ASTR 1040
FINAL REVIEW

12/12/2023

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END OF SEMESTER LOGISTICS

- Extended review on Thursday in usual classroom during usual time
- Observing report + any reading reflections due Thursday night
- Homeworks 1-8 should be graded (reach out ASAP if something looks wrong!)
- Final is 1:30 – 4 on Saturday, 12/12 in usual classroom (same rules as midterms just a little longer)

TRUE/FALSE (I)

1. Electromagnetic radiation is both a particle and a wave.
2. The wavelike nature of light is described by oscillating electric and magnetic fields.
3. The sky is blue because our atmosphere absorbs blue light more than other colors.
4. Planets and stars are more likely to collide than galaxies.
5. Suppose you really dislike your TA, and you want to squash him into a black hole. Your classmate warns you that doing so will make everyone get sucked in, are they right?

TRUE/FALSE (II)

1. A lightbulb twice as far away will appear 1/4th as dim
2. Blue stars live longer than red stars
3. A star twice as cold will radiate 1/4th as much
4. A 1st magnitude star is ~2.5 times brighter than a 2nd magnitude star
5. Stars range in size from roughly 0.1 – 100 solar masses

TRUE/FALSE (III)

1. The CMB is a relic of the era of nuclei in the early universe’s history
2. Standard candles are objects whose intrinsic luminosity is known
3. The highest element that stars fuse in their cores is magnesium
4. Elliptical galaxies are older and don’t form stars as often when compared to spiral galaxies
5. When the most massive stars die they leave behind a white dwarf or a black hole

CONCEPTUAL (I)

1. What limits the masses of stars?
2. What supports main sequence, red giant, neutron, and white dwarf stars against gravitational collapse?
3. What scenarios create an absorption vs. emission spectrum?
4. What is relative in relativity, and what is constant?
5. How does the universe recycle material into successive generations of stars?
6. What is a black hole? Why are they black? What creates them?
7. What is the fate of the universe, and what is its origin? What evidence do we have for both?

CONCEPTUAL (II)

1. Why is the CMB at such a low temperature today? What do we think it originally was at, and what does this imply about its redshift?
2. If the universe is infinite, why are parts of the night sky dark? (Olber's paradox)
3. How does the uniformity of the CMB provide evidence for the Copernican principle?
4. What is inflation, and why is it important to large scale structure in the universe?
5. Are most stars low or high mass? Why or why not? What does that imply about what kind of stellar remnant should be most common across the universe?
6. What are dark matter and dark energy? Are they related? What evidence do we have for them?
7. How has the universe's elemental composition evolved over time, and why?

SHORT ANSWER PRACTICE (I)

Algol's paradox: In the Algol system there is a binary where a star with a temperature of ~4,000 K has a mass of ~0.7 solar masses, while the other has a mass of ~3 solar masses and a temperature of ~13,000 K. Spectra indicates that the cooler star is likely in a later evolutionary phase than the hotter one – why is this unexpected and how might this discrepancy?

Why do we think the best candidate for dark matter is a "weakly interacting massive particle"? What does it mean for a particle to be weakly interacting? Neutrinos are weakly interacting but aren't very massive – why does the particle also need to be massive?

