Droplets: Pressure-Dominated Sub-0.1 pc Coherent Structures in L1688 and B18

Hope **Chen**, Jaime **Pineda**, Alyssa **Goodman**, Stella **Offner**, Rachel **Friesen**, Philip **Myers**, & the ***Green Bank Ammonia Survey*** (GAS) Collaboration

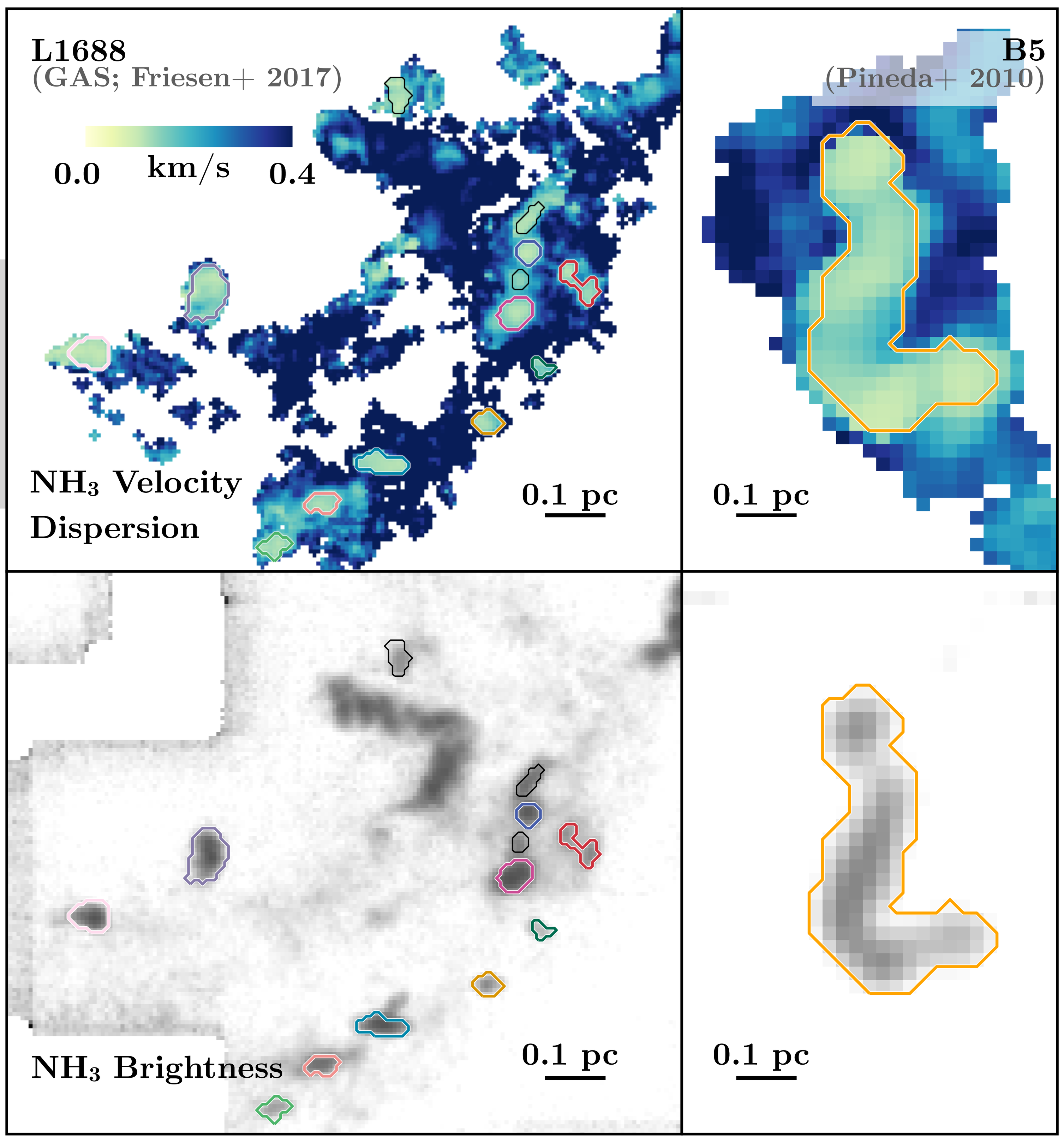
hhchen@cfa.harvard.edu

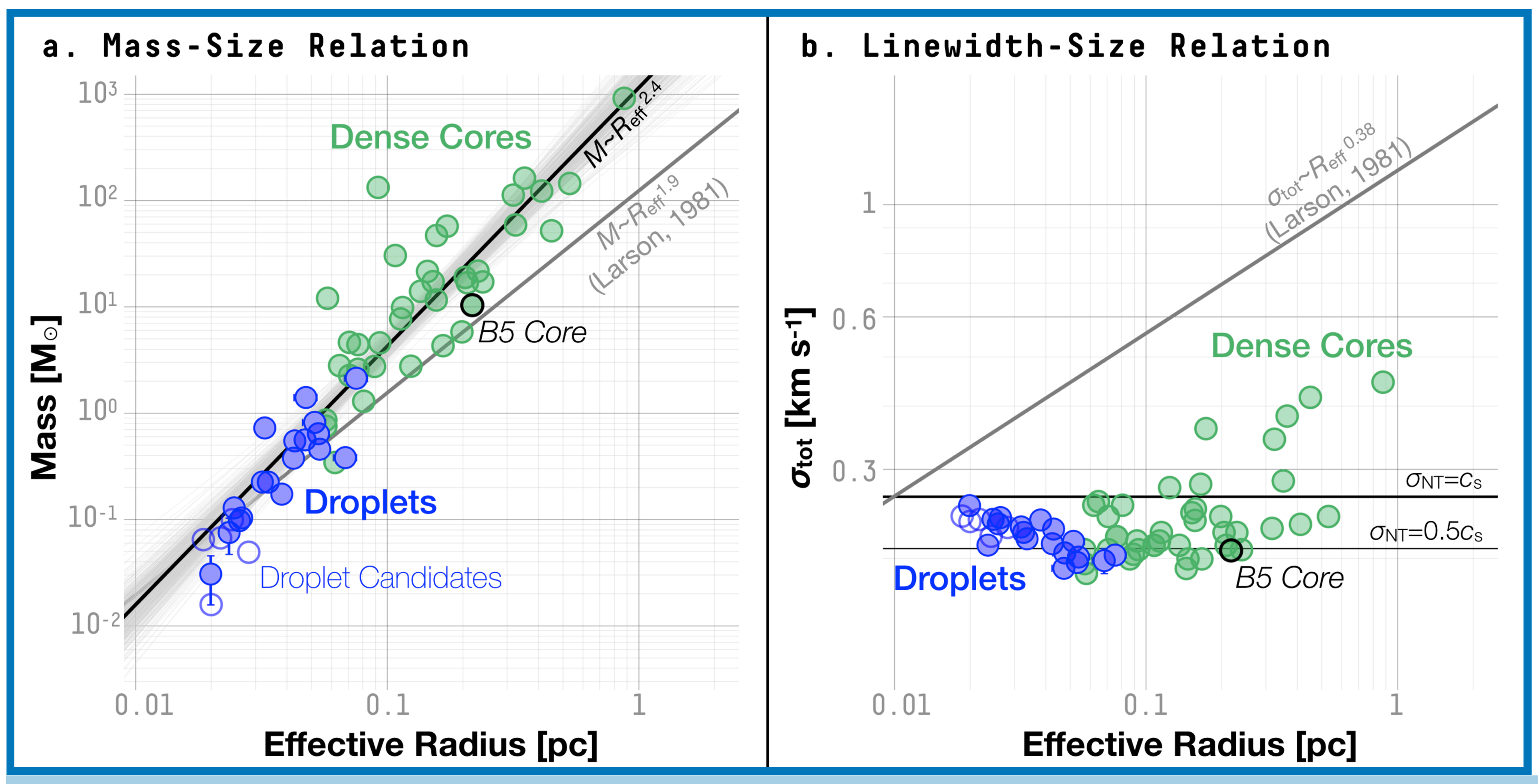
Droplets

We identify a population of **pressure-dominated sub-0.1 pc coherent structures**—"*droplets*." These structures **look like coherent cores**, but are **gravitationally unbound** and predominantly **confined by ambient gas pressure**. The existence of the pressure-confined coherent structures poses questions to a conventional dense core–coherent core paradigm of star formation.

