We **detect 300+** pre- and protostellar cores in the giant molecular cloud Sagittarius B2, most of which are **resolved and optically thick**.

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Motivation:

The environment in the Central Molecular Zone (CMZ) is similar to when most stars were formed (higher temperature, density, turbulence compared to the solar neighborhood) ($z \sim 2$ Madau & Dickinson 2014) (Henshaw et al. 2016). In young star clusters such as the Arches and Quintuplet clusters, there is evidence of a top-heavy IMF (Hosek et al. 2019). Peering into early stages of star formation in the CMZ can help us understand if the IMF varies systematically with local environmental conditions and is thus shallower in the early universe.

We investigate pre- and protostellar cores in a molecular cloud that contains over 50% of star formation in the CMZ despite containing <10% of the mass and <1% of the volume – Sagittarius B2 (Sgr B2). With ~500 AU ALMA resolution, we find 314 compact sources at 3 mm and 163 in the smaller field of view at 1 mm. We describe the mass distribution of the cores in an attempt to understand whether the IMF is top-heavy in young clusters and varies with the surrounding conditions.

Data acquisition and reduction:

The data consist of four pointings centered on Sgr B2 North (N) and Main (M) at 3 mm (Fig. 1) and 1 mm (Fig. 3) each, observed in September 2017 (ALMA Project 2016.1.00550.S). The data were imaged and phase-calibrated using CASA.

Source extraction:

Our field of view contains a variety of high-dynamic-range structures: extended emission from HII regions and collapsing dust, compact emission from dusty cores, and waves and streaks from imaging artifacts. Thus, we opted to use `astrodendro` package augmented with a by-hand approach.

We inspect the images and identify regions in each image that contain what appear to be real sources. Then, we run the dendrogram algorithm and include detections only within the defined regions. Finally, we inspect each detection by hand to remove false detections.

