Determining Galactic Structure through 21cm Emission Lines

Henry Shackleton

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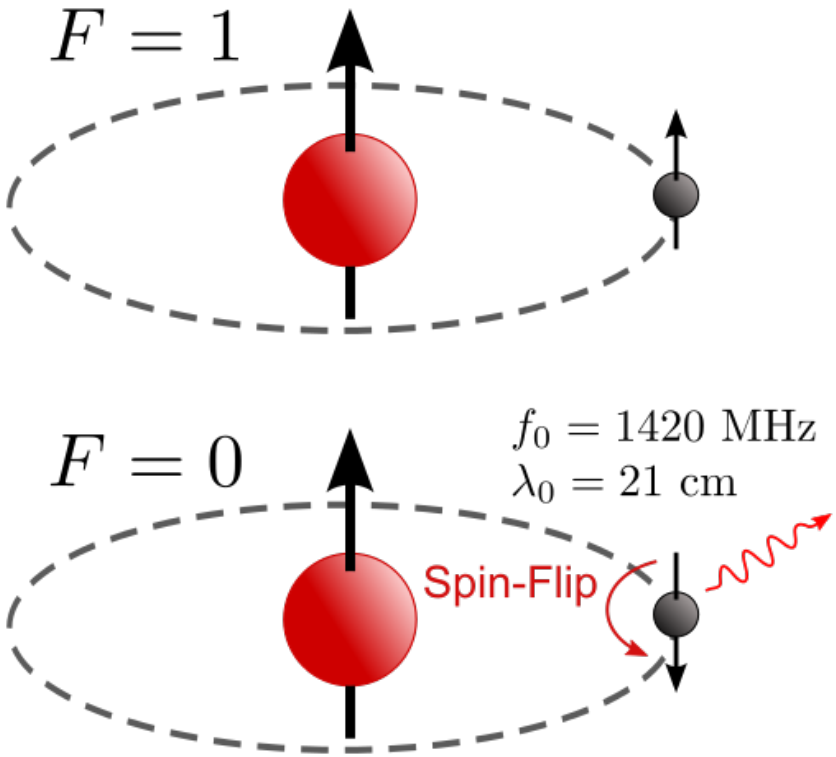
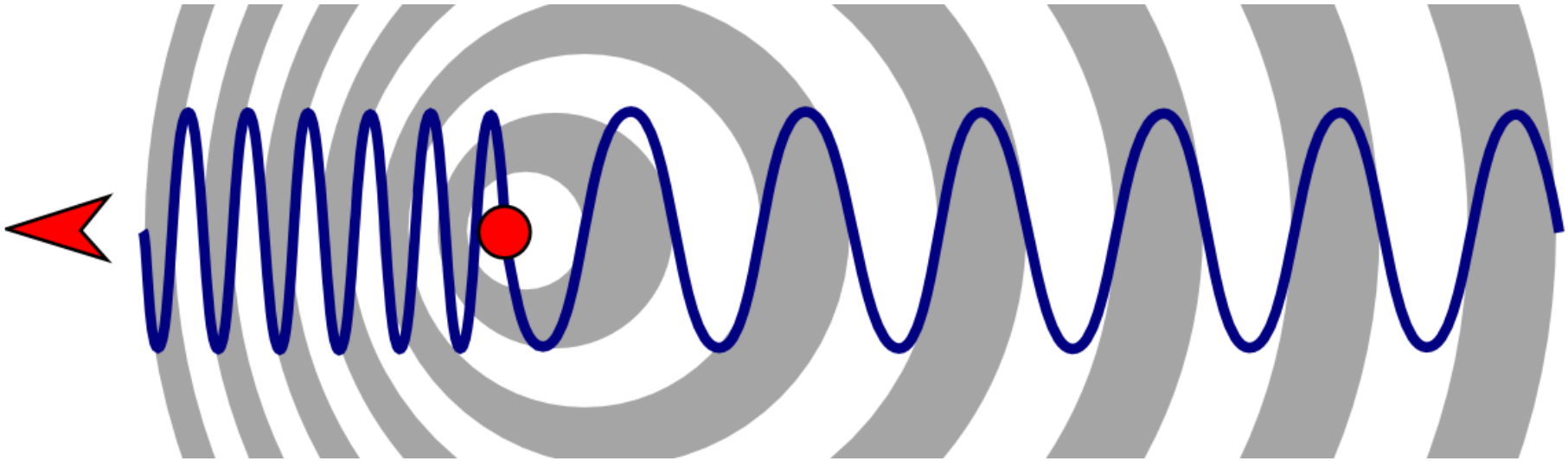
Hyperfine Transition of Hydrogen Emits 21cm Wavelenth Emission



