Infall as a Function of Position and Molecular Tracer in Dense Cores

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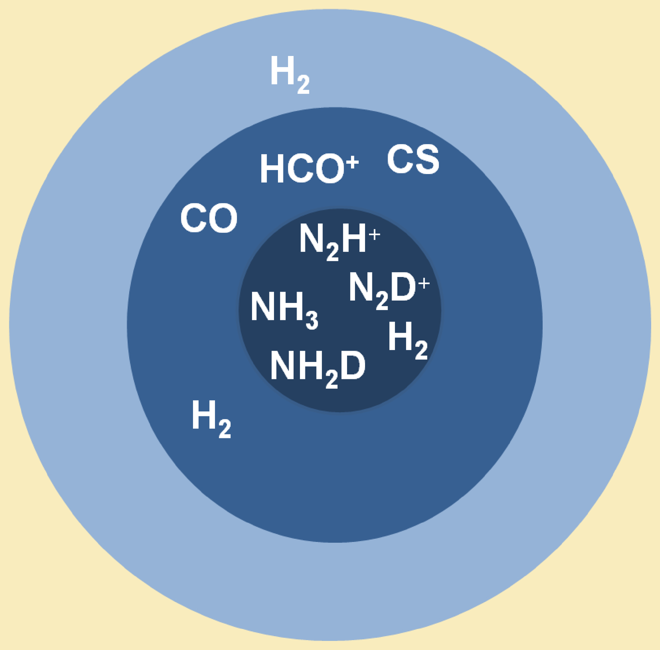
1. Abstract

➢ The standard model of core collapse suggests that this process works from the inside and moves outwards, with the fastest motions at the center. The relative abundances of many molecules also vary within cores, with certain molecules found only in specific regions characterized by narrow ranges of temperature and density. These characteristics lead to the hypothesis that the observed infall speeds in starless cores depend on both the position of the observations and the molecular tracer chosen.

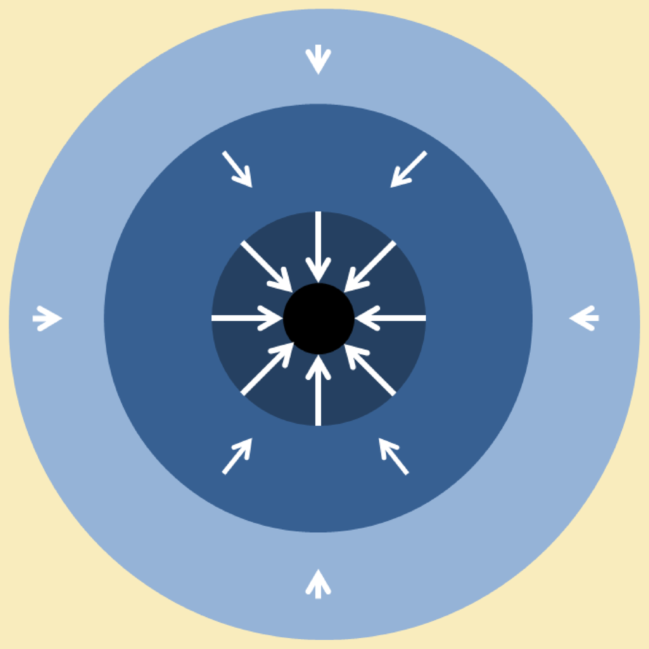
➢ Although surveys of infall motions in dense cores have been carried out for years, very few surveys have been awarded enough time to map infall across cores using multiple spectral line observations. To fill this gap, we present IRAM 30m maps of N_2H^+(1-0), DCO^+(2-1), DCO^+(3-2) and HCO^+(3-2) towards two prestellar cores (L1544 and L694) and one protostellar core (L1521f).

➢ We find that the measured infall velocity varies as a function of position across each core and varies with the choice of molecular line, likely as a result of radial variations in core chemistry and dynamics.

