

SPAC 201 TEST #2

Calculator allowed, closed Book, closed notes.

4/27/99 ; 75 minutes ; 1:00pm – 2:15pm

Be Concise: Long answers that are unclear will not get much credit. Label your variables, draw figures clearly, write clearly.

Don't Forget the Constants: If you need a constant look below, it might be there.

Do Not Panic: Give yourself a minute to think physically about the problem before you start to write. The exams will be graded on a curve.

Manage Your Time: Note that the problems do not all have equal weight.

Honor Pledge: You must include the honor pledge and your signature on the exam.

Useful Constants:

1 AU	=	1.495×10^8 km
	=	1.495×10^{11} m
1 pc	=	3.09×10^{13} km
1 yr	=	3.15×10^7 sec
1 radian	=	206265 arcseconds
R_{\odot}	=	6.96×10^5 km
M_{\odot}	=	1.99×10^{30} kg
R_{\oplus}	=	6.37×10^3 km
M_{\oplus}	=	5.98×10^{24} kg
R_{moon}	=	1.74×10^3 km
M_{moon}	=	7.35×10^{22} kg
L_{\odot}	=	3.83×10^{26} W
σ	=	5.67×10^{-8} W m ⁻² K ⁻⁴
G	=	6.67×10^{-11} m ³ kg ⁻¹ s ⁻²
h	=	6.626×10^{-34} J-s
c	=	3.00×10^5 km s ⁻¹
m_H	=	1.67×10^{-27} kg
Absolute Mag of \odot	=	4.75
$T_{eff}(\odot)$	=	5780 K

Part I: One-Line Answer (Answer 6 out of 7)

[6 pts; recommended time = 11 minutes]

1. Why does the 21 cm emission line of H map the overall density structure of our galaxy better than the distribution of visible stars on the sky?
2. Define the Schwarzschild radius.
3. What observation first showed astronomers that the Sun was not located near the center of our Galaxy?
4. Sketch the shape of an Sa, an Sc and an E0 galaxy.
5. The cosmic background radiation observed by the COBE satellite was emitted during what period of the universe?
6. Sketch the galaxy, and indicate where the Sun is located with respect to the center. Label the disk, halo, and bulge.
7. What two criteria must be satisfied by any scientific theory?

Part II: Short Answer (Answer 4 out of 5)

[20 pts; recommended time = 37 minutes]

1. Briefly describe Olber's paradox and its resolution. You do not need to include any quantitative calculations. Remember to be concise.

2. List four observational constraints that any modern theory of cosmology must explain.

3. Describe the significance of flat rotation curves for galaxies.

4. What evidence is there for massive black holes at the center of our galaxy and other galaxies?

5. Why are galactic collisions common, while collisions among stars within galaxies rare? Describe what happens to the dust, gas, and stars in the galaxies during and after a collision.

Part III: Derivation/Long Answer:

Answer 2 Of the following 3 questions

[14 pts; recommended time = 26 minutes]

1. Derive expressions for the Planck length and Planck time, the shortest lengths and sizes currently usable by our theories. [Hint: Equate the smallest size set by the uncertainty principle with the Schwarzschild radius of a black hole, and substitute the mass from one expression into the other.]

2. Suppose that one supernova goes off every 30 years in the Milky Way, and that the climate of the Earth would be seriously affected if one were to occur within 20 parsecs of the Sun. Estimate roughly how many times such an event has occurred within the lifetime of the Earth. Take the age of the Earth to be 4.5×10^9 years, and assume the galaxy is a disk with thickness 600 pc and radius 25 kpc.

3. Two items of great current interest in astronomy are the cosmological constant and inflation. Describe how each arose within the theory, and what observations these two concepts have been able to explain.