The temperature of the diffuse HI in the Milky Way

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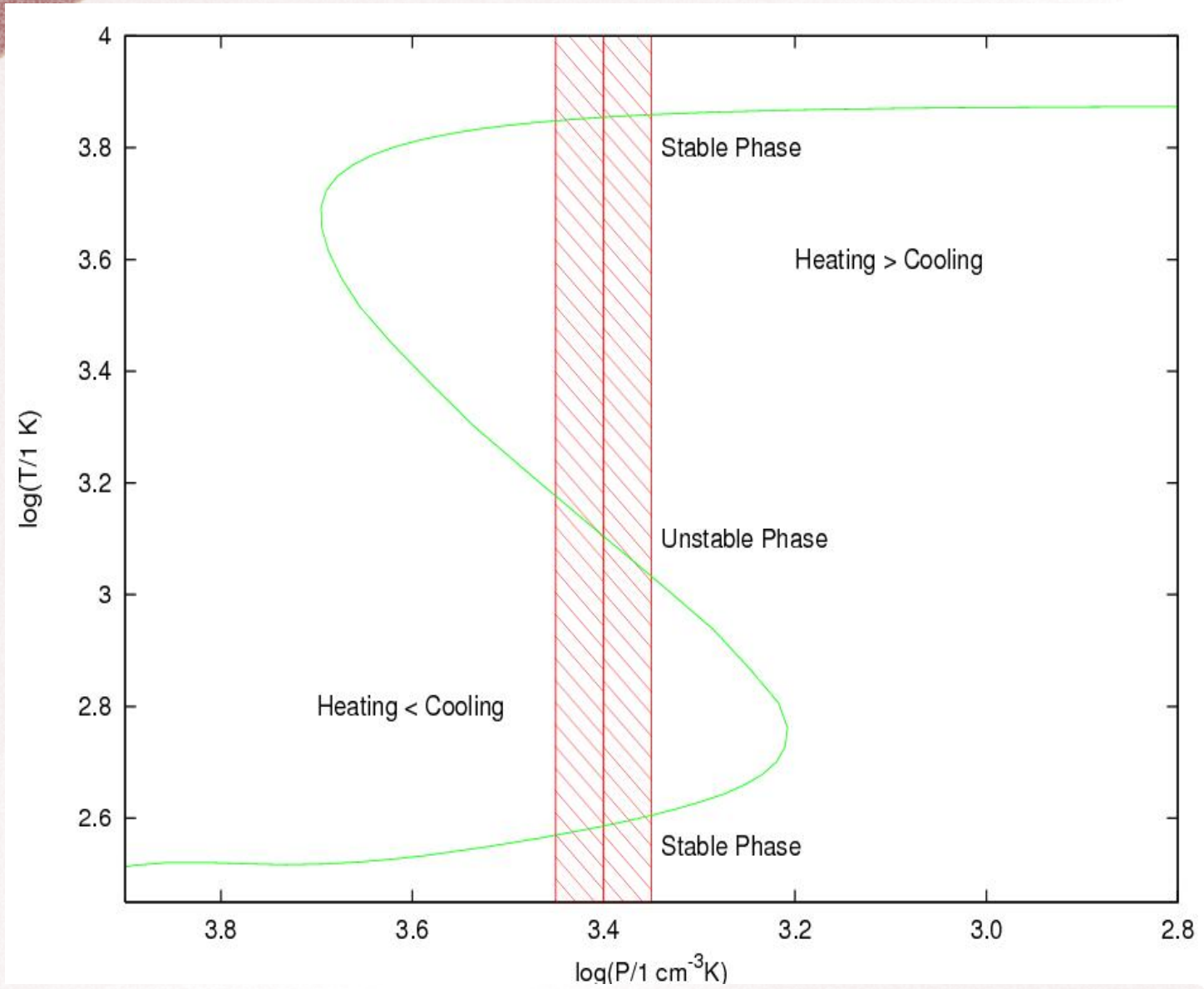
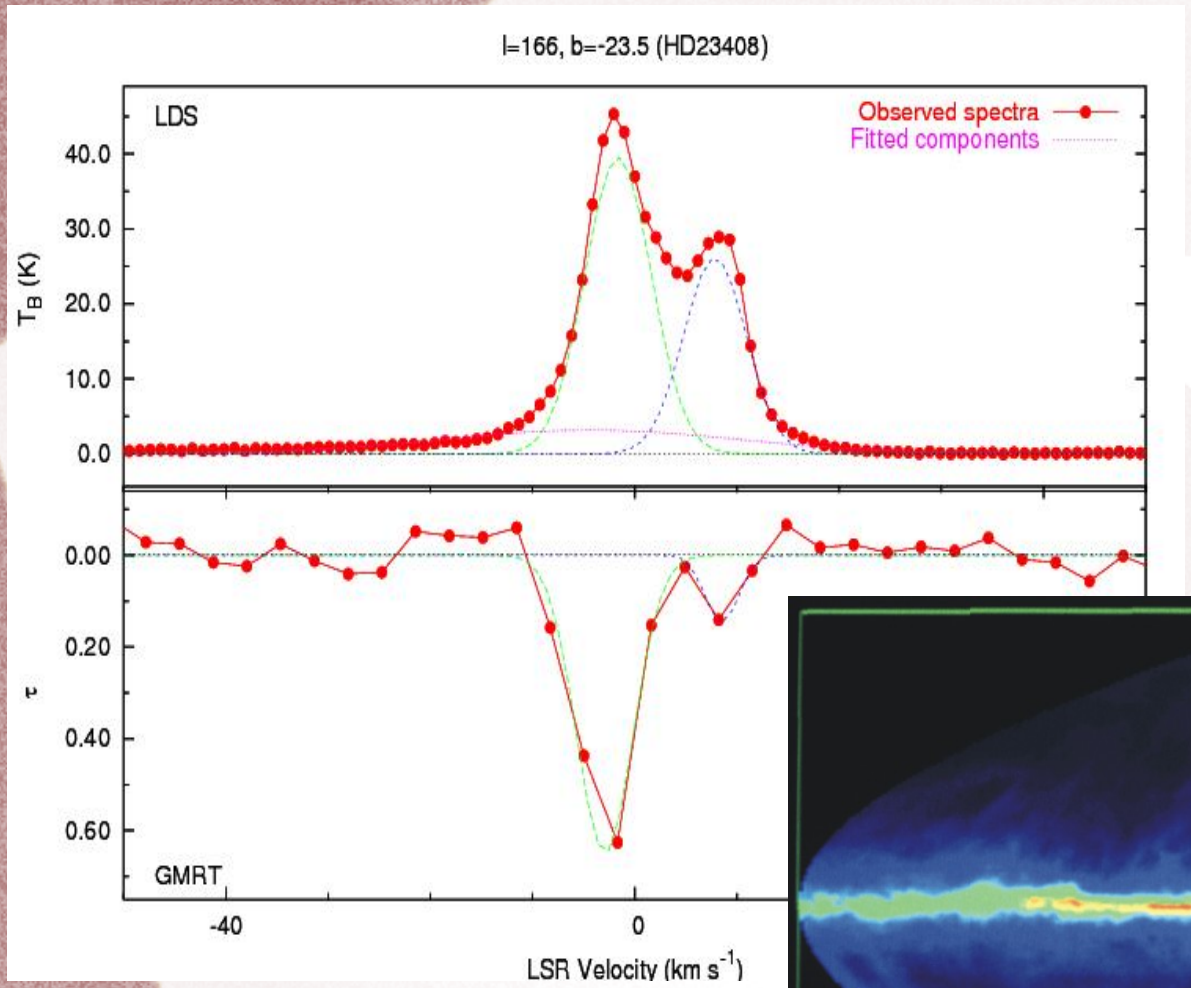
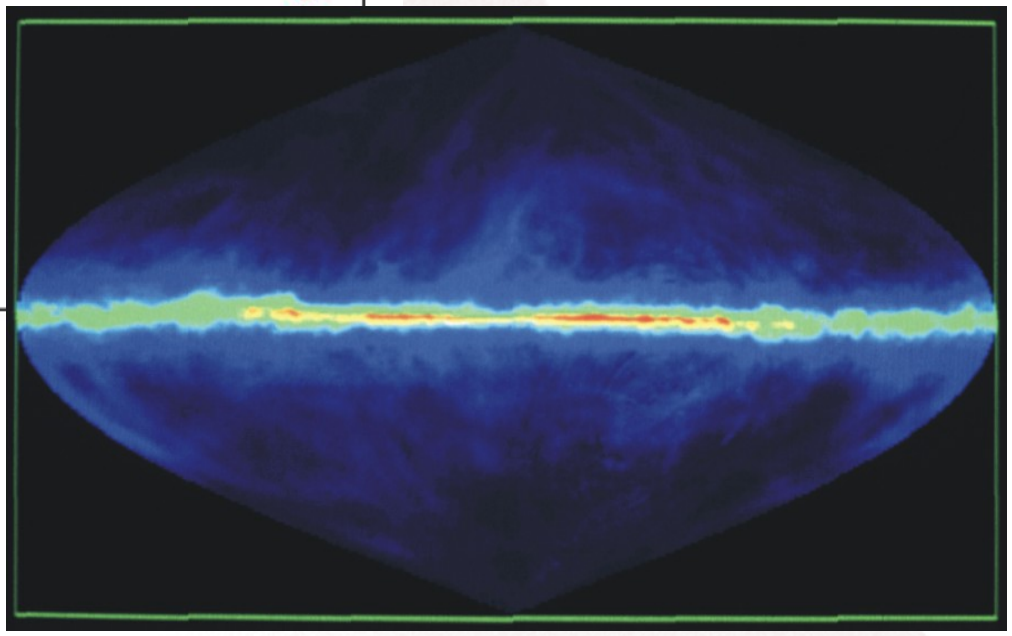
The multiphase atomic ISM: a schematic



