Physical conditions of a giant stellar nursery

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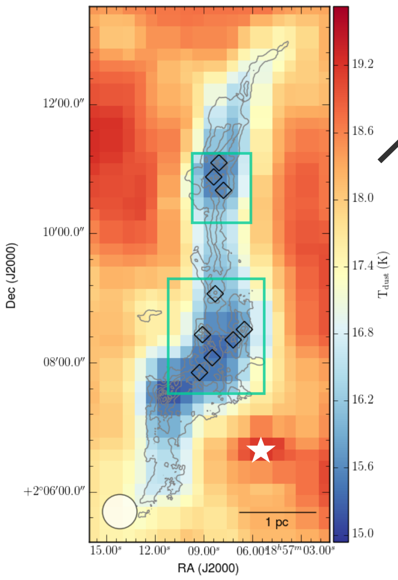
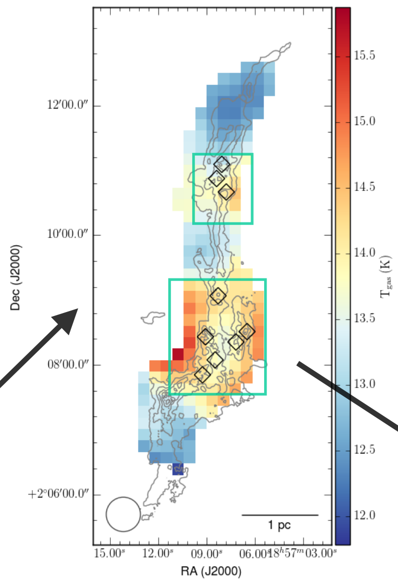
We present an overview of the physical conditions in the IRDC G035.39-00.33, a massive infrared dark cloud harbouring a number of compact dense gas cores (Nguyễn Lương et al. 2011, black diamonds on the maps below), some in early act of forming massive stars and protoclusters. We present the temperature maps for both gas - from ammonia emission mapped with the GBT, and dust - from FIR Herschel continuum, towards the cloud, below.

1. When compared to the dust temperature (down), the ammonia gas temperatures (right) do not follow the transition between the warm and cold material ($r=-0.25$).



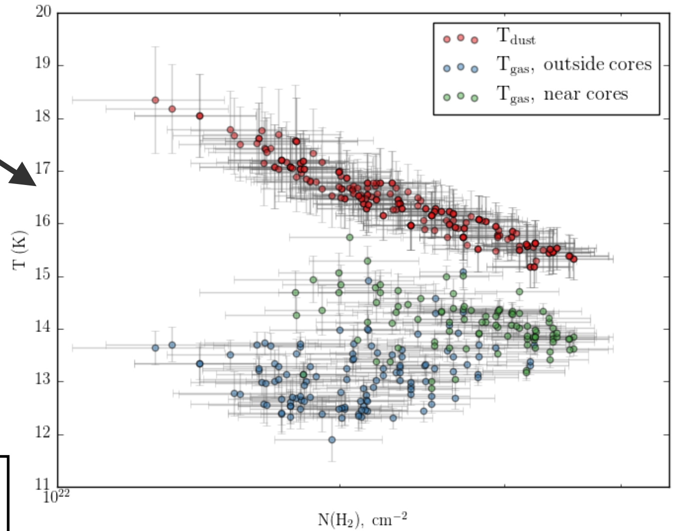
Dust temperature derived from Herschel. Contours: MIREX extinction map (Butler & Tan 2012).



A map of gas kinetic temperature derived from GBT NH_3 observations.

2. Interestingly, the regions with the coldest dust temperature and embedded dense SF-cores (green boxes) have the highest gas temperature values.

3. The densest gas component appears to be relatively warmer (ΔT_{gas} = 1 K for typical $\sigma_T \sim$ 0.2 K) than the rest of the filament. In addition, it exhibits a temperature gradient of (~1 K) similar ($r=0.4$) to that of T_{dust}.



Gas (blue, green) and dust (red) temperatures as a function of gas column density derived from Herschel archival data.

The observed non-uniformities in gas temperature and its density profile can have several underlying possibilities:

- The cold and dense IRDC is likely to be embedded in a warmer envelope consisting of less dense gas, which may be part of a larger GMC structure (Hernandez & Tan 2015). The line-of-sight *Herschel* dust temperature measurements would then be tainted by a warm fore- and background component (e.g. Forbrich et al. 2009).
- While the heating from the embedded protostars (black diamonds) may contribute to the gas temperature, it alone can not explain the inverse temperature gradient in the dense gas (green points in the right panel).
- Another possibility for heating the gas up is slow shocks resulting from colliding streams of gas. Indeed, large-scale velocity gradient was found in the IRDC, and its embedded cores were found to be at the intersection positions of multiple filaments (Henshaw et al. 2013, 2014; Jiménez-Serra et al. 2014). In addition, a widespread SiO emission (Jiménez-Serra et al. 2010) is present throughout the cloud.
- Finally, irradiation by an external, luminous source may be responsible for the ~1 K temperature gradient in the southern part of G035.39-00.33. It is unclear whether an H II region candidate at a projected distance of ~1.5 pc (Mottram et al. 2011), marked with a white circle at the leftmost figure, can provide such an uneven heating.

In conclusion, we used the ammonia thermometer to probe the coldest dust in an IRDC to find temperature enhancements in the immediate vicinity of the dense and cold star-forming material instead. Future work, preferably with higher angular resolution, is needed to assess the feasibility of the scenarios above.

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