GENERAL RELATIVITY WS 2017/2018
Technische Universität München
October 30, 2017

Exercise Sheet 3[*]

The solutions to the following problem set should be handed in by the 6th of November at 8:30 a.m. at the postbox next to PH 3218.

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1. **(3 pts.)** a) Starting from the Lagrangian for a free relativistic particle,

$$L = -mc^2\sqrt{1-\beta^2}, \qquad (1)$$

   write the L in a covariant manner and deduce that there must be no external forces acting on it i.e. $dp^\mu/dt = 0$. Couple the particle in a to an electromagnetic field, i.e. to a four-potential $[A^\mu] = (\phi(x^\mu), \vec{A}(x^\mu))$, by adding

$$L_A = qu^\mu A_\mu \qquad (2)$$

   and show that the equation of motion in a) now becomes the usual Lorentz force.

2. **(2 pts.)** Manifolds: a) Show that the circle S^1 cannot be covered with only one chart however, b) show that the cylinder $\mathbb{R} \times S^1$ can be covered with one chart, in other words it is diffeomorphic to an open set of $\mathbb{R}^2$.