HERSCHEL Gould Belt Survey

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National and Kapodistrian UNIVERSITY OF ATHENS

Two Mass Distributions in the L1641 MCs

The Herschel connection of Dense Cores and Filaments in Orion A

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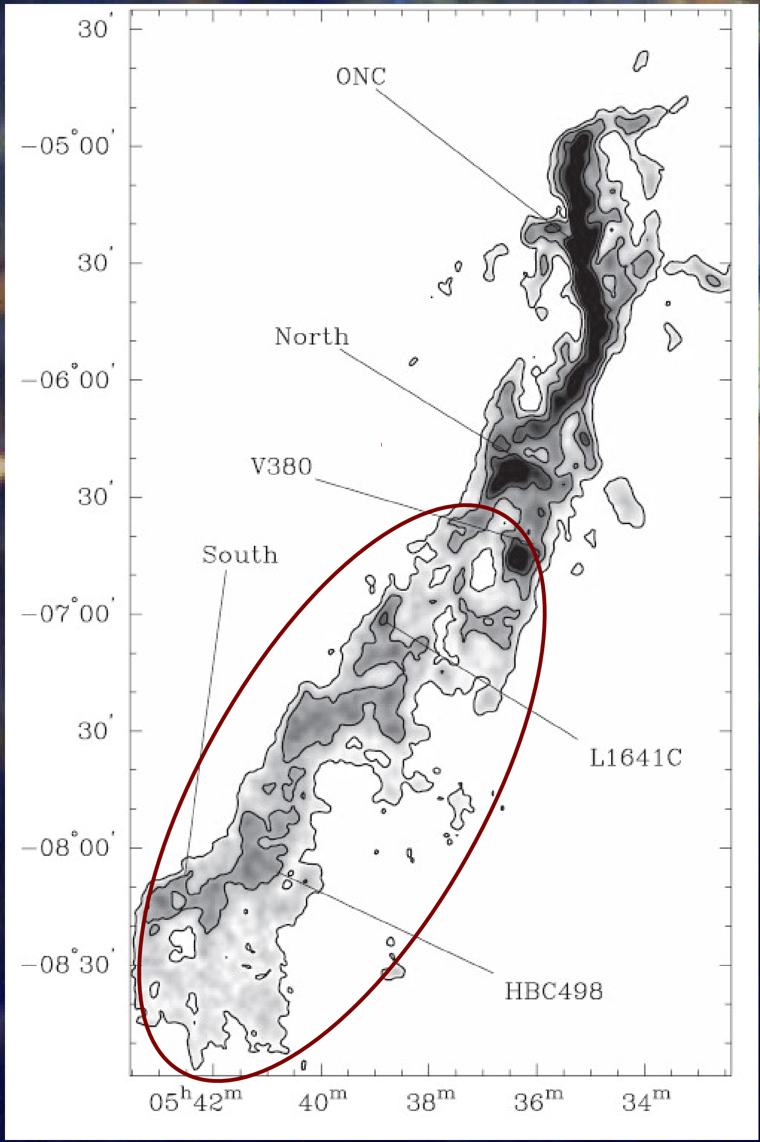
Orion A Molecular Cloud

Part of the nearest Giant Molecular Cloud complex (414 pc) in the Orion constellation.

Bally et al. (1987) mapped 2/3 of Orion A in ^{13}CO and measured it's mass (over the 13pc map coverage) of 5×10^4 M☉. They estimated that ~25% of the mass of the cloud is located in the integral shaped filament structure.