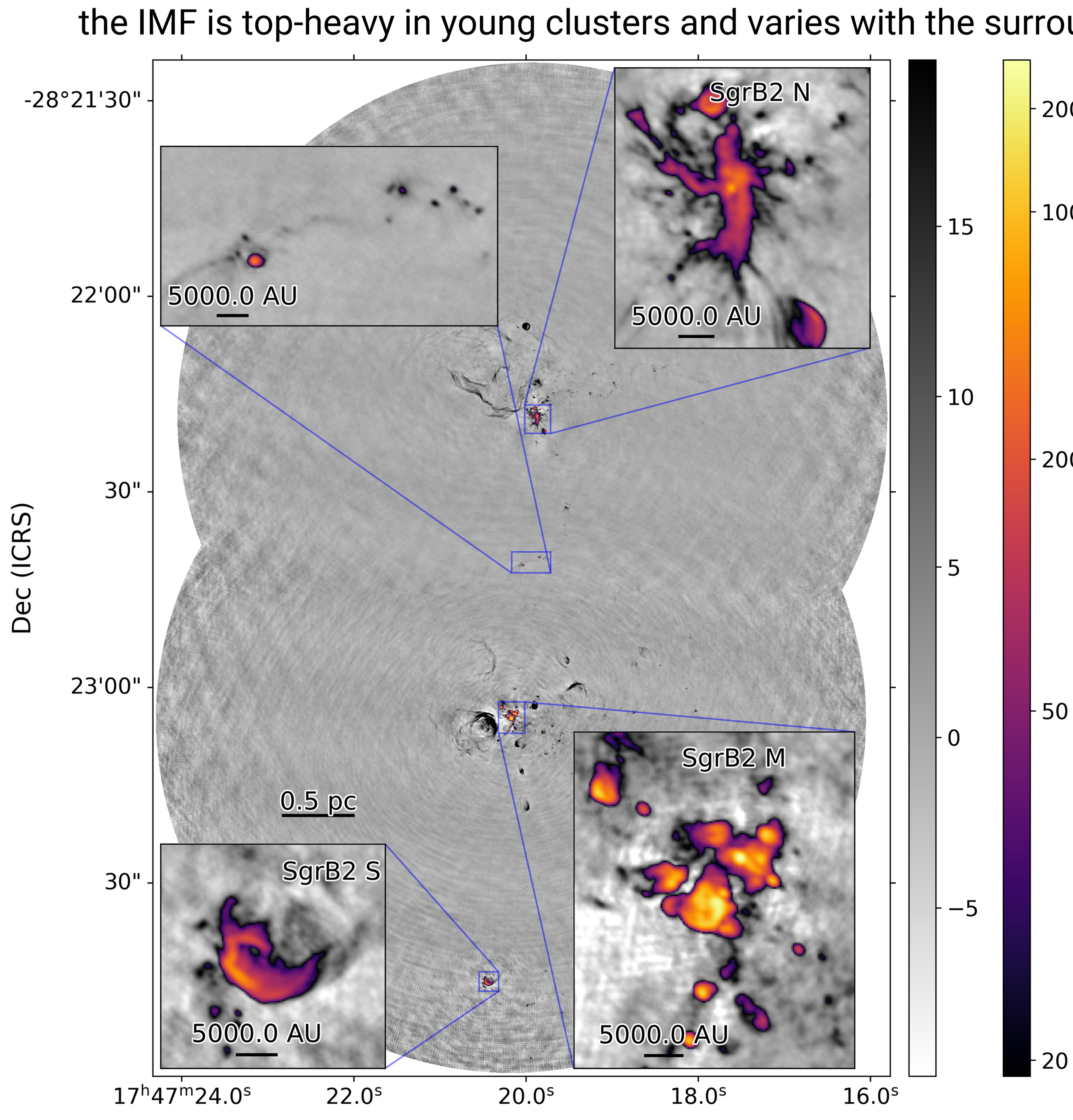

Fig. 1: **3 mm continuum** image of Sagittarius B2 Main and North at ~**500 AU resolution**. Ginsburg et al. (2018) detected ~150 sources in the same field of view with ~5000 AU resolution (Fig. 5). The insets show the high-density regions of Sgr B2 N and M, as well as Sgr B2 S and a region around Sgr B2 z. The two pointings were imaged separately and then the final images were cut and overlaid to not overlap. The images were subsequently stitched together; the pixels in the central zoom-in on Sgr B2 z come from only the N pointing.

