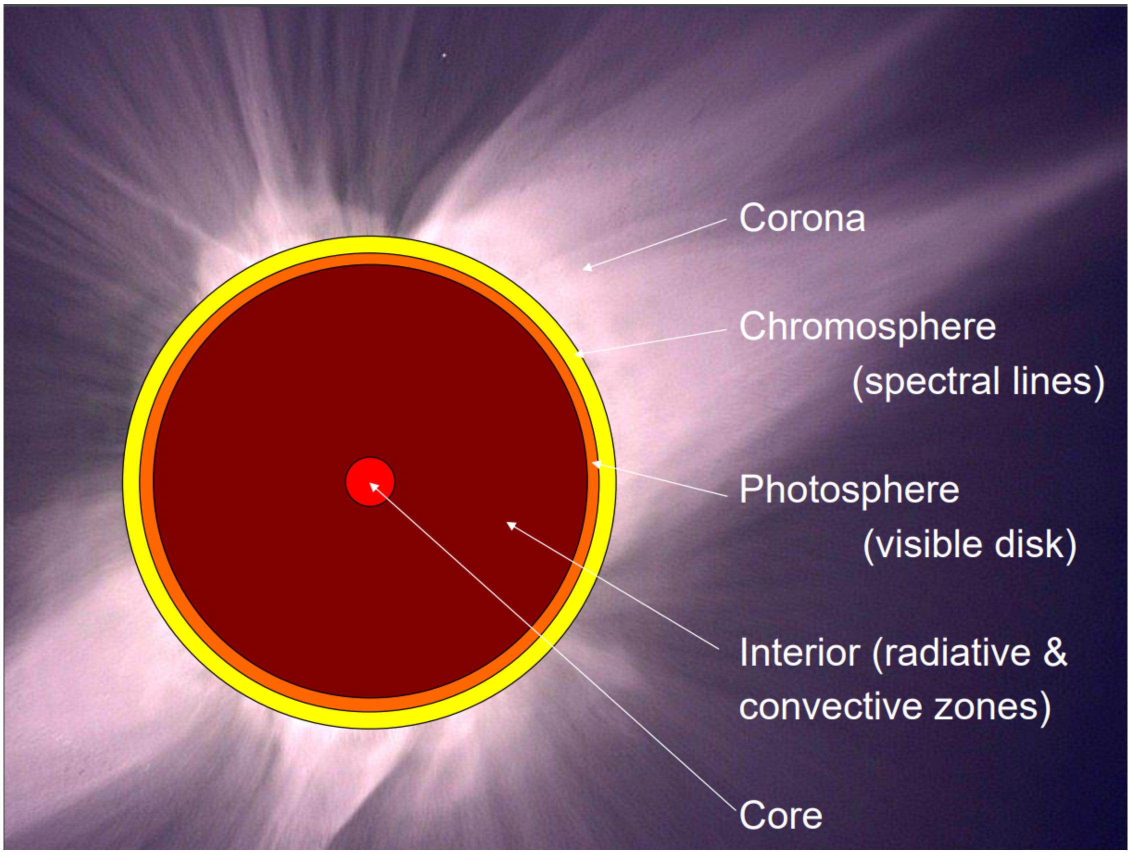


  -

- Why are there some exoplanets we theoretically cannot find by that method, no matter how sensitive our equipment becomes.
  - When exoplanetary orbits rotate "face-on" we cannot measure their oscillations in doppler shift.