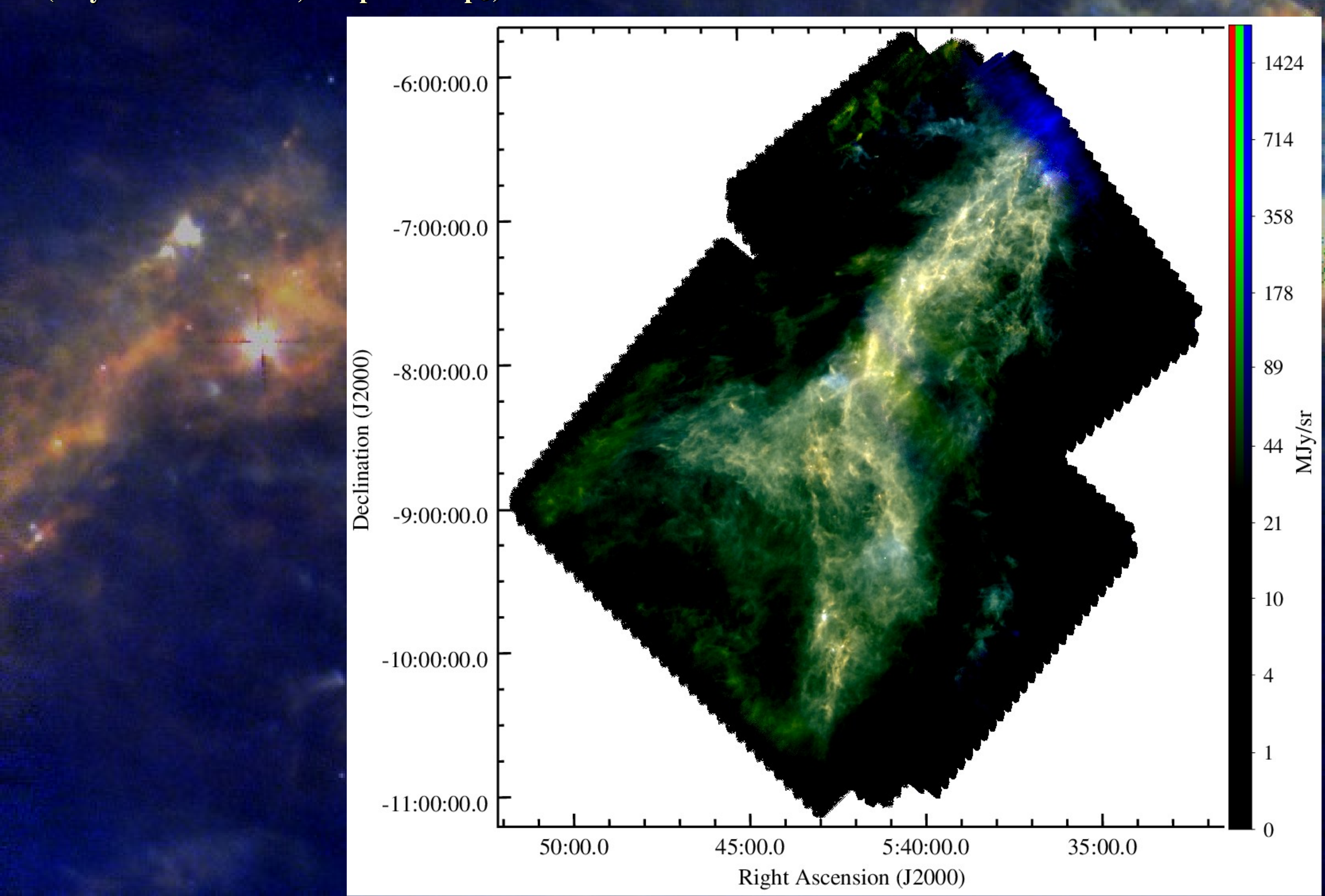
The regions from L1641N and lower are very often collectively called the L1641 cloud (e.g. Allen & Davis 2008). These regions exhibit largely low mass star formation and contain prominent Herbig-Haro objects and H_2 jets (e.g. HH1/2; HH34)



Orion A cloud in ^{13}CO (Bally et al. 1987)

The L 1641 clouds with Herschel

(Polychroni et al. 2013, accepted in ApJ)



Filaments:

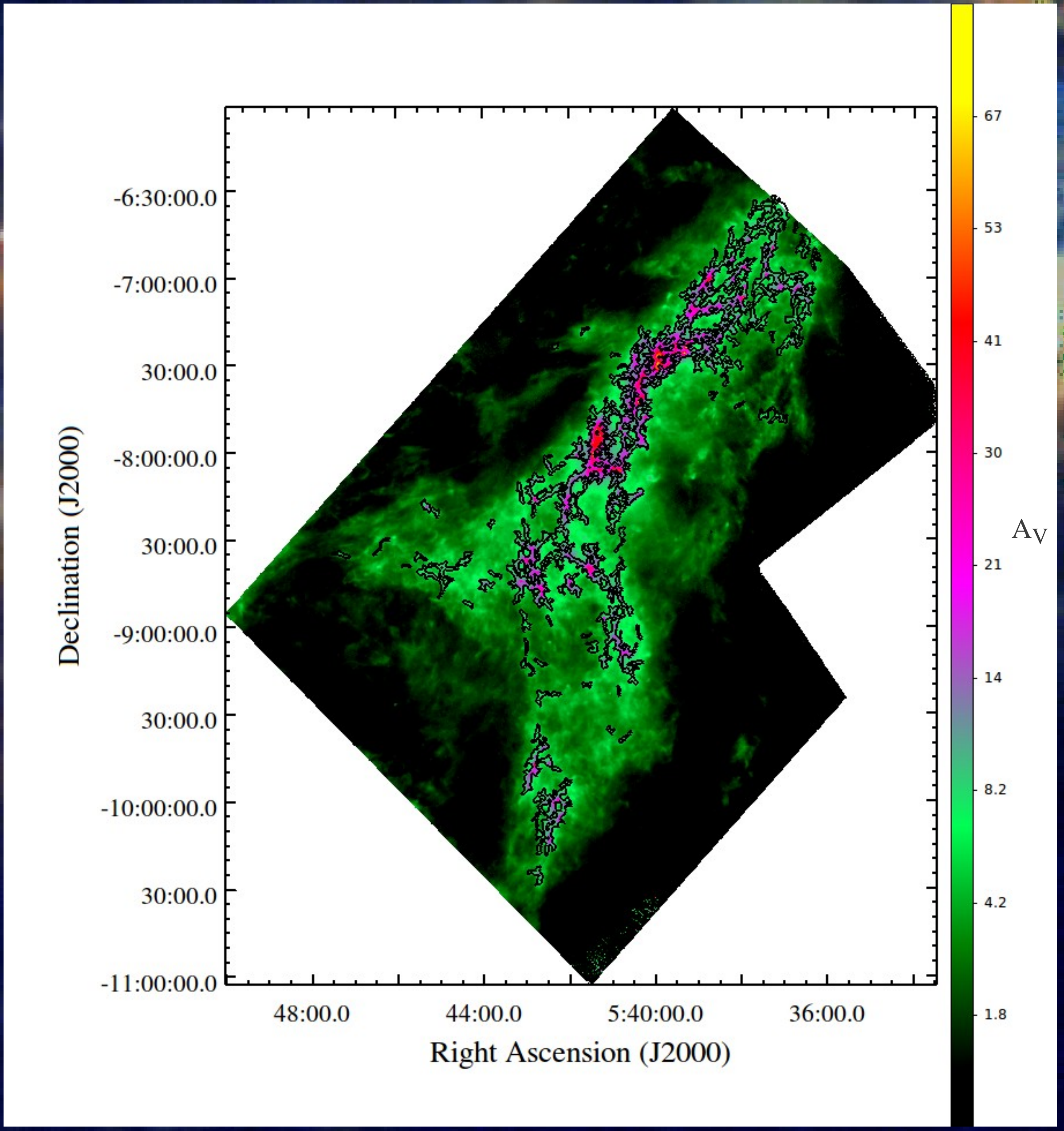
Schisano et al. in prep

<u>Pattern recognition algorithm:</u>

Start from the 2nd derivative of the column density map and compute the eigen value of the Hessian matrix at each pixel.

Select the regions where the curvature along one of the eigendirections exceeds a certain threshold. Such threshold defines the minimum variation in the contrast that is accepted to separate a filamentary region from its surroundings.