2. Introduction



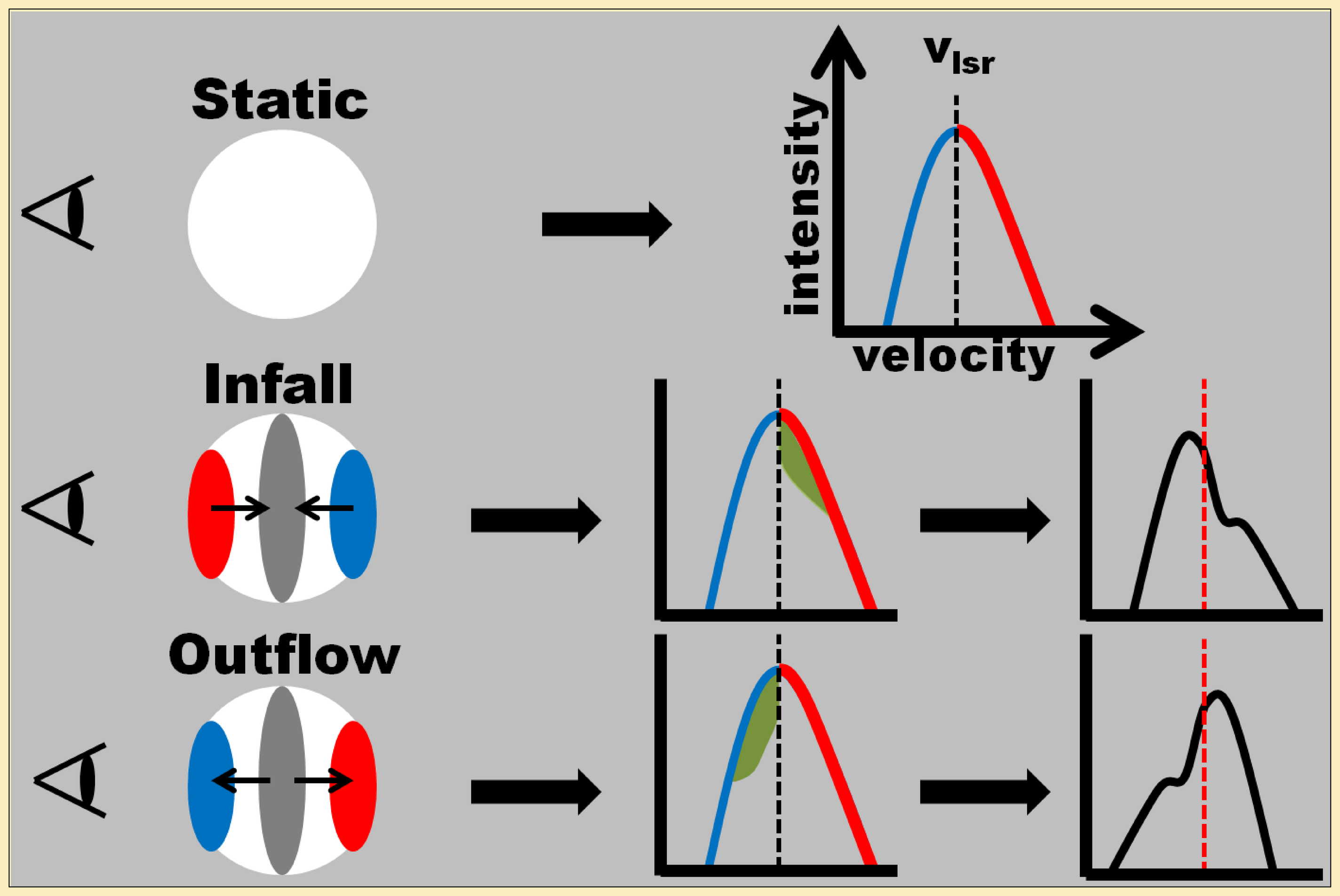
Left: Molecular abundances vary with position inside a core. Therefore, different molecules can be used to trace the properties of certain regions of the core.



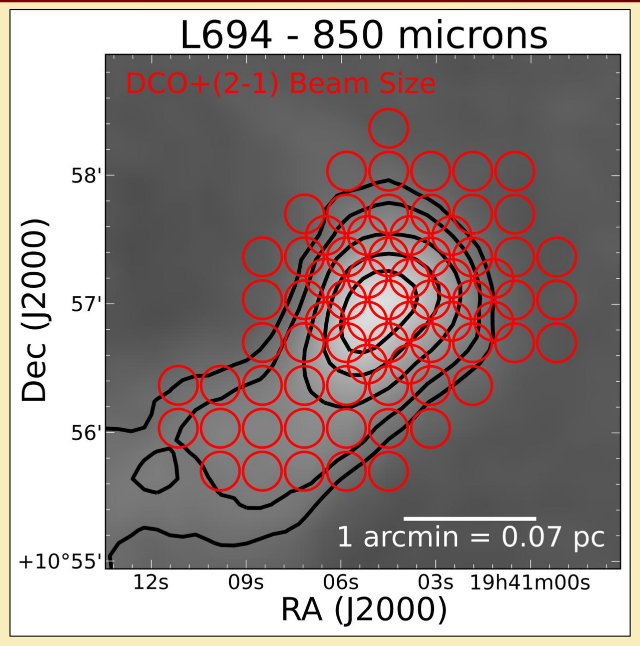
Right: Infall speeds are theorized to decrease with distance from the core center. This suggests that observed infall velocities should show a spatial dependency.

