ASTRONOMY 320: RELATIVISTIC ASTROPHYSICS

Winter Quarter 1999

Homework Set 4

Due Thursday, 25 February 1999

1. Exercise 8.13 in *Black Holes, White Dwarfs, and Neutron Stars* by Shapiro & Teukolsky. [This problem makes you think about the constraint imposed on any equation of state by causality.]

2. Exercise 18.2 in *Black Holes, White Dwarfs, and Neutron Stars* by Shapiro & Teukolsky. [This problem shows the importance of photo-dissociation for conditions typical of the center of the progenitor star of a Type II supernova.]

3. Exercise 18.6 in *Black Holes, White Dwarfs, and Neutron Stars* by Shapiro & Teukolsky. Using these results, estimate the neutrino luminosity during neutronization (*i.e.*, before neutrino trapping), assuming electron capture on free protons dominates. Estimate the total energy released during neutronization. [This problem evaluates the luminosity and total energy of an important signature of stellar collapse].

4. Exercise 18.8 in *Black Holes, White Dwarfs, and Neutron Stars* by Shapiro & Teukolsky. [This problem allows you to confirm that electron neutrinos are trapped in the collapsing stellar core.]

5. Exercise 18.9 in *Black Holes, White Dwarfs, and Neutron Stars* by Shapiro & Teukolsky. [This problem evaluates the expected energy of the majority of the neutrinos emitted during a supernova; knowledge of this energy is important in designing and understanding underground neutrino detectors capable of detecting supernova events.]

6. Exercise 18.11 in *Black Holes, White Dwarfs, and Neutron Stars* by Shapiro & Teukolsky. [This problem evaluates the characteristic entropy per baryon of the baryons during stellar collapse.]

7. Exercise 18.12 in *Black Holes, White Dwarfs, and Neutron Stars* by Shapiro & Teukolsky. [This problem gives you a feel for the nature of the liquid drop model of nuclei, and allows you to estimate the importance of nuclear excited states in keeping the temperature of the collapsing matter low.]

8. Exercise 18.13 in *Black Holes, White Dwarfs, and Neutron Stars* by Shapiro & Teukolsky. [This problem gives you a feel for the importance of the various constituents of matter to the entropy per baryon along various possible trajectories of matter in the (ρ, T)-plane during stellar collapse.]