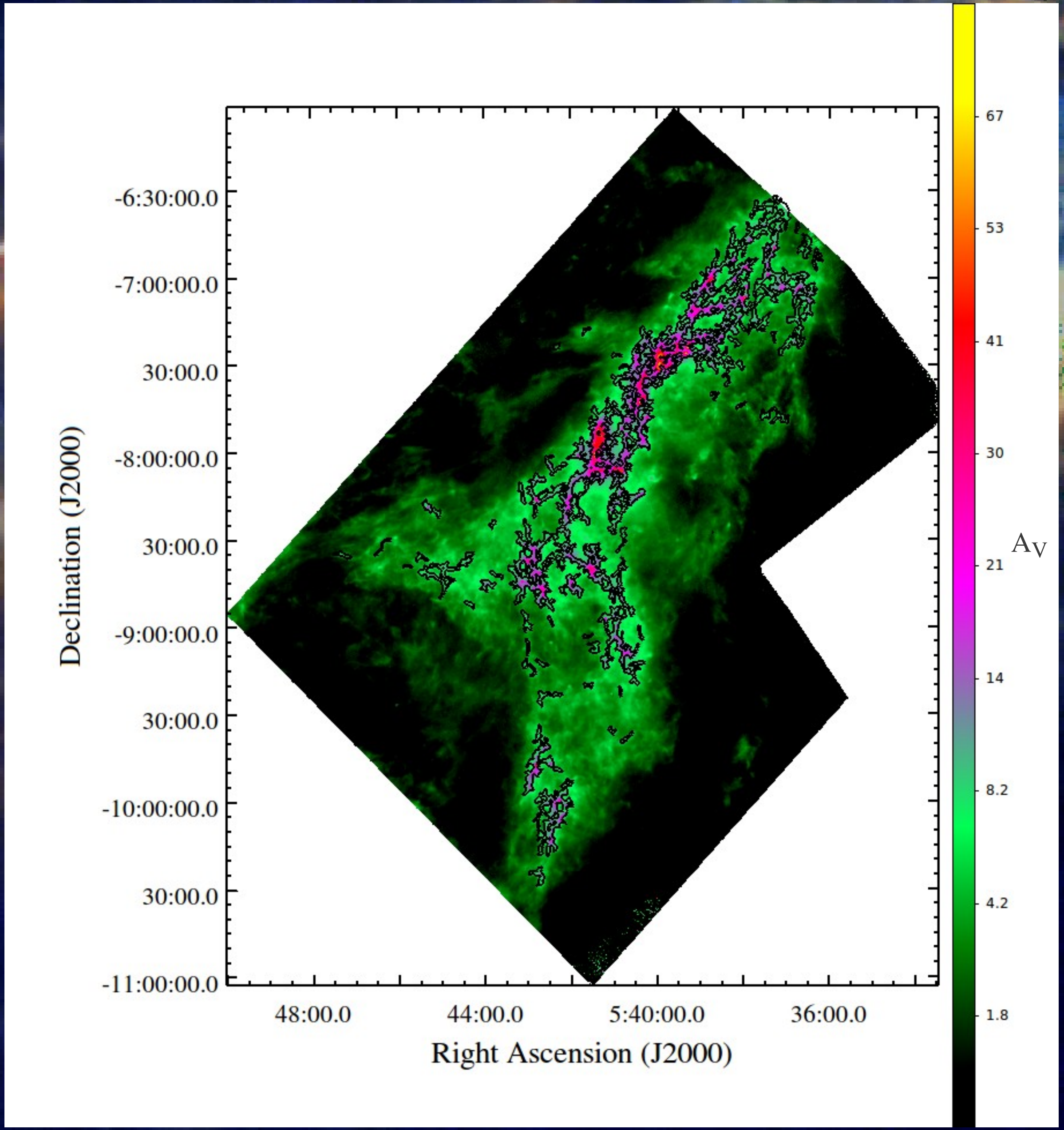
Afterwards, morphological operators are applied to determine the central pixels of the identified regions. Those with few pixels or those that do not have an elongated shape are rejected.



Filaments:

Properties

Average deconvolved FWHM: 0.15 pc
Lenghts: 0.5 to ~ 9 pc
Temperatures: 12 to 13 K
Masses: ~5 to 5×10^3 $M_\odot$



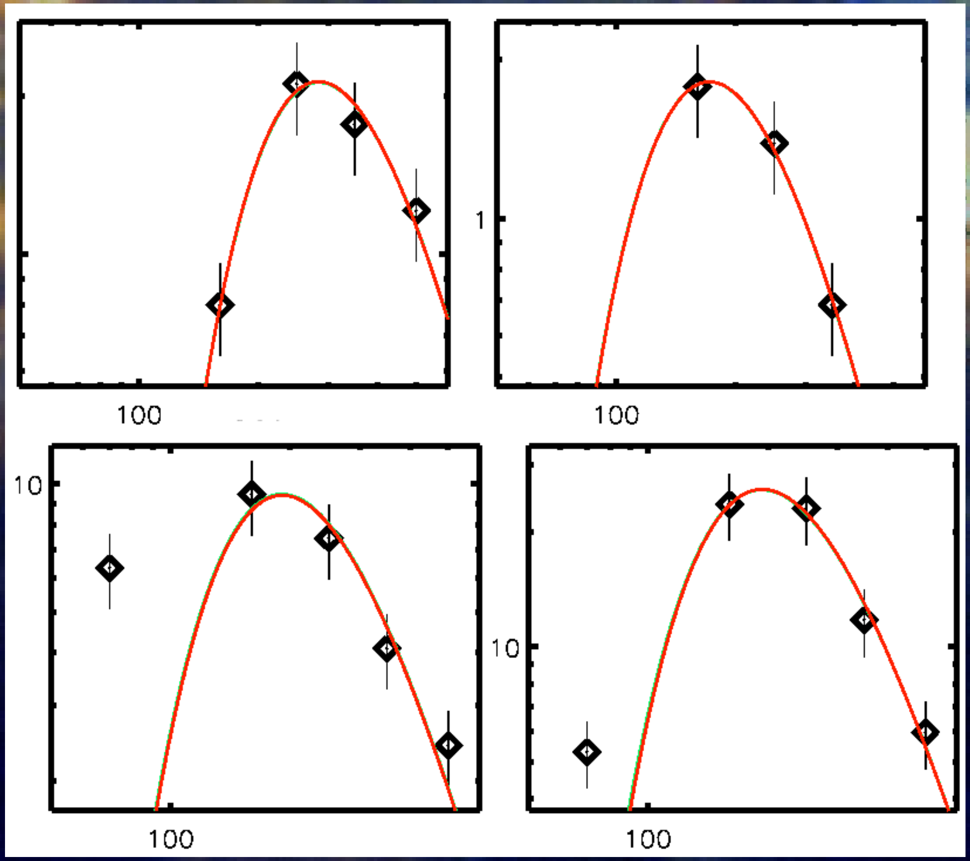
Source Detection & Photometry

We used CUTEX (Molinari et al. 2010) to identify and extract sources. We bandmerge the catalogue keeping only those sources that have detections in 3 consecutive bands & good SEDs.

We fit the SEDs with an optically thin grey-body model using a fixed dust emissivity β=2 and dust opacity κ_{THz}=0.1cm^{2}g^{-1} (Beckwith et al. 1990; Hildebrand 1983)

We find in total 493, of which 109 we classify as proto-stellar and 384 as starless based on the existence of a 70 micron (and also 24µm) object (Stutz et al 2013; Megeath et al 2012; Dunham et al. 2008).

We check which of our sources have a size smaller than 0.1 pc and use the M_{obs}/M_{BE}=1.0 (Rygl et al. 2013) criterion to distinguish between gravitationally bound *pre-stellar* sources (84%) and the *starless* gravitationally unbound sources (16%).

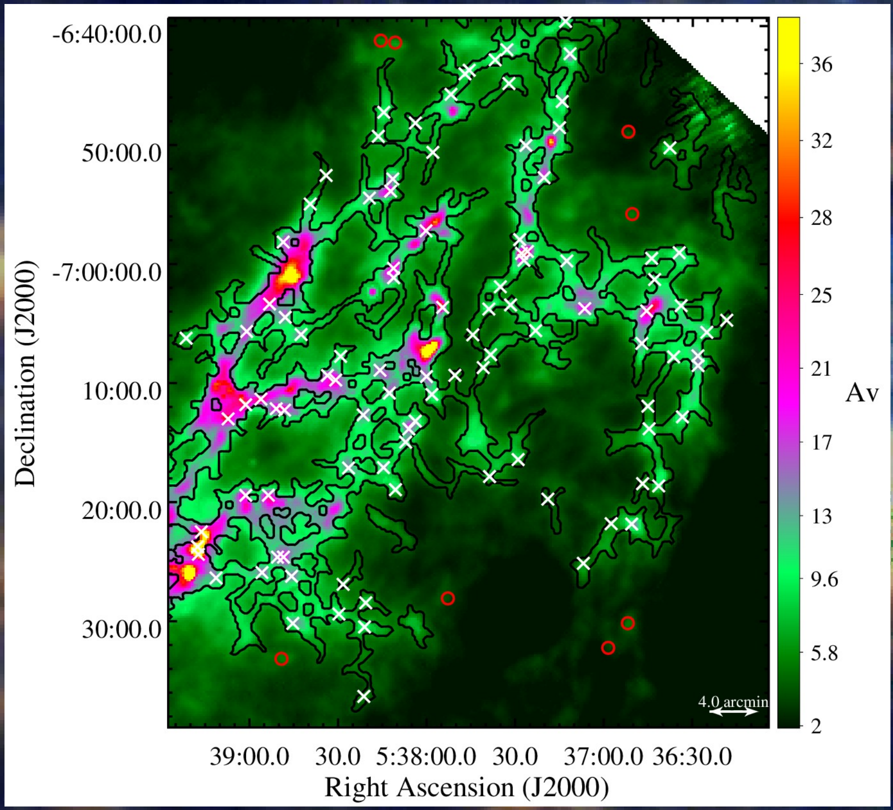


Pre-stellar sources *on* & *off* filaments

67% of the cores are located *on* the filaments, of which 229 are pre-stellar, 92 are starless and 83 are proto-stellar.

Of the cores located *off* the filaments 19 are pre-stellar, 44 are starless and 26 proto-stellar.

92% of the sources *on* filaments are pre-stellar, which drops to 68% when considering sources *off* filaments.



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