Exploring Core Formation in Perseus B1-E

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ABSTRACT: A key problem on the path to star formation within a large molecular cloud is understanding the origin of substructure on the scale of dense cores capable of forming protostars. While gravity plays a key role in the evolution of small structures, the relative contributions from other processes (e.g., turbulence, ambipolar diffusion) remain unknown. To study the processes that form cores, we need to explore a **core-forming region.**

Perseus B1-E: Perseus B1-E (Ridge et al. 2006) is a small (~ 0.1 sq. deg) clump of high extinction (Av > 5) located roughly 0.7° east of the B1 clump in the Perseus cloud (see Figure 1). Previous studies of core populations in Perseus have shown that dense cores and early phase YSOs are located in regions of high extinction (Kirk et al. 2006). Despite this correlation, a SCUBA 850 micron map (see Figure 2a) of B1-E does not indicate prominent substructure.

Recently, western Perseus was observed as part of the *Herschel* Gould Belt survey (see Pezzuto et al. in prep) using the PACS (Poglitsch et al. 2010) and SPIRE (Griffin et al. 2010) instruments at 70 – 500 microns in Parallel Mode. These data show evidence of substructure (see Figure 2b) with fluxes of ~1 Jy/beam (at 250 microns) in B1-E.

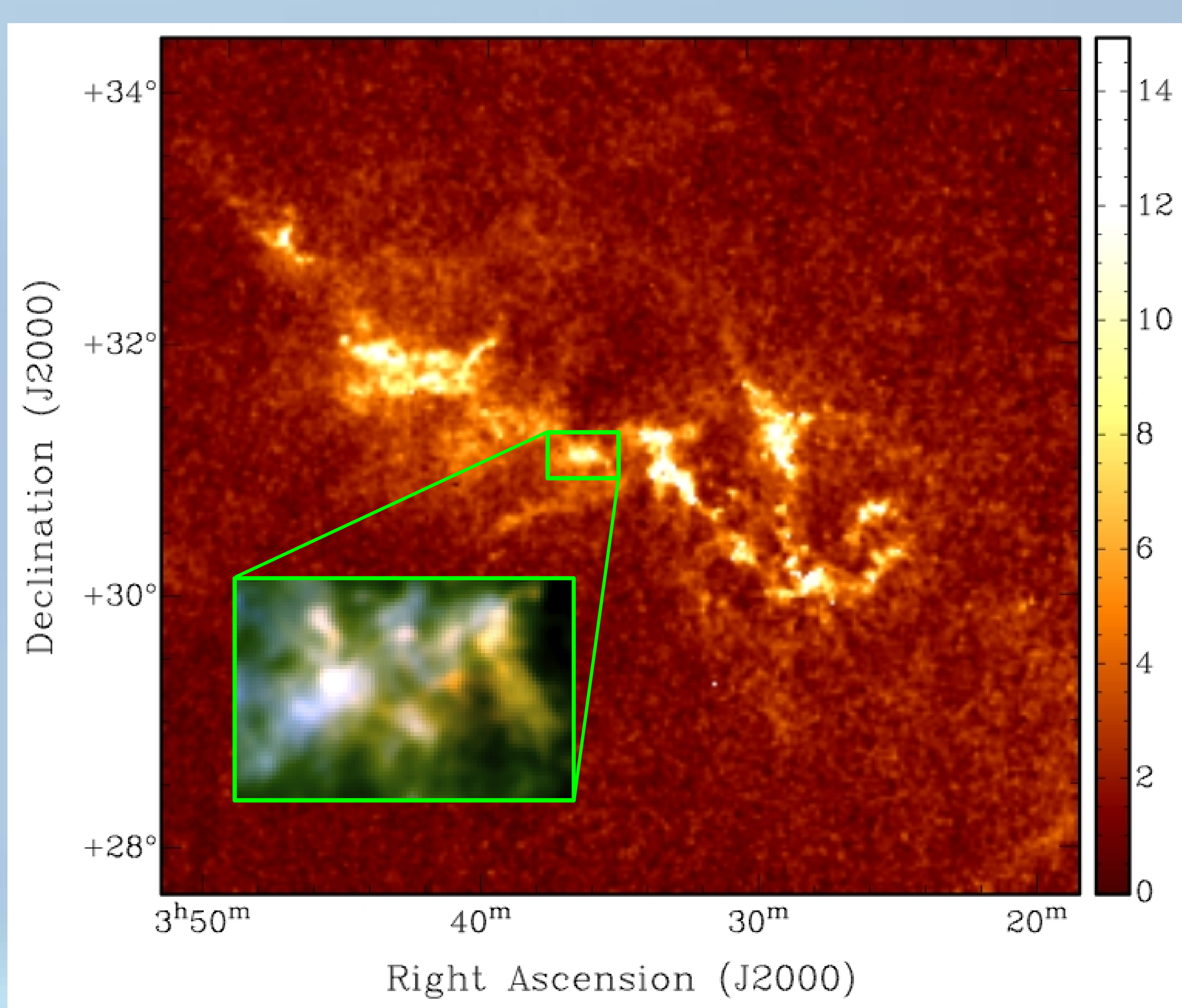

Figure 1: Extinction map of the Perseus molecular cloud (S. Bontemps, priv. comm.). The green box shows a 3-colour image with 160 micron (blue), 250 micron (green), and 500 micron (red).