Data & Identification of Coherent Structures

Using data from the ***Green Bank Ammonia Survey*** (GAS; Friesen+ 2017), we identify a total of **18 coherent structures** in L1688 and B18. These structures are identified in a similar fashion **as a coherent core**—with 1) a change in the NH_3 linewidth from supersonic to subsonic values across their boundaries and 2) a centrally concentrated NH_3 emission (e.g. B5; Pineda+ 2010).



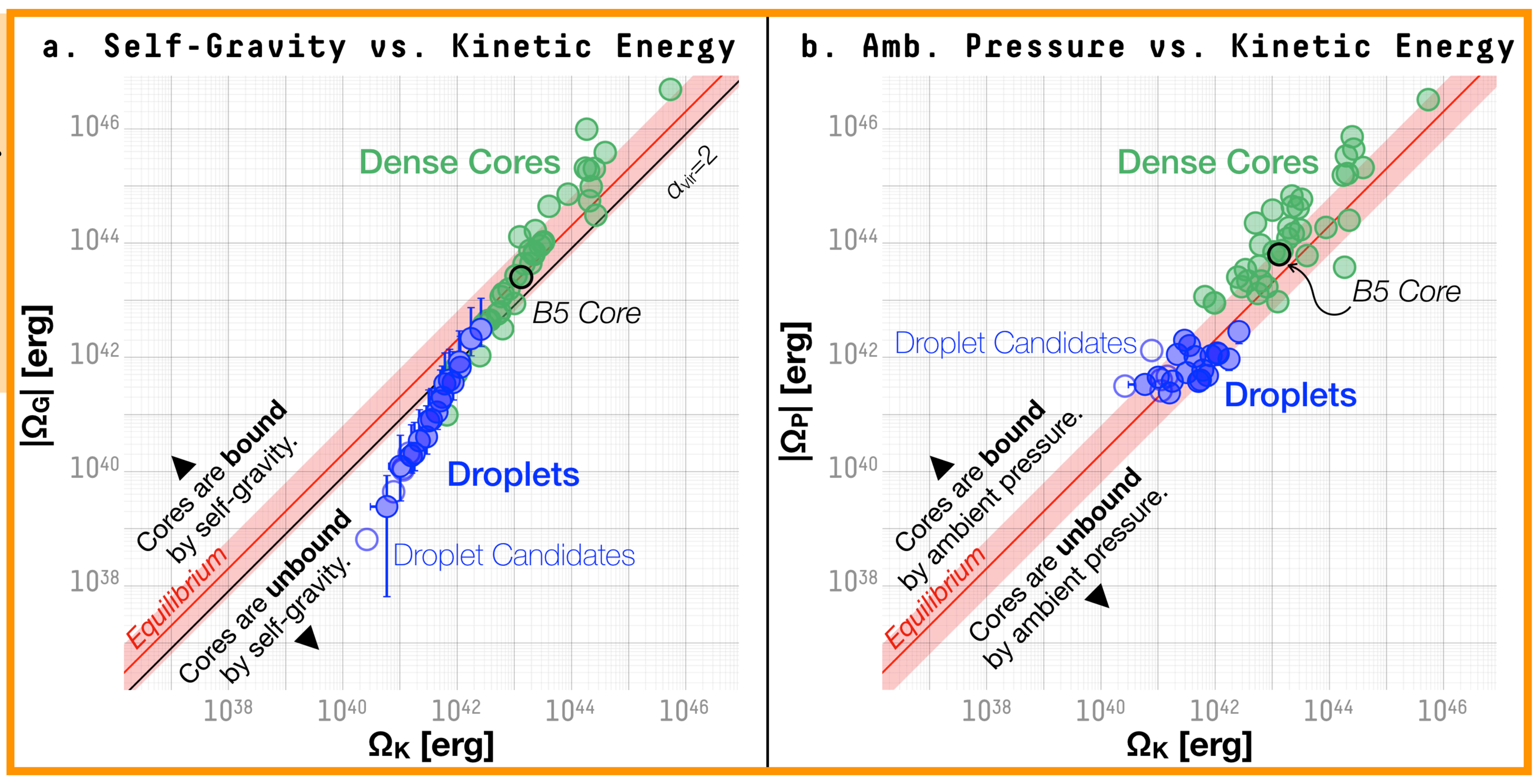


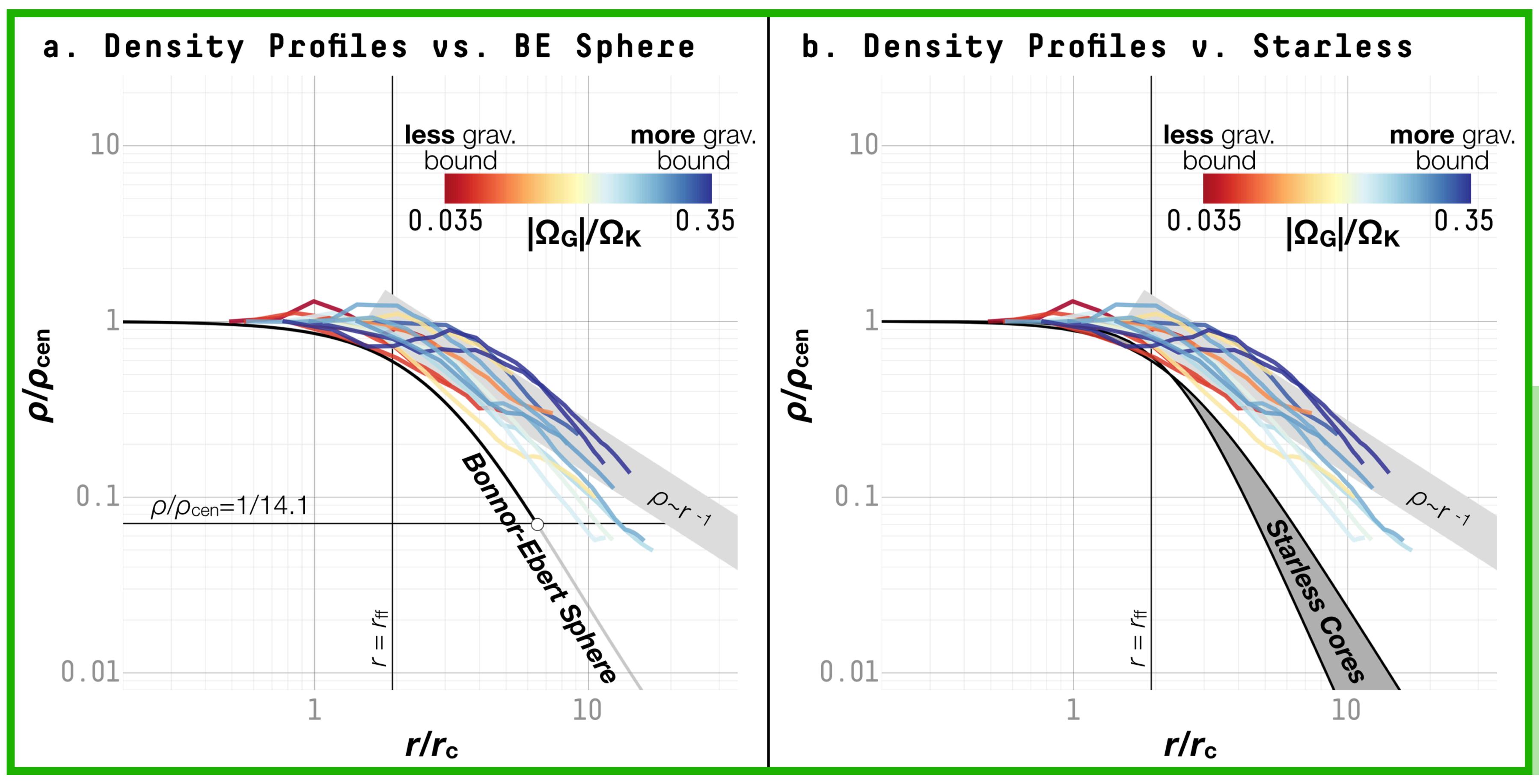
Basic Properties & Relation to Larger-Scale Cores

