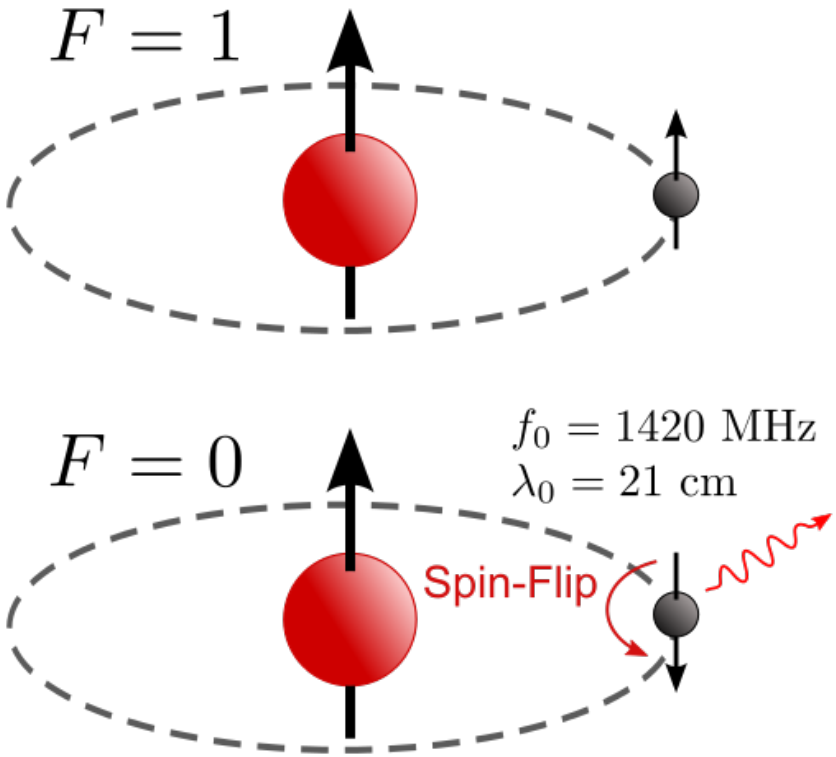
# Determining Galactic Structure through 21cm Emission Lines

