Queen Mary
University of London

BSc/MSci EXAMINATION

PHY-312 Explaining the Universe

Time Allowed: 2 hours 15 minutes

Date: 03 May 2005

Time: 14:30

Answer ONE question from Section A and TWO questions from Section B. Each question in Section A carries 25 marks. The questions in Section B each carry 12.5 marks. The coursework carries 50 marks.

Calculators are not permitted in this examination

DO NOT TURN TO THE FIRST PAGE OF THE QUESTION PAPER UNTIL INSTRUCTED TO DO SO BY THE INVIGILATOR

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SECTION A

Answer ONE question from this Section

QUESTION 1

The following paragraph is a quotation from a recent issue of *Physics World:*

As most members of the physics community are surely aware, this year will mark the 100th anniversary of Einstein's annus mirabilis. In 1905 the unknown patent clerk from the Swiss capital Bern published a series of groundbreaking papers on Brownian motion (which convinced the doubters that atoms really did exist), special relativity and the photoelectric effect. Few individual physicists will read, let alone write, papers on such a diverse range of subjects this year. To mark the centenary, the United Nations has declared 2005 "International Year of Physics".

Write an essay (1200 – 1500 words) on the lasting significance of Einstein's 1905 publications. You should have in mind a reader who is not a scientist.

QUESTION 2

Most biographers of Albert Einstein quote his famous saying *"Raffiniert ist der Herrgott, aber boshaft ist er nicht"* [which may be translated as: "Subtle is the Lord, but malicious is He not"]. Write an essay (1200 – 1500 words) in which you elaborate on this saying, and give your own reasons for agreeing or disagreeing with what it expresses. You may use your essay to express your own beliefs, but should back them up with persuasive arguments, and not with simple assertions or an appeal to dogma.

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SECTION TWO

Answer TWO questions from this Section

QUESTION 3

In the last decade Nobel Prizes in Physics have been awarded to:

- David J. Gross, H. Dvaid Politzer and Frank Wilczek "for the discovery of asymptotic freedom in the theory of the strong interaction" (2004)
- Alexei A. Abrikosov, Vitaly L. Ginzburg and Anthony J. Leggett "for pioneering contributions to the theory of superconductors and superfluids" (2003)
- Raymond Davis Jr. and Masatoshi Koshiba, and Riccardo Giacconi "for pioneering contributions to astrophysics, in particular for the detection of cosmic neutrinos" and "for pioneering contributions to astrophysics, which have led to the discovery of cosmic X-ray sources" respectively (2002)
- Eric A. Cornell, Wolfgang Ketterle and Carl E. Wieman "for the achievement of Bose-Einstein condensation in dilute gases of alkali atoms, and for early fundamental studies of the properties of the condensates" (2001)
- Zhores I. Alferov, Herbert Kroemer and Jack S. Kilby respectively " for basic work on information and communication technology" "for developing semiconductor heterostructures used in high-speed- and opto-electronics" and "for his part in the invention of the integrated circuit" (2000)
- Gerardus 't Hooft and Martinus J.G. Veltman "for elucidating the quantum structure of electroweak interactions in physics" (1999)
- Robert B. Laughlin, Horst L. Størmer and Daniel C. Tsui "for their discovery of a new form of quantum fluid with fractionally charged excitations" (1998)
- Steven Chu, Claude Cohen-Tannoudji and William D. Phillips "for development of methods to cool and trap atoms with laser light" (1997)
- David M. Lee, Douglas D. Osheroff and Robert C. Richardson "for their discovery of superfluidity in helium-3" (1996)
- Martin L. Perl and Frederick Reines "for pioneering experimental contributions to lepton physics", specifically "for the discovery of the tau lepton" and "for the detection of the neutrino" respectively (1995)

Write an essay (500 - 600 words) on what you regard as the significance of any ONE of these discoveries in "explaining the universe".

QUESTION 4

Your friend, a History student, asks you to explain what is meant by "Schrödinger's cat paradox",

Try to do so in 500 to 600 words.

QUESTION 5

Write an essay (500 to 600 words) in which you describe what you regard to be some of the outstanding unanswered problems for physics. You should also give some indication of whether you expect that they may be solved in the next decade.

End of Examination Paper **Professor John M Charap**