H I 21 cm emission: emission and absorption

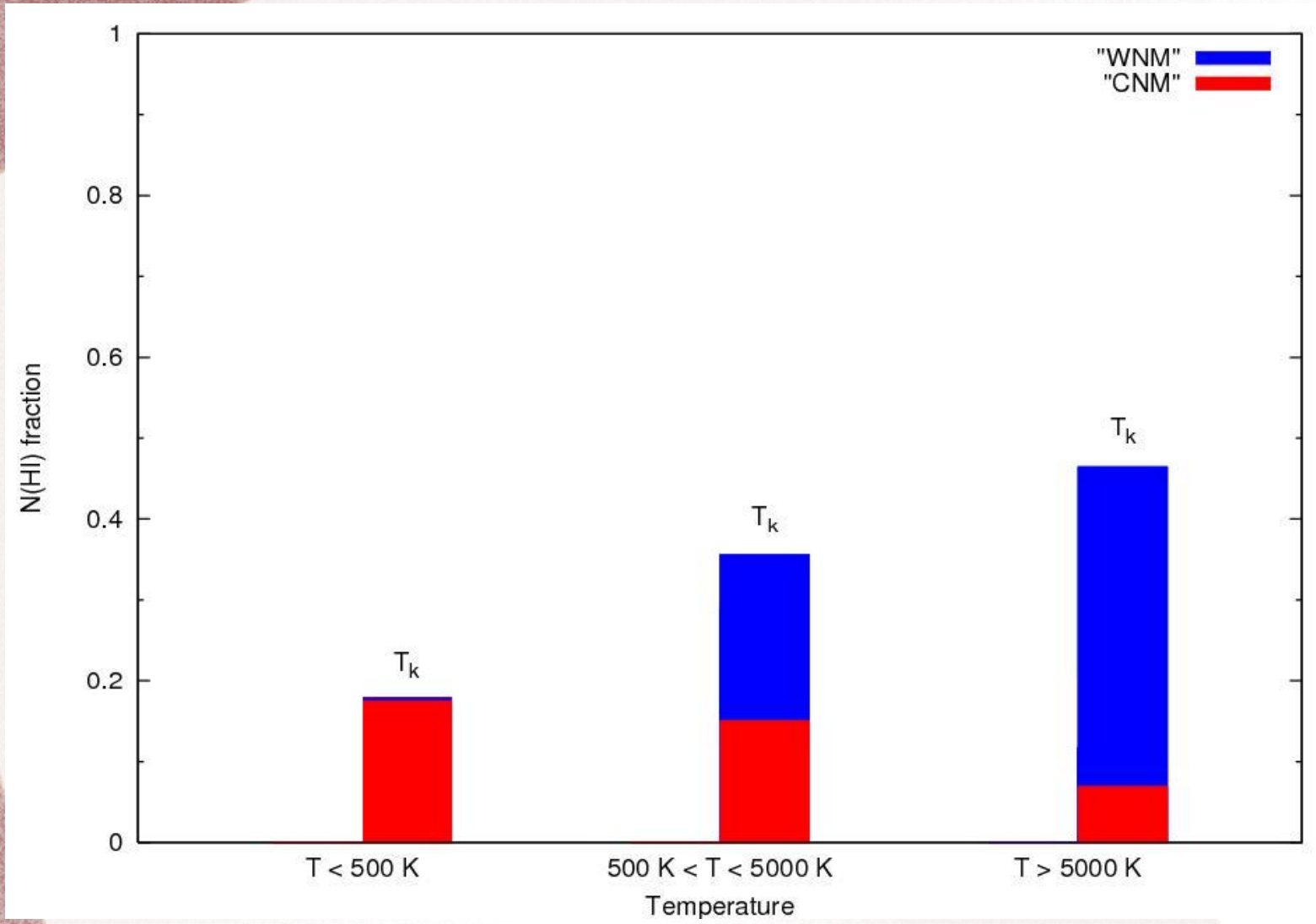


Roy et al. 2006



Credit: NRAO/AUI, Dickey & Lockman

A large fraction of unstable gas?

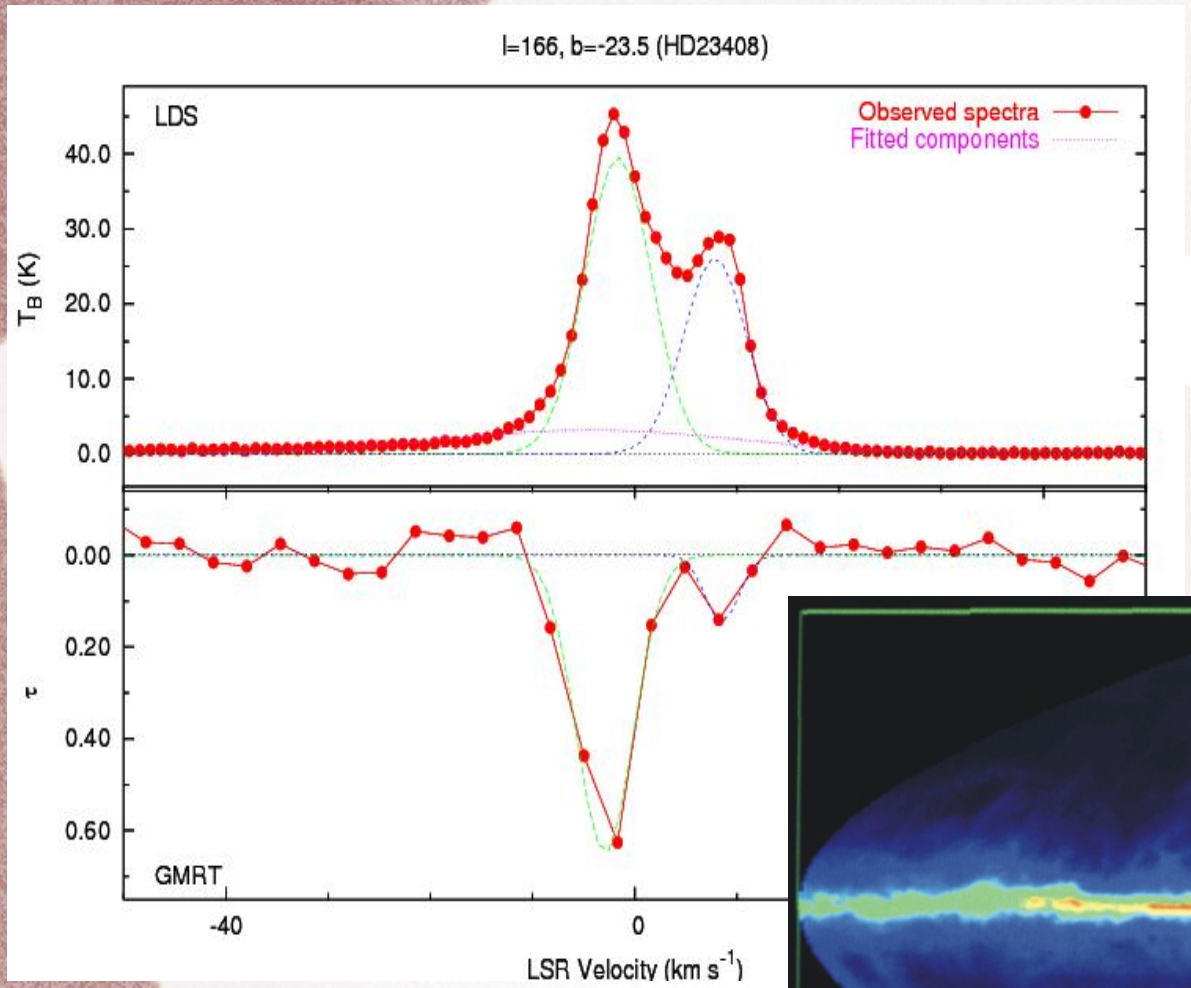


Arecibo Millennium survey (Heiles & Troland 2003)

