

Exam astroparticle physics

1.
 - a. On which theory and principle is the Standard Model of cosmology based?
 - b. Give the different sources of energy density ρ_i in the Universe.
 - c. How large are the corresponding observed closure parameters Ω_i ?
 - d. What is the observational evidence for the existence of dark matter?
 - e. Name one experimental effort devoted to the search for dark matter.

2.
 - a. At which time and temperature did radiation and matter decouple and why?
 - b. Explain the origin of the acoustic peaks in the cosmic microwave background.
 - c. What can we learn from these peaks?
 - d. When and why did neutrinos decouple?
 - e. Why is the present temperature of the neutrinos *lower* than that of the photons?

3.
 - a. At which time and temperature did primordial nucleosynthesis take place?
 - b. Which elements were synthesized? Why only these?
 - c. Which primordial nucleus is the most sensitive probe for the baryon density of the Universe?
 - d. How does one determine the relative abundance of this nucleus?

4.
 - a. Which nuclear fusion cycle(s) is (are) presently running in the Sun?
 - b. What is the relation between the temperature and the energy production rate?
 - c. What is the Gamow peak?
 - d. What will happen to the Sun after it has run out of hydrogen?
 - e. What happens to neutrinos on their way from the core of the Sun to the Earth?

5.
 - a. What is the GZK cutoff for ultrahigh-energy cosmic rays?
 - b. Which experimental methods are used to measure such cosmic rays?
 - c. Why is the isotopic abundance for lithium, beryllium, and boron isotopes in the cosmic-ray spectrum higher as compared to that in the solar system?
 - d. How can one reduce the background from atmospheric neutrinos in neutrino telescopes?

6.
 - a. What are “standard candles” in astronomy?
 - b. Name two different standard candles.
 - c. Describe for each one of them one major experimental breakthrough.

7.
 - a. Give the Sakharov criteria for baryogenesis.
 - b. Name two different experiments tailored to the detection of anti-matter.