HOMEWORK 2 ASTR 610, SPRING 2019

DUE DATE: February 2~~1~~6, 2019

1. The unit of flux in radio astronomy is the Jansky (written as Jy). Look up what that corresponds to.

1a. Calculate the flux density in Jy of a microwave oven with an output of 1 kW at a distance of 10m if the power is radiated over all angles and is uniformly emitted over a bandwidth of 1 Mhz.

b. Let's try to estimate the total energy collected by the VLA in a year. Assume that the array of 27 dishes, each with a diameter of 25-m, is on average observing sources for 20 hrs per day with an average, total flux density of 1 Jy over the entire field of view. Take a total bandwidth of 5 Mhz. The actual bandwidth is much larger now, but the average flux density is likely well below one Jy, so I am curious what this amount is. Convert it to kiloWhr of energy to see for how long we could power a 100 W light bulb with this, if at all.

2. Estimate the optical depth to Thomson scattering in the central region of the Sun by finding the relevant parameters you need to know to do that calculation. What is the mean free path of a photon there? Also address if the minimum condition for Thomson scattering to be valid that we discussed in class, is still correct there.

3. Consider the discussion of pulsar dispersion measure in the class notes.

3a. In those notes there is a figure of a dispersed pulsar signal. Assume that the pulsar has a period of 0.5 sec. Derive the dispersion measure to that pulsar.

3b. Get some estimates from the literature for the average density of the diffuse ionized interstellar medium and use that to calculate a distance to the pulsar.

3c. Did your result depend on knowing the period of the pulsar? Does the "dispersion measure" as a quantity itself depend on the period of the pulsar? What would change in the figure if I looked through that same layer to a pulsar at the same distance but with a shorter pulse period?

3d. Suppose that in this layer of diffuse gas there is a magnetic field embedded of 5 micro-Gauss. We happen to be seeing this at an optimum orientation so the field is parallel to the line of sight. The pulsar emits a decent amount of linearly polarized radio waves. For the frequency limits in the plot, how large a change in angle, $\Delta\Theta$, would this produce in the linear polarization angle?

3e. Is there an "nπ" problem in the determination of this change in angle? How would one in general find out the rotation measure knowing that there is such an ambiguity in any derived RM?

3f. Do some research on the pulsar distribution in the MW. Roughly how many pulsars are known? What is their spatial distribution? What is known about their progenitors? How do we get them at substantial distances above the MW plane?

4. Sketch what the Fourier Transform of the function displayed below would look like, by applying the various theorems we have discussed for the FT to get to the answer. Describe the steps and theorems you use. Note that you should pay attention to the actual values on the x-scale to properly scale to relevant x-scale in the Fourier domain. The function shown can be described as a truncated cosine that is damped by a Gaussian (as you can see in how the amplitudes drop off).