Caution: a variety of temperatures …

- **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

H I 21 cm emission: emission and absorption



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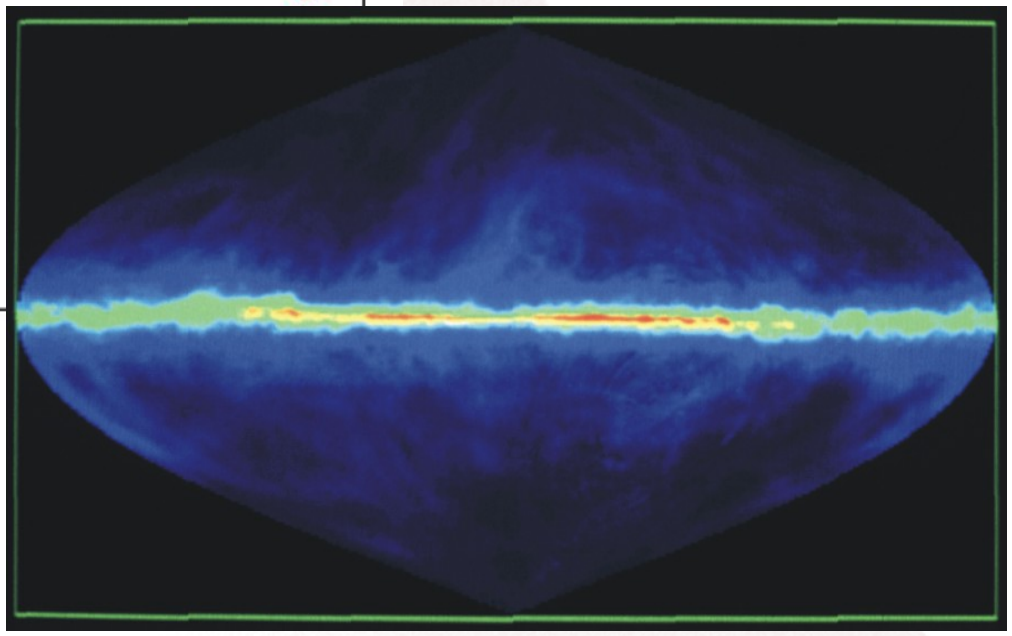


Credit: NRAO/AUI, Dickey & Lockman

Key Questions

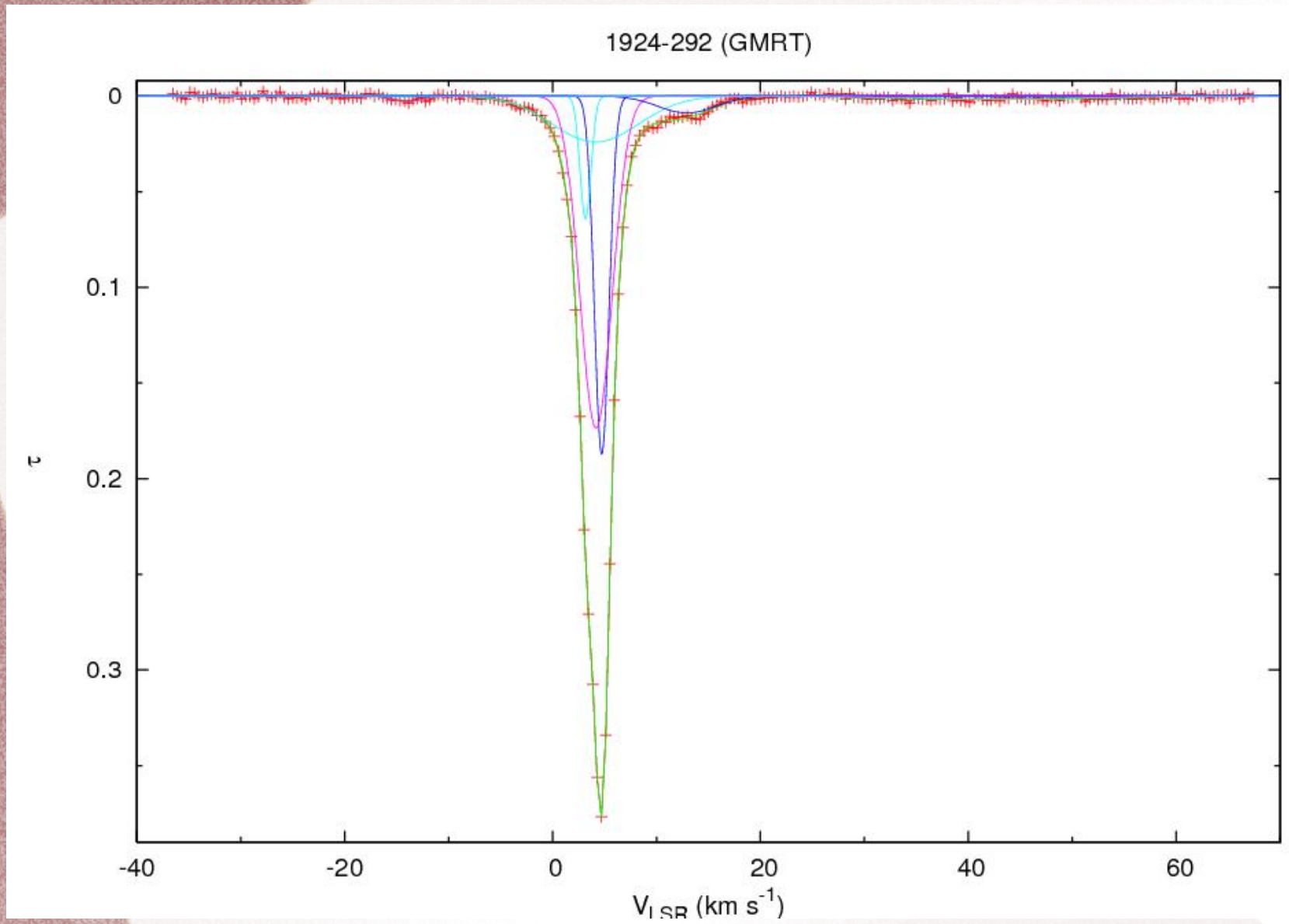
- **Can we detect "WNM" in H I 21 cm absorption?**
  - **Carilli et al. (1998), Dwarakanath et al. (2002) …**
  - **Lane et al. (2000), Braun & Kanekar (2005) …**
- **What is the "true" temperature distribution?**
- **How much gas, if any, is in unstable phase?**
  - **Heiles & Troland (2003) …**
  - **McKee & Ostriker (1977), Wolfire et al. (1995, 2003) …**

"WNM–in–absorption"

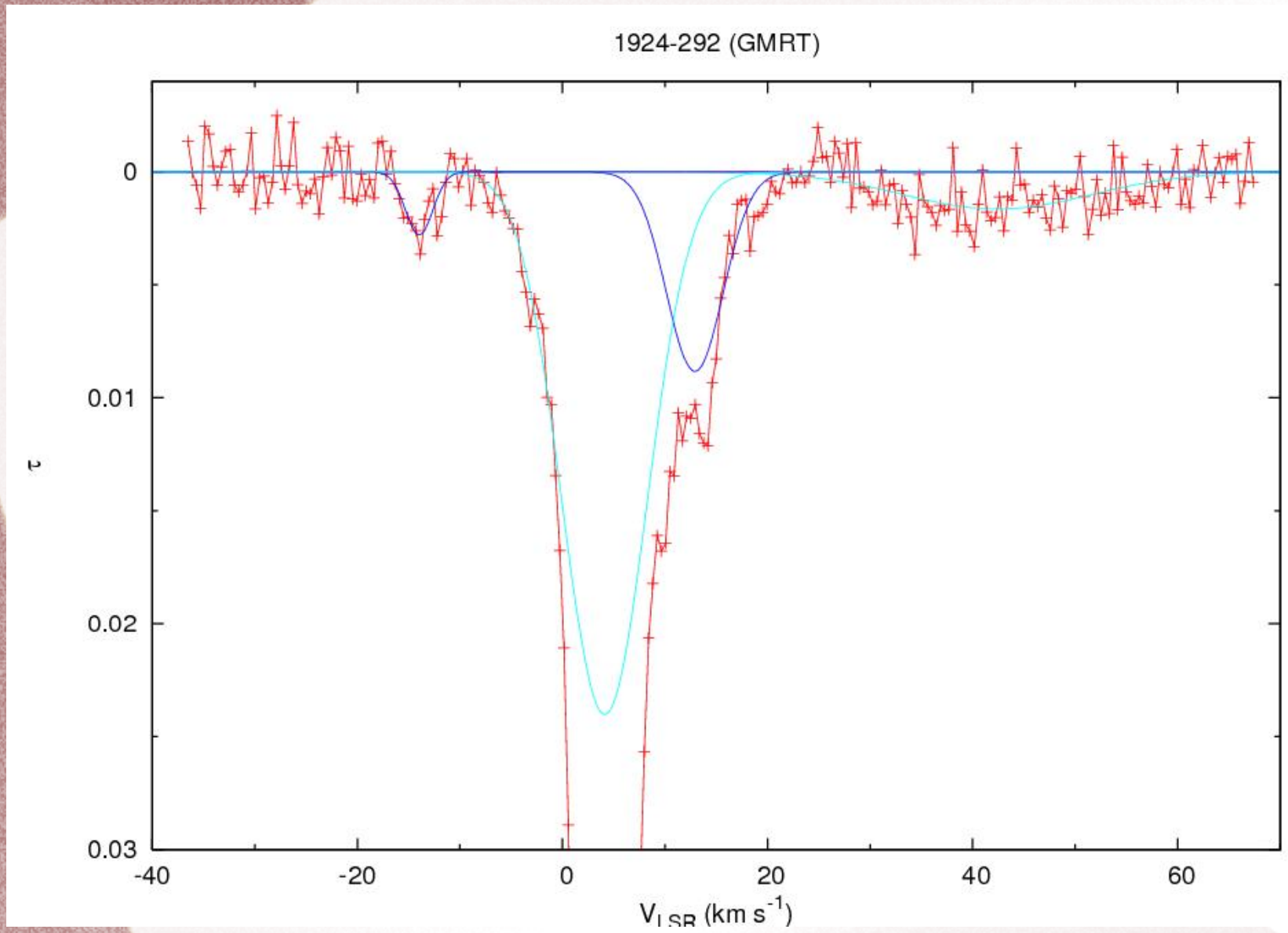
- H I absorption study with GMRT & WSRT
- 34 sources: 23 (WSRT), 11 (GMRT), [+2 (ATCA)]
- Bright, compact sources; deep integration …
- High spectral resolution, good bandpass
- Aim to detect 8000 K gas for $N_{HI} \sim 10^{20}\,cm^{-2}$