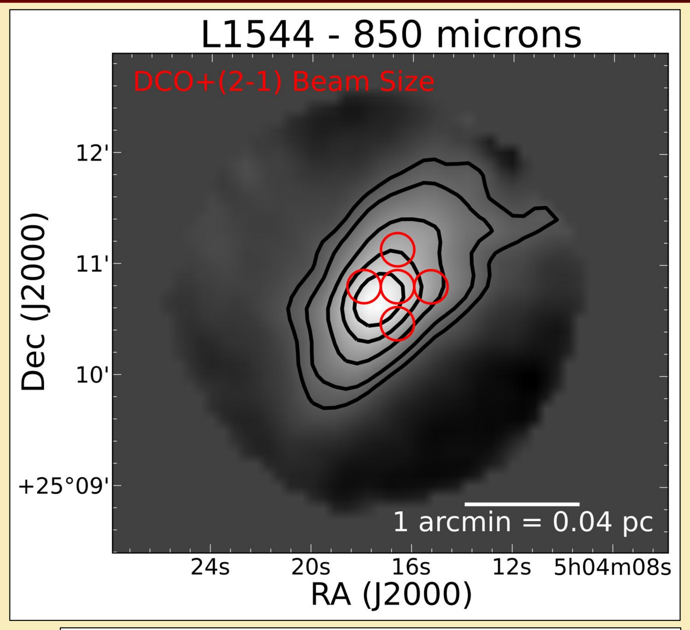
3. Spectral Asymmetries

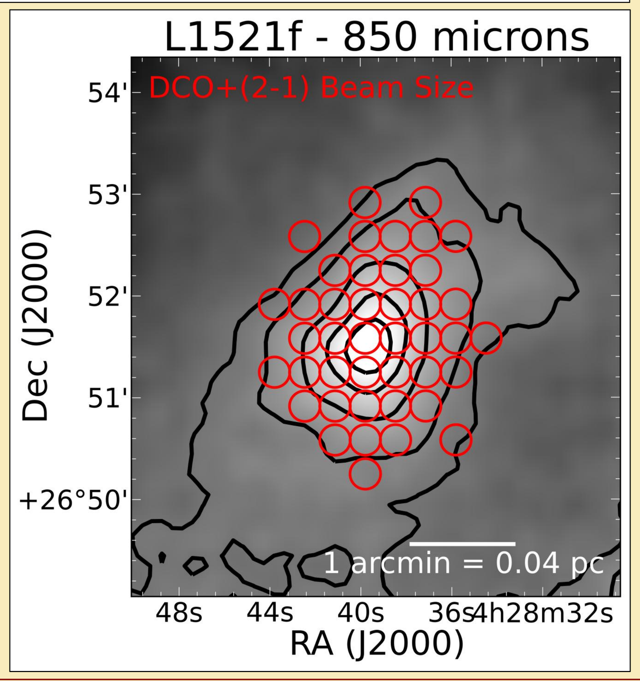
Asymmetric emission line profiles are signatures of collapsing and expanding cores. Based on the shape of the spectra, one can determine how fast or slow a core is either collapsing (infall) or expanding (outflow).



