THE STABILITY OF DENSE CORES NEAR THE SERPENS SOUTH PROTOCLUSTER

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INTRODUCTION

- Star formation occurs due to the collapse of molecular clouds and many stars form in clusters. Serpens South is one example of a nearby, young clustered star forming region. We investigate the stability of dense cores in Serpens South and the influence of the protostellar cluster on the surrounding dense gas and future star generations.

OBSERVATIONS

- We observe Serpens South using 5'' angular resolution data from the **Very Large Array**.
- We observe the **NH_3 emission** as this is a tracer of cold, dense gas in molecular clouds.
- We obtain integrated intensity maps of the NH_3 (1,1) and (2,2) and maps of temperature, line width, line of sight velocity and NH_3 column density through NH_3 hyperfine line fitting.

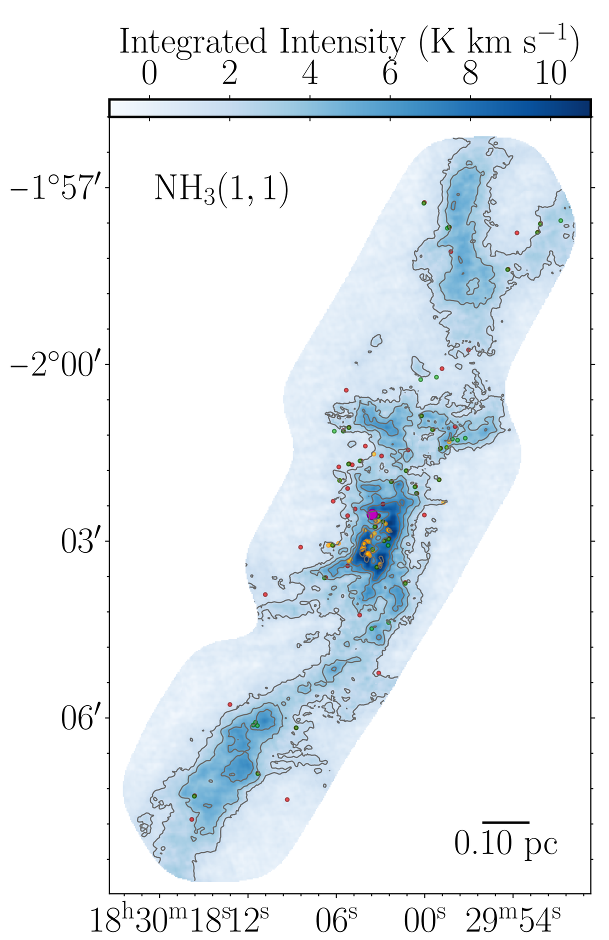

Figure 1. Map of the NH_3 (1,1) integrated intensity towards Serpens South with dots marking locations of known protostars. The purple circle marks the centre of this protostellar distribution.

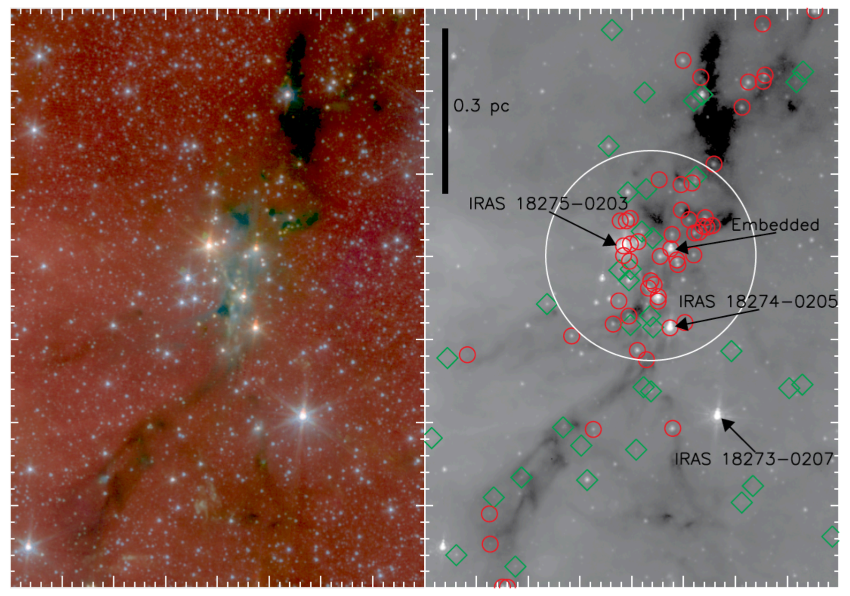

Figure 2. Infrared image of Serpens South with YSOs marked (right). Red circles are Class I protostars and green diamonds are Class II protostars.