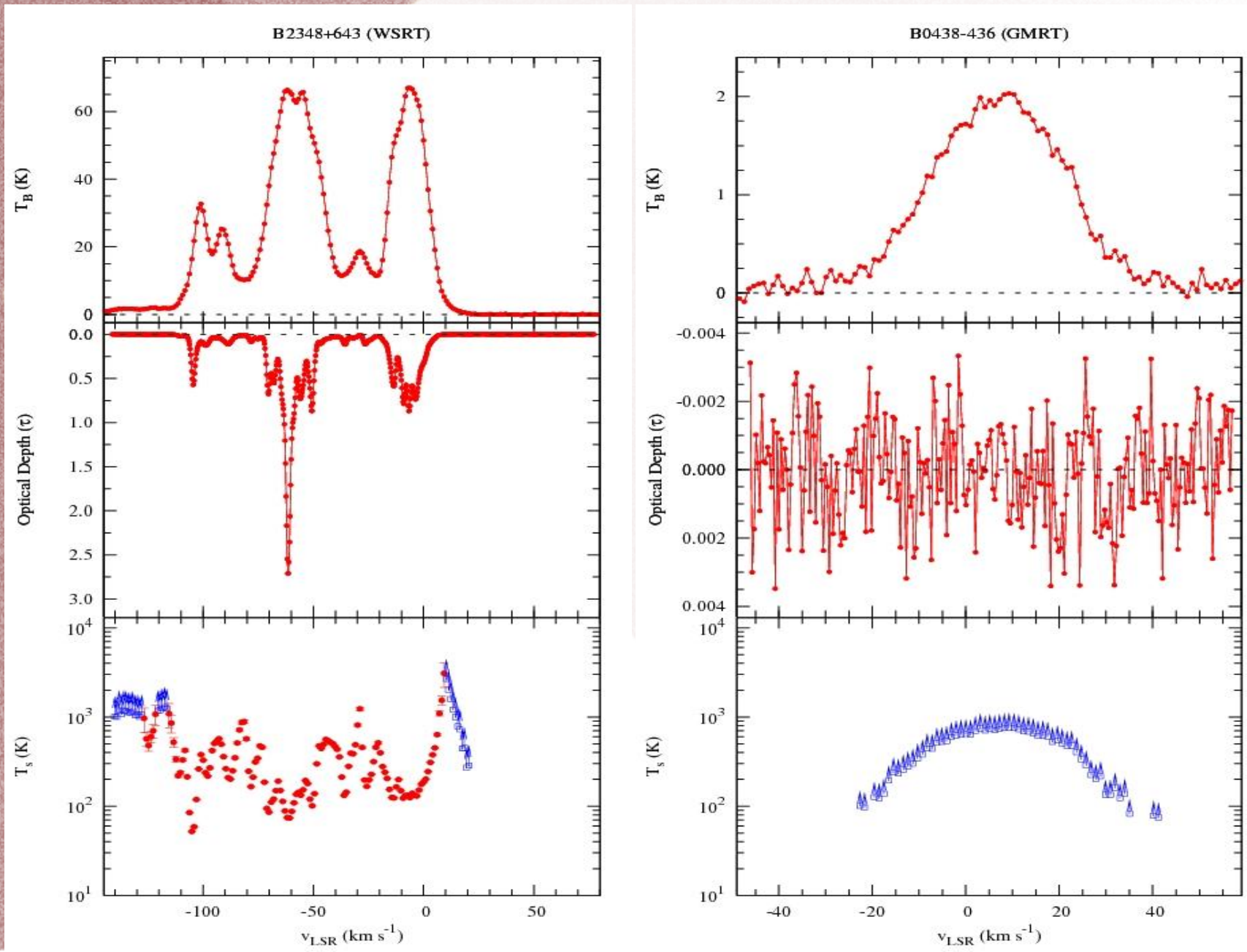
Example spectrum



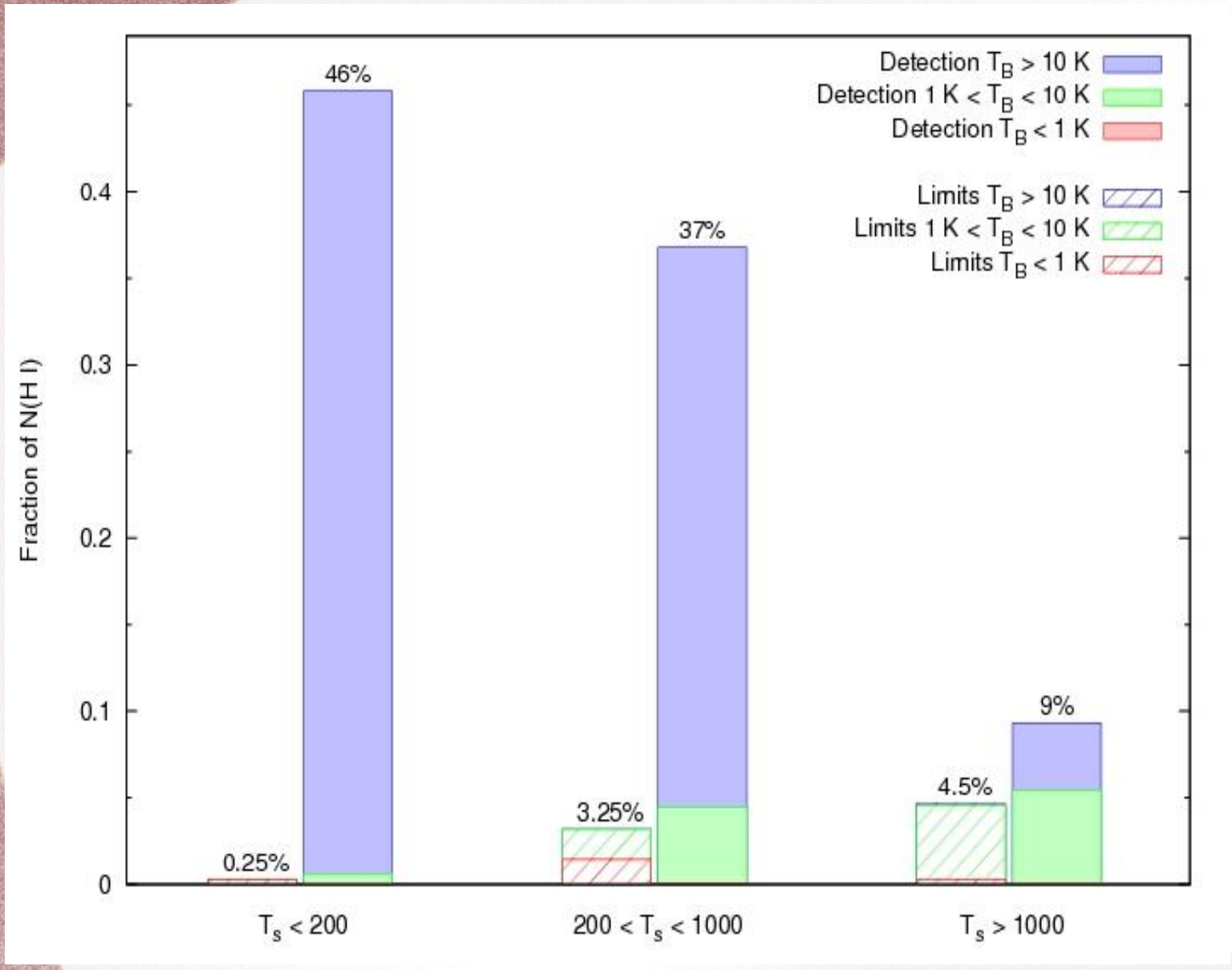
Example spectrum



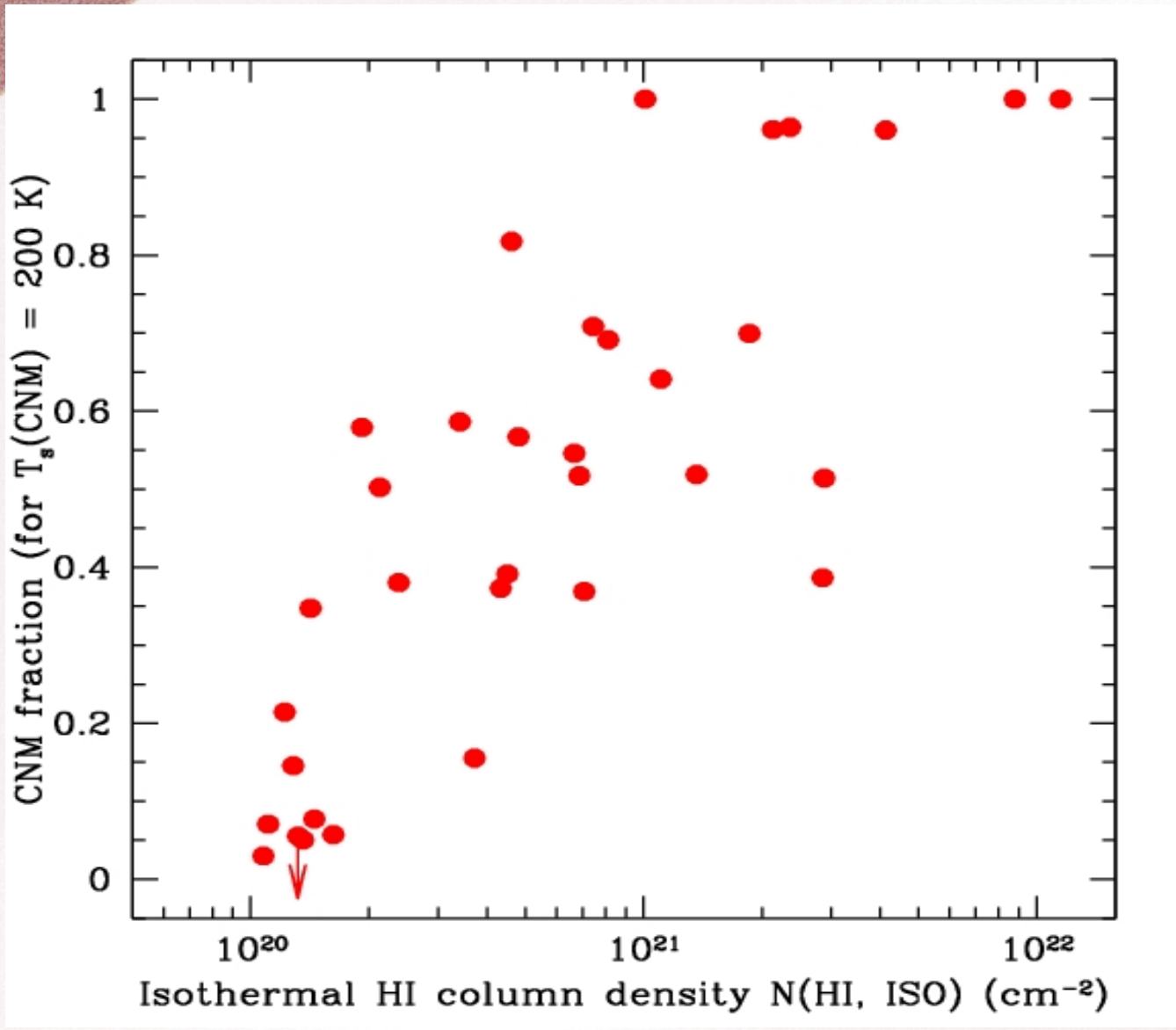
Emission/absorption and T_S spectra



Column density distribution (~1 km/s resolution)

