ThrUMMS and CHaMP: large-scale maps of the Milky Way

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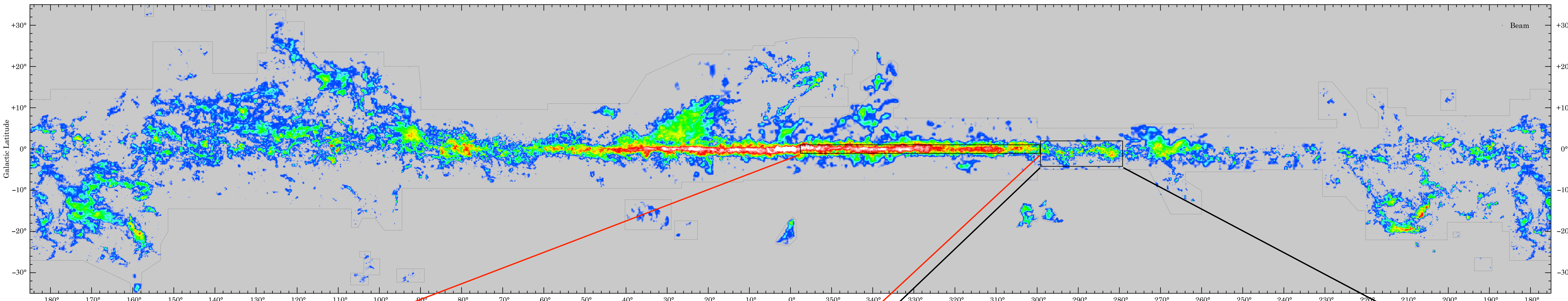
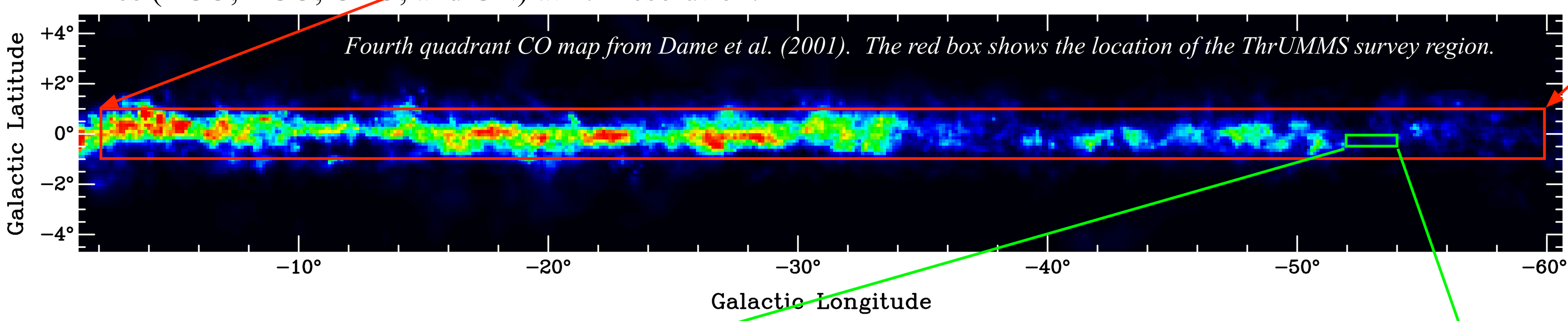


All-sky CO map from Dame et al. (2001). The black boxes show the locations of the ThrUMMS and CHaMP survey regions.

The Three-mm Ultimate Mopra Milkyway Survey

Starting point: Mopra superfast OTF **complete** mapping of 58°×2° area simultaneously in four J=1–0 lines (^{12}CO, ^{13}CO, $C^{18}O$, and CN) at 1.′2 resolution.