4. Observations





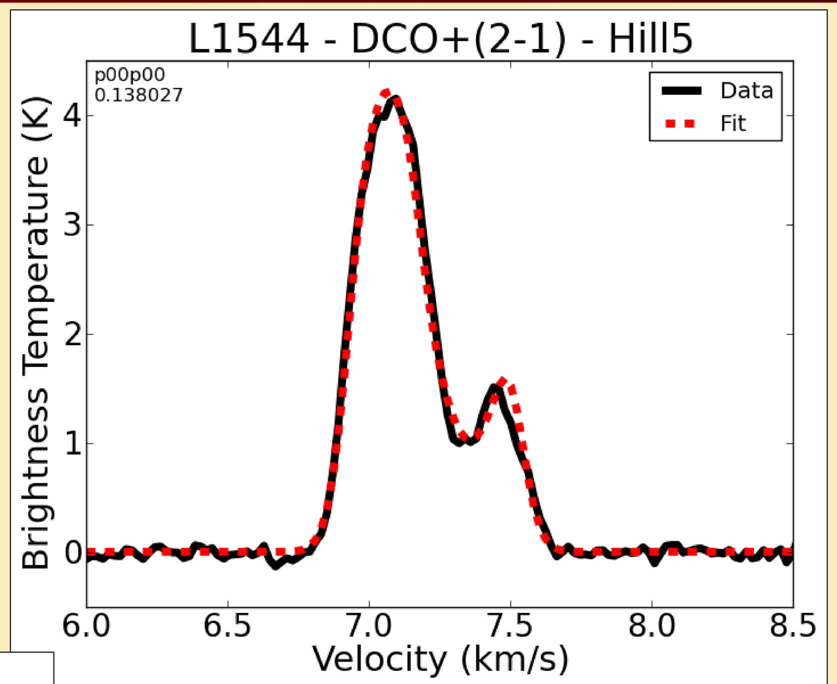


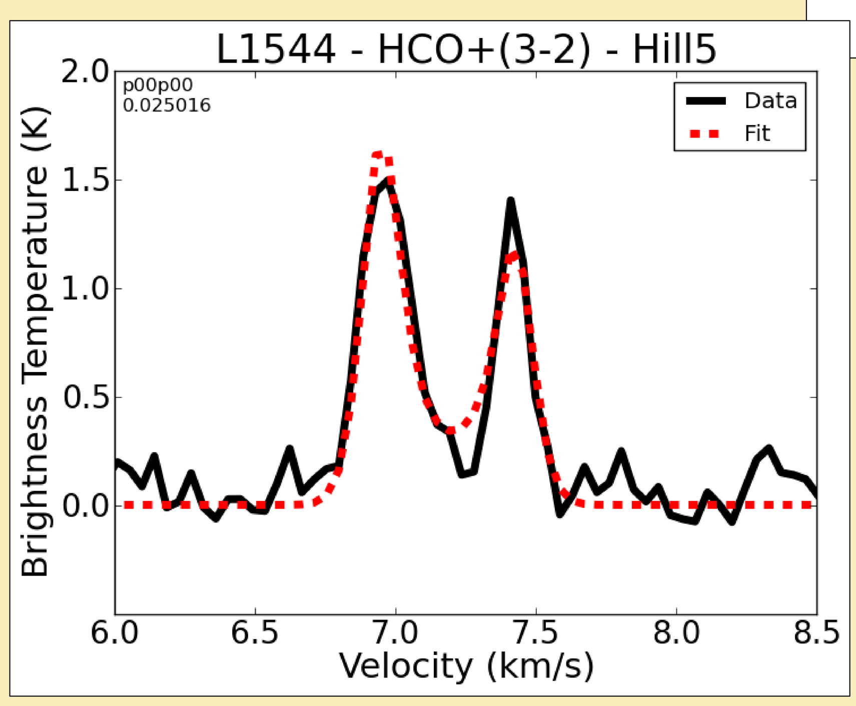
Above and Right: The positions within each core where spectra were obtained. ***Below:*** The four molecular tracers used in this survey.

Molecule	Frequency	Ang. Res.
N_2H^+(1-0)	93.174 GHz	27.0"
DCO^+(2-1)	144.077 GHz	17.5"
DCO^+(3-2)	216.113 GHz	11.6"
HCO^+(3-2)	267.558 GHz	9.41"

5. Line Fitting

Radiative transfer models that reproduce the spectral asymmetries characteristic of collapsing cores have been created so that the infall velocities of a given core can be extracted from its observed spectra.