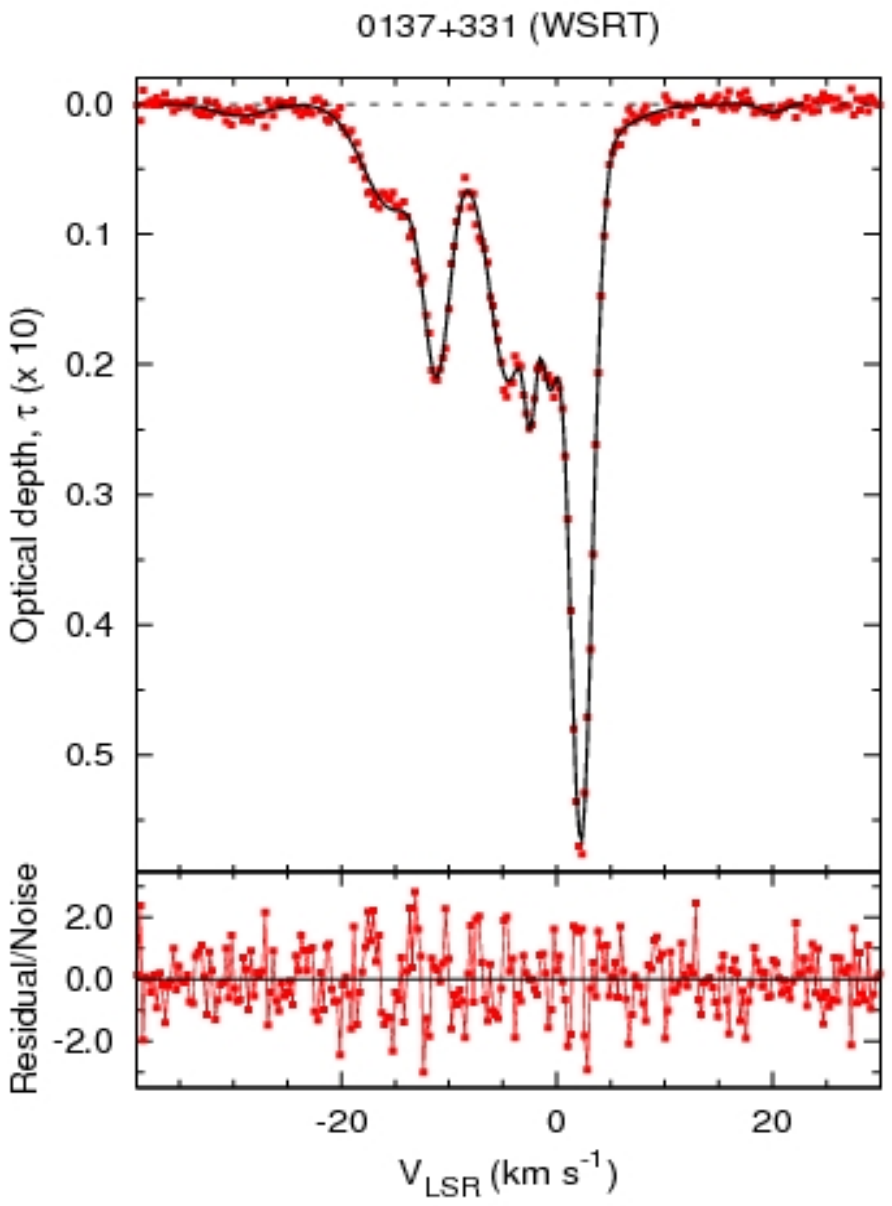


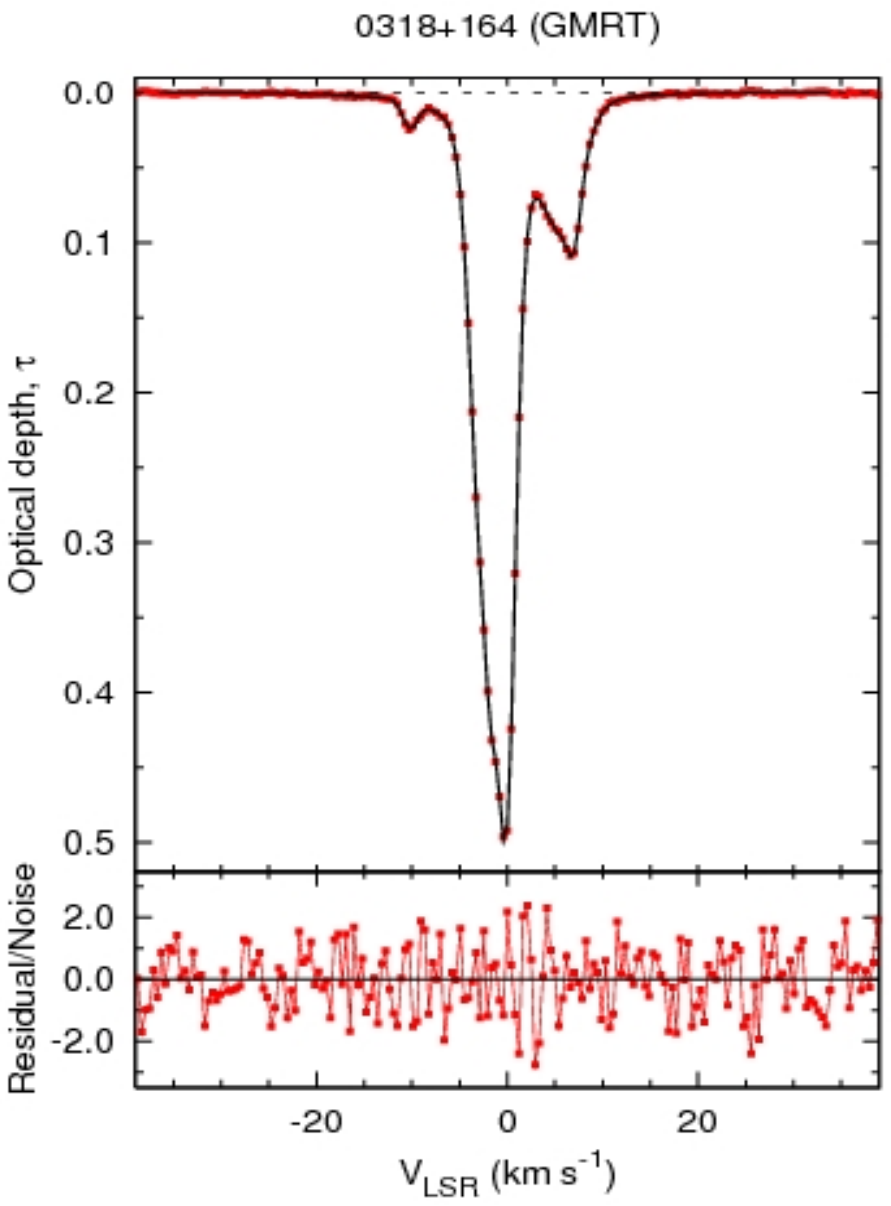
Cold gas fraction for individual lines of sight



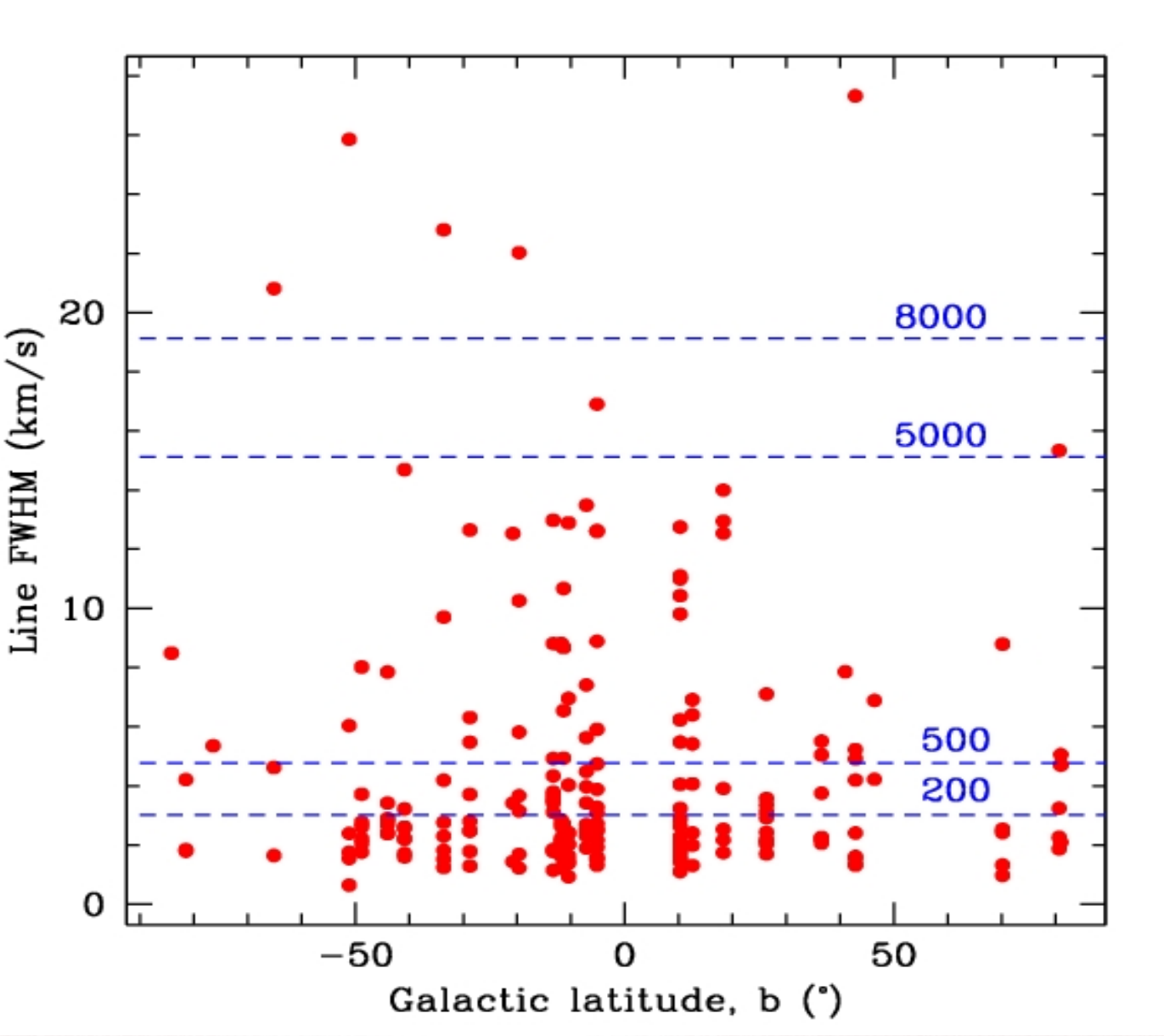
All absorption is definitely NOT from cold gas …