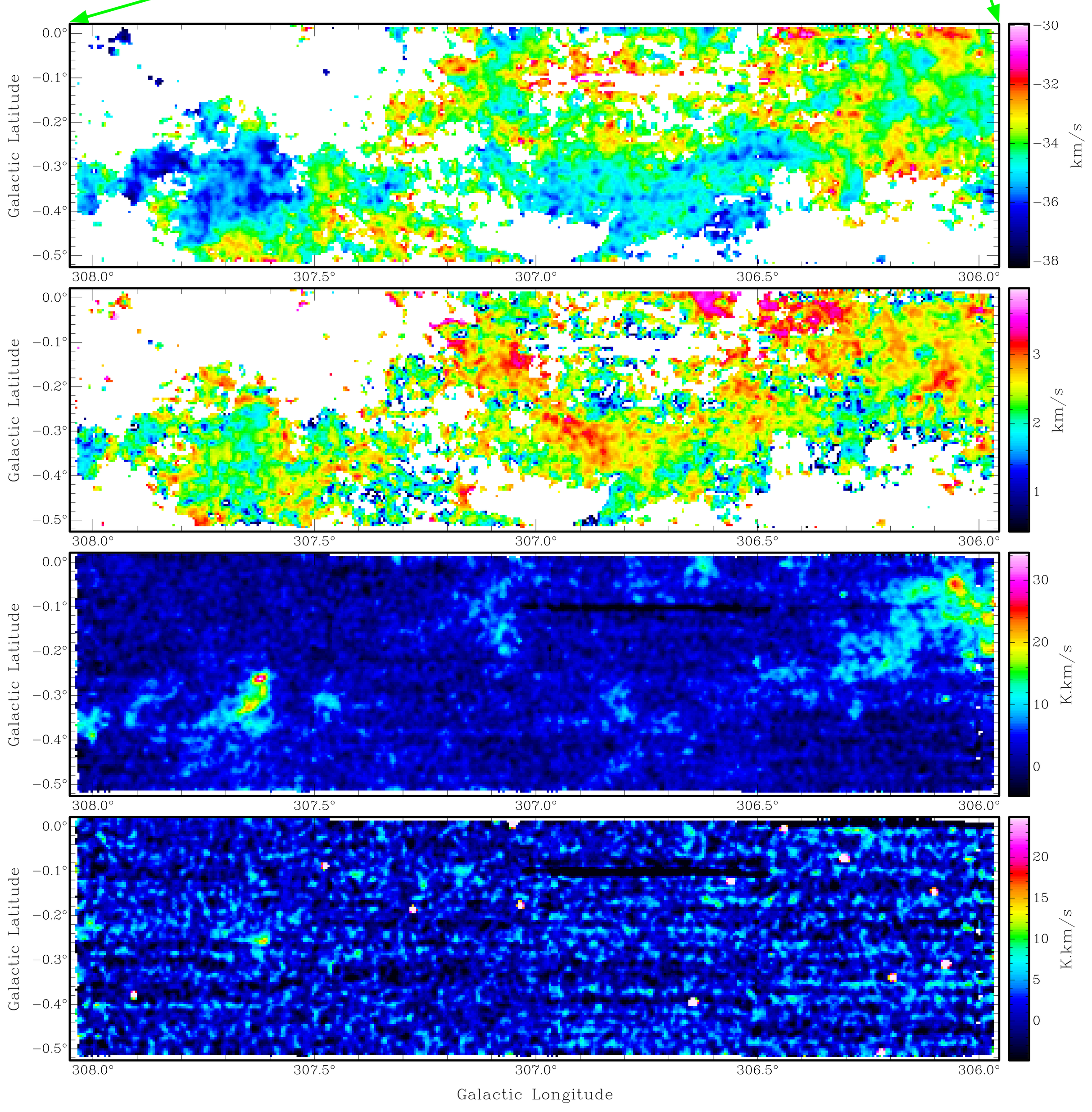
Mopra samples

^{12}CO V_{LSR}

^{12}CO ΔV

^{13}CO $\int T\,dV$

CN $\int T\,dV$



Sample: Shown above are 2.°0×0.°5 maps from 2010 pilot observations as labelled (note faintness of this area in the Dame et al 2001 map), obtained simultaneously in just 5 hr clock time at Mopra. 10% of survey area already mapped during pilot time!

Time awarded: More than 500 hours at Mopra in Oct 2011 and Feb 2012. Anticipate completion of 50% of the above survey area (ie, $|b|$ < 0.°5) during this time. Processing of these data to be substantially complete by ~May 2012.

