

# Physics 136, Caltech: Applications of Classical Physics — Fall Term, 2006

## Assignment 2

### Reading

Chapter 2 of Blanford and Thorne. You can find the notes in pdf format at

<http://www.pma.caltech.edu/Courses/ph136/yr2006/text.html>

### Problems (due in class, 1pm Wednesday October 11)

Numbers refer to exercises in Blanford and Thorne, as posted on website.

A. Do the following:

2.4 Observations of cosmic microwave radiation from moving earth

B. Work one of the following:

2.1 Distribution function for particles with a range of rest masses

2.10 Collisionless Boltzmann equation implies conservation of particles and 4 momentum.

C. Work one of the following:

2.9 Specific heat for phonons in an isotropic solid

2.7 Equation of state for electron-degenerate hydrogen. (Don't bother to evaluate the integrals in Eq. (2.46b). Better is to derive the asymptotic expression Eq. (2.46e) directly from the integrals.)

D. Do one of

2.11 Solar heating and the greenhouse effect

2.12 Olber's paradox and solar furnace (requires more thought: remember (Doppler free) propagation of photons preserves  $I_\nu$ )

E. Work one of

2.13 Diffusion coefficient in collision-time approximation

#### Drude a.c. conductivity

(a) Use the single relaxation time approximation to the Boltzmann equation to solve for the distribution function  $\mathcal{N}(\mathbf{x}, \mathbf{p}, t) = \mathcal{N}_0(\mathbf{p}) + \mathcal{N}_1(\mathbf{p}, t)$  of a uniform electron gas (density  $n$ ) in a background of fixed uniform neutralizing positive charge plus some scattering sites and subject to a spatially uniform, temporally oscillating electric field  $\mathbf{E} = \mathbf{E}_0 e^{i\omega t}$ . (Calculate the result for large times after "switching on" transients have decayed. Also note that  $\partial\mathcal{N}/\partial t = \partial\mathcal{N}_1/\partial t$  and this term must be retained in the calculation)

(b) Calculate the resulting current density for a classical electron gas, i.e., when  $\mathcal{N}_0$  is Maxwellian.