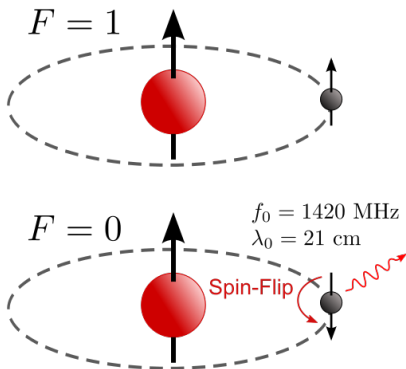


Determining Galactic Structure through 21cm Emission Lines

Henry Shackleton

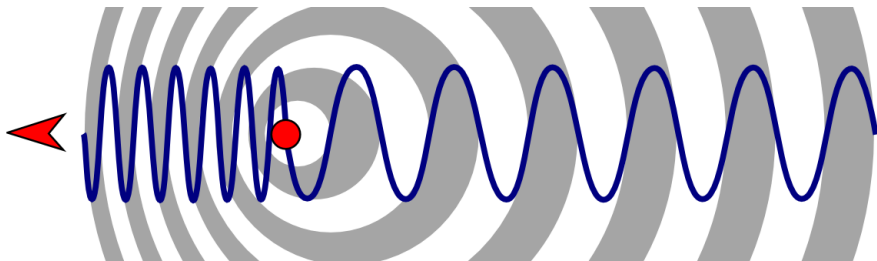
May 11, 2017

Hyperfine Structure of Hydrogen Emits 21cm Wavelength Emission



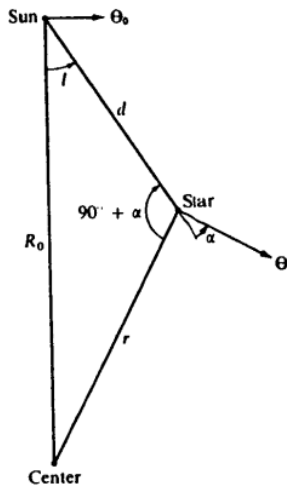
- Hydrogen electron spin-flip causes electromagnetic radiation at a frequency of 1420.41 MHz.
- Low probability ($2.9 \times 10^{-15} \text{ s}^{-1}$), but the vast amount of hydrogen in the galaxy allows for this detection

Doppler Shift Gives Change in 21cm Line Proportional to Velocity



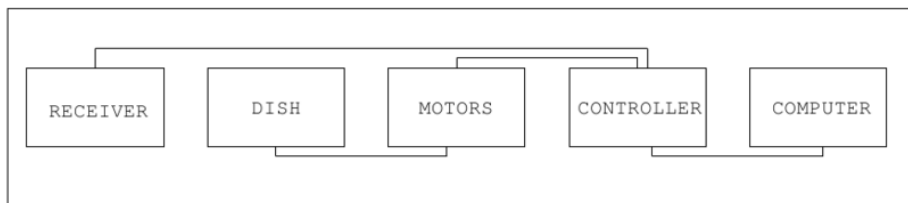
$$v = c \frac{1420.41 - \nu}{\nu}$$

Location of Hydrogen Masses Determined through Geometry



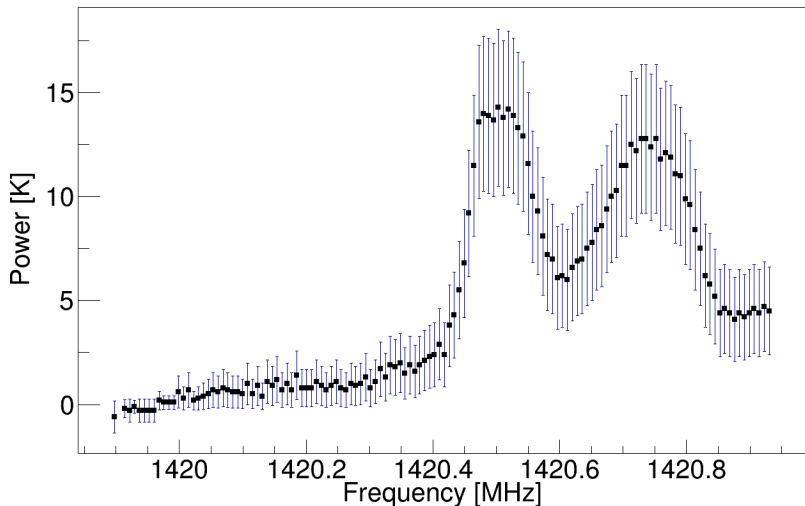
- Velocity we observe is the velocity of the mass *projected* onto our line of sight.
- $v_{obs} = \frac{\Theta}{r} R_0 \sin \ell - \Theta_0 \sin \ell$
- Relation between Θ and r obtained through Galactic Rotation Curve.
- Between $90^\circ < \ell < 180^\circ$, Galactic Rotation Curve is approximately constant.

SRT Measures Radio Power Within Given Frequency Domain

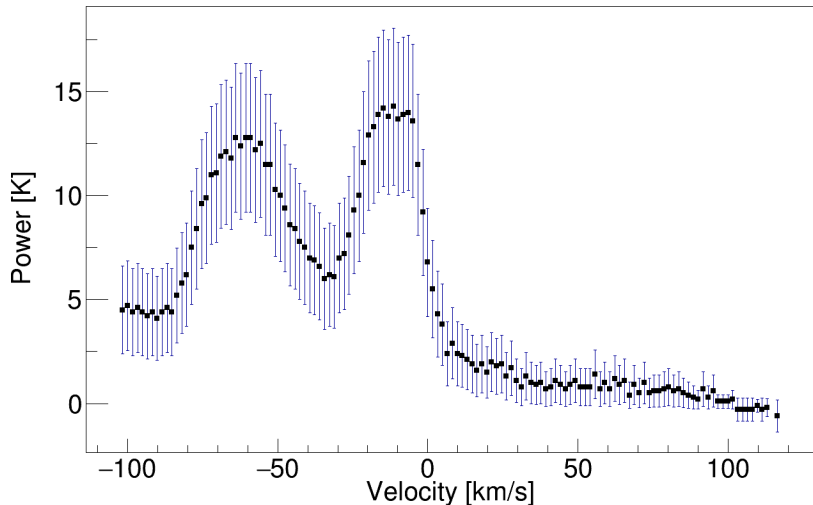


- Noise diode allows for calibration of telescope.
- Receiver selects desired bandwidth for data collection.

Peak in Antenna Readings Signal Hydrogen Density Concentration



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- Distance from sun to center of galaxy also uncertain, 8.2 ± 0.5 kpc.
- Poissonian uncertainty in number of counts.
- Beam width approximated as constant across five degree bin width - taking into account beam profile would allow for more accurate data analysis

Hydrogen Mapping to Polar Histogram Indicates Spiral Arm