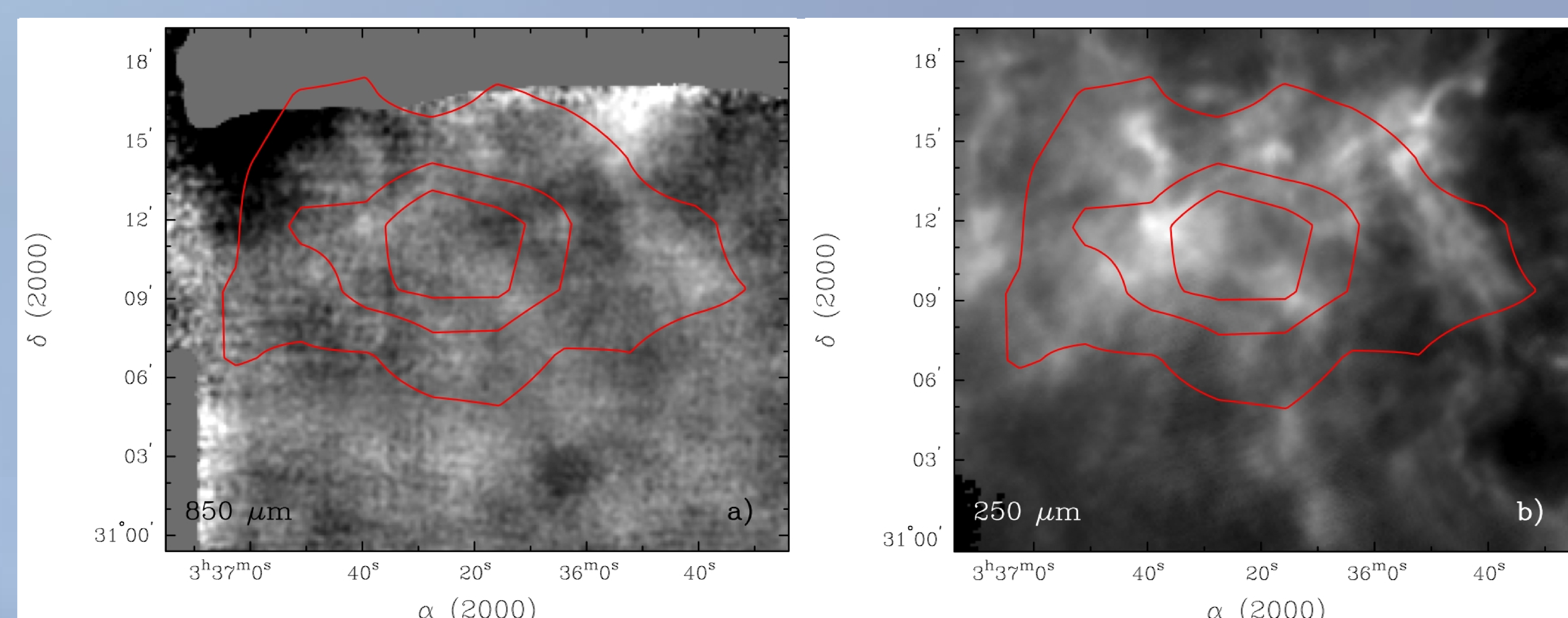

Figure 2: Perseus B1-E at 850 micron (2a) from SCUBA and 250 micron (2b) from SPIRE. Substructure at 250 microns have fluxes of ~ 1Jy/beam. Contours show extinction levels of 5, 7, and 8 magnitudes (from the COMPLETE survey; Ridge et al. 2006). SCUBA data from the SCUBA Legacy Catalogue (Di Francesco et al. 2008).

