# ASTR469: Problem Solving Day #5.

Here are some more calculations we need to do to determine whether observing HI emission in the Triangulum Galaxy, also known as Messier 33 (M33), will be appropriate (and a few calculations to set up our observations). Note some of these are copied from last problem solving session, as I know many of you didn't get through them. Skip those that you did get through!

Remember we will be observing on ∼March 6, 2019 sometime in the range 11am and 3pm.

**Time and telescope pointing logistics:**

- Will the object fit within the field of view of your telescope? Note: the interactive AladinLite view on SIMBAD will allow you to estimate the angular extent of the object. Hint: for GBT, the field of view is actually the same as the resolving power of the telescope.

- (If not fitting in FOV) How many total fields-of-view would you have to observe to totally cover the galaxy? Determine this assuming your FOV is square, and first determine it in the N-S and E-W direction.

- (If fitting in FOV) What fraction of the field of view will this object fill?

- Draw the galaxy and a circle representing the field-of-view of GBT at this frequency.

**Dealing with the sun:**

- The atmosphere is transparent to radio waves so we can observe during the day! However, the Sun itself is a bright radio source, so pointing too close to the Sun or the Solar limb (within $\sim 10^\circ$ of Sun's position) can mess up your observation. Will M33 be too close to the sun between 11am and 3pm on March 8?

**Determining observing (integration) time:**

- Let's try to get an HI detection of at *least* $500\sigma$ within a narrow 10 kHz band (this would be a nice strong detection for us to do our line analysis). This will hopefully let us resolve any frequency-dependent structure in the line, representing different velocity distributions. Based on previous observations, the HI flux should be on the order of 10 Jy in this band.

- What is the velocity resolution you have in a 10 kHz sub-band (i.e. if two atoms were emitting in different sub-bands, what would their relative velocity be)?

- For your integration time calculation, you will find some of the parameters needed for the radiometer equation on the GBT information provided here:
  `http://www.gb.nrao.edu/~fghigo/gbtdoc/sens.html`
  Note we will be observing in the 1–2 GHz band, so we will be using the **Rcvr1_2** instrument, which filters out everything except $\nu = 1$–2 GHz light. The other receivers will not give us light that covers the HI band!
  What is the system temperature?
  What does this mean about the radiometer (is it cooled?).
  What is the Gain of GBT for this receiver?

- Using the radiometer equation (the version of it that accounts for the presence of a dish), determine the on-source observing time you would need to get a detection of at least $10\sigma$ within a 0.1 MHz bandwidth.

- Based on the flux given above, what is the approximate *surface brightness* of the HI in M33?

**Making measurements:**

- Based on the field of view computed earlier, we will probably have to do a scan of this object to make a map of it. If you were to do this, what angular scales will you be able to resolve in the object?

- What linear scales will you be able to resolve in the object with the GBT?