University of Cologne
Institute for Theoretical Physics
Prof. Dr. Claus Kiefer
Manuel Krämer

10th October 2012

www.thp.uni-koeln.de/gravitation/courses/rci12.html

1st exercise sheet on Relativity and Cosmology I

Winter term 2012/13

Deadline for delivery: Wednesday, 17th October 2012 at the end of the lecture.

Exercise 1 (6 credit points): *Newtonian Gravity I: Radial motion of a mass point*

Consider a mass m in the gravitational field of a mass $M \gg m$. At some initial time $t = 0$, m is located at a distance $r(0) = R$ and has an initial velocity $\dot{r}(0) = v_0 > 0$ (one-dimensional motion).

When is the solution $r(t)$ unbounded?
Give an explicit solution for $r(t)$ for the lowest initial velocity that allows for an unbounded solution.

Exercise 2 (4 credit points): *Newtonian Gravity II*

Give a brief review ($\lesssim 2$ pages) of the Kepler problem in classical mechanics.

Exercise 3 (10 credit points): *Newtonian Gravity III: Potential of a homogeneous spherical shell*

Consider a spherical shell of a mass M with constant density ρ. Denote the inner radius with R_1 and the outer radius with R_2.

Calculate the Newtonian potential at a distance r from the origin. Distinguish between the cases $r < R_1$, $R_1 < r < R_2$, and $r > R_2$.