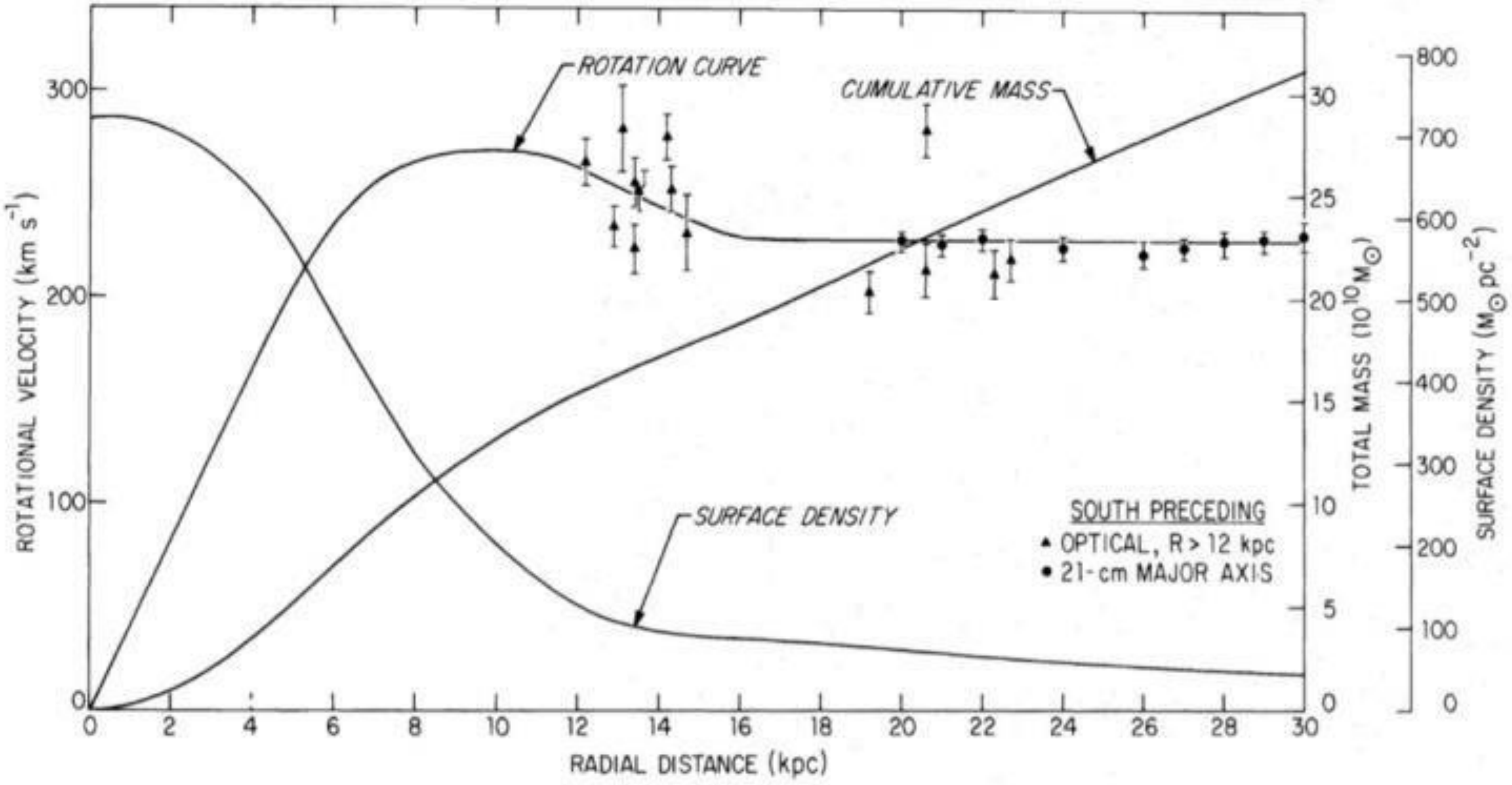
SHORT ANSWER PRACTICE (II)

Han Solo famously completed the Kessel run in 12 parsecs, moving at very high speed. Should the distance he measured be shorter or longer than the distance everyone else in the galaxy (not moving so fast) would measure? What about their relative times? Is this special or general relativity, and what is a real-world example of this concept?

How is astronomy different as a science when compared with say, chemistry? What fundamental principles underpin our ability to understand and interpret the universe?

INTERPRETING PLOTS

Below is an early “rotation curve” for the Andromeda galaxy. What do each of the lines in this plot show?