Henry Shackleton

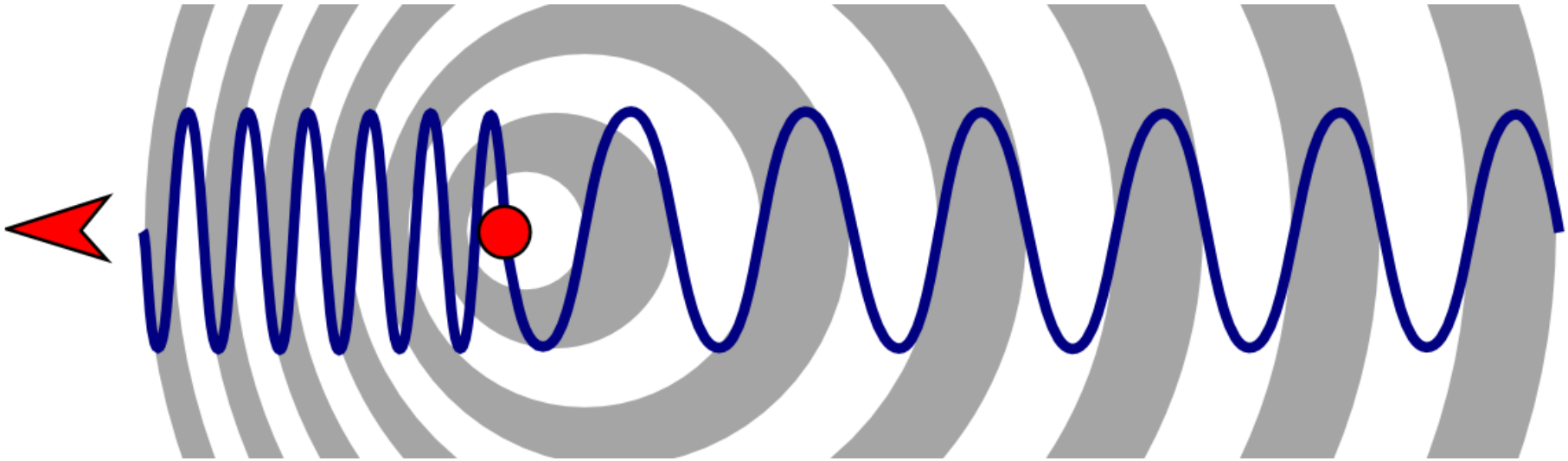
May 11, 2017

# Hyperfine Transition of Hydrogen Emits 21cm Wavelenth Emission




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

# Doppler Shift Gives Change in 21cm Line Proportional to Velocity



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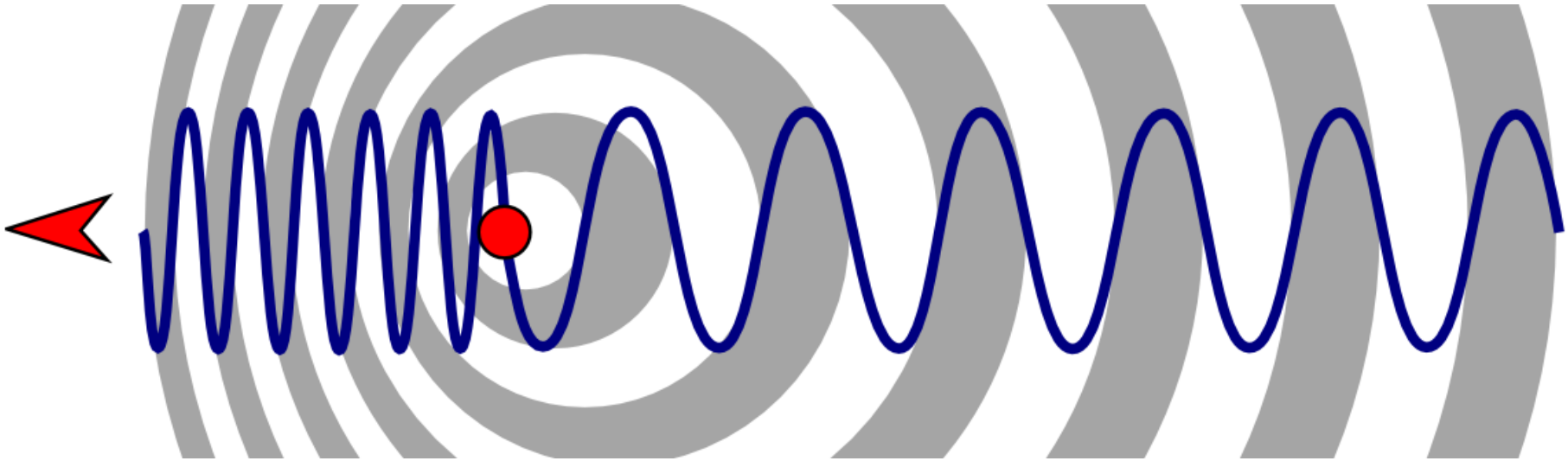
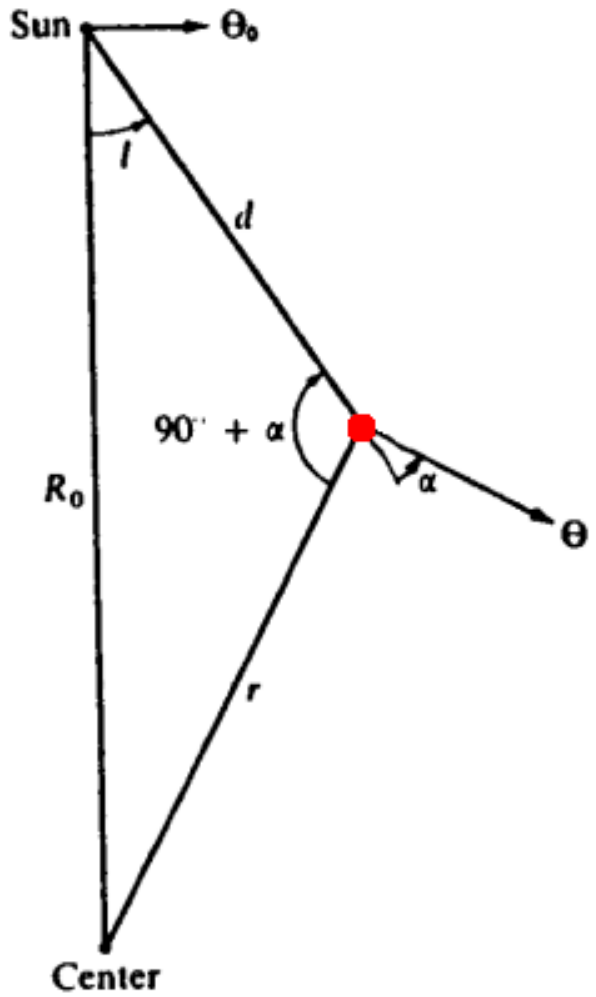