The coherent structures newly discovered in L1688 and B18 appear to follow **the same power-law mass-size relation found for larger-scale dense cores** (Goodman+ 1993). The structures have **subsonic velocity dispersions** and **a flat linewidth-size relation**. In the interiors of the droplets, the NH_3 linewidth is nearly thermal and uniform.

Virial Analysis & Pressure Confinement

Following a virial analysis presented by Pattle+ (2015), we find that the *droplets* are **gravitationally unbound**, unlike larger-scale coherent cores. **The confinement of these structures is primarily provided by the pressure** exerted on the "surfaces" by the ambient gas motions, which is estimated locally for each droplet using NH_3 observations from the GAS.



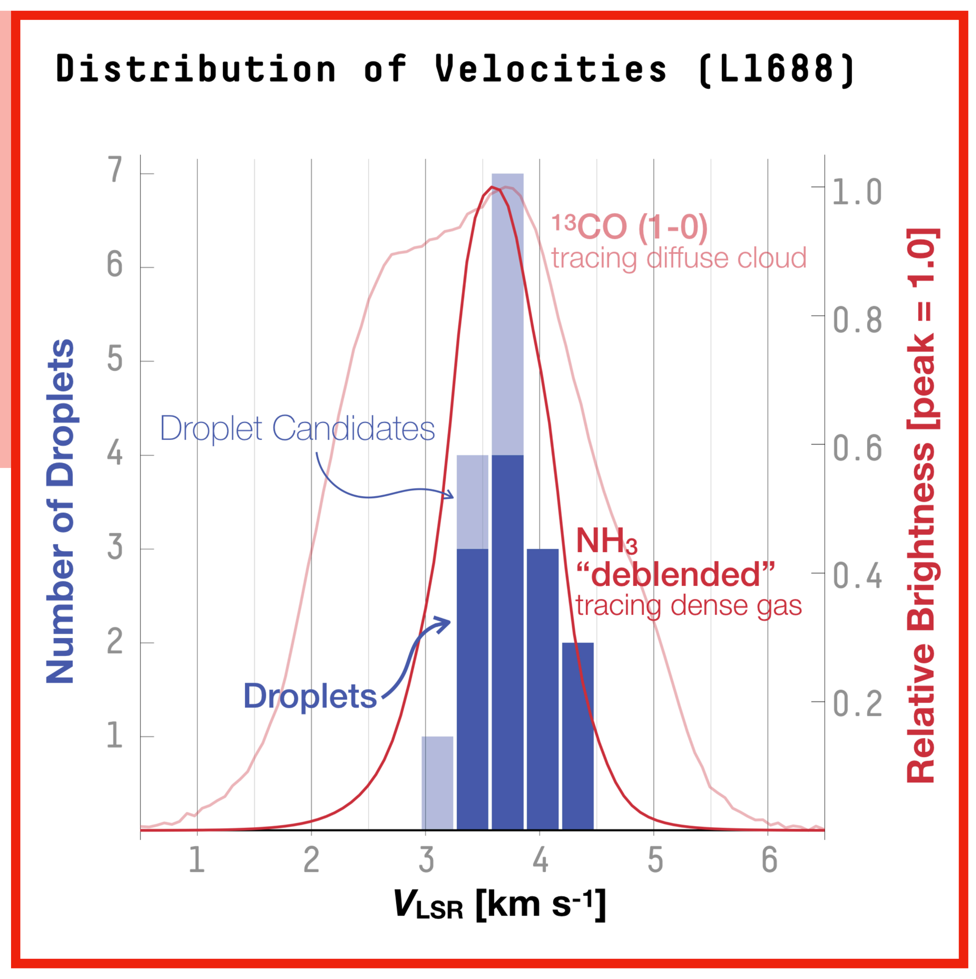


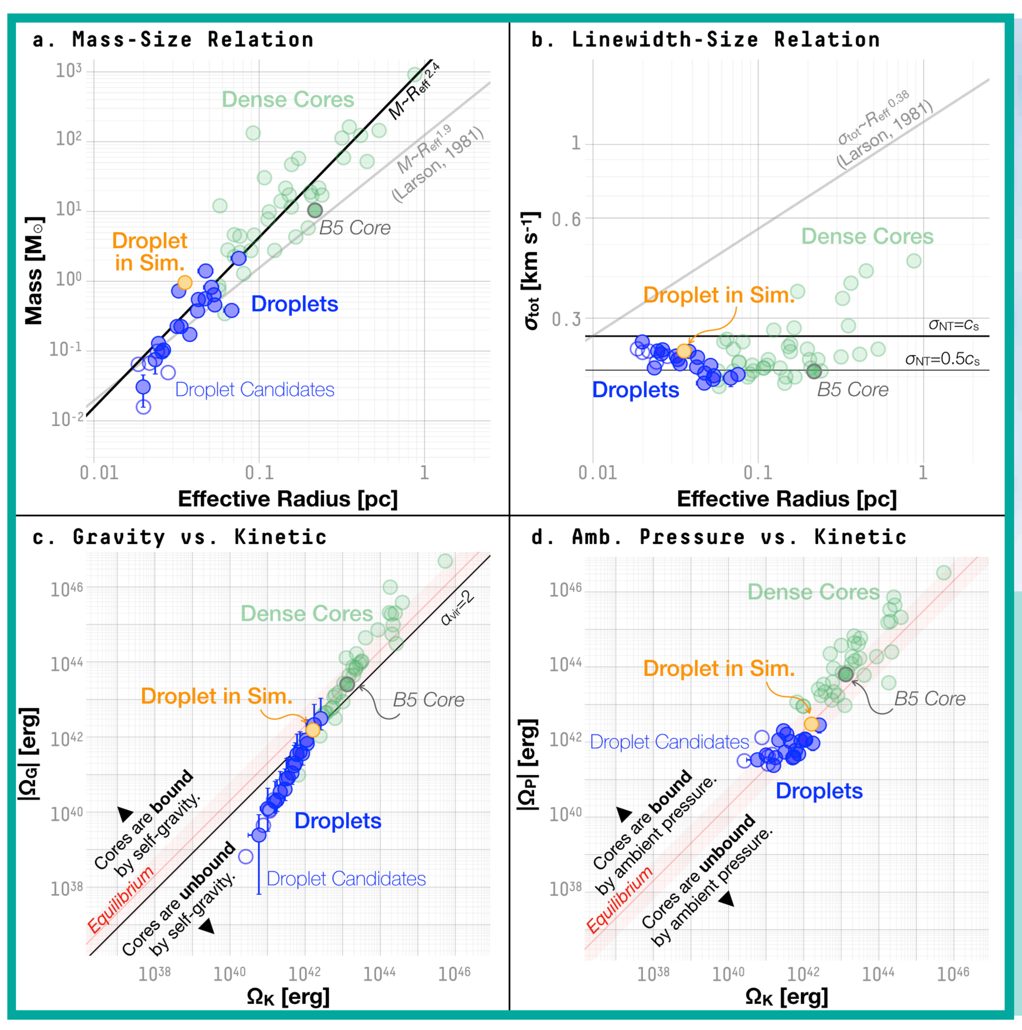
Comparison to a Bonnor-Ebert Sphere

