CHAPTER 2: KINETIC THEORY

Reading:

Chapter 2 of Blandford and Thorne. Most of the applications of kinetic theory are in Example Exercises. These Examples are designed to give you some feel for how kinetic theory is used in practice. I urge you to read all Example Exercises as though they were part of the text, even though you will be working only a few of them.

Chapter 2 is available at http://www.pma.caltech.edu/Courses/ph136/ph136.html . It may sometimes be useful to look directly at the index page for the course material, http://www.pma.caltech.edu/Courses/ph136/ , where you can see more explicitly the names of the files you are downloading. Chapters that have been revised for this year's course have names beginning with 00[chapter number]. Chapters from last year's course (not yet revised this year) have names beginning with 99[chapter number].

TA:

The TA for this problem set is Alexander Putilin: putilin@its.caltech.edu; extension 2615; office hours Tuesday 3:00PM to 5:00PM in 253 Lauritsen.

Problems

A. Exercise 2.3: Observations of cosmic microwave radiation from moving earth.

B. Exercise 2.8: Vlasov implies conservation of particles and 4-momentum.

C. Exercise 2.7: Equation of state for electron-degenerate hydrogen. Don't hesitate to use Mathematica or Macsyma or Maple to do the integrals you encounter, or to do any other part of this or any problem.

D. Do one of the following two exercises:
   - Exercise 2.9: Solar heating and the greenhouse effect. This one has the virtue that I lead you through it step by step.
   - Exercise 2.10: Olber's paradox and solar furnace. This one requires more independent thinking, and actually might be shorter than 2.9.

E. Exercise 2.11: Diffusion coefficient in collision-time approximation. This is a rather long exercise, designed to give you experience doing a Boltzmann-transport analysis in the diffusion approximation. If you think you fully understood the Boltzmann-transport computation of thermal conductivity in the text, then I suggest that, in place of 2.11 you attempt
   - Exercise 2.12: Neutron diffusion in a nuclear reactor. Note that in this problem the distribution function is independent of space (the reactor is regarded as homogeneous), independent of time (the reactor is assumed to be running in a steady state), and independent of the neutron direction of motion (the neutrons move isotropically); i.e., the distribution function depends only on the neutrons' (nonrelativistic) energy E. The Boltzmann transport equation is used to compute that dependence on E, and having done so, to determine the conditions the reactor must satisfy in order for at least half of the neutrons to trigger fusions.