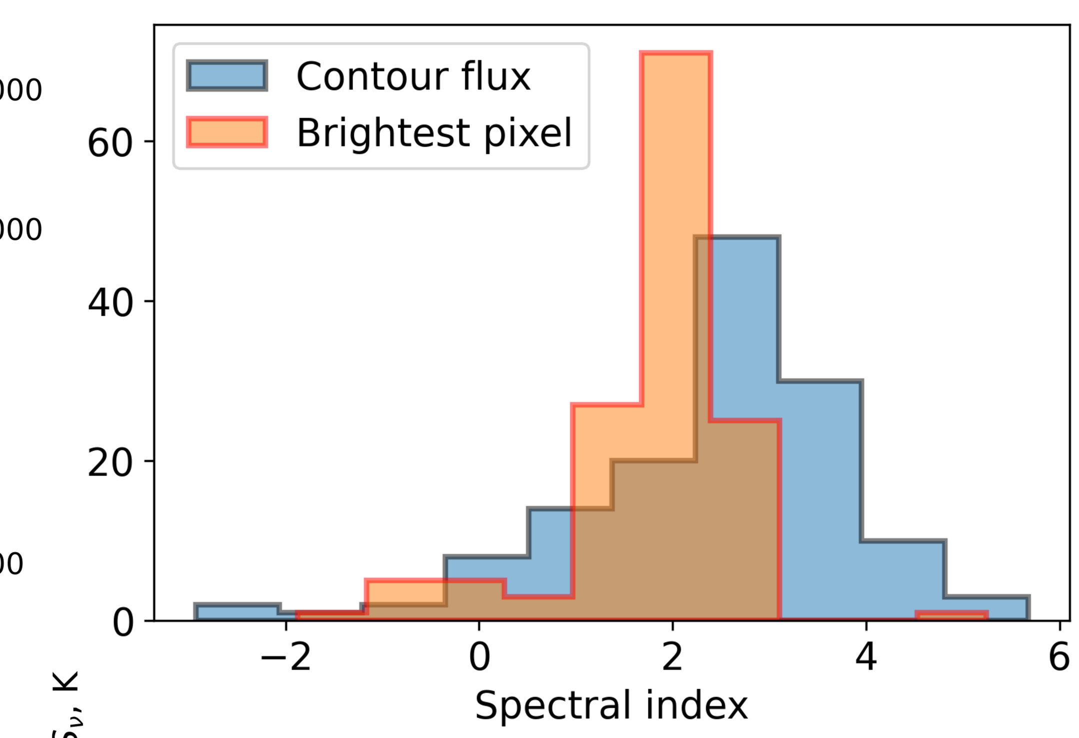

Fig. 2: We cross-matched 1 mm and 3 mm detections to derive spectral indexes. We used the brightest pixel of each source and the summed-up flux within the source contour to get two measurements of the spectral indexes. Since most of our sources are spatially resolved, the spectral indexes based on the brightest pixel give information about the central part of the source. Most of the sources have spectral index values close to 2, which indicate blackbody emission and thus the sources are **optically thick**.