Credit: Gutermuth et al 2008

DENSE CORES

- We identify cores by applying **dendrograms** to the integrated intensity which uses a hierarchical algorithm to locate peaks in the NH_3 emission.
- We locate **94 dense cores**.
- We calculate the core masses from the NH_3 column density by assuming a constant ratio of NH_3 to H_2.
- We assess the **stability** of cores using the virial mass:

$$M_{vir} = \frac{5R\sigma^2}{G}$$

where R is the radius, σ is the line width and G is the gravitational constant.

  - If the ratio of the virial to core mass (the *virial parameter*) is greater than 2, the core is stable and unbound by gravity whereas if this ratio is less than 2, the core is bound by gravity and should be actively collapsing.

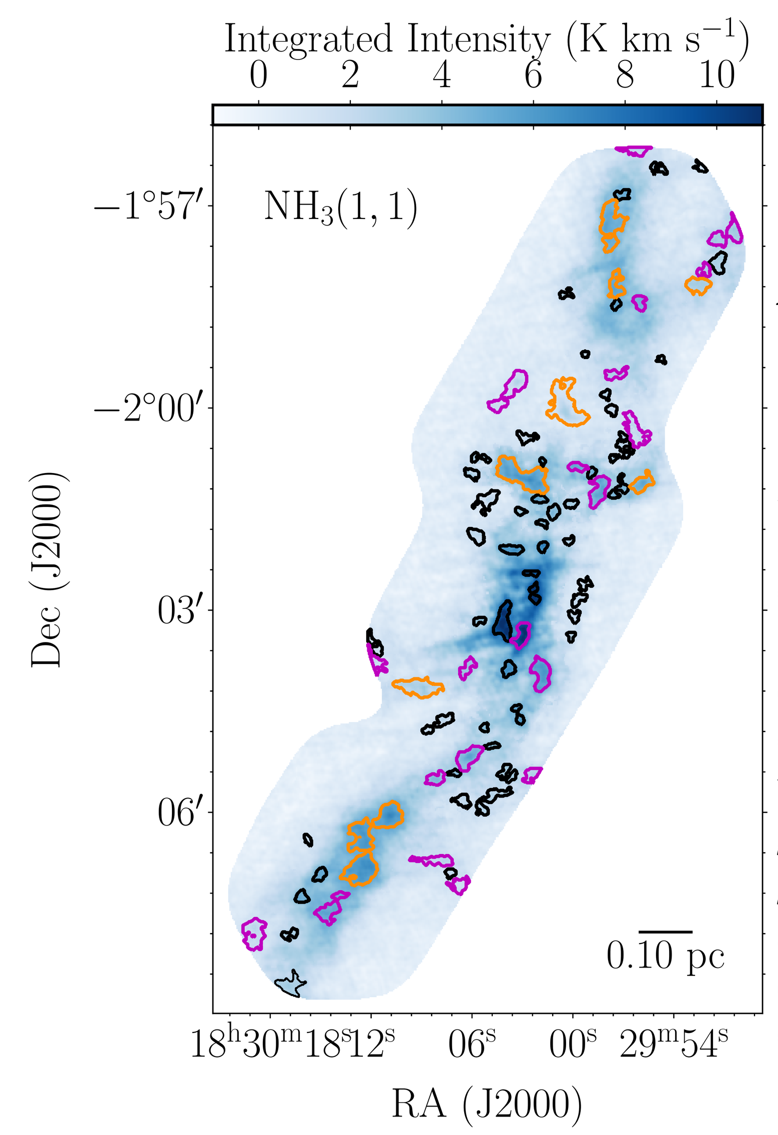

Figure 3. Map of the NH_3 (1,1) integrated intensity towards Serpens South contours marking locations of cores obtained from the dendrogram analysis. Black contours mark cores with virial parameter above 2, purple contours between 1 and 2 and orange contours below 1.