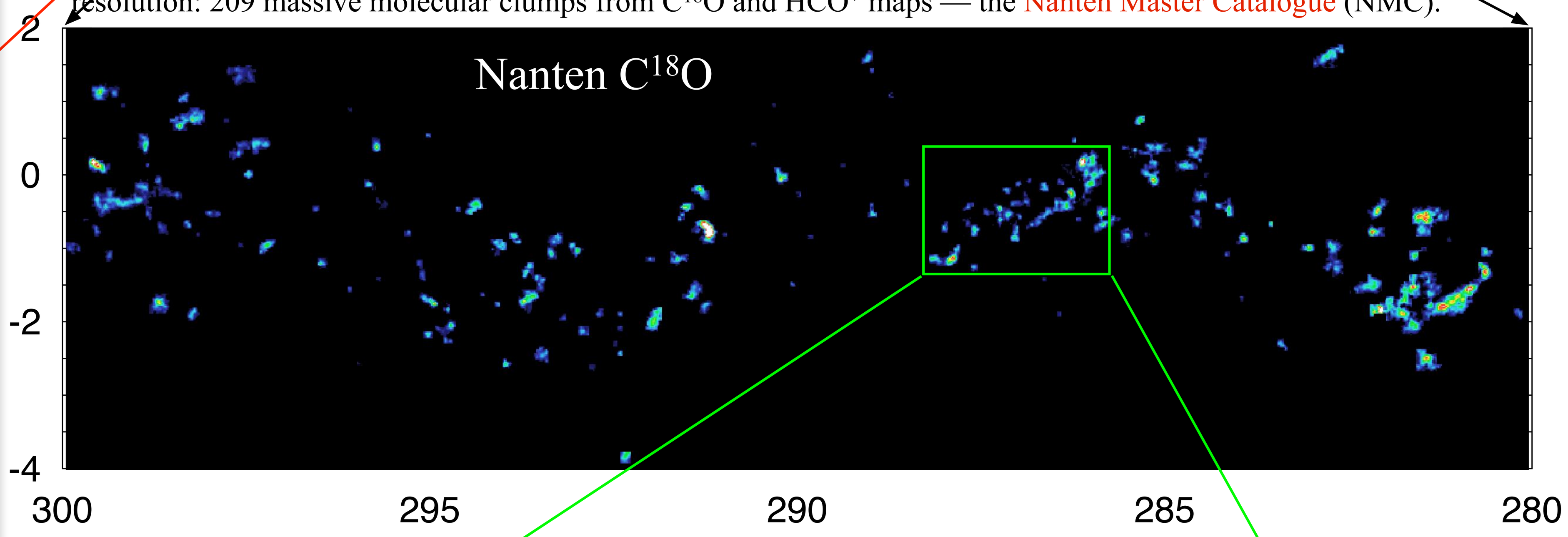
More background information and all maps & data are freely available at the ThrUMMS website, www.astro.ufl.edu/thrumms, AHEAD OF PUBLICATION! Collaborations encouraged.

Pending applications:

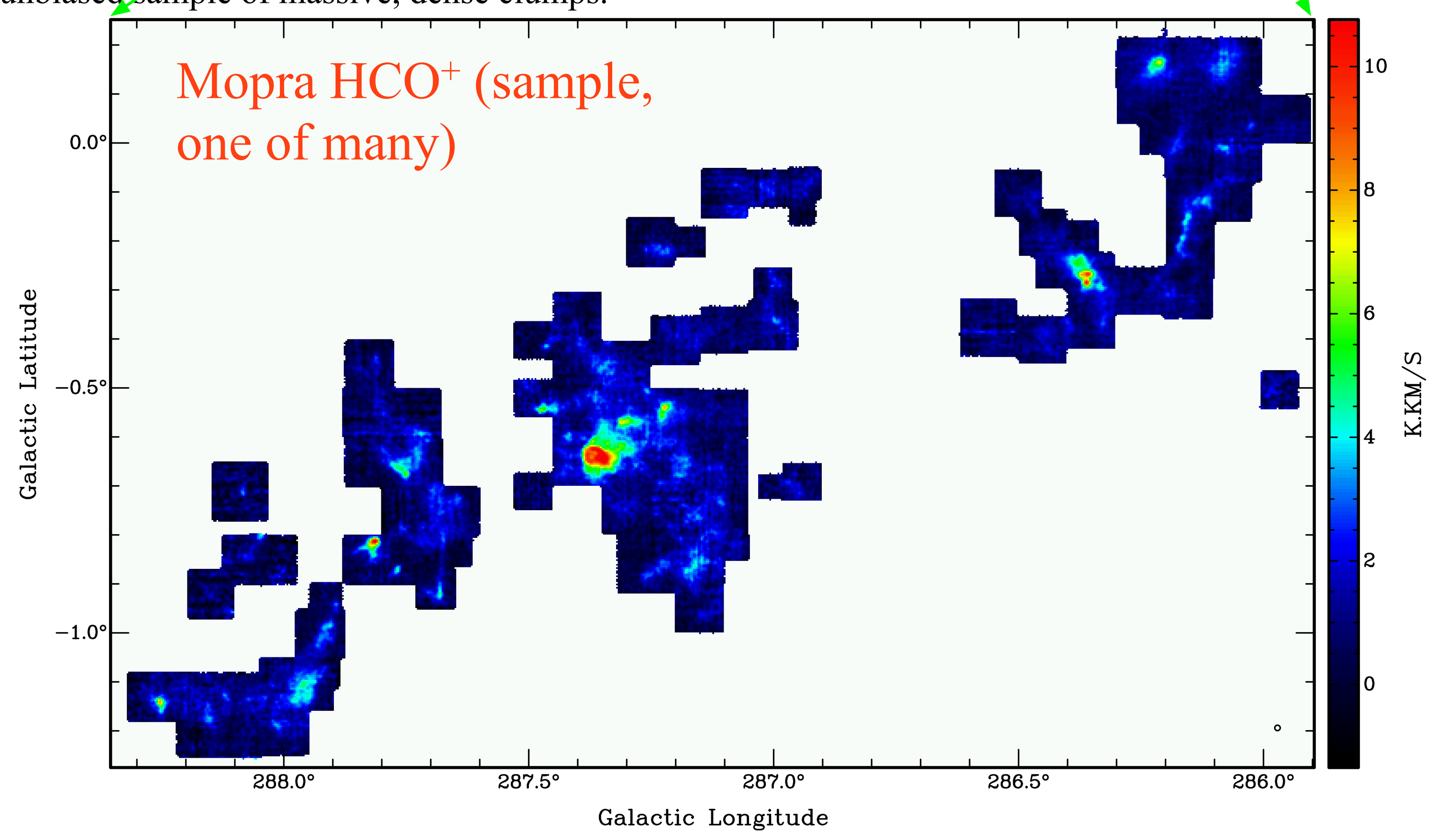
Spatially-resolved gas temperature map of GMCs, comparison with Herschel-based SED fits/dust temperatures
Detailed comparison with Herschel data and GASKAP HI survey, studies of molecular cloud formation
Kinematic distances of all major ISM structures from ThrUMMS+GASKAP comparison
Detailed dynamics of Galactic-scale features
Studies of Galactic structure, arm-interarm comparisons, radio-FIR correlation
Spatial dependence of cloud turbulence, origin of turbulence
Unbiased catalogue of all CN-bright clouds, suitable for Zeeman measurements with ALMA
Dependence of astrochemistry on Galactocentric distance

The Census of High- and Medium-mass Protostars

Starting point: Nanten maps of 20°×6° area in J=1–0 lines of $C^{18}O$ (shown below), plus ^{12}CO, ^{13}CO, HCO^+, at 4′ resolution: 209 massive molecular clumps from $C^{18}O$ and HCO^+ maps — the Nanten Master Catalogue (NMC).



Detailed molecular follow-up: Mopra maps of 121/209 brightest NMC clumps in 16 molecular lines near 90 GHz, simultaneously including HCO^+, HCN, N_2H^+, etc, at 40″ resolution (eg, HCO^+ map of η Carinae GMC shown below). In HCO^+, NMC clumps break up into 303 Mopra clumps — the BYF catalogue: a flux-limited, uniform, complete, unbiased sample of massive, dense clumps.