- 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



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

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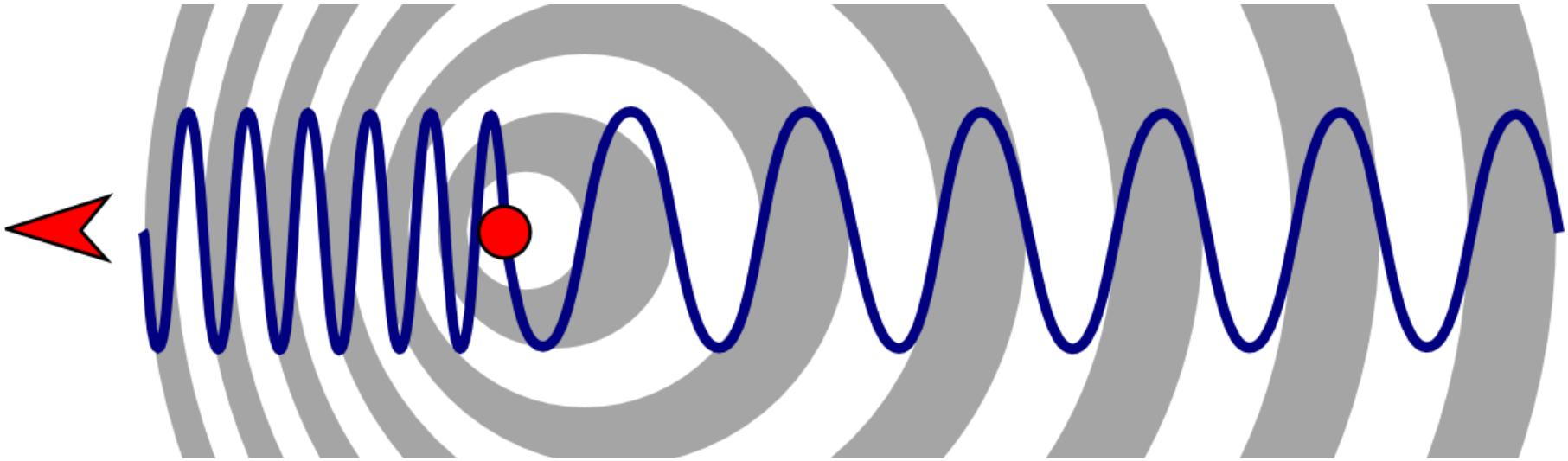
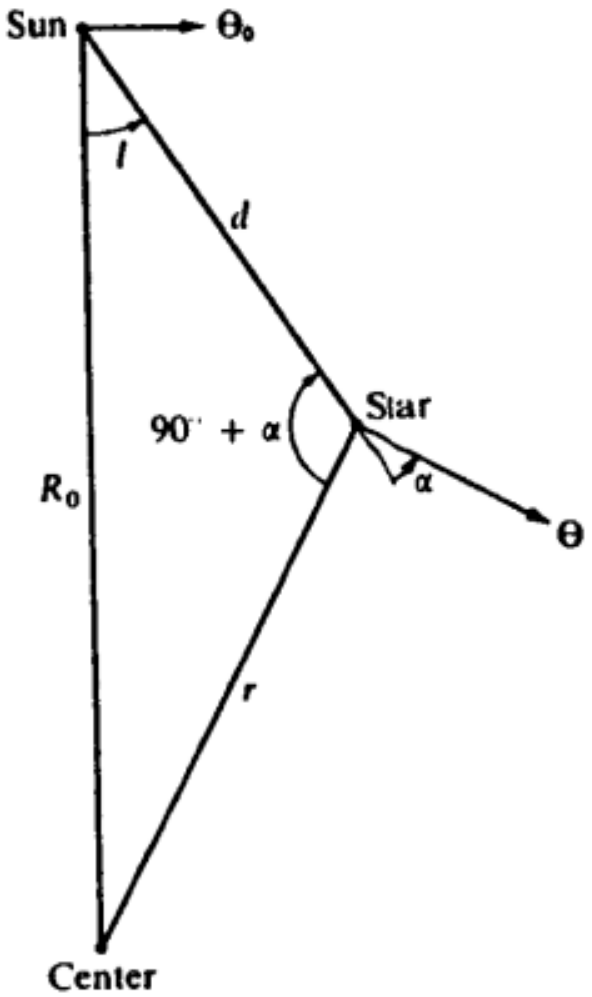


