Homework problems set 1, FYTN08, vt19

We will have 5 sets of homework-problems with 4 or 5 exercises each week. Of those one, chosen randomly, will be corrected. You can get one point for each homework set, thus allowing a total of 5 points by the end of the term. The written exam is on forty points of which you need 23 to be allowed to do the oral exam, if you obtain the full 5 points on the homework sets you only need 18 points to be able to pass the written exam. Essentially, you will pass the course if you pass the written exam and have done the presentation but I reserve the right to still fail if the oral exam is too bad.

The exercises for this week (due Friday 5 April, 10.15) are:

1 Exercise 1.2 page 28

2 Exercise 1.17 page 30-31, related problems are brainteasers below

3 Exercise 2.13 page 52 and 2.15 page 52

4 Exercise 3.34 page 83. Note: these funny coordinates are called light-cone coordinates and will show up again when we talk about black holes.

5 Exercise 3.30 page 81-82. This exercise is not required but I recommend you make sure you can solve it, it helps very much in understanding precisely what the notation means.

Collaboration and discussion on the homework sets are **strongly** recommended, straightforward copying obviously not.

App. A in the book gives a short review in case you have forgotten about linear algebra.

Solutions: In App. B of the first edition you will find hints and solutions to many of the exercises including several which will appear on the homework sets. You can also find solutions on the web (I know of at least two places with solutions to some of the exercises). If you use any of those, I can check if you simply copy their sometimes wrong solution but I do not consider that worth my time, copiers tend to fail the oral exam rather badly anyway. But if you use the hints in the first edition and/or solutions on the web do it intelligently, i.e. use them to check your own solutions.

A general comment: I recommend starting on the homework immediately. That way you have the option of asking me questions about it. This is especially relevant for some of the later exercises where missing the first steps can turn a problem from doable into something very hard or even impossible.

Brainteaser 1

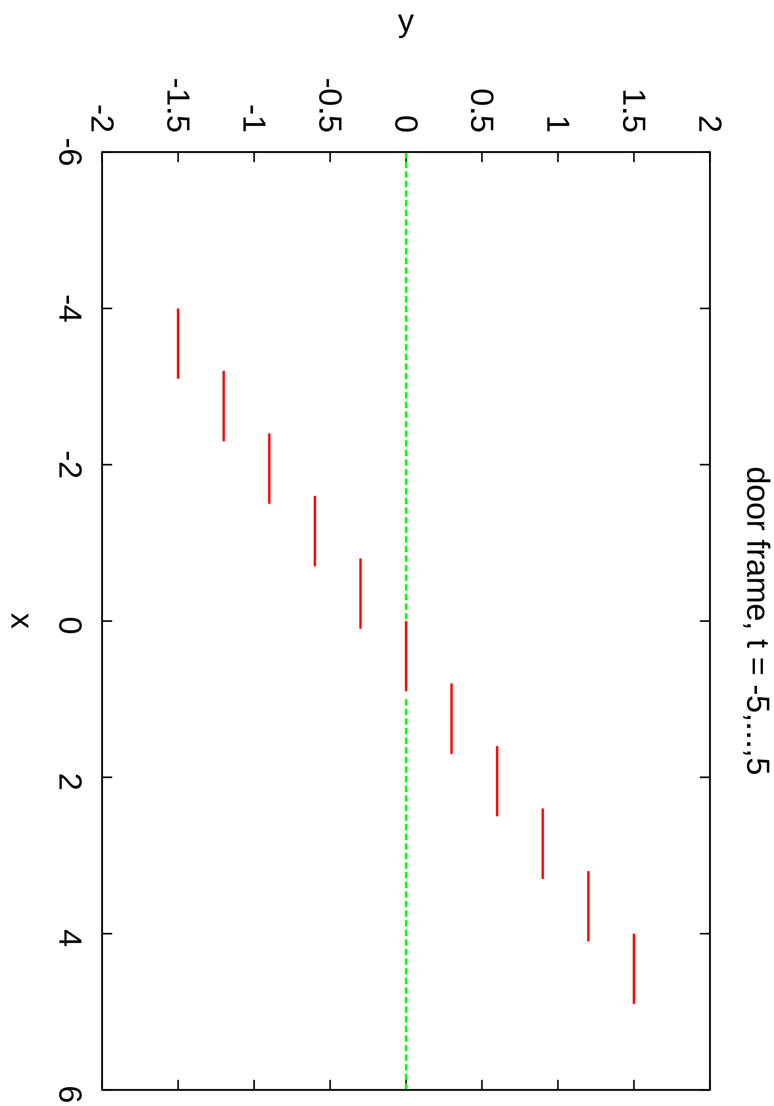
A socalled brainteaser is very useful in helping to think about the various coordinate systems and (especially) the (usually not stated) underlying (physical) assumptions is:

Two giant frogs are captured, imprisoned in a large metal cylinder, and placed on an airplane. While in flight, the storage doors accidentally open and the cylinder containing the frogs falls out. Sensing something amiss, the frogs decide to break out. Centering themselves in the cylinder, they push off from each other and slam simultaneously in the end of the cylinder. They instantly push off from the ends and shoot across the cylinder past each other into the opposite ends. This continues until the cylinder hits the ground and stops. Consider how this looks from some other inertial frame, falling at another speed. In this frame the frogs do not hit the ends of the cylinder simultaneously, so the cylinder jerks back and forth about it with mean speed β. The cylinder however was at rest in one inertial frame. Does this mean that one inertial frame can jerk back and forth with respect to another?

Brainteaser 2

A less destructive variant of problem 2 above is the following:

A runner runs in the xy plane with a velocity $v^x = 0.8$ and $v^y = 0.3$ passing through the origin at $t = 0$. The runner holds a stick in the x direction that is 0.9 m long in the observers frame. The x axis is really a wall with a door 1 m wide between $x = 0$ and $x = 1$ m. This is shown below in the observer frame, i.e. door at rest.



The dashed line indicates the wall and the short lines are the positions of the stick the runner holds at different times. You need the full Lorentztransformation here to change the different coordinate systems but in the runner's frame the door is 0.6 m wide and his stick is 1.652 m. How does it look for the runner that his stick gets through the door? (Hint: calculate the position of the door and the stick in the runner's frame using the Lorentztransformation and visualize what happens)