Introduction

The data for this assignment were provided by Loren Anderson from his paper which you can read here:
http://adsabs.harvard.edu/abs/2011ApJs..194...32A
Download the paper, and take a look at it after class. A very useful (and pretty) resource is the associated website:
http://www.cv.nrao.edu/hrds
You will perform two tasks: (i) fit a Gaussian profile to a continuum scan; (ii) fit a recombination-line spectrum. You can use whatever data analysis package you like for this assignment. For simple tasks like this, I recommend "gnuplot". Find all data referenced below on our course webpage.

Exploring telescope beam-width

Download the continuum-mode scan which is an ASCII file containing Right Ascension position (degrees) and antenna temperature (K). Make a plot of it and fit a gaussian function using your favorite software (or your own software!). As an example, in gnuplot, this can be accomplished like this:

```
f(x)=a*exp(-1.0*(x-b)*(x-b)/2.0/c/c)
a=1.1
b=283.99
c=0.01
fit f(x) 'continuum.dat' using 1:2 via b,c
plot 'continuum.dat' with lines, f(x)
```

What we have done here is just fit the width and centroid of the gaussian to the continuum scan based on some initial guesses of the parameters. If you use gnuplot as above, be sure to check the fit by eye to see if it looks reasonable. Were your starting parameters reasonable or should you choose ones a bit closer? Use the width of this scan to determine the aperture efficiency of the GBT at this frequency band (8–10 GHz).

G034.133+0.471 data

One of the stronger sources in the paper can be obtained from the website as an ASCII file of frequency (MHz) and antenna temperature in (K). These data are an average of the H87α to H93α recombination lines. The spectrum of this source has baseline effects in the data. Fit a polynomial function to the data and remove this trend before carrying out the above analysis. Once you've done your fit it might be useful to look at the "Details for Individual Region" derived on the HRDS website. Some of the values listed here are what you will be determining, but of course you will need to determine them yourselves (note, your measurements may be somewhat off from what's reported due to differences in assumptions and fitting techniques)! Estimate the FWHM and use this to determine the approximate electron temperature. Determine the line brightness temperature and estimate the EM. What does this line of reasoning imply about the source size? Fit a gaussian to this line profile to determine the width and amplitude. Be sure to identify and quote the errors from the fit in your write up.

Final product: your "published" project write-up

Write up your results in the form of a short lab report. The report should have an abstract, introduction, methods, data, results, discussion and conclusion sections and include figures where appropriate. I anticipate that the write-up would be 2–3 pages of ApJ formatting (e.g. the format used for Loren's paper). A very good rule of thumb for any scientific write-up is that it should allow a knowledgeable reader to reproduce (thus confirm) your results exactly. Assume the reader is an expert in astronomy but not in the same field you're writing about. In any paper, you should provide enough description (i.e. how you got to your conclusion via evidence) and detail (i.e. values of all relevant telescope set-up parameters) to enable this. Similarly, all plots need axes labels, units, and a brief caption! Discussions can detail snags encountered or assumptions you made en route to your conclusions. "Conclusions" can serve as a summary or a concise listing of what you concluded from the data in reference to the broader scientific context.