

## PHYSICS 161

Instructor: Dr. A. M. Wolfe (phone: 47435)

Text: General Relativity: J. Hartle

Homework no. 5

Due: Tues., March 12

**1**

Consider the lightcone structure surrounding a black hole.

(a) Write down the differential equation for a radial moving photon in the Schwarzschild metric in the original Schwarzschild coordinates.

(b) Integrate that equation for outgoing (increasing  $r$ ) and ingoing (decreasing  $r$ ) photons starting at  $t=0$  and radii  $r/r_s=3,6,8,20$ , where  $r_s=2GM/c^2$ . Plot your results in a clear diagram

(c) Now consider the region  $r < r_s$ . In this case you can either plot your results or describe them qualitatively.

**2**

Can an observer who falls into a spherical black hole receive information about events taking place outside? Is there any region of spacetime outside the black hole which an interior observer cannot eventually see before crashing into the singularity? Illustrate your answer with a clearly drawn diagram in Szekeres-Kruskal coordinates.

**3**

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**4**

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Hint: Make use of the expression and sign for the Lagrangian for time-like geodesics in Kruskal-Szekeres coordinates.

**5**

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