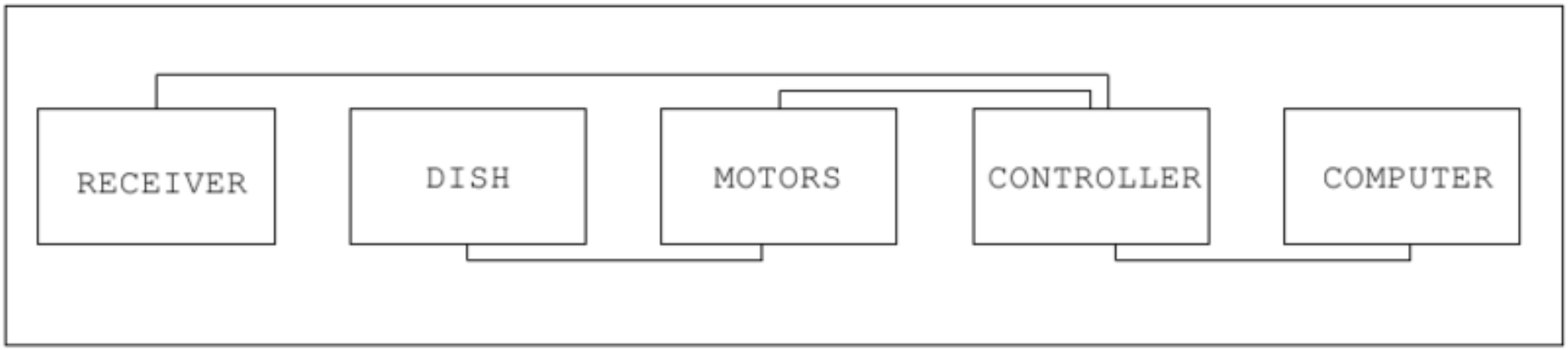
$$v = c\frac{1420.41 - \nu}{\nu} - v_{lsr}$$

