# Astro 519A; Problem Set 3

Due Nov 13 by 5pm (in McQuinn's mailbox).

Please use cgs units for all calculations.

1.) Please do problem 3.1 in Rybicki and Lightman.

2.) a.) An alien civilization is "checking out" the Solar System. They do not want to be discovered by those pesky humans on earth. They have figured out how to make the albedo of their space ships nearly zero. However, the spaceships are not transmissive to the light from background stars. Because of this, they require each of the space ships in their massive fleet sitting at 10a.u. from the earth to block out less than 1% of the light from background stars that they might eclipse for an observer on earth. *Estimate* the maximum radius this requirement imposes on their flying saucers. [Extra credit: Calculate this radius exactly.]

b.) One of the aliens' ships carries a 10 m in diameter optical telescope that it uses to observe earthlings. What is the diffraction limit resolution with which the aliens can observe the earthlings (expressed in units of cm on earth)? Is their observation likely to be diffraction limited or do they also have to worry about earth's atmosphere?

c.) The aliens' "hyperdrive" operates at a Lorentz factor of $\gamma = 100$. Still, traveling 100 light years – the distance from their home planet to the earth in the CMB rest frame – takes a long time! How much time passes for the aliens on the ship? Assume that the time it takes to accelerate to $\gamma = 100$ and then back down is small such that most of the trip is spent at $\gamma = 100$.

d) The in-transit aliens want to communicate with their home and their fleet on earth while they are traveling. In their frame, they broadcast isotropically a signal with average bolometric power $P$ halfway between the solar system and their home planet. What is the average bolometric flux ($F = \int d\nu F_\nu$) received at both locations?

3. The corona of the sun, as seen during a total solar eclipse, consists of very hot, ionized gas, which scatters light from the sun by means of Thomson scattering. The diagram bellow indicates what a photograph of the sky might look like during an eclipse. The black circle is the moon just blocking out the sun. The area enclosed by the solid line is meant to suggest the corona, which is typically very irregular in shape.

a) What kind of polarization would the light from point P have? What would its direction be relative to the radius vector (dotted line)? Would you expect to see 100% polarization? Please explain, but a quantitative answer is not required.

b) The brightness of the corona is typically of order $\sim 10^{-9}$ of the brightness of the sun itself. Assume that the electron density falls off rather slowly with radius (perhaps like an inverse square law) beyond the solar radius. Give an order of magnitude estimate of the electron density in the solar coronal near the sun.