

國立中央大學 109 學年度碩士班考試入學試題

所別： 天文研究所 碩士班 不分組(一般生)

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科目： 物理與天文

本科考試禁用計算器

*請在答案卷(卡)內作答

Potentially useful constants and quantities

M_{\odot} : 2×10^{33} gm; L_{\odot} : 4×10^{33} ergs s^{-1} ; solar radius: 7×10^{10} cm;

Gravitational constant G : 6.7×10^{-8} cm³ g⁻¹ s⁻²; electron charge e : 4.8×10^{-10} esu;

au: 1.5×10^{13} cm; parsec: 3×10^{18} cm; speed of light c : 3×10^{10} cm s^{-1} ;

Planck constant h : 6.6×10^{-27} ergs s; k_B : 1.4×10^{-16} ergs K^{-1} ;

Mass of proton m_p : 1.7×10^{-24} g; mass of electron m_e : 9.1×10^{-28} g

1. (40%, 5 points each) Star A and star B are seen to separate by 0.1 arcsec in the sky.
 - (1) Observing at wavelength 500 nm, what is the minimum size (mirror aperture) of the telescope which will have a diffraction limit capable of resolving the two stars?
 - (2) For a ground-based telescope, describe one particular observational technique to achieve such an angular resolution.
 - (3) How can one determine if this is a true binary system, that is, the two stars being gravitationally bound to orbit each other, instead of just an optical projection of two stars which are not related physically?
 - (4) Star A has an apparent magnitude of $m_V = 12.0$ mag, and a measured annual parallax of 10.0 milliarcsec. What is its absolute magnitude?
 - (5) The spectrum of star A indicates it to be an early K-type main sequence star. Is the surface of star A hotter or cooler than that of the Sun? How can one distinguish a main sequence star from a giant star from its spectrum?
 - (6) After careful studies, it is realized that star A actually is a binary, consisting of two components with a brightness ratio of 9. What is the apparent magnitude of the fainter component in the binary system?
 - (7) A giant planet is found to move around star B in a circular orbit with a radius of 0.1 au, and an orbital period of 36 days. Estimate the approximate mass of star B in terms of solar masses. What does it mean by a "giant" planet?
 - (8) Describe one observing technique that possibly led to the discovery of the exoplanet in star B. Will the technique be able to find an additional planet?

參考用

注意:背面有試題

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2. (40%, 10 points each) Our Sun moves about the galactic center in a nearly circular orbit. In each of the computational answer below, formulate your answer, explain each parameter, and state whatever assumption you need to make. In each case a final numerical is required but it does not need to be exact. A rough estimation is sufficient.
- (1) The orbit has a semimajor axis of 8000 pc. How could this be known?
 - (2) The Sun moves at an orbital speed of about 220 km/s. How could this be measured? What is the orbital period?
 - (3) Compute the mass of all the matter of the galaxy inside the Sun's orbit in the unit of solar masses.
 - (4) Even though the stellar density decreases toward the outer parts, ending roughly at 10,000 pc, individual stars and gas clouds out to at least 16,000 pc still move at an orbital speed equal to or even faster than 220 km/s. The motion of a star could be measured by the Doppler effect on the spectral lines of the star. (a) The motion of a gas cloud, on the other hand, could be measured, e.g., by its 21-cm line radiation. What is the mechanism of this radiation?
(b) Explain how the observed "flat rotation curve" suggests the existence of dark matter.
3. (20%, 10 points each) It is estimated that the universe has a finite age, about 13.7 billion years, and is currently expanding. In recent years, there is indication that the expansion is accelerating, though the cause is still unknown.
- (1) Present 3 lines of evidence that the universe has a finite age.
 - (2) How is the age of the universe estimated?

參考用

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