Location of Hydrogen Masses Determined through Geometry



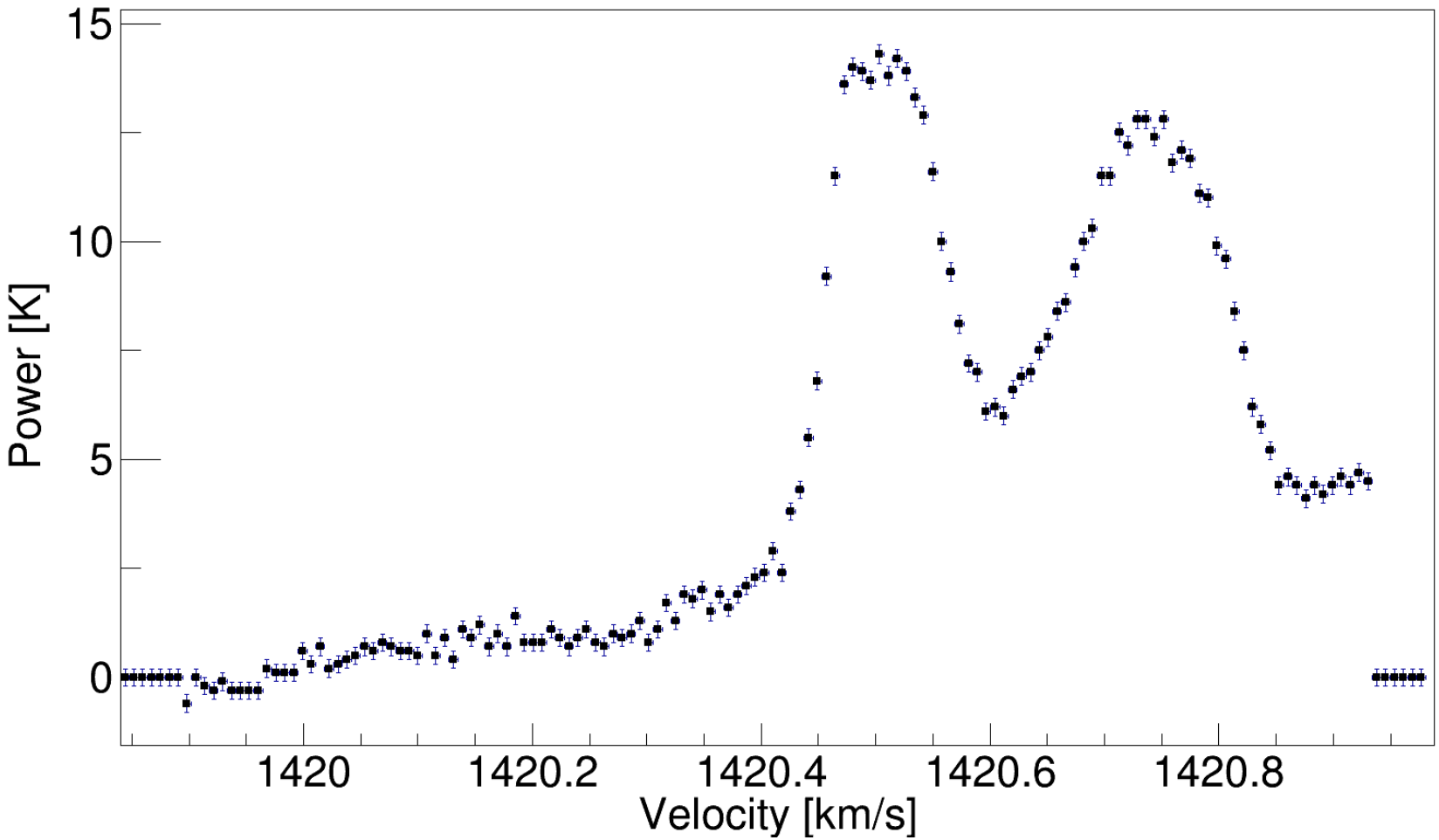
- Velocity we observe is the velocity of the mass *projected* onto our line of sight.
- $v_{obs} = \frac{\Theta}{r} R_0 \sin \ell - \Theta_0 \sin \ell$
- Relation between Θ and r obtained through Galactic Rotation Curve.
- Between $90° < \ell < 180°$, Galactic Rotation Curve is approximately constant.