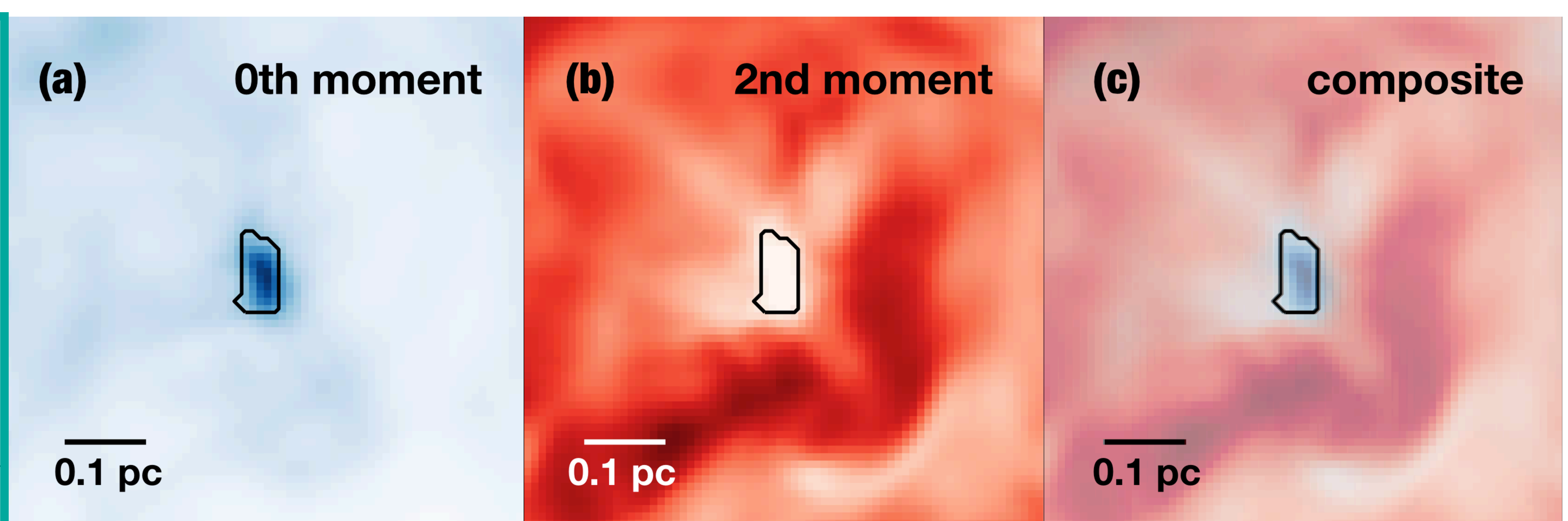
Inspired by the results of the virial analysis, which indicates that these structures are gravitationally unbound and kinetically dominated by ambient gas pressure, we compare the radial density profiles of the droplets to that of a Bonnor-Ebert sphere. The droplets appear to have **profiles shallower than a critical BE sphere and previous observations of starless cores**. On the outer edge, the droplet density profiles approach $\varrho \propto r^{-1}$, which were observed for larger-scale molecular clouds.

Systematic Velocities Inherited from Turbulent Gas Motions?

We compare the distribution of median systematic (LOS) velocities of the droplets to the average NH_3 and ^{13}CO spectra of the same region. We find that the **distribution of velocity centroids has a shape similar to the average NH_3 line profile**. While the result is subject to the caveats of small-number statistics, it is consistent with **a picture where the systematic velocities are inherited from the turbulent motions of the dense gas component of the cloud**. The result can further imply a relation between the formation of droplets and the turbulent motions, and consequently the pressure distribution, in the cloud.







Droplets in MHD Simulations

A search in an MHD simulation (Offner+ 2012) finds a droplet-like structure, with a subsonic linewidth and coincident with a centrally concentrated distribution of synthetic NH_3 emission. The physical properties of the droplet-like structure found in the MHD simulation is consistent with the observed droplets. The result suggests that a droplet can form from interaction between the physical processes regularly observed in molecular clouds: turbulence, magnetic fields, and stellar feedbacks.