

Homework # 7; due Thursday, October 21

Reading: Chapters 6 and 7 of Griffiths, Internet

25. *Ultracold neutrons (UCN)* have kinetic energies on the order of 10^{-7} eV.
- What is the order of magnitude of the temperature of UCN (in K)?
 - What is the order of magnitude of the DeBroglie wavelength of a UCN? How does it compare with interatomic distances in condensed matter?
 - Compare the kinetic energy of a UCN with the magnetic energy of the neutron inside a magnetized medium (in fully magnetized medium, magnetic induction is typically on the order of $B = 1 \text{ T} = 10^4 \text{ G}$). Comment on how one can use this to make polarizers for UCN beams.
 - Calculate the change in the potential energy of a neutron when it moves vertically by 1 m in the Earth gravitational field. Compare this value with the kinetic energy of UCN. Comment on the role of gravity in UCN experiments.
26. Using the explicit form of the Dirac matrices, show that the anti-commutator of two such matrices γ^μ and γ^ν is a unit 4×4 matrix times $2g^{\mu\nu}$, where $g^{\mu\nu}$ is the *Minkowski metric*. See the Section 7.1 in Griffiths.
27. You receive a call from a Swiss lawyer with a desperate plea for urgent expert help. (She has heard of you as an outstanding physicist presently studying elementary-particle physics, and, since the professors she had tried to contact never responded, you are her only hope.) CERN is (once again) being sued by anti-nuclear activists on the basis of the fact that the collision energy accessible to LHC is higher than has ever been possible with previous colliders. Thus, new particles can, in principle, be produced. The lawsuit is based on theories that a *black hole* may be produced, which will trigger catastrophic end of the Earth. You are asked to comment on whether such outcome is plausible, but there is only time for a quick assessment of facts. (Say, 15 minutes on internet.) Please draft a brief (but responsible) reply.