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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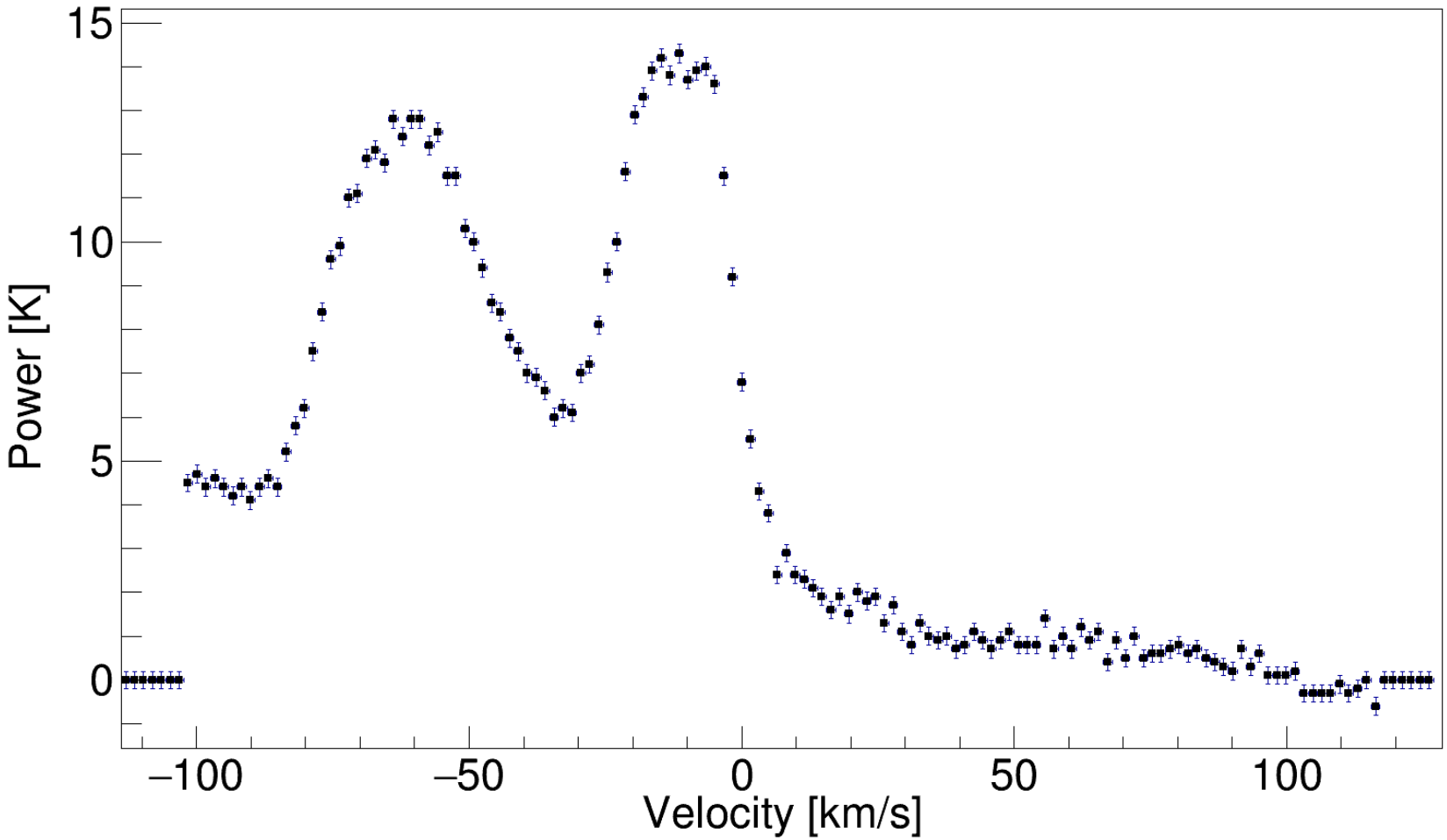

Sources of Error Largely Due to Unknown Constants

- Velocity of sun lacks certainty, approximately 231 ± 14 km/s.