Gaussian decomposition: data, model, residual …

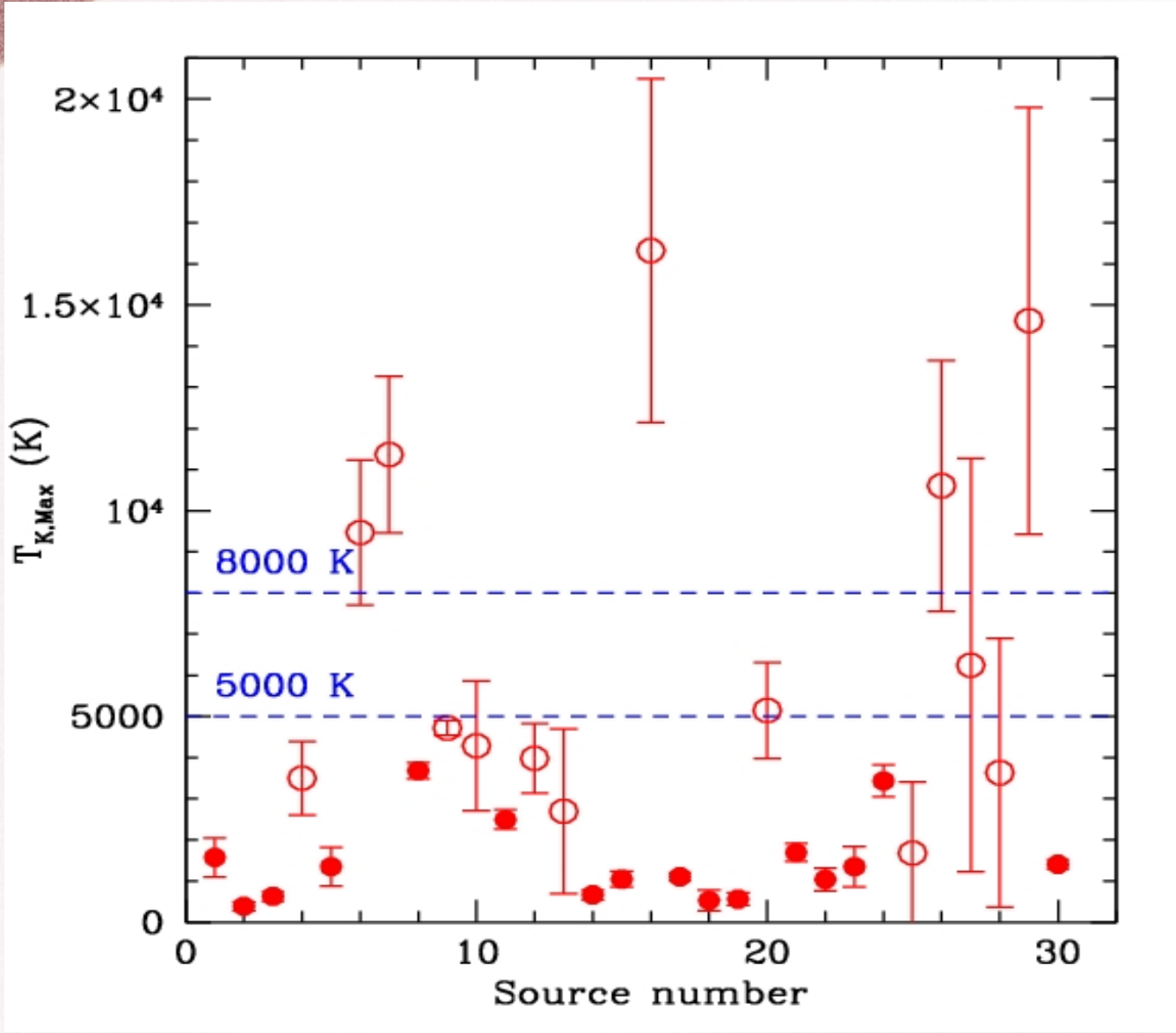




Component statistics



Warm phase: stable or unstable?



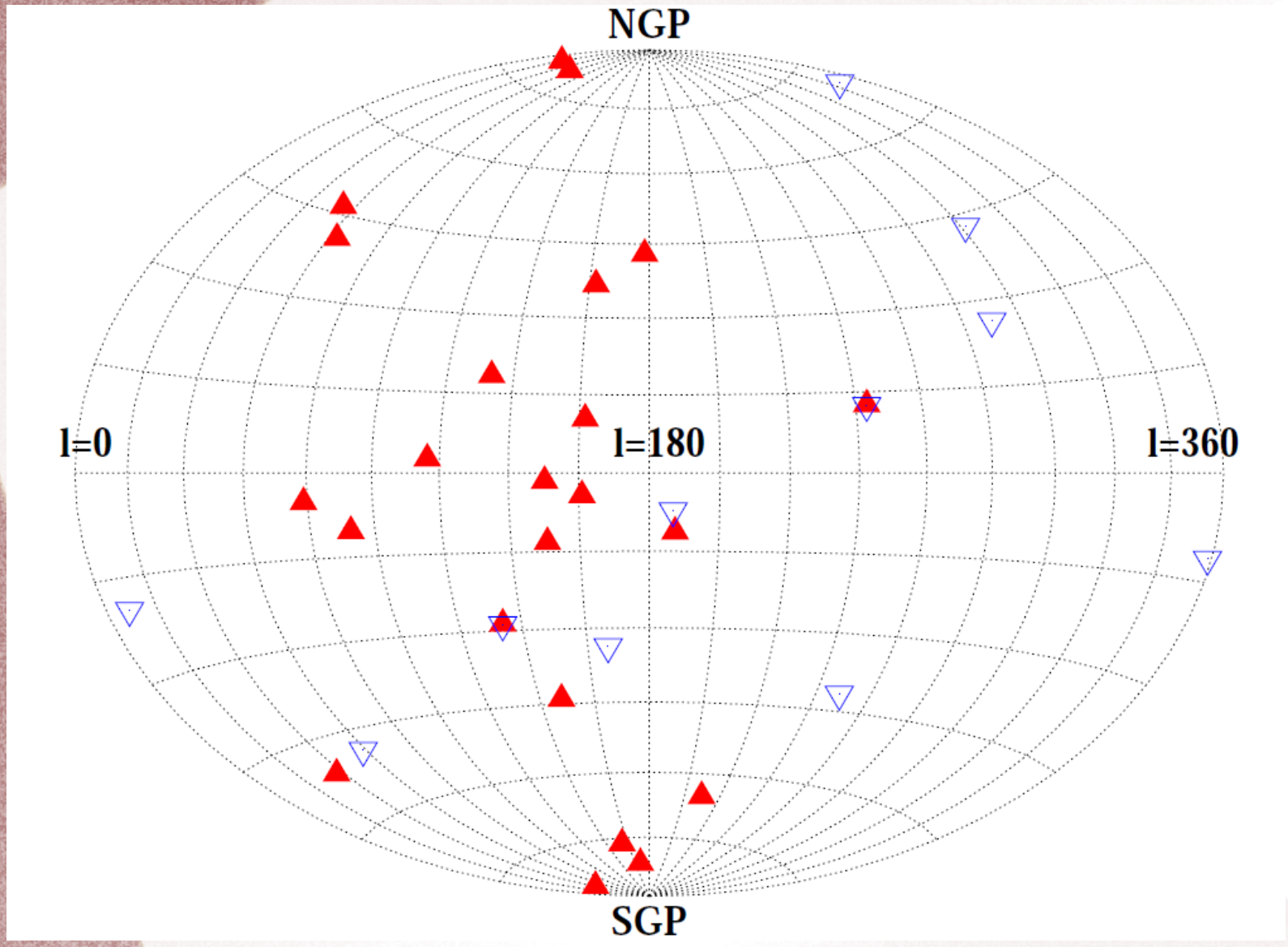
All absorption is definitely NOT from stable gas …

Conclusions

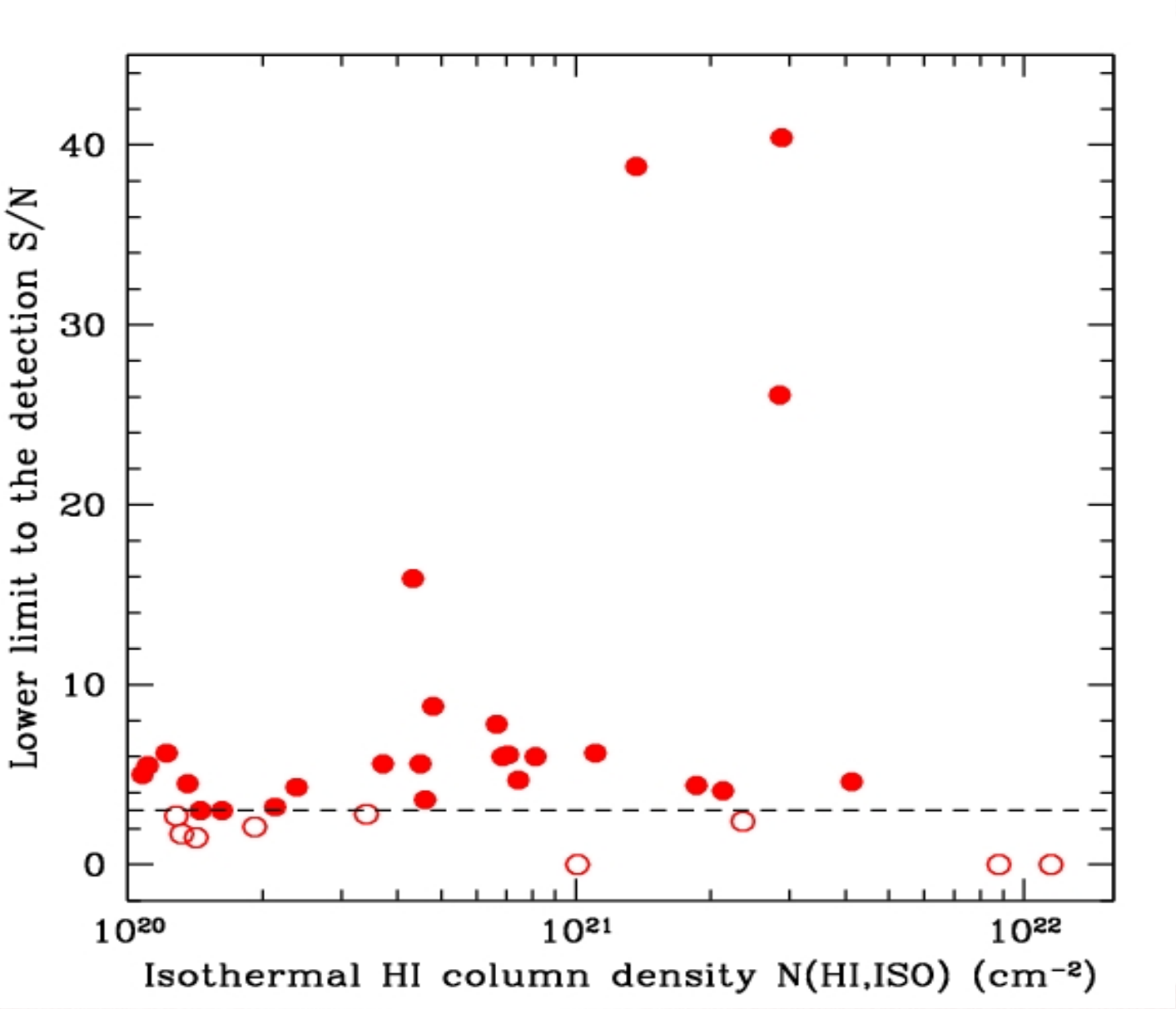
- Sensitive H I observations can detect WNM in absorption
- Measured T_s values suggest a mix of cold and warm gas
- At least ~ 50% gas, on an average, is in the WNM phase
- But, very few (< 5%) stable WNM Gaussian components!
- Comparable thermal and non-thermal line width
- Definite signature of “unstable” phase gas (> ~ 30%) for at least 40% of the lines of sight.