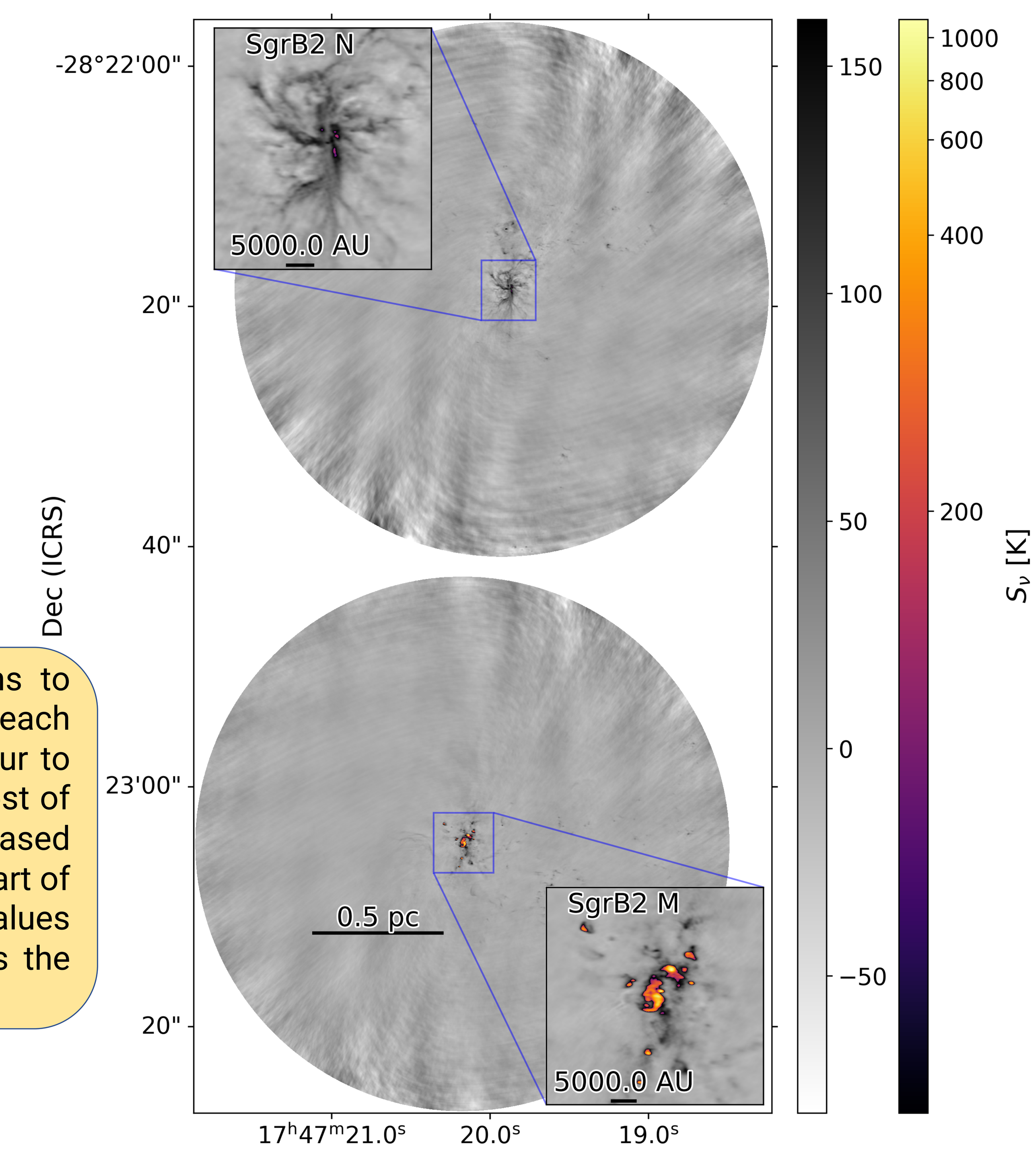

Fig. 3: **1 mm continuum** image of Sagittarius B2 Main and North at ~**500 AU resolution**. Sgr B2 M, where most sources are likely HII regions, appears to be hotter and denser than Sgr B2 N. Due to the smaller field of view, Sgr B2 S and z are visible in 3 mm (Fig. 1) but are not present here.

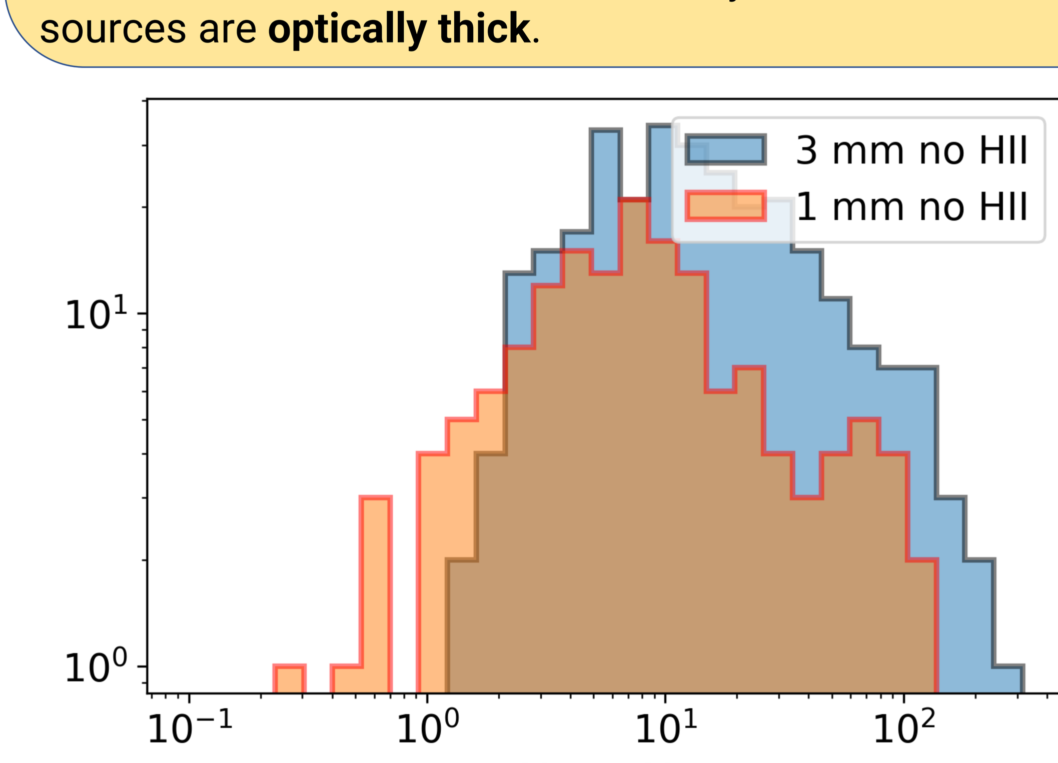

Fig. 4: The inferred **lower mass limit of the sources** using the **optically thin dust assumption** for 1 mm and 3 mm data. 1 mm data have higher mass sensitivities that are most likely caused by the dust becoming more optically thick at higher frequencies, thus lower mass sources can be detected.

