GENERAL RELATIVITY WS 2017/2018
Technische Universität München
October 16, 2017

Homework Sheet 1[*]

The solutions to the following problem set should be handed in by the 23rd of October at 8:30 a.m. at the postbox next to PH 3218.

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1. **(2 pts.)** Consider the situation of a wave pulse emitter moving with velocity v away from a stationary observer. For the case of v being close to the speed of light, derive the relativistic formula for the Doppler effect. Check that in the case of the waves emitted being light the formula you get is:

$$\frac{\nu_{ob}}{\nu_0} = \sqrt{\frac{1-\beta}{1+\beta}} \tag{1}$$

   where $\beta = v/c$. What is the speed required for frequencies to have a ratio of $1/2$.

2. **(2 pts.)** Imagine a rocket which is able to travel by expelling fuel at a relativistic speed u. Find the classical rocket equation (that relates M the mass of the rocket at a given speed with its speed and the fuels' speed) as well as its relativistic version.

3. **(1 pts.)** The electromagnetic strength tensor is defined as $F_{\mu\nu} = \partial_\mu A_\nu - \partial_\nu A_\mu$, where A_μ is the vector potential. By transforming into a boosted frame in the x direction. Find the way in which the electric and magnetic field components $\vec{E}$ and $\vec{B}$ transform.

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[*]Given the short notice, this problem sheet has a total number of points equal to half the normal sheets (5 pts.). The score for the rest of the sheets will be 10 pts.