GENERAL RELATIVITY WISE 2017/2018
Technische Universität München
October 17, 2017

Exercise Sheet 1

1. Derive the rule for the relativistic addition of velocities by using boosts and the group structure of the Lorentz group.

2. Consider a relativistic harmonic oscillator, described by the following lagrangian:

$$L = -mc^2\sqrt{1 - \beta^2} - \frac{1}{2}kx^2 \tag{1}$$

   and study the case of a particle with energy E under this conditions. Find the corrections to its period for the situation in which the potential energy is small compared to mc^2.

3. Prove that an observer with constant acceleration a follows a wordline described by a hyperbola.

4. Special relativity might be counter-intuitive. Consider a situation in which you are at rest relative to a straight corridor with a door at each end. A *very fast* burglar wants to steal your long sofa (which is longer than the corridor in its rest frame.) however he doesn't know about special relativity effects, therefore he attempts to take it (assuming he can carry the sofa by himself) and speed out through the corridor at an arbitrarily high speed (but not c). Are you able to trap the burglar in the corridor? Does this pose a paradox when you consider the events in the burglar's frame?