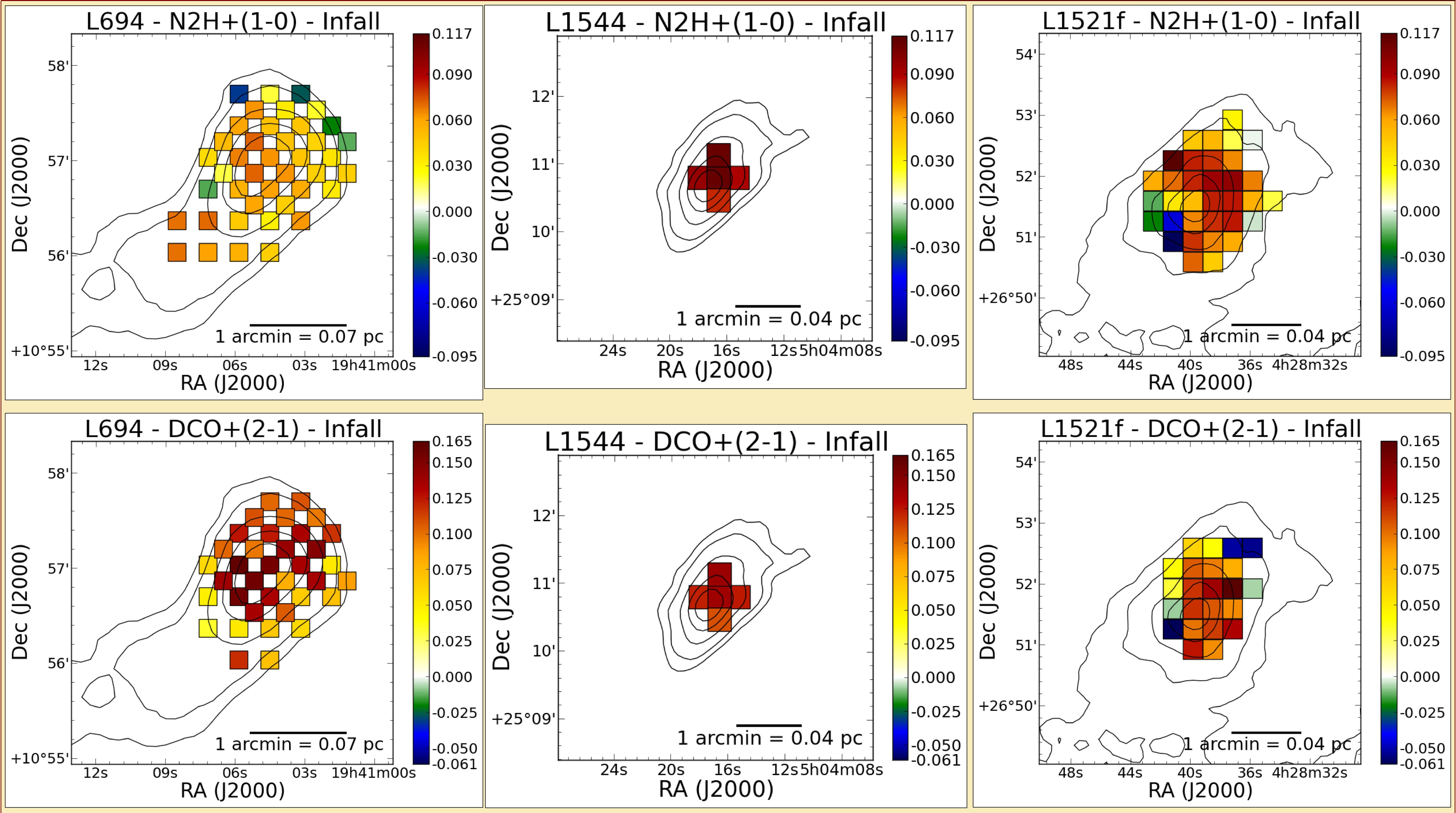




Above and Left: Two sample spectra fit using the HILL5 model created by De Vries & Myers (2005).

Black = measured data
Red = best fit (based on the least-squares curve fitting method)

6. Results



Infall velocity gradient maps for the three cores in this survey. Velocities are in km/s.
Red = fastest infall and Blue = fastest outflow

7. Discussion

- Infall does seem to have a dependency on both the observed position and choice of molecular tracer.
- On average, DCO^+(2-1) produced greater infall speeds than N_2H^+(1-0) in all three cores.
- Position and molecular tracer must be taken into consideration when attempting to characterize the rate at which a core is collapsing.

8. Future Work

- Expand survey to include additional cores and molecules
- Create an improved radiative transfer infall model

9. Acknowledgments

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References

De Vries, C. H., & Myers, P. C. 2005, ApJ, 620, 800