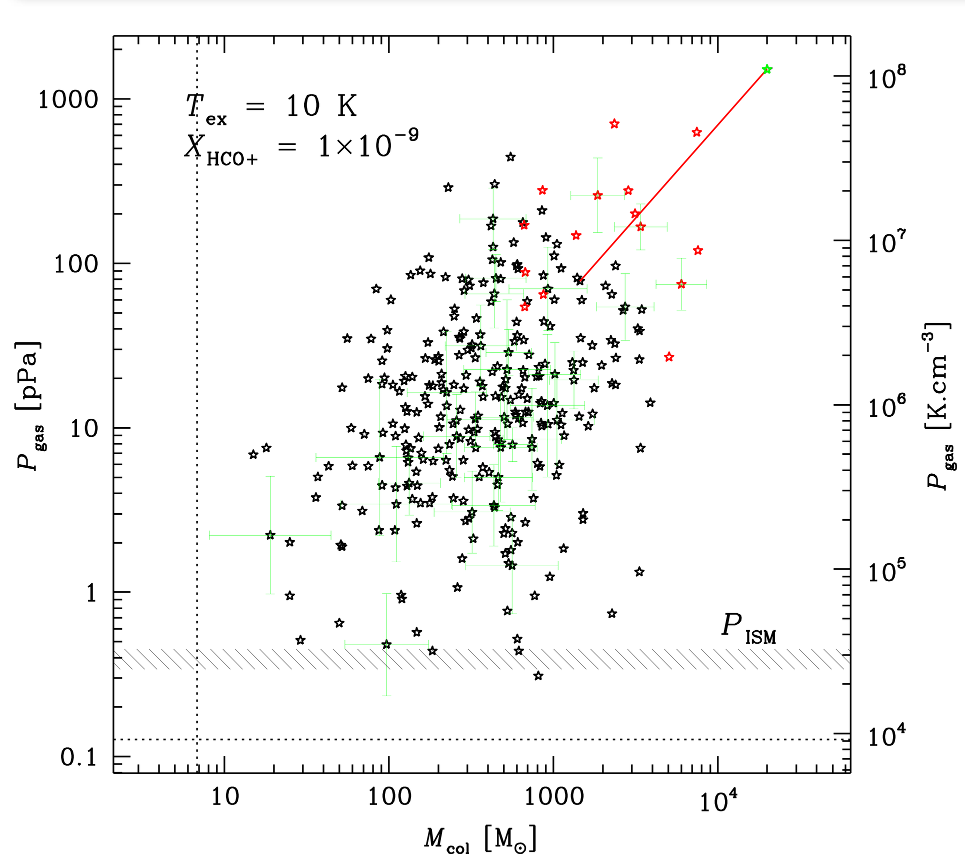


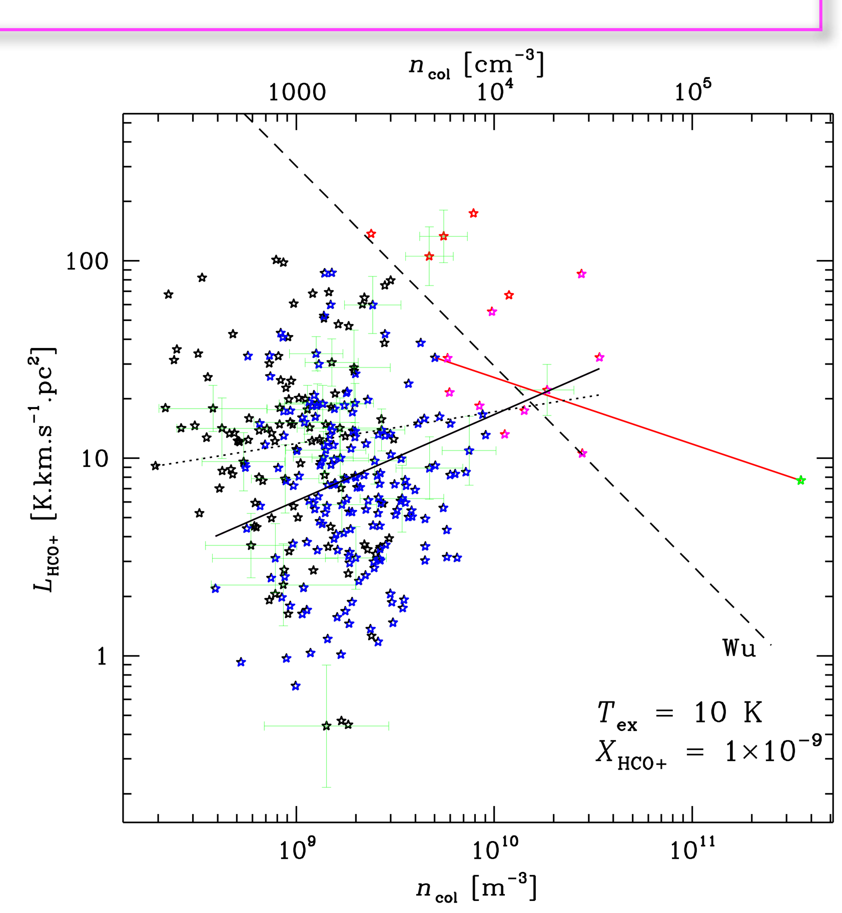
Some results:

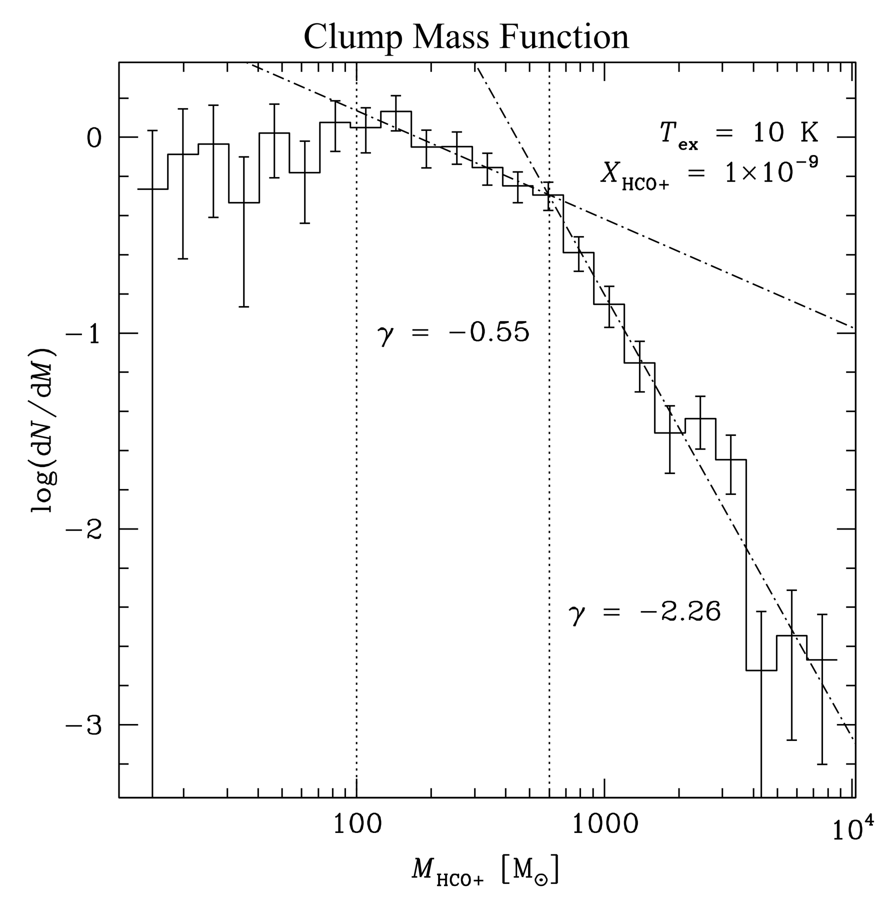
integrated line intensity 1–30 K km/s
peak line brightness 1–7 K
linewidth 1–10 km/s
integrated line luminosity 0.5–200 K km/s pc^2
FWHM size 0.2–2.5 pc
mean projected axial ratio 2 : **similar to clusters**
optical depth 0.08–2 : **low**
total surface density 30–3000 $M_\odot$/pc^2
number density (0.2–30) × 10^9/m^3 : **much less than n_{cr}!**
mass 15–8000 $M_\odot$: **massive**
virial parameter 1–55 } **pressure confined?**
total gas pressure 0.3–700 pPa }
no Larson-type size–linewidth relation
clumps are long-lived, probably > 50 Myr