31:

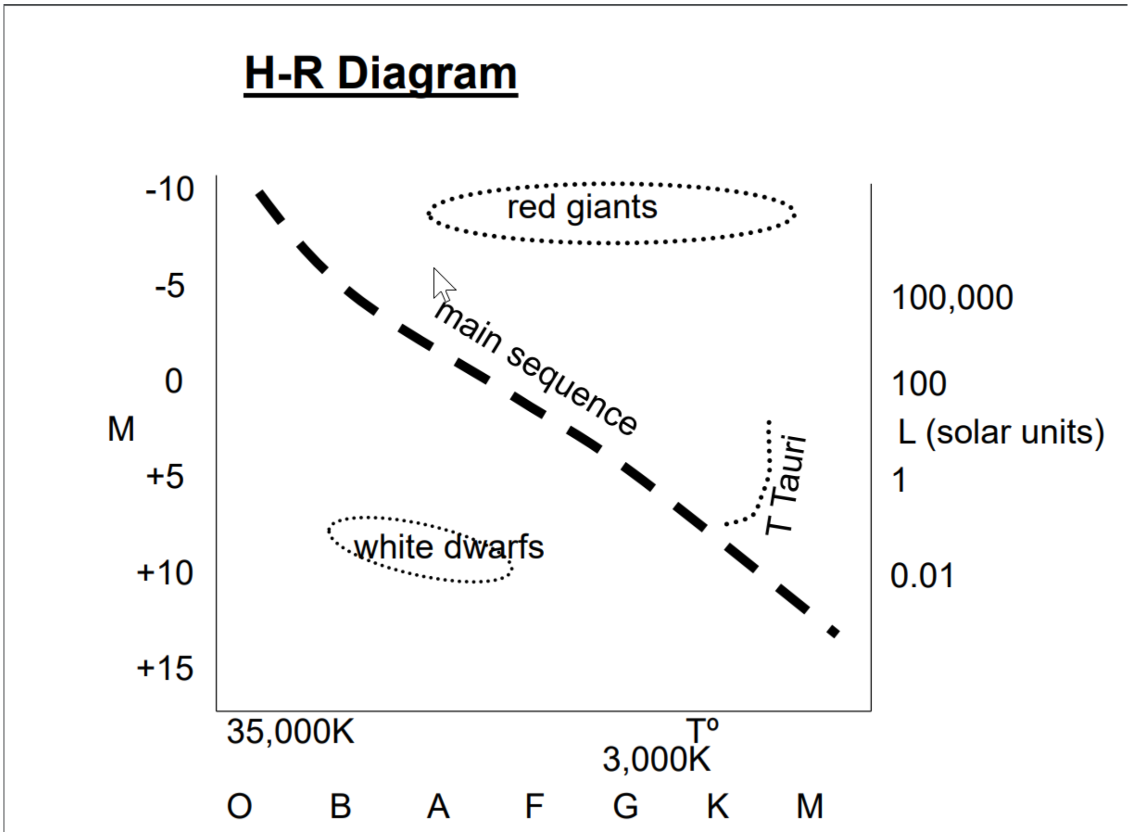
- Draw a diagram of a star showing and labeling the various layers that astronomers recognize. Indicate which layer is seen as the visible surface, where spectral absorption lines are formed and where hydrogen fusion occurs.

– 

- What is the distance in parsecs to a star of parallax angle 1/100 second of arc? Approximately what is that in light years.
  - $R = 1/p$
  - (R = Parsecs)
  - $100 = 1/(1/100)$
  - Lightyears = 3x Parsecs
  - 100 Parsecs = 33.3 Lightyears

33:

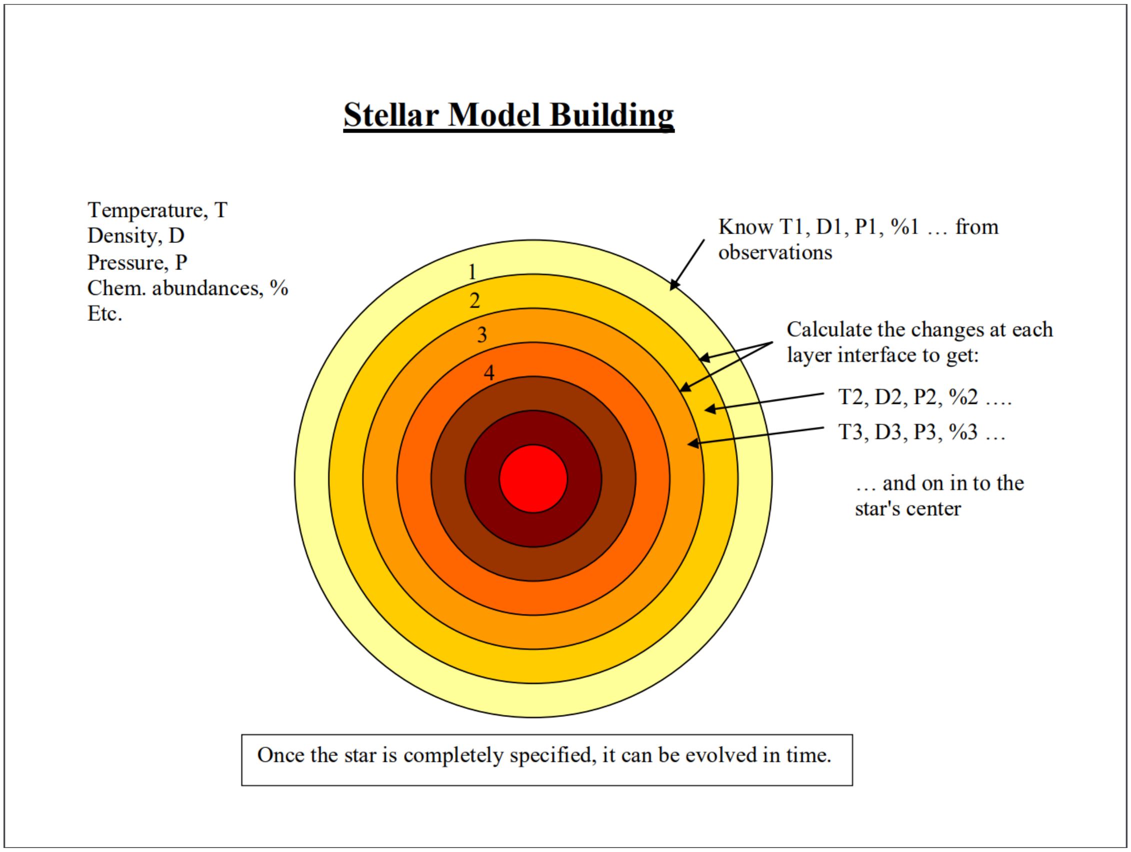
- Draw an H-R diagram, showing the major domains where stars are found. Label each axis in at least two different ways.



- Briefly describe how the "spectroscopic parallax" method works for determining a star's distance
  - Knowing the apparent magnitude (m) and absolute magnitude (M) of the star, one can calculate the distance (d, in parsecs) of the star using the following formula:
    - $M - m = -5log(d/10)$

35:

- Use a diagram and a few sentences to describe the basic method of constructing a mathematical stellar model. (Assume no rotation so that is spherically symmetric)



  - If you know any of the properties of the chromosphere layer, you can derive the value of the same property at a deeper layer by calculating the changes in the layer interface.
- State 5 physical properties of the chromosphere layer of a stellar model that can be evaluated directly from observational measurements.
  1. Temperature
  2. Density
  3. Gas Pressure
  4. Chemical Abundance
  5. Magnetic Strength
  6. Convection Rate (extra)
  7. Rotational Velocity (extra)

39:

- Discuss white dwarf stars.
- In what decade was the first one discovered, in what decade was it found to be unusual, what is its name, and why was it thought to be unusual?
  - Discovered - 1862
  - Found to be unusual - 1915
  - Name - Sirius B
  - Property - The star had an unusually high density for its size
- What was the stability problem, who explained it and in what decade?
  - The material in a white dwarf no longer undergoes fusion reactions, so the star has no source of energy. As a result, it cannot support itself by the heat generated by fusion against gravitational collapse, but is supported only by electron degeneracy pressure, causing it to be extremely dense.
  - Chandrasekhar explained the stability problem in 1931.