$$v = c\frac{1420.41 - \nu}{\nu} - v_{lsr}$$

# Location of Hydrogen Masses Determined through Geometry

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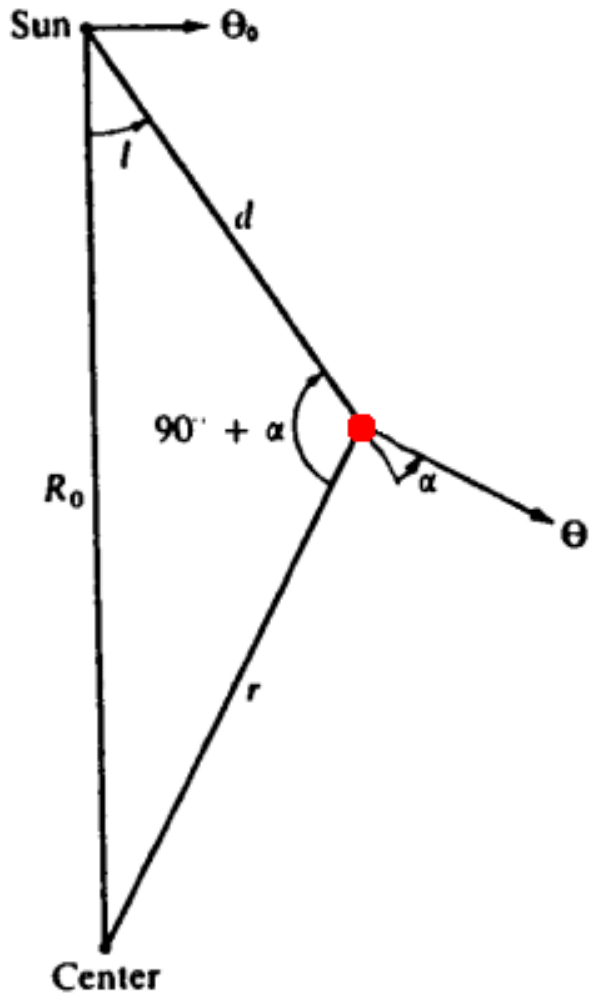


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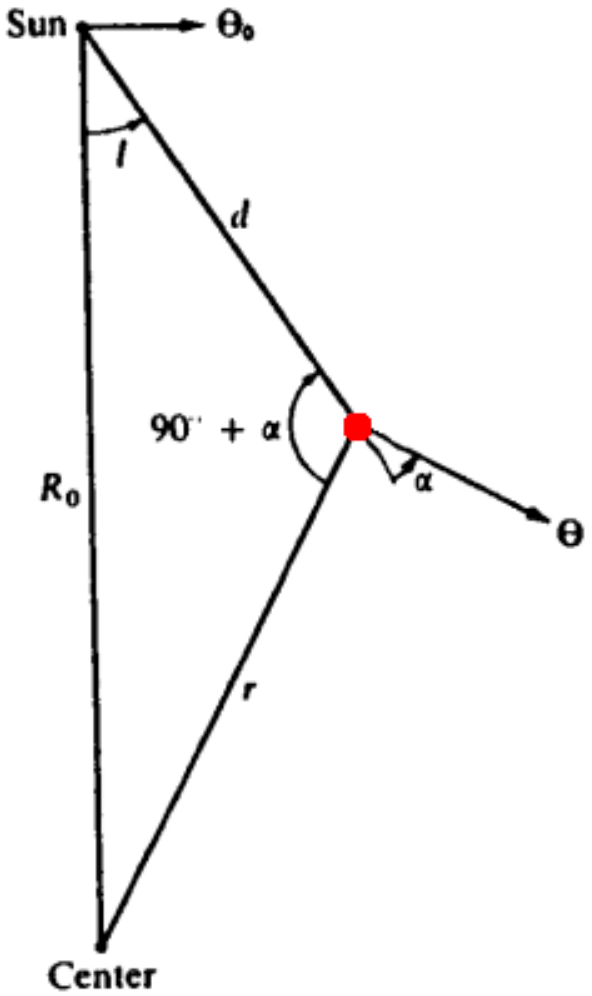