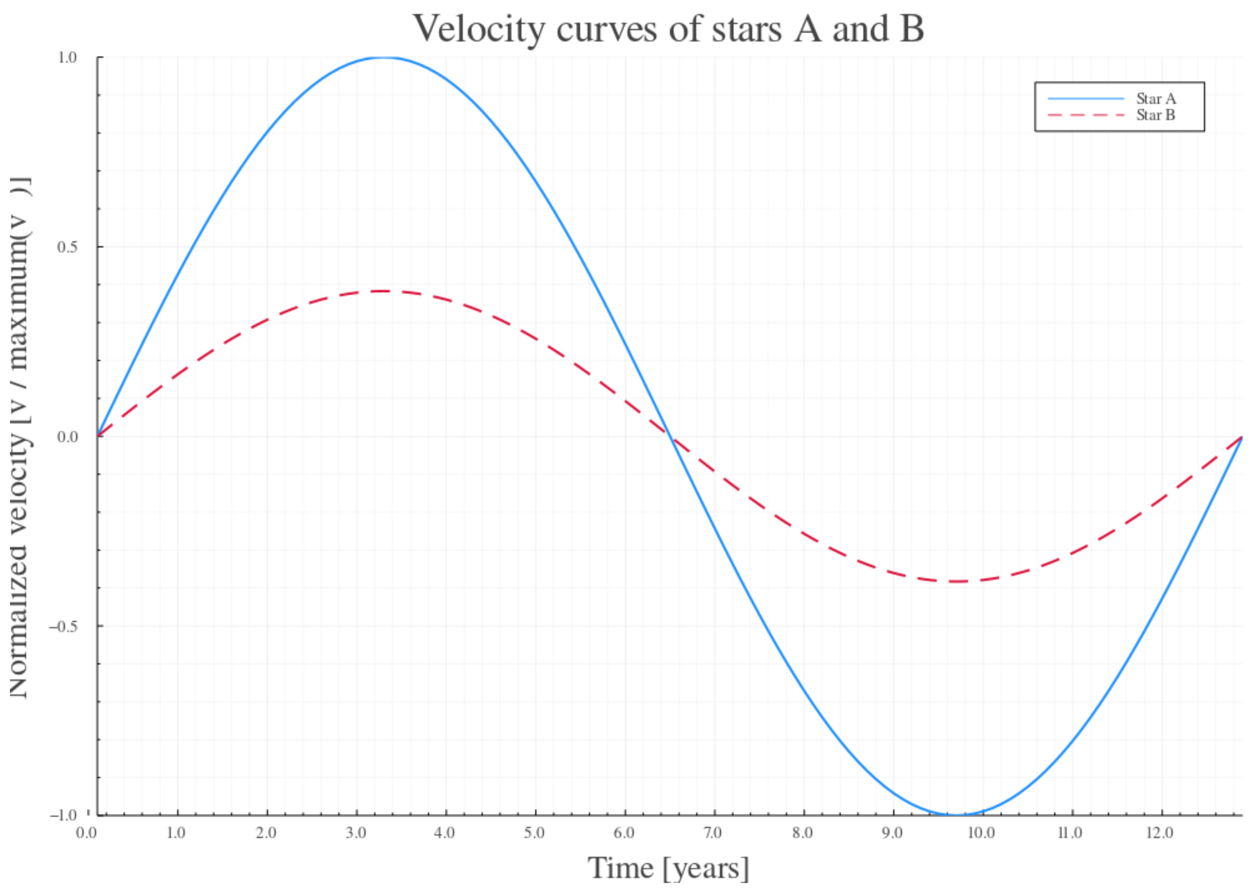
INTERPRETING PLOTS + MATH

What is the ratio of the masses of Star A and B?

Are they in a binary? Why or why not? Hint: think about periodicity.

Suppose the maximum velocity of Star A is 3 km/s and suppose both orbits are roughly circular. What is the semimajor axis of the system?

What is the total mass? The mass of Star A? Star B? What kind of stars might they be and how long would you expect them to live?



