

**PHY 300 Problem Set #3**  
**Assigned 2-Mar-2015**  
**Due 9-Mar-2015, start of class**

## Radio Astronomy – Examples sheet 2

1. Determine the general expression for the frequency of a recombination line and hence calculate the frequency of the  $109\alpha$  line of hydrogen. What is the frequency of the equivalent carbon line.
2. The two radio telescopes at Hartebeesthoek are about 40m apart. Determine the highest resolution of an interferometer formed with the two dishes at the frequency of the OH line at 1665 MHz. Express your answer in arc-seconds.
3. Compare the resolution of the human eye, say in the light of the sodium line, with that of a radio telescope with a diameter of 25m and a long baseline interferometer stretching across South Africa.
4. Over the whole world there have been about 40 radio telescopes, of average diameter 25m, in operation since 1960. Assuming that the average power received by each is  $10^{-16}$  W, over that period of time, compare this to the energy released by the ash falling from a cigarette under the Earth's gravity. Take the mass of ash to be 1 gm, falling over 2 cm.
5. Draw a block diagram of a heterodyne radio receiver explaining the purpose of each component. Describe the way each component adds to the total system noise of the receiver.
6. Derive, using a statistical analysis, the equation for the sensitivity of a radio astronomy system:  $\Delta t/t = 1/\sqrt{B\tau}$ , where B is the bandwidth and  $\tau$  is the integration time.