

THIRD ASSIGNMENT, ASTR 8700 DUE: 24 February 2010
RELATIVISTIC ASTROPHYSICS AND COSMOLOGY

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The point value for each question is given in brackets. You may collaborate on Question 1, but not on the others.

0. Read HEL Chapters 6, 7, 8 and 19. Do not worry about following every detail, particularly on the topics not discussed in class, but the explanations of many topics in these chapters are very nice indeed and should help you to understand this difficult material.

1. Find all the Killing vectors X^i of the three dimensional Euclidean line-element [20]:

$$ds^2 = dx^2 + dy^2 + dz^2.$$

2. Show that the conservation equations for a perfect fluid in Minkowski space-time ($T^{ik}_{;k} = 0$) lead to the equation of continuity and the equations of motion of a perfect fluid. [15]

3. Problem 6.4 in HEL. Or, equivalently, but in the notation we used in class, show explicitly how the Maxwell's equations in Minkowski space we know and love can be obtained from [25]

$$F^{ik}_{;i} = 4\pi j^k \quad \text{and} \quad F_{[ik;l]} = 0.$$

4. Problem 8.3 in HEL, which provides another motivation for the Lagrangean used in class. [20]

5. Describe in words the differences between the Riemann, Ricci, Einstein and Energy-Momentum tensors. You will want to say what each means physically and you will also want to describe their fundamental mathematical natures. [20]

Doing these questions should help you prepare for the Midterm Examination, which will be on March 1st. That will be a closed-book, closed-notes, exam for which you will have 110 minutes.