The temperature of the diffuse H I in the Milky Way

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HI 21 cm emission: emission and absorption

Credit: NRAO/AUI, Dickey & Lockman

Roy et al. 2006
A large fraction of unstable gas?
Kinetic temperature \( (T_K) \)
- velocity distribution of the thermalized gas

Doppler temperature \( (T_D) \)
- thermal and non-thermal broadening of line

Spin temperature \( (T_S) \)
- Boltzmann distribution of population
HI 21 cm emission: emission and absorption

Roy et al. 2006

Credit: NRAO/AUI, Dickey & Lockman
Key Questions

- Can we detect “WNM” in H I 21 cm absorption?
  - Carilli et al. (1998), Dwarakanath et al. (2002) …
  - Lane et al. (2000), Braun & Kanekar (2005) …

- What is the “true” temperature distribution?

- How much gas, if any, is in unstable phase?
  - Heiles & Troland (2003) …
“WNM–in–absorption”

- H\textsuperscript{i} absorption study with GMRT & WSRT
- 34 sources: 23 (WSRT), 11 (GMRT), [+2 (ATCA)]
- Bright, compact sources; deep integration …
- High spectral resolution, good bandpass
- Aim to detect 8000 K gas for $N_{\text{HI}} \sim 10^{20} \text{ cm}^{-2}$
Example spectrum
Example spectrum

1924-292 (GMRT)

\[ V_{lsr} \text{ (km s}^{-1}) \]

\[ \tau \]
Emission/absorption and $T_s$ spectra
Column density distribution (~1 km/s resolution)
Cold gas fraction for individual lines of sight

![Graph showing cold gas fraction vs isothermal HI column density. The graph has a scatter plot with red data points. The x-axis represents isothermal HI column density (N(HI, ISO) in cm⁻²), and the y-axis represents the CNM fraction for Tₗ(CNM) = 200 K. The data points show a range of values.]
All absorption is definitely NOT from cold gas ...
Gaussian decomposition: data, model, residual …
Component statistics
Warm phase: stable or unstable?
All absorption is definitely NOT from stable gas ...
Conclusions

- Sensitive H\textsubscript{i} observations can detect WNM in absorption.
- Measured $T_s$ values suggest a mix of cold and warm gas.
- At least $\sim 50\%$ gas, on an average, is in the WNM phase.
- But, very few ($< 5\%$) stable WNM Gaussian components!
- Comparable thermal and non-thermal line width.
- Definite signature of “unstable” phase gas ($> \sim 30\%$) for at least $40\%$ of the lines of sight.
Thank you!
Sky distribution: towards compact background sources
Detection SNR of possible warm gas
$T_B - \tau - T_S$ relation (~1 km/s resolution)
Possible handle on non-thermal broadening ...
Variation of component properties with Galactic (l,b)