(Astro)Physics 343 Lecture # 6: Lab # 3 + Radio Antennas
Problem: ambiguous data from the GBT

A new instrument (the *Zpectrometer*) observes new sources (dusty high-redshift galaxies) and doesn't detect anything...

Weak CO lines or a malfunctioning instrument?
Solution: observe an “old” source

Blain (1998): optical (left) and submillimeter (right) images of the “Cloverleaf” quasar

Data from yesterday:
CO(1-0) detected at expected frequency for source redshift.
Lab # 2: spectral line observations!

So far all of our observations with the SRT have been with receiver mode 1, and we've simply averaged over (most) channels since we're interested in continuum emission from the Sun.

For HI observations, we care about individual channels!

- mode 1 = 500 kHz bandwidth
- mode 2 = 250 kHz bandwidth
- mode 3 = 125 kHz bandwidth
- mode 4 = 3 x 500 kHz bandwidth (with overlaps)
Velocities in astronomy

Observed frequency and wavelength are related to rest (emitted) frequency and wavelength by a velocity (or redshift).

Exact relation = Doppler shift:
\[ \frac{\nu_0}{\nu} = \frac{\lambda}{\lambda_0} = 1 + z = \gamma (1 + \frac{v}{c}) \]
for \( \gamma = \left(1 - \frac{v^2}{c^2}\right)^{-1/2} \)

and for relative velocities, \( \frac{\Delta \nu}{\nu} = \frac{\Delta \lambda}{\lambda} = \frac{\Delta z}{1 + z} = \frac{\Delta v}{c} \).

However, astronomers make approximations...

radio: \( \nu \approx \nu_0 \left(1 - \frac{v_{rad}}{c}\right) \)

optical: \( \lambda \approx \lambda_0 \left(1 + \frac{v_{opt}}{c}\right) \)
Distances in astronomy

Nearest stars can have distances measured by **parallax**: the apparent shift in position relative to the background pattern of more distant stars caused by the earth's motion around the Sun.

1 parsec = 1 pc:
3.089 x 10^{18} cm
~ 3.3 light years

Distances inside galaxies ~ kpc.
Distance between galaxies ~ Mpc.
Stellar components of spiral galaxies

Spiral galaxies have two principal components: disk and bulge.
Where is the Sun within the Galaxy?

Note on terminology: Milky Way = “the Galaxy”; other “galaxies” are not capitalized.

Sun and solar system lie at a distance of 7.94 kpc from the Galactic Center, where a supermassive black hole lies.

Eisenhauer et al. (2003)
Galactic coordinates

The Sun is also located within the disk.

\( b = \text{Galactic latitude (above/below plane)} \)

\( l = \text{Galactic longitude (0 towards Galactic Center)} \)
HI in the Milky Way

Nearly all the HI in the Galaxy is located in the disk.
Observed velocities governed by (a) rotation (b) random motions.

(Plotted in Galactic coordinates)
Quiz