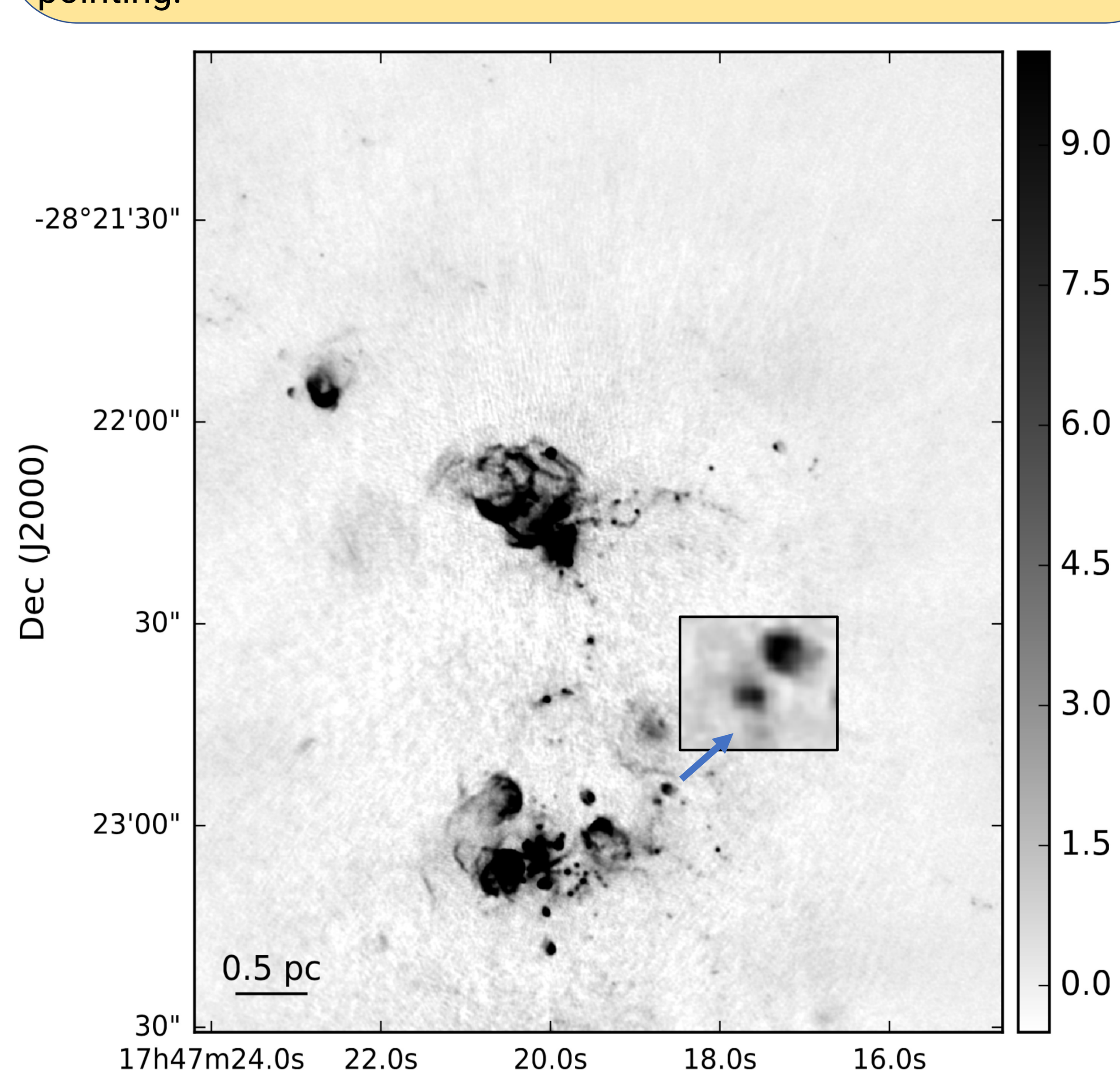

Fig. 5: **3 mm continuum** image of Sgr B2 with ~**5000 AU resolution** (Ginsburg et al. 2018). Over half of the cores in this sample ended up fragmented. Thus, the cluster formation efficiency is higher than the previously thought ~37%. The inset highlights a core that fragmented into seven individual cores also shown in Fig. 6.