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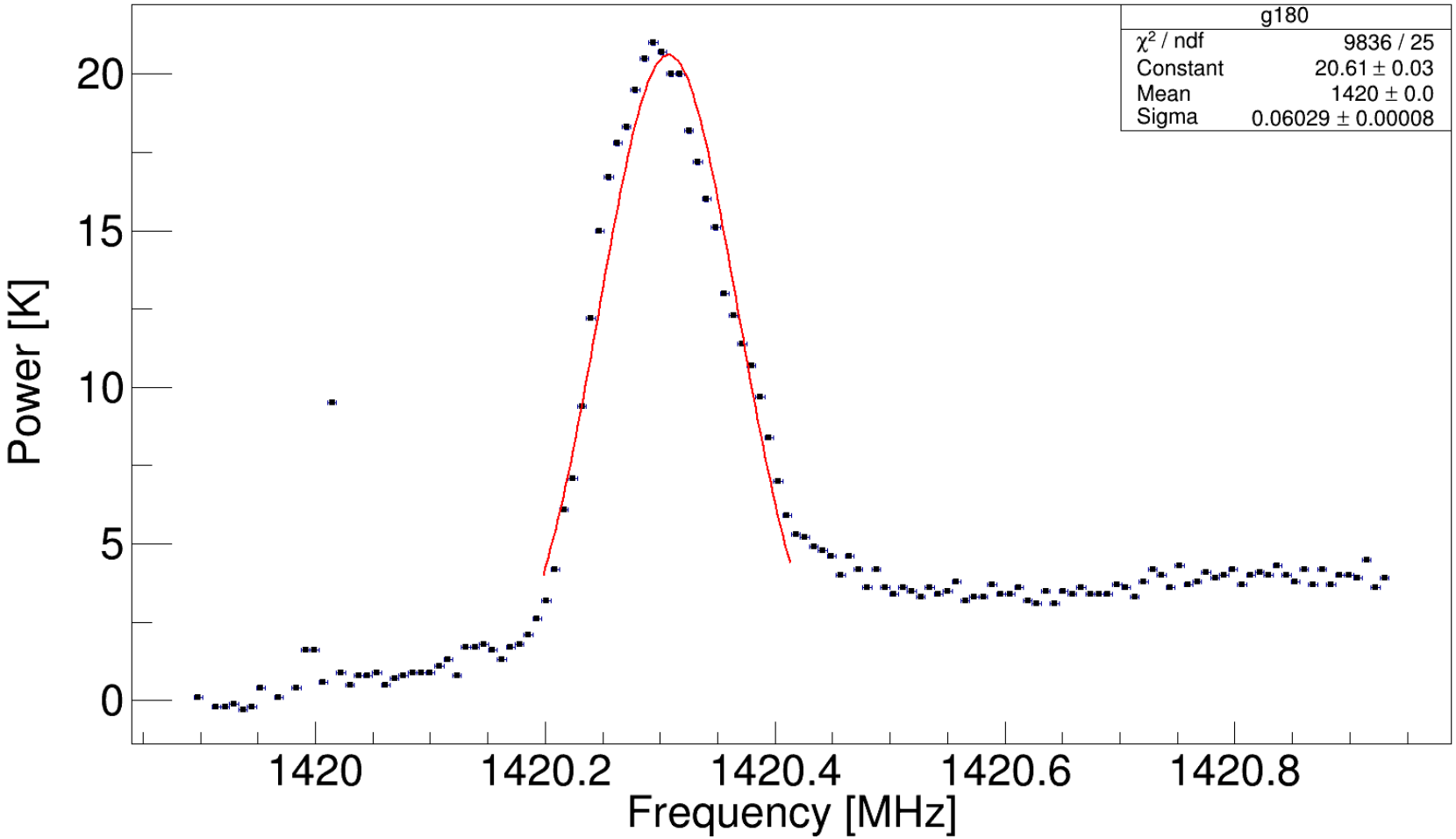