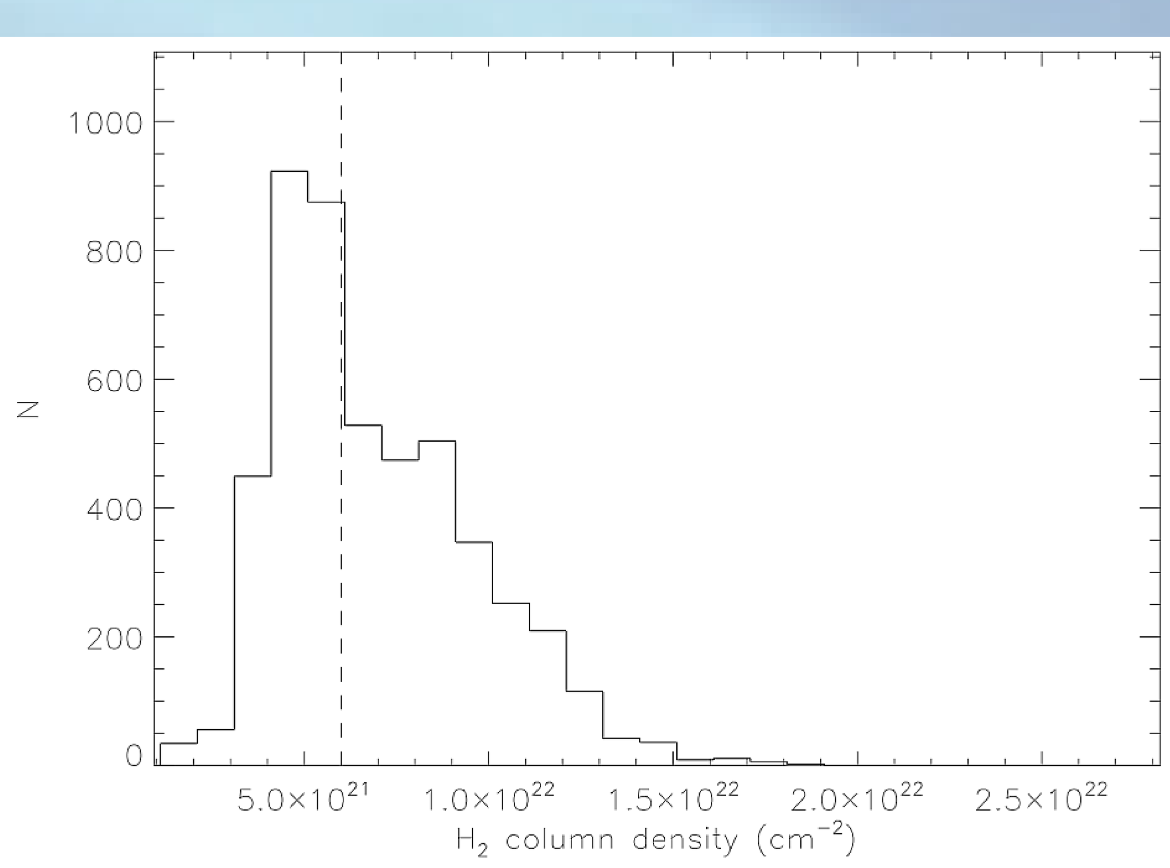

Figure 3: Column density distribution in B1-E. Each band was corrected for non-zero offsets using Planck/IRAS data and then convolved to the 500 micron beam and regridded to a common resolution. SEDs were fit assuming β = 2. The dashed line shows the column density threshold for gravitational instability in a filament.

