Universität Leipzig, Fakultät für Physik und Geowissenschaften

Exercises for Experimental Physics 1 – IPSP

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Exercise Sheet 7 (WS 2013/14)

Date of Issue: Nov. 29th 2013

Date of Submission: Dec. 6th 2013

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 seminar.

Exercises:

1. Relativity 1: Supersonic jets achieve maximum speeds of about $3.00 \cdot 10^{-6}$ c. (a) By what percentage would a jet traveling at this speed contract in length? (b) During a time of exactly one year or $3.15 \cdot 10^7$ s on your clock, how much time would elapse on the pilot's clock? How much time is lost by the pilot's clock in one year of your time? Assume you are on the ground and the pilot is flying at the specified speed for the entire year. (7 Points)

2. Relativity 2: The rest energy of a proton is about 938 MeV. If its kinetic energy is also 938 MeV, find (a) its momentum and (b) its speed. (6 Points)

3. The boron isotope ^{9}B is unstable and disintegrates into a proton and two α particles. The total energy released as kinetic energy of the decay products is $4.4 \cdot 10^{-14}$ J. After one such event, with the ^{9}B nucleus at rest prior to decay, the velocity of the proton is measured as $6.0 \cdot 10^6$ m/s. If the two α particles have equal energies, find the magnitude and the direction of their velocities with respect to the direction of the proton. (7 Points)

4. In the center-of-mass reference frame a particle with mass m_1 and momentum p_1 makes an elastic head-on collision with a second particle of mass m_2 and momentum $p_2 = -p_1$. After the collision its momentum is p_1'. Write the total kinetic energy in terms of m_1, m_2, and p_1 and the total final energy in terms of m_1, m_2, and p_1', and show that $p_1' = \pm p_1$. If $p_1' = -p_1$, the particle is merely turned around by the collision and leaves with the speed it had initially. What is the situation for the $p_1' = +p_1$ solution?