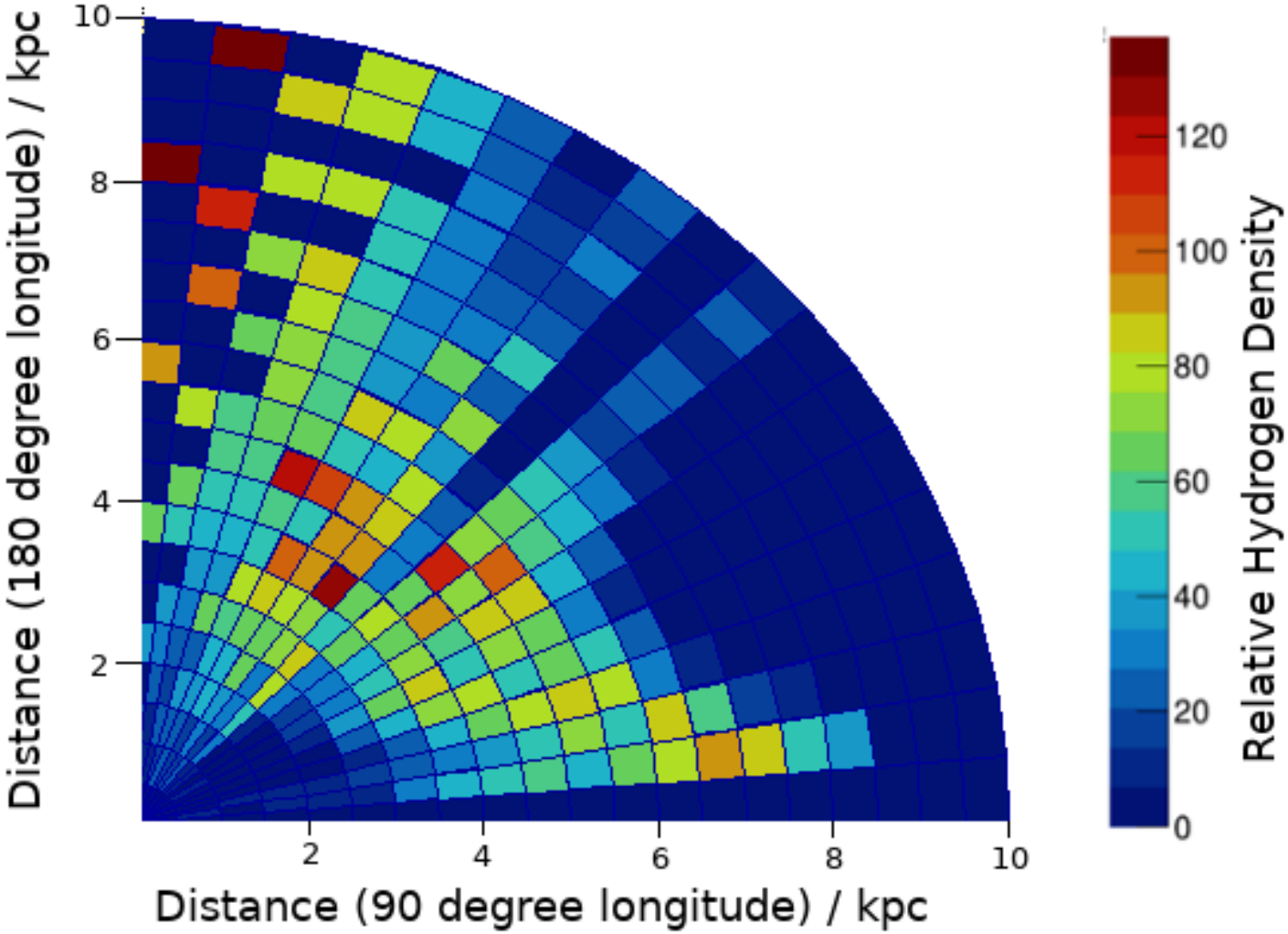
- Poissonian uncertainy in number of counts.