Thank you!

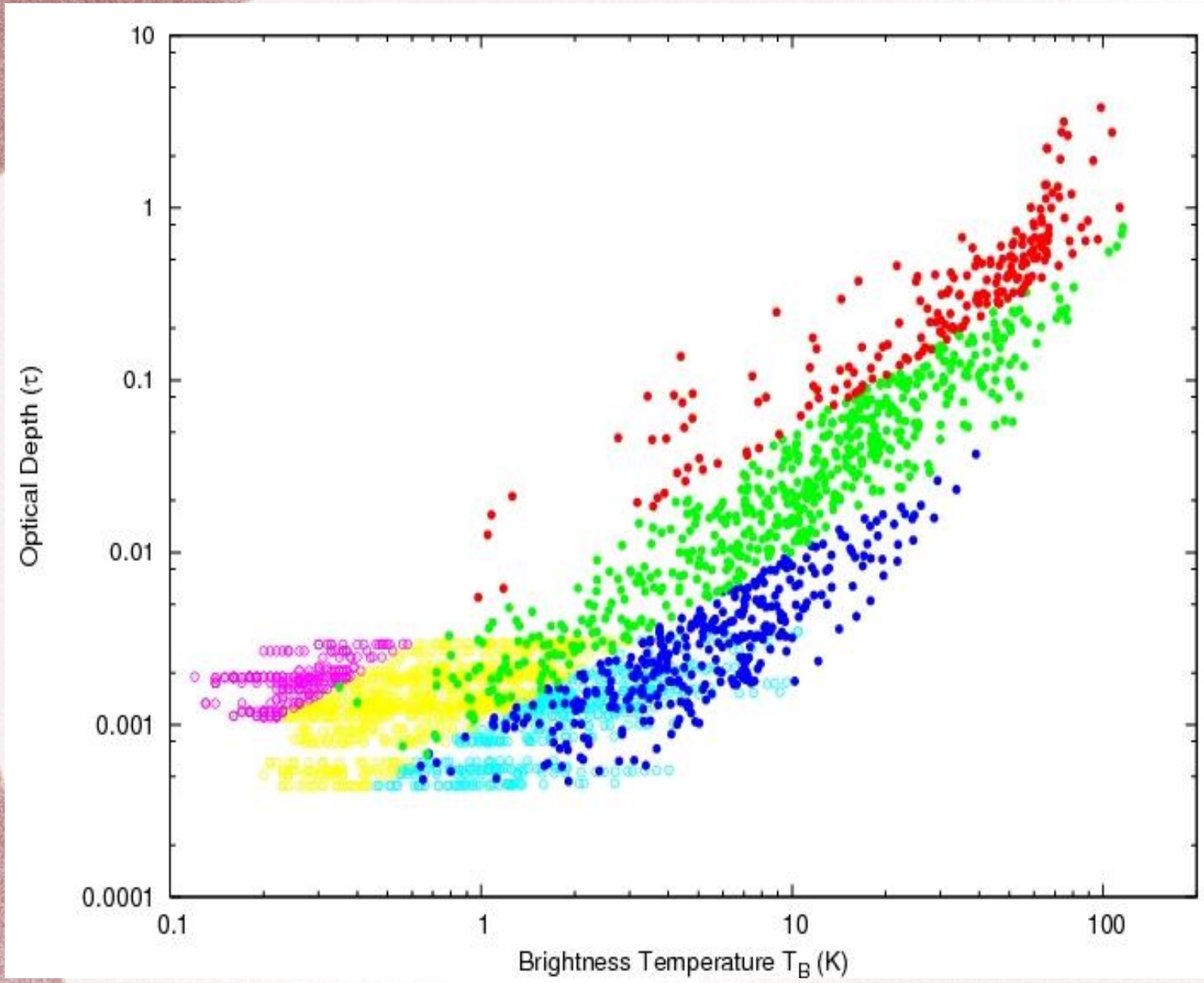
Sky distribution: towards compact background sources



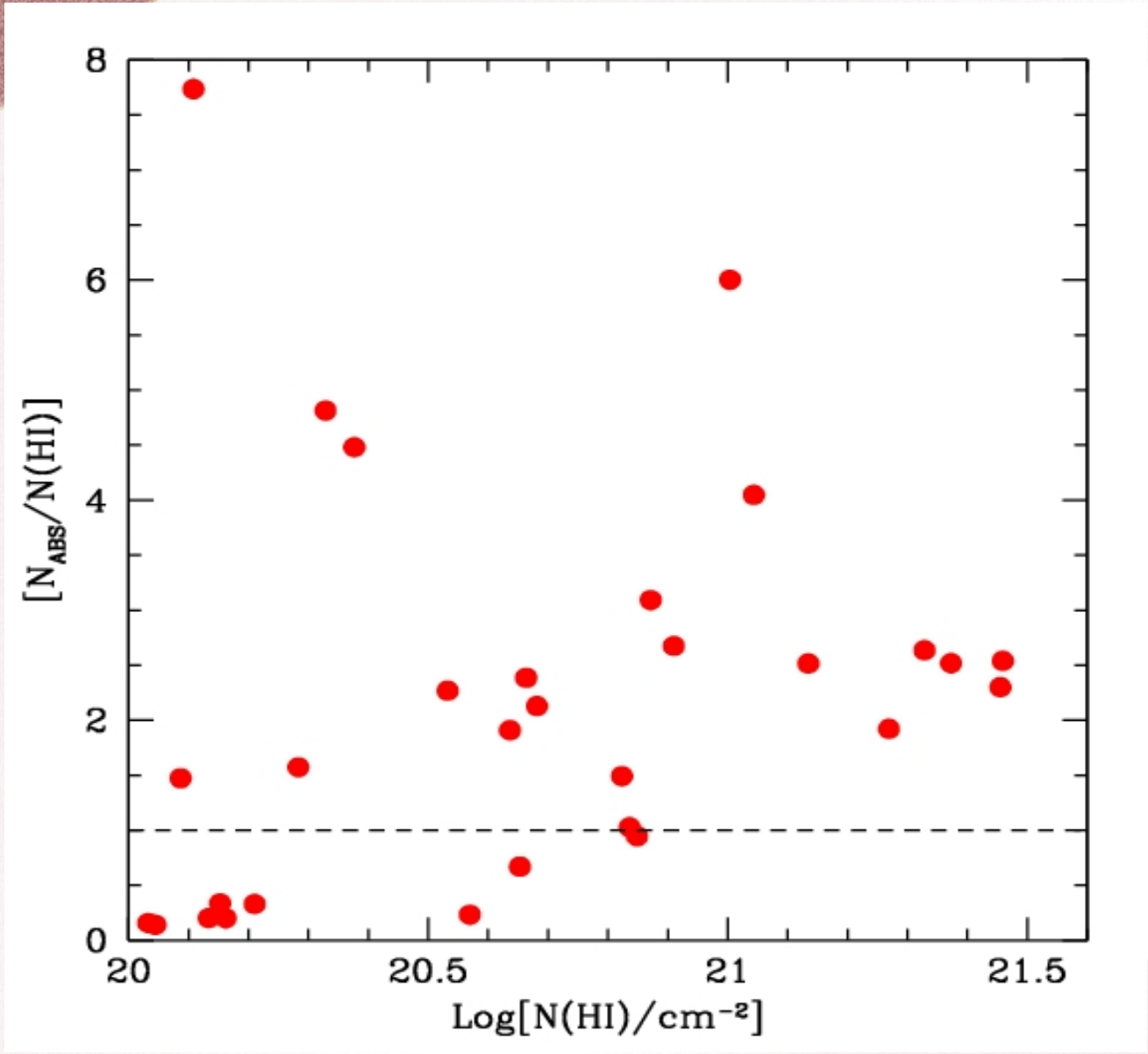
Detection SNR of possible warm gas



$T_B - \tau - T_S$ relation (~1 km/s resolution)



Possible handle on non-thermal broadening …



Variation of component properties with Galactic (l,b)