Analysis: We corrected the offset in each band using Planck/IRAS data and then convolved each map to the 500 micron beam and regridded them to a common resolution. The map intensities of the well detected bands (160 – 500 microns) were fit by the modified black body function,

$$I_\nu = \kappa_\nu B_\nu(T) N_{H_2},$$

where $\kappa \propto \nu^\beta$ and is 0.1 $cm^2\ g^{-1}$ at 1000 GHz. Assuming β = 2, we produced temperature and column density maps (e.g. see Figure 3). The median column density is ~6.3 x 10^{21} cm^{-2}, which is similar to the threshold column density (6 x 10^{21} cm^{-2}) for dense structures to form by gravitational instability in filaments (André et al. 2010).

Indeed, B1-E appears to be undergoing dense core formation. Dense structures were identified using the algorithm GETSOURCES (Men'shchikov et al. in prep), which extracts objects at different spatial scales simultaneously over all bands. For B1-E, 42 objects were extracted, of which 30 had good SED fits in at least four bands. Figure 4 shows four well-fit SEDs with best-fit modified black body functions. The median temperature and β were ~11.8 K and ~2.5, respectively. Assuming a distance of 250 pc, the median mass was ~0.2 $M_\odot$, with a maximum of ~10 $M_\odot$.

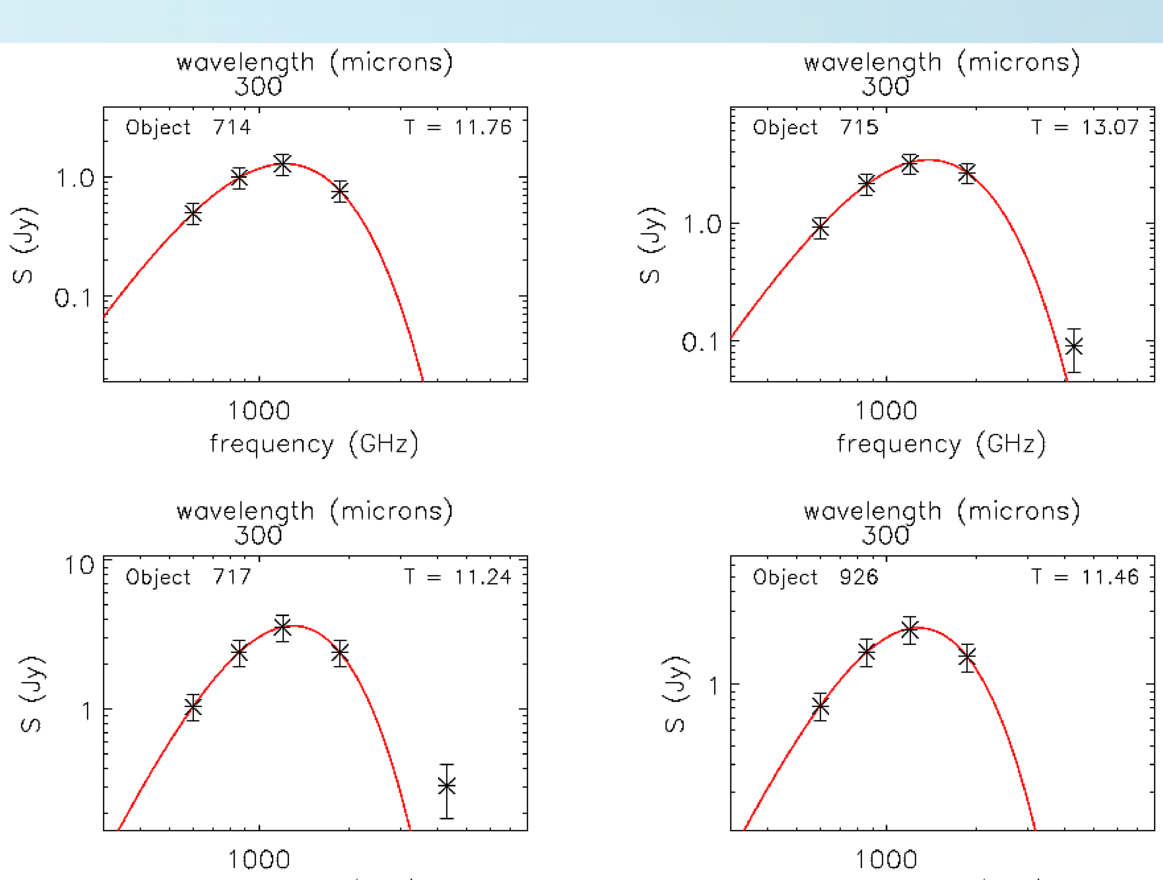

Figure 4: SEDs of 4 cores in B1-E with best fit modified black body functions. Errors in the 160 – 500 micron fluxes are assumed to be 20%. The 70 micron band was not used for fitting due to increased influence from noise.

Future work: Figure 5 shows low angular resolution (46 arcsec) CO line profiles of this complex. Planned higher resolution CO maps are necessary to home in on the dense structures to see from line widths whether these objects are gravitationally bound or transient.

In addition, planned observations of ammonia emission will be used to reveal the properties of gas in the dense structures, such as density, temperature, and kinematics, providing additional important constraints to core formation mechanisms.

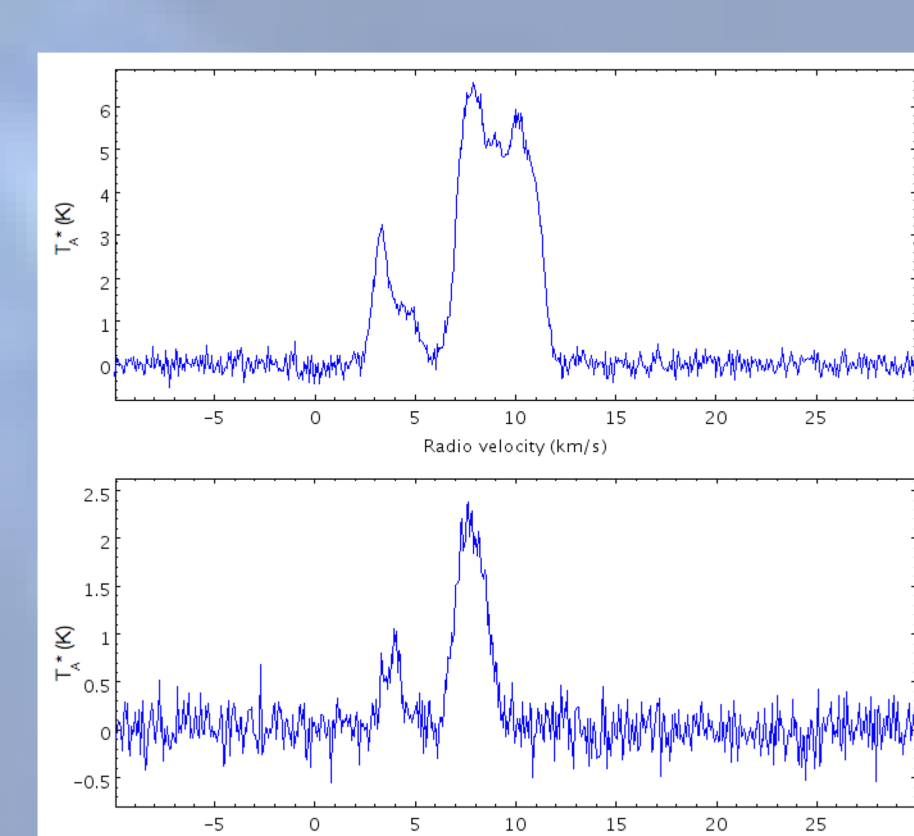

Figure 5: Low angular resolution 12CO (top) and 13CO (bottom) line emission towards B1-E (Ridge et al. 2006).

References:

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