Mean core properties

- Mass: 1.3 $M_\odot$
- Radius: 0.012 pc
- Temperature: 12 K
- Line width: 0.32 km/s
- Virial parameter: 3.8

PROTOCLUSTER

- We calculate the distance from each core to the centre of the protostellar distribution

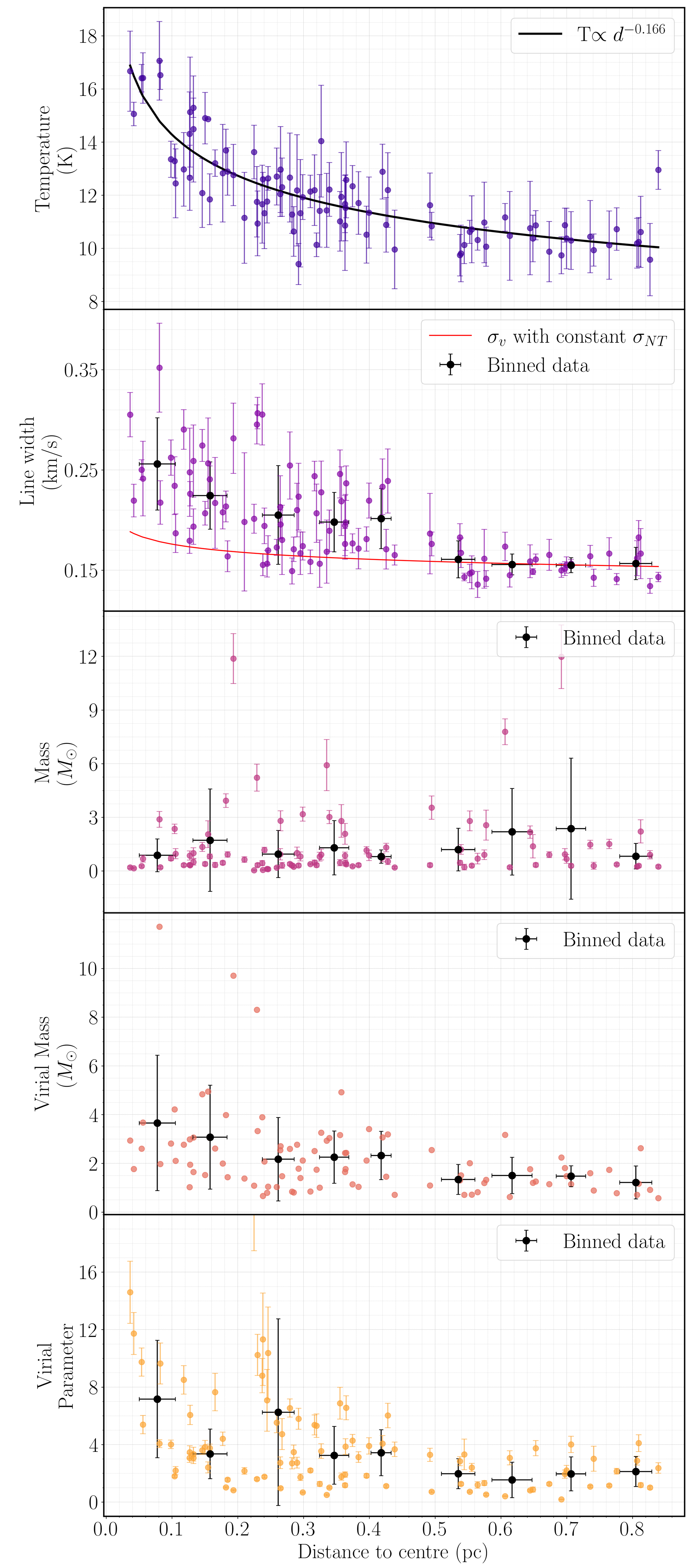

Figure 4. Core properties versus their distance to the central cluster. Black points in panels 2-5 depict the mean values in 0.1 pc bins to highlight the trend towards the central cluster.

DISCUSSION

- Only **12% of cores are gravitationally bound** and most of the bound cores are located along the filaments.
- Core **temperatures increase towards the central cluster** indicating that the central cluster is playing a role in heating the surrounding dense gas.
- Core line widths generally increase towards the central cluster and this results in an increase in the virial parameter towards the central cluster indicating that **cores are more stable in the cluster** with a mean virial mass 1.8 times greater for cores within 0.4 pc of the centre and a mean virial parameter 2.5 times greater.
- The increase in virial mass and parameter towards the central cluster indicates that higher mass stars could form in the cluster if they are able to accrete more mass as the cores in the cluster are not currently massive enough to form stars.
- We also investigate the fragmentation of the gas and find that the core spacing and masses are comparable to the Jean's length and mass.
- By looking at the line of sight velocity towards Serpens South, we find a velocity gradient along the filaments towards the central cluster. This is likely due to gas flows along the filament toward the cluster, which could potentially allow these cores to accrete more mass and become gravitationally unstable in future.

CONCLUSION

- With high resolution data we investigated the small scale structure of the nearby, clustered star forming region, Serpens South. We found that the central protocluster is playing a role in increasing the temperatures, line widths and virial parameters of dense cores .