Physics 725: Special and General Relativity

Thornton 335, San Francisco State University (c) 2011 Andisheh Mahdavi Fall 2011, MWF 3:10PM

Homework 7 Due 11/16

While I may have consulted with other students in the class regarding this homework, the solutions presented here are my own work. I understand that to get full credit, I have to show all the steps necessary to arrive at the answer, and unless it is obvious, explain my reasoning using diagrams and/or complete sentences.

Name **Signature:**

1. You are falling radially into the center of the 4-million solar mass black hole at the Galactic center. You start from rest at infinity with no angular momentum (pure radial infall). As you fall in, you keep your eye on a distant star whose rest-frame peak color is green ($\lambda = 520$nm). Assume Schwarzschild geometry.

   (a) What is the amount of proper time it will take you to fall from an arbitrary coordinate radius r to the singularity? How much time do you have left to live when you cross $r = 2M$? (This question is easy).

   (b) Calculate the amount of Eddington-Finkelstein "time" v it will take for you to fall from an arbitrary coordinate radius r to the singularity.

   (c) Solve for the peak wavelength of the star as a function of r for your entire journey to the singularity. What color do you see the star as when you cross the event horizon? You will need to use Eddington-Finkelstein coordinates to do this.

   (d) What would you observe as the peak wavelength of the star if you could turn on a powerful rocket and hover just above the event horizon?

2. Hartle 12.14

3. Find the ordinary basis vectors $\mathbf{e}_\alpha$ and the dual basis vectors $\mathbf{e}^\alpha$ for the Schwarzschild metric in Eddington-Finkelstein coordinates.

4. Hartle 20.3

5. Hartle 20.11

6. Hartle 20.17