Universität Leipzig, Fakultät für Physik und Geowissenschaften

Exercises for Experimental Physics 1 – IPSP

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Exercise Sheet 8 (WS 2011/12)

Date of Issue: Nov. 25^{th} 2011

Date of Submission: Dec. 2^{nd} 2011

Submission Place: Marked mailbox next to room 302 (Linnestr. 5)
Submission Time: 11:00 a.m. at the submission day noted above

Please note: Write your name and matriculation number on EACH sheet of paper.
Only submit the calculations and results for exercise 1-3, exercise 4 will be discussed during the instruction classes.

Exercises:

1. A spaceship travels past Earth moving at $0.70c$ relative to Earth. 5.0 minutes after the spaceship passes closest to Earth, a message is sent from Houston, Texas, to the craft. (Neglect all effects of the rotational motion of Earth.) (a) How long does it take for the signal to arrive? (b) The spaceship and the control center agree on the time when the ship passes closest to Earth. Five minutes after the message is received aboard the ship, a return message is sent by the ship back to Houston. What is the time interval in Houston between the time their message was sent, and the time the return message is received? (7 Points)

2. A gold nucleus has a radius of $3.00 \cdot 10^{-14}$ m, and a mass of 197 amu. (1 amu has a rest energy of 932 MeV.) During experiments at Brookhaven National Laboratory, these nuclei are routinely accelerated to a kinetic energy of $3.35 \cdot 10^{4}$ GeV. (a) How much less than the speed of light are they traveling? (b) At these energies, how long does it take them to travel 100 m in the laboratory frame? (7 Points)

3. In frame S, event B occurs 2.0 μs after event A, and event A occurs at the origin whereas event B occurs on the x axis at $x = 1.5$ km. How fast and in what direction must an observer be traveling along the x axis so that events A and B occur simultaneously? Is it possible for event B to precede event A for some observer? (6 Points)

4. A particle of mass 1.0 MeV/c^2 and kinetic energy 2.0 MeV collides with a stationary particle of mass 2.0 MeV/c^2. After the collision, the particles stick together. Find (a) the speed of the first particle before the collision, (b) the total energy of the first particle before the collision, (c) the initial total momentum of the system, (d) the total kinetic energy after the collision, and (e) the mass of the system after the collision.