

ASTR 1040 RECITATION 10

MIDTERM 2 REVIEW

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KIRK LONG CU BOULDER

HOUSEKEEPING

- a) Midterm 2 next week!
 - a) Review session Sunday, 11/12 from 2-4 PM in E126
 - b) Study guide + extra quantitative practice will be posted soon
- b) PS8 deadline pushed to Sunday night, solutions will be posted Monday
- c) Fun planetarium day Wednesday, 11/29 from 12-1:30 pm
 - Can you make this?
 - May try to do this again with last day of class, time permitting

MID SEMESTER CULTURE RESET

- Thanks for taking feedback survey in class last week – some direct actions that we will implement as a result are:
 - Clear dates for important things for the rest of the semester
 - Last two homeworks will be much easier / shorter
 - Extra review session outside of recitation for midterm 2 + final exam
 - Extra study resources for exams
- We are all on the same team!
 - Sorry that our words / actions have made you feel differently
 - Would like to emphasize that you *all* are excellent students and we know you are working hard!
 - Bad tone set after first exam discussion (our fault) – let's reset and have a good rest of the semester
- Please come and talk to me anytime if you're feeling stressed / confused about anything in the class!
Can only provide support if you reach out for help.

PS8 QUESTIONS (~5-10 MIN)

- Look at the homework and ask any questions you have now before we get to exam review

MIDTERM 2 REVIEW: CONCEPTS

- What are three consequences that the universe is expanding in all directions? If the universe is infinite, why can we only see so far? What is the fundamental observational evidence we have that supports this? What is the Hubble constant and how do we measure it?
- Name a few methods we use to determine the distances to objects in astrophysics – at what scales does each operate at and why?
- What is relative in relativity (either special or general) and what isn't?
- How and why do stars die, and what determines what they become at the end of their lives? Think about the differences in life track across the HR diagram for small stars and massive stars.
- How has the universe changed over cosmic time, and why? What will the future of the universe hold?
- What determines the speed that objects orbit with, and what determines the scale at which an object's gravity dominates?

MIDTERM 2 REVIEW:

QUALITATIVE

- What is the difference between a white dwarf (type I) supernova and a massive star supernova? What is left behind in both cases? Why can we use type I supernovae as standard candles and, conversely, why can't we use type II?
- What is a black hole? What is the event horizon? How do we infer the presence of black holes from observations?
- What is degeneracy pressure, and how is it different from "normal" pressures? What quantum effect causes it? Bonus: why do neutron stars have radii ~ 1000 times smaller than white dwarves?
- Considering special relativity alone, explain the concepts of length contraction and time dilation and how they are related. In the twin paradox, which twin ends up younger and why?
- What causes gravitational time dilation and gravitational redshift, and how are the two connected?
- Would you rather fall into a supermassive or stellar mass black hole, and why?
- What is the equivalence principle?
- Why are galaxies more likely to collide than stars?

MIDTERM 2 REVIEW: QUANTITATIVE

- Given the Hubble constant is measured at roughly $H_0 \approx 70 \frac{\text{km}}{\text{s Mpc}}$, estimate the age of the universe. Explain (conceptually) how this works. Suppose we had evolved much earlier in the universe (say $1/4^{\text{th}}$ of the Universe's age today) – would our measurement of the Hubble constant change? If so, what would its value be?
- Calculate the density of a supermassive black hole ($10^7 M_{\odot}$) and a stellar mass black hole ($10 M_{\odot}$). Which is greater and why?
- Suppose a galaxy is observed with JWST to have a redshift of 10 ($z = 10$). Say galaxies usually have a feature at 1000 angstroms – what wavelength will those features appear at in this distant galaxy? What is the galaxy's recessional velocity (use full equation!)? Given Hubble's constant from above, what is the distance to the galaxy?
- The last place you can stably orbit a black hole is at 1.5 times the Schwarzschild radius. Assuming the orbit was Keplerian, what speed is associated with such an orbit? Answer in terms of the speed of light. Does the mass of the object matter?