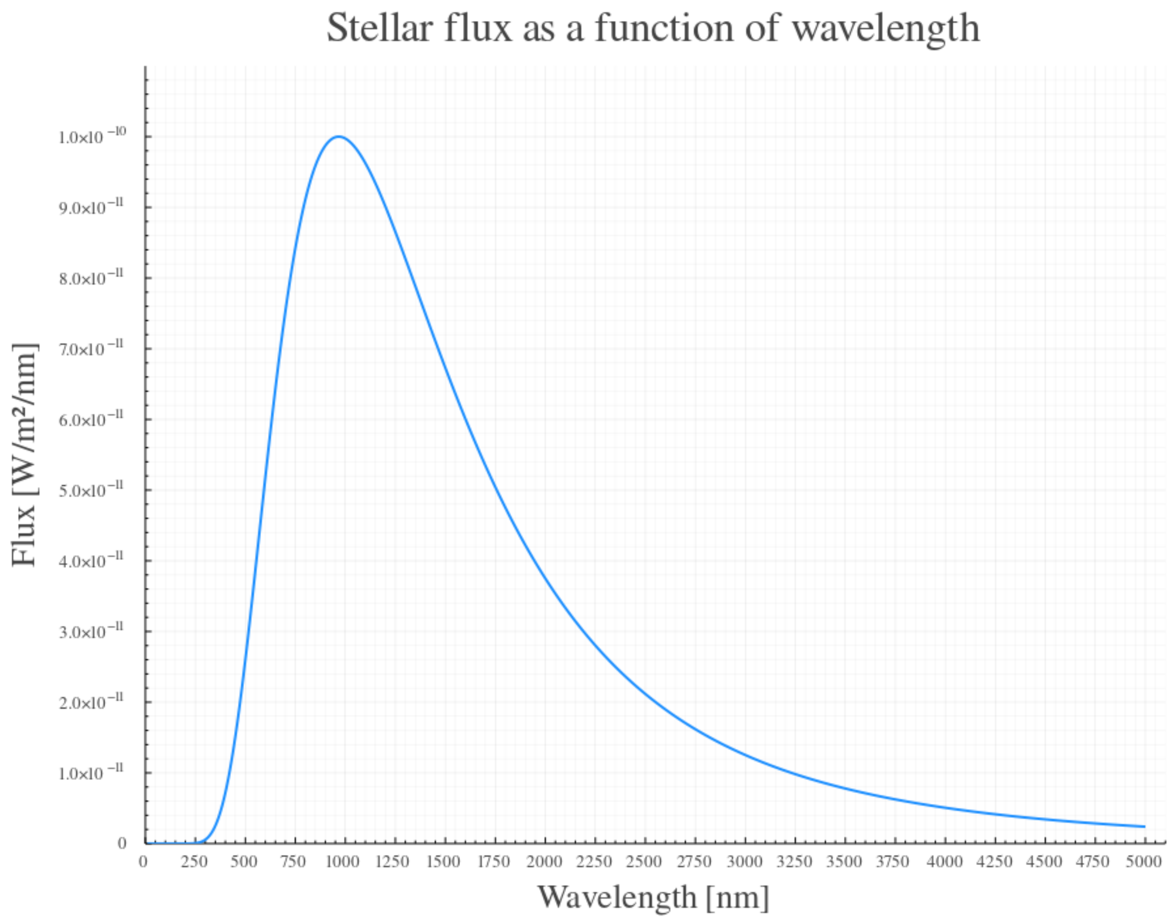
INTERPRETING PLOTS + MATH

Estimate the temperature of the mystery star at right. What kind of star is it?

Suppose it has a measured parallax angle of 0.01 arcseconds. How far away is it?

Using the answers to the first two parts, what is its intrinsic luminosity?

Using a typical mass for the kind of star you estimated in part 1, how long a lifetime should this star have? Does your answer make conceptual sense?



MORE QUANTITATIVE PRACTICE

You take spectra of a mystery object and find that the set of lines normally associated with your favorite element have been blue-shifted by 100 nanometers. You measure the shift from the center, and know the line usually has a rest wavelength of 10,000 nm.

a. Is the mystery object approaching or receding from you?

b. How fast?

c. Suppose you obtain a parallax measurement of the object of 0.004″. How far away is it?

d. Assuming the velocity remains roughly constant, how long will it take to collide with us?

$$\frac{v}{c} = \frac{(1+z)^2-1}{(1+z)^2+1} \approx z \text{ if z is small, with } z = \frac{\Delta\lambda}{\lambda}$$

MORE QUANTITATIVE PRACTICE

The plot at right is data from Hubble's original paper first demonstrating Hubble's law. What does it show?

Estimate Hubble's constant from the plot and calculate the age of the universe Hubble might have inferred. How does it compare to values today?