Ph 161 Black Holes

Homework Assignment 6

Due Tuesday, March 14, 2006

This should be your own work; do not copy problem solutions.

(1.) Write down the Kruskal-Szekeres metric in terms of the coordinates (U, V, θ, φ) discussed in class and in Chapter 12 of Hartle's book. How are these coordinates related to the Schwarzschild coordinates (t, r, θ, φ)?

(a.) Draw the Kruskal spacetime diagram (U-V plane) and place on it curves corresponding to Schwarzschild radial coordinate $r = 0$, $2M$, and $4M$. Justify your result.

(b.) On this Kruskal spacetime diagram place curves corresponding to Schwarzschild timelike coordinate $t = 0$, $-\infty$, $+\infty$, $-M$, and $+M$. Justify your result.

(c.) By drawing the world line of a physical observer falling through $r = 2M$ who sends out periodic light beams, argue why the surface $r = 2M$ acts like a causal horizon. (Light lines in the Kruskal diagram are 45 degree straight lines - why?)

Hint: all of these tasks were done explicitly in class (see your notes and course web pages): I want you to work through it again by yourself.