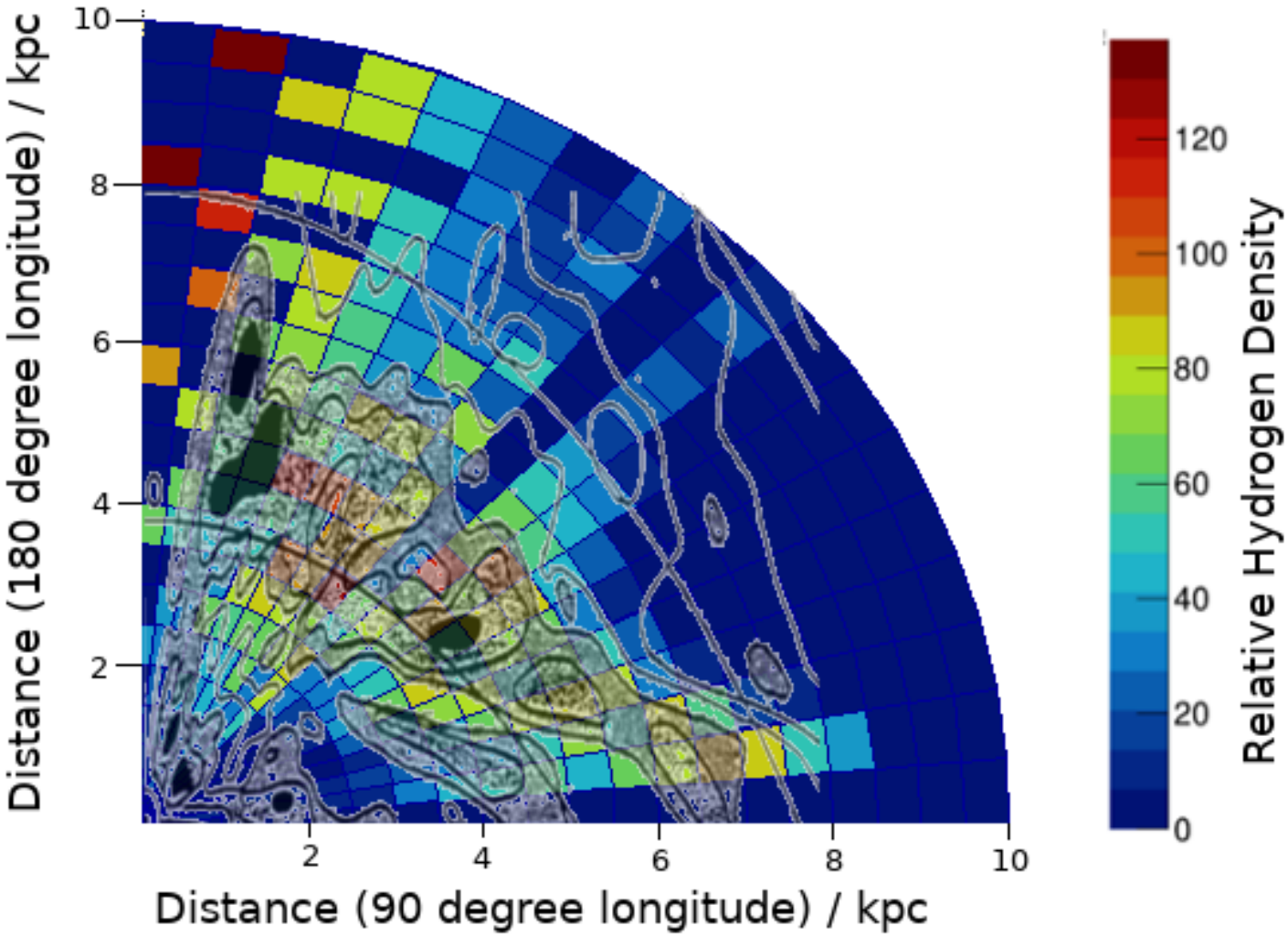
Thermal Broadening Irrelevant at Current Galactic Resolution



Hydrogen Mapping to Polar Histogram Indicates Spiral Arm



Hydrogen Mapping Agrees with Density Data



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- Resolution limited due to telescope size and thermal broadening, but qualitative features agree with literature.