

# High-Energy Astrophysics (Ay125), Spring 2009

## Problem Set 8

**Due: In class, 28 May 2009**

1. Frank, King, and Raine's problem 8.5
2. Frank, King, and Raine's problem 8.6.
3. If the redshift of detectable bursts is about unity, roughly estimate the rate of GRBs per galaxy (number/year). What is the energy/year/galaxy released by GRBs? Which of these two numbers is sensitive to the (unknown) distance to the bursts? Why is the other relatively insensitive?
4. A 1D gas is at rest in a box of length  $L$ . It has particles of rest mass  $m$  with number density  $n$ . Half of them are going in the  $+x$  direction with Lorentz factor  $\gamma$  and half are going in the opposite direction with the same Lorentz factor (they are reflected once they reach the sides of the box).
  - (a) What is the pressure and the energy density of this gas.
  - (b) What is average distance  $l$  between particles moving in each direction.
  - (c) What is that distance in the rest frame of those particles?
  - (d) An observer moves relative to the box with Lorentz factor  $\Gamma$ , what does he think is the distance between the particles that are moving in each direction?
  - (e) What is the particle and energy density in the observer frame?