

SEMESTER 2 (SUMMER) EXAMINATIONS 1998-99

Experimental Physics – Paper 2

EP323: Nuclear and Astrophysics

Dr. J.M. Woolsey
Dr. M. Lang
Prof. R.M. Redfern

Answer THREE questions

Time allowed: TWO hours

- Q.1 Tabulate the properties of the *up*, *down* and *strange* quarks.
Explain how the quarks combine to produce mesons and baryons.
Define what is meant by the isospin quantum number I_3 .
List the properties of the spin 0 mesons which can be produced from the *up*, *down* and *strange* quarks, and illustrate their positions on the *strangeness*/ I_3 plane.
- Q.2 A cyclotron of radius 0.25m accelerates protons using a 10 MHz voltage supply. Using non-relativistic expressions, calculate the magnetic field required and the maximum energy of the protons.

Derive an expression for the centre of mass energy in a system where accelerated particles strike a fixed target
- Q.3 Answer parts (a) and (b)
- (a) Discuss Cherenkov radiation and derive an expression for the threshold energy for Cherenkov emission. Calculate the threshold energy for a muon in water.
(Refractive index of water = 1.33, Mass of muon = 106 MeV)
- (b) Explain what is meant by conservation of parity (P). Describe the classic experiment which demonstrated that parity is not always conserved. Briefly explain what is meant by CP conjugation.

Q.4 Answer *two* parts only of this question.

- (a) Derive the expression for *Olber's Paradox*, which leads to the conclusion that the night sky should be as bright as the surface of the sun. Discuss possible solutions to this paradox. What would be the modern solution?
- (b) Discuss the cosmological distance ladder.
- (c) Discuss the processes of energy generation in main sequence stars.
- (d) Discuss the *Solar Neutrino Problem*, and possible solutions to it.

Q.5 Derive the dependence of orbital speed on orbital distance for matter in a spiral galaxy (i.e., its rotation curve). Assume that the matter is distributed in a spherically symmetric fashion.

Is this what is observed?

How can this be explained, and what implication does this have for our understanding of the Universe?