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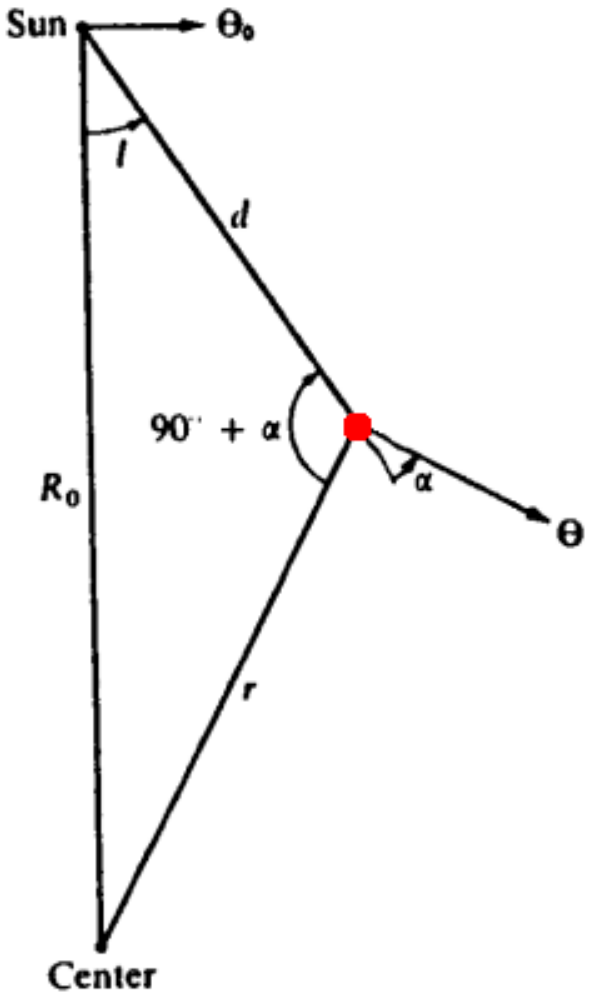


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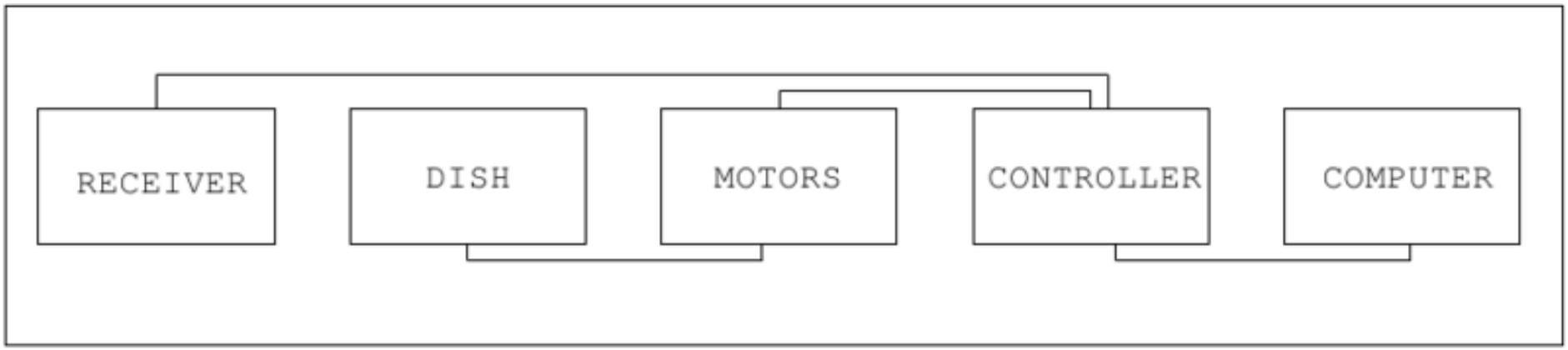
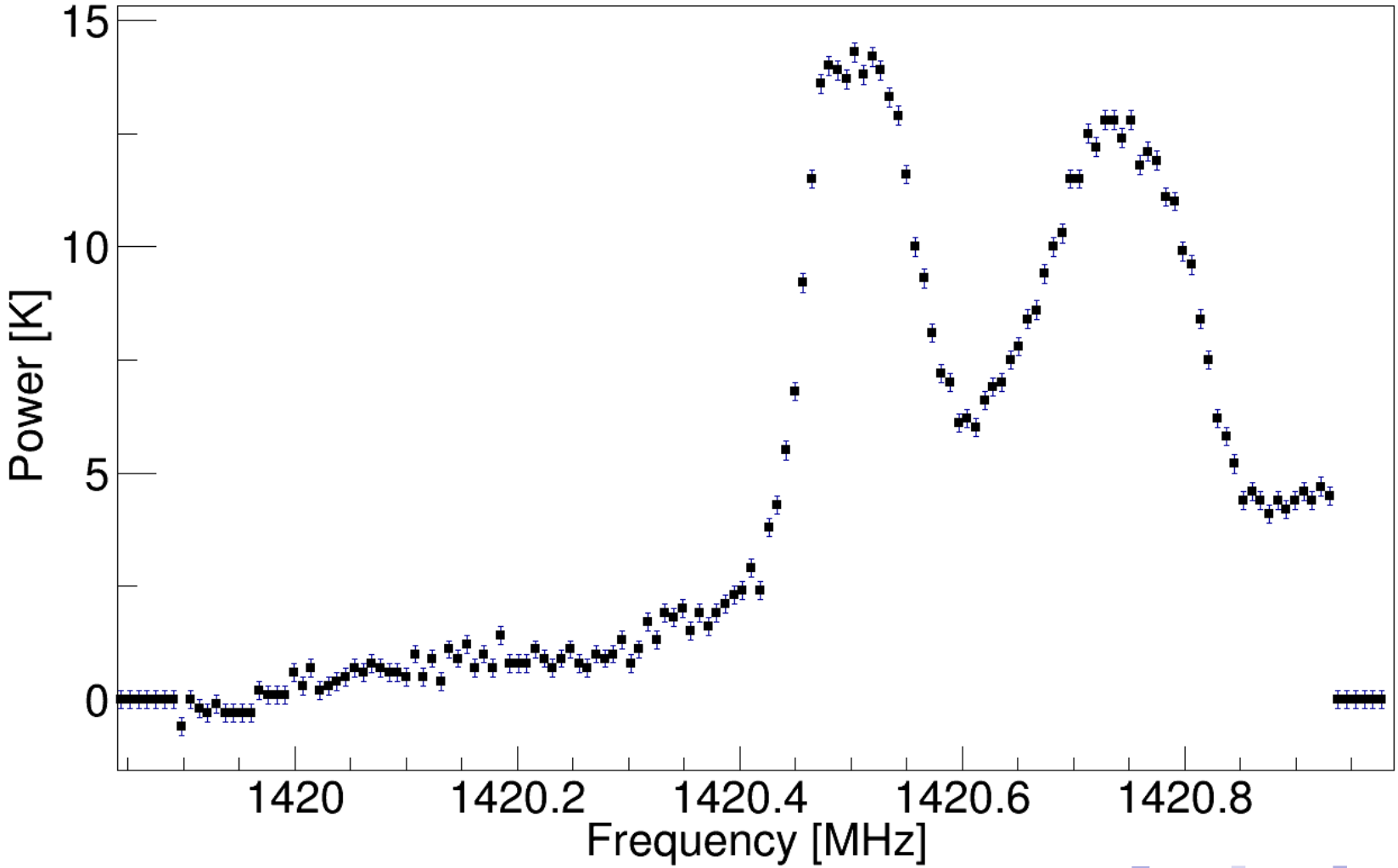
- Between $90° < \ell < 180°$, Galactic Rotation Curve is approximately constant.