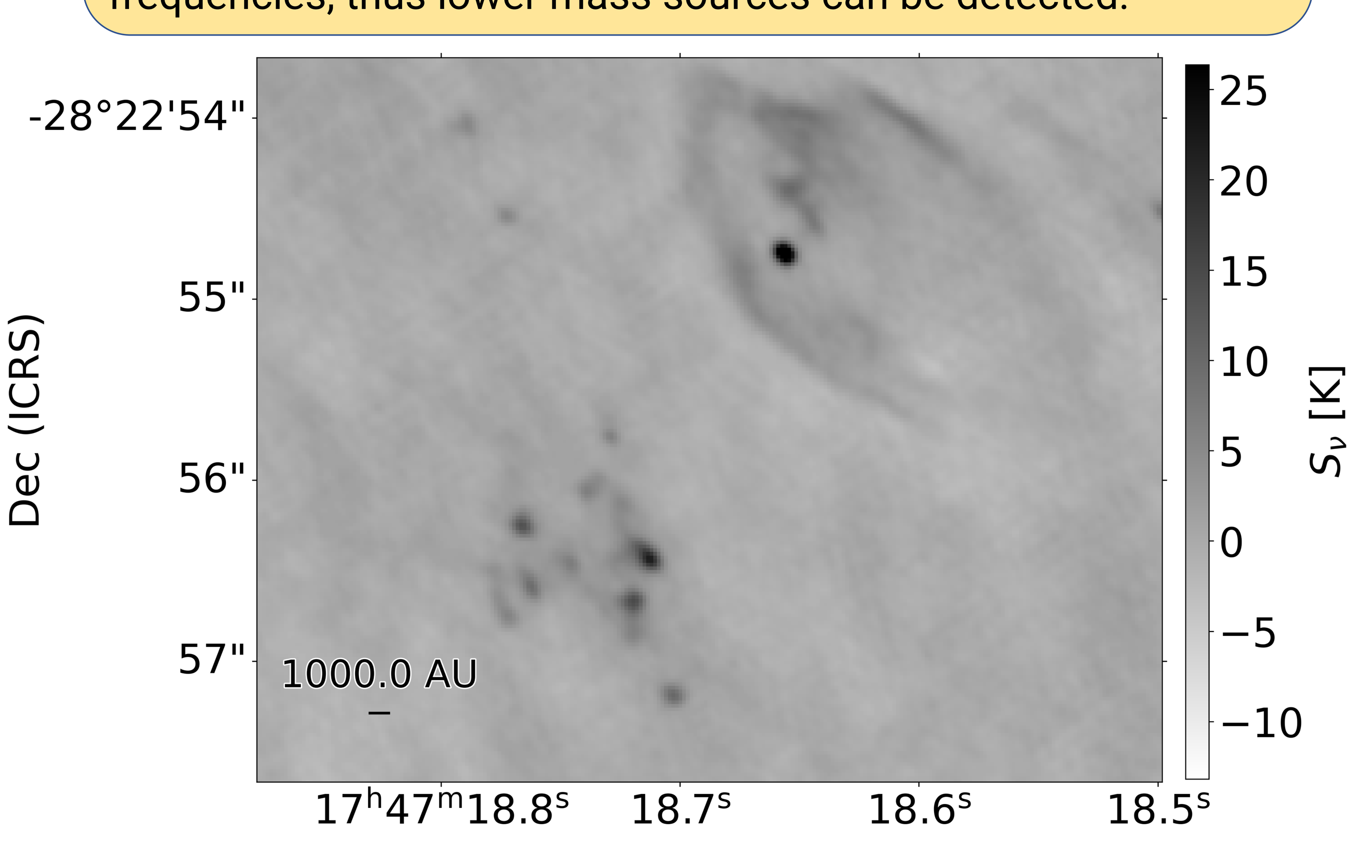

Fig. 6: A zoom in on a region north-east from Sgr B2 M. It features a **highly fragmented source**, an HII region Sgr B2 Y, and a core that is within the HII region on the sky. It is not clear whether this core is inside the HII region. The group of seven detected cores was previously thought to be one massive core as shown in Fig. 5.

Future work:

- Address some issues with how the data was processed.
- Re-calculate the Star Formation Rate and Cluster Formation Efficiency for the cloud.
- Use recent VLA data to create an H_2O maser catalog of Sgr B2.
- Measure proper motions of the cores with follow-up observations.

References & Acknowledgments:

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