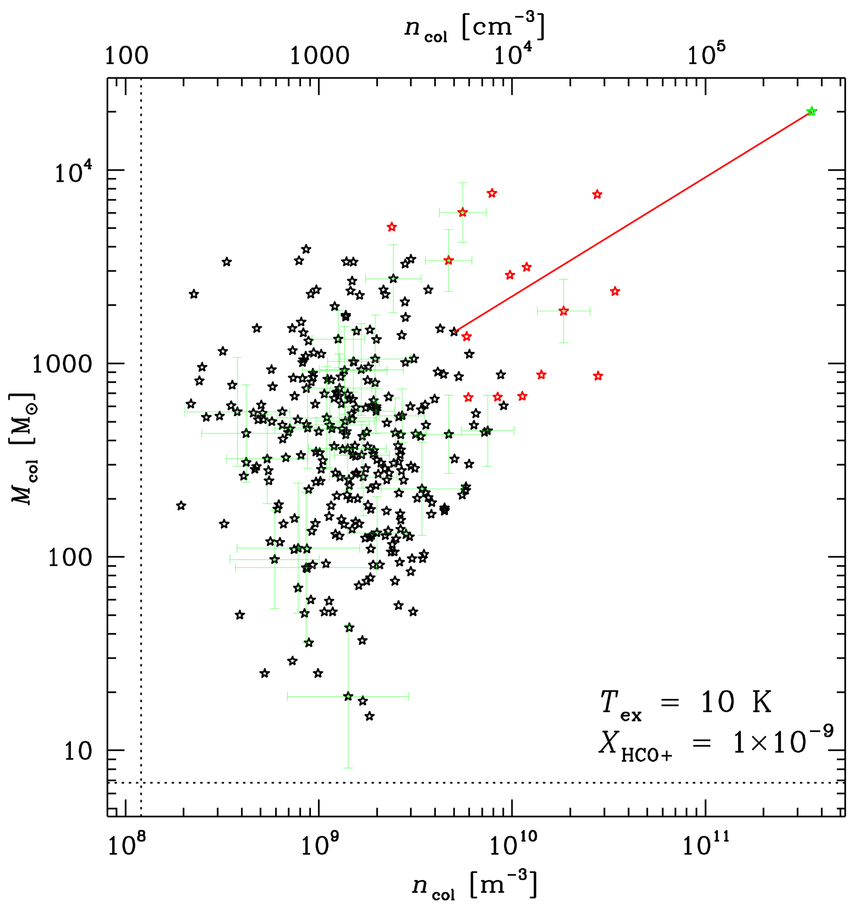
See sample figures below.

- 95% of clumps by number (87% by mass) are subthermally excited, massive, & dense (confirming Narayanan et al. 2008 prediction, L-n fig.), unlike typically studied bright massive star-forming regions (red points in figs.)
- If clumps evolve by slow contraction, fainter clumps may represent a long-lived stage of pressure-confined, gravitationally stable massive clump evolution, and clump population may not engage in vigorous massive star formation until the last 5% of their lifetimes
- Brighter sources are smaller, denser, more highly pressurized, and closer to gravitational instability than the less bright sources (P-M fig.)
- Massive clumps approach critical Bonnor–Ebert-like states at constant density, while lower-mass clumps reach such states at constant pressure
- Evidence of global gravitational collapse of massive clumps is rare (extreme green point in figs.), suggesting that this phase lasts <1% of the clumps' lifetime









Next steps: Analysis of other Mopra spectral lines, NIR survey of all Mopra clumps, SED analysis including Herschel data, deep IRAC survey, mm-interferometry of interesting sources, etc. Free download of above data also encourages new collaborations.

Main publication is Barnes et al (2011) *ApJS* **196** 12. More background information, maps, images, and data files (including all derived physical parameters) are available at the CHaMP website, www.astro.ufl.edu/champ