# SRT Measures Radio Power Within Given Frequency Domain




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

# Peak in Antenna Readings Signal Hydrogen Density Concentration



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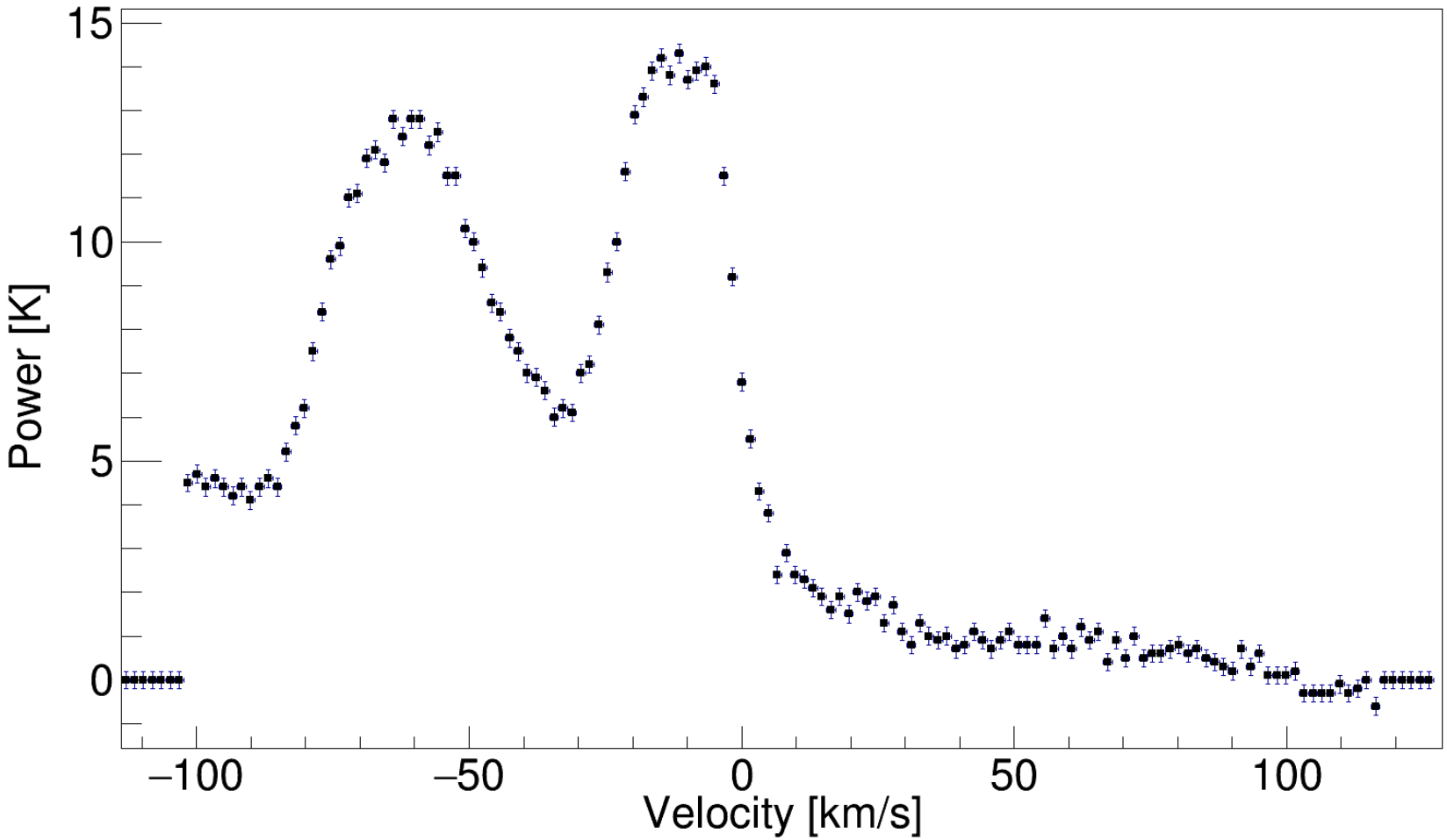

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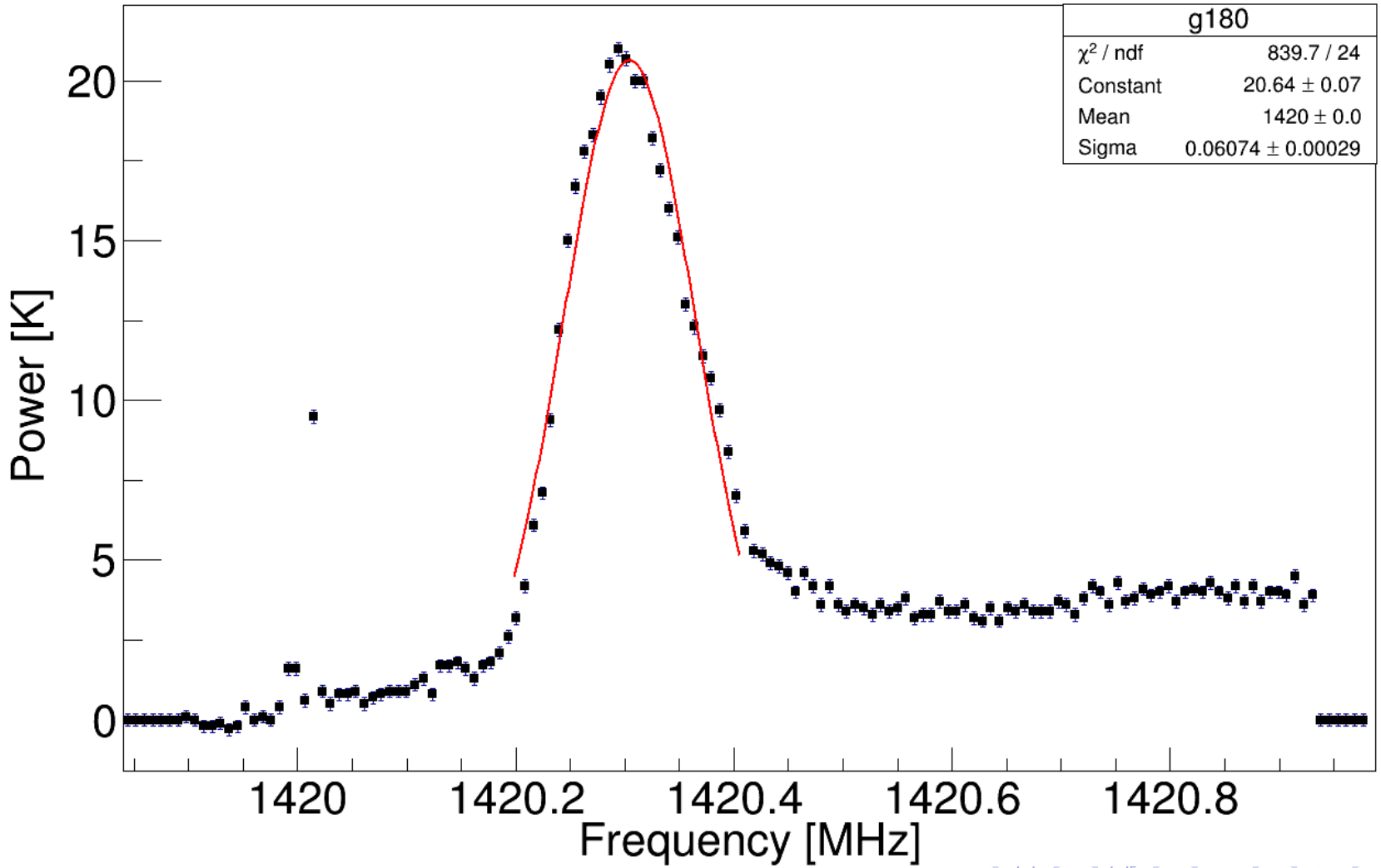
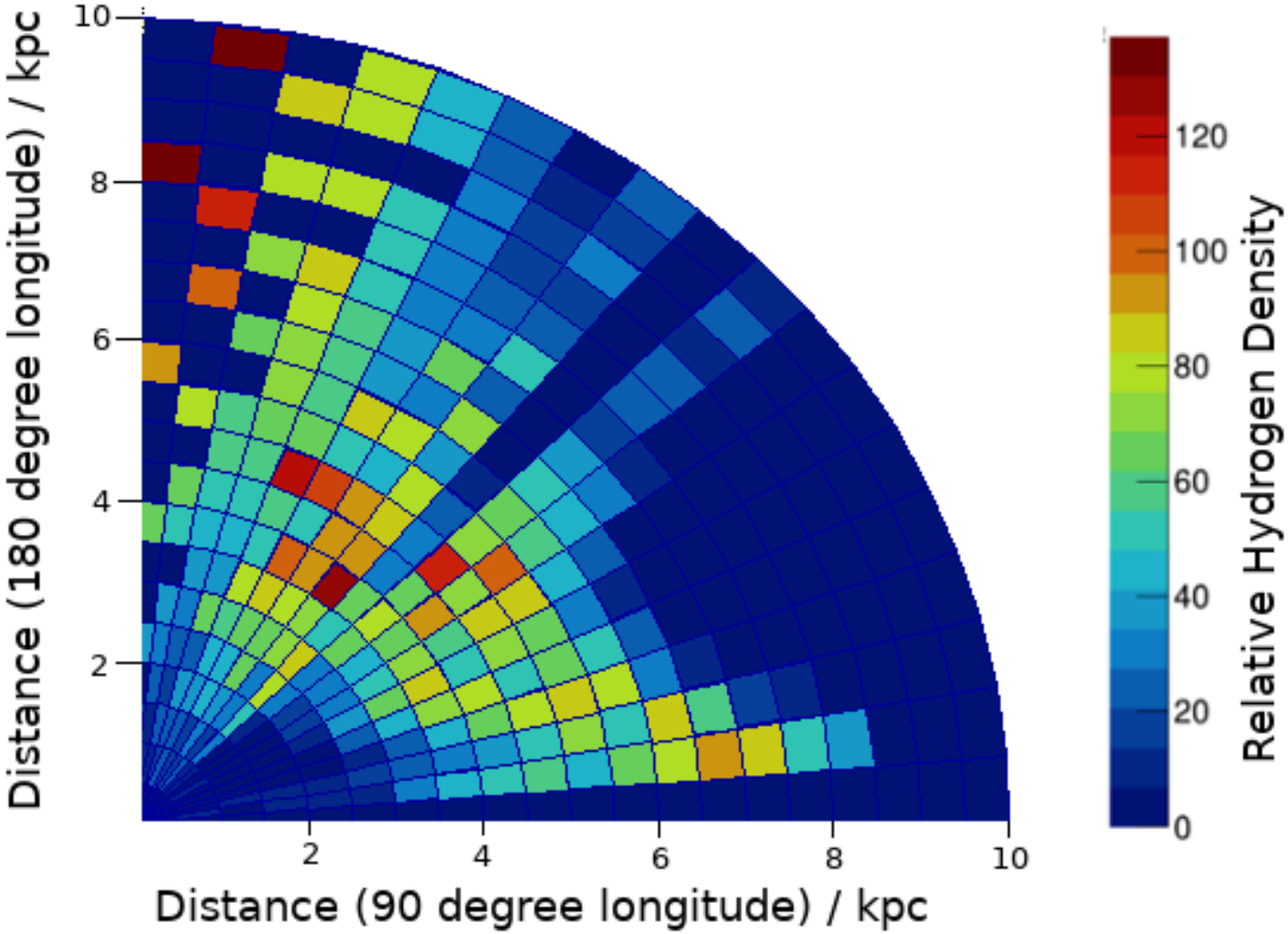
- Poissonian uncertainy in number of counts.

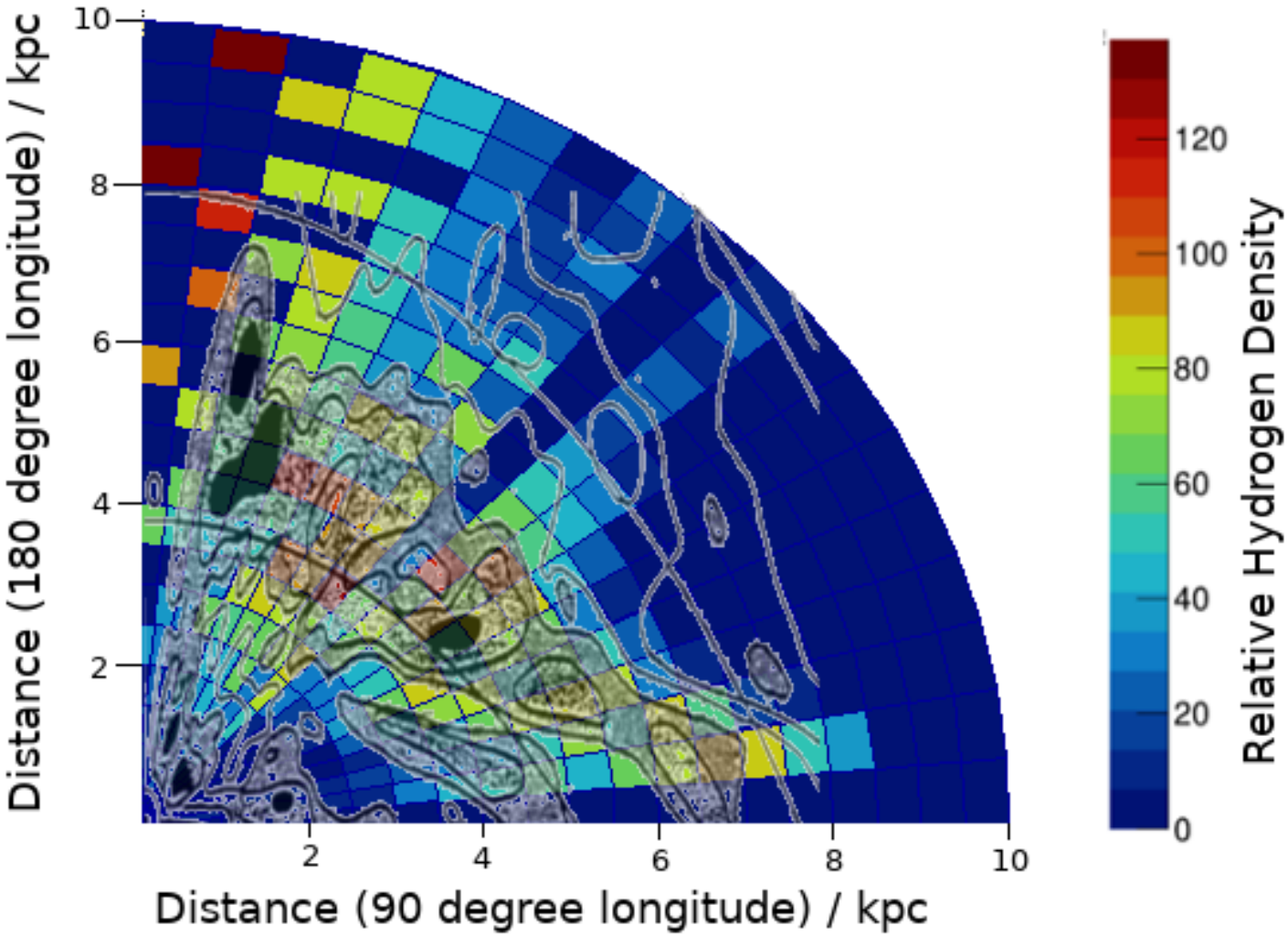
# Thermal Broadening Irrelevant at Current Galactic Resolution



# Hydrogen Mapping to Polar Histogram Indicates Spiral Arm



# Hydrogen Mapping Agrees with Density Data



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- Analyzing Doppler shift allows for determining of source location and a mapping of hydrogen density.
- Resolution limited due to telescope size and thermal broadening, but qualitative features agree with literature.