

Exercises on General Relativity TVI TMP-TC1

Problem set 9

Exercise 1 – Gravitational Redshift

Consider two spaceships travelling behind each other along the z direction both with constant acceleration a . They are far away from any gravitational fields and are moving non-relativistically. The distance between them is d . Compute the redshift $\Delta\lambda/\lambda_0$ of a photon emitted by the spaceship in the back and observed in the spaceship in front, where λ_0 is the wavelength of the photon at the time of emission.

Argue that the Equivalence Principle can then be used to immediately imply the existence of gravitational redshift. Think of an example of a system which would lead to such a gravitational redshift.

Exercise 2 – Constant acceleration equals uniform gravitational fields

Imagine an observer sitting at $x = 0$ in the center between two mirrors located at $x = \pm D$. The observer emits light to the mirrors and detects the reflected light from the different mirrors after the same time. Calculate the time delay of the light beams when the whole experiment accelerates in the x direction. Show that this time delay agrees with the one in a system at rest, but in an appropriate uniform gravitational field in the x direction.

Exercise 3 – Charge carrier on a table

Consider a charge carrier placed on a table in a flat spacetime. What are the conditions on the charge such that it radiates electromagnetic waves? What changes when you place this setup in a curved spacetime and let it fall freely? Imagine a power unit which prevents the table to fall and reconsider the situation.

General information

The lecture takes place on Monday at 10:00-12:00 and on Wednesday at 10:00-12:00 in A348.

Presentation of solutions:

Thursday at 08:00 - 10:00 in A 348

There are two tutorials:

Monday at 12:00 - 14:00 in A 249

Friday at 14:00 - 16:00 in A 348

The webpage for the lecture and exercises can be found at

www.physik.uni-muenchen.de/lehre/vorlesungen/wise_19_20/tvi_tc1_gr/index.html