

Lecture spring 2017:

General Relativity

Problem sheet 9

↪ These problems are scheduled for discussion on **Thursday, 30 March 2017**.

Problem 30

In the lecture on Friday, we will introduce Eddington-Finkelstein coordinates

$$v \equiv t + r^*,$$

$$u \equiv t - r^*,$$

where $r^* = r + R_s \log(r/R_s - 1)$. Here, $R_s = 2GM$ is the Schwarzschild radius, and r , t are the radial and time coordinates of the Schwarzschild metric. Show explicitly that ingoing radial null geodesics are characterized by $v = \text{const.}$, while outgoing radial null geodesics are given by $u = \text{const.}$ Determine (again) the form of radial light cones for the different coordinate choices – i.e. (t, r) vs. (v, r) vs. (u, r) – and discuss qualitatively the interpretation of the behaviour of the light cones around $r = R_s$.

Problem 31

Do the very instructive exercise 5.5 in the book by Carroll, i.e. study how an object falling into a black hole appears to a distant observer!

Problem 32

Solve problem 5.3 in the book, i.e. calculate the maximal time it takes you to reach the singularity once you have passed the event horizon of a Schwarzschild black hole.