Winter Quarter 2013 – UCSB Physics 24 Midterm

- **Problem 1 (25 points)**

  Two thin infinitely long concentric cylinders of radii a and $2a$ carry uniformly distributed currents in the opposite direction. The currents are flowing parallel to the axis of the cylinders. The magnitude of the current in the inner cylinder of radius a is I. The magnitude of the current in the outer cylinder of radius $2a$ is $2I$.

  Find the magnitude of the magnetic field at a distance r from the axis of symmetry for the three cases (use Gaussian-cgs units)

  (a) $r < a$

  (b) $a < r < 2a$

  (c) $r > 2a$

  Show clearly in a sketch the direction of the currents (you can pick the current directions as you wish, as long as they are opposite in the two cylinders) and the directions of the magnetic fields in (a), (b), and (c).

- **Problem 2 (25 points)**

  A pion (rest mass m_π) decays at rest into an electron (rest mass m_e) and a neutrino (rest mass $m_\nu = 0$). What is the magnitude of the 3-momentum of the electron? Of the neutrino? (You can do this problem using $c = 1$ if you wish).

- **Problem 3 (25 points)**

  Two rings of radius r, with a common center and the same current I are placed at right angles to each other as shown in Figure 1. What is the magnitude and direction of the magnetic field at their center (point P in Figure 1). Use Gaussian-cgs units.

- **Problem 4 (25 points)**

  Spaceships A and B are approaching the earth as shown in Figure 2 at speeds of $0.9c$ as measured by an observer on the earth. What is the speed of spacechip B as measured by the pilot of spaceship A. (Reminder: *speed* is the magnitude of velocity).
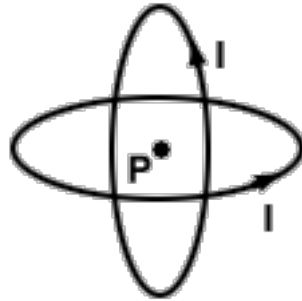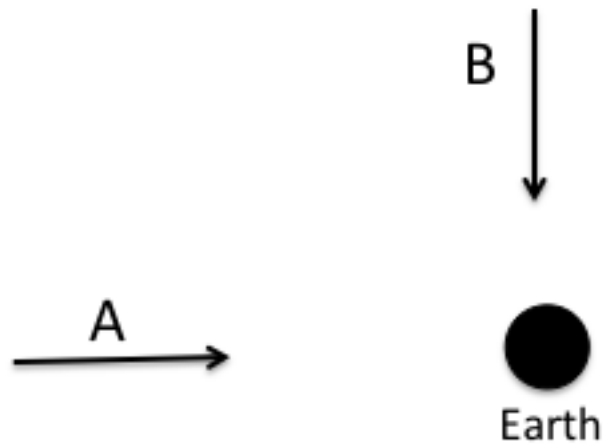
Figure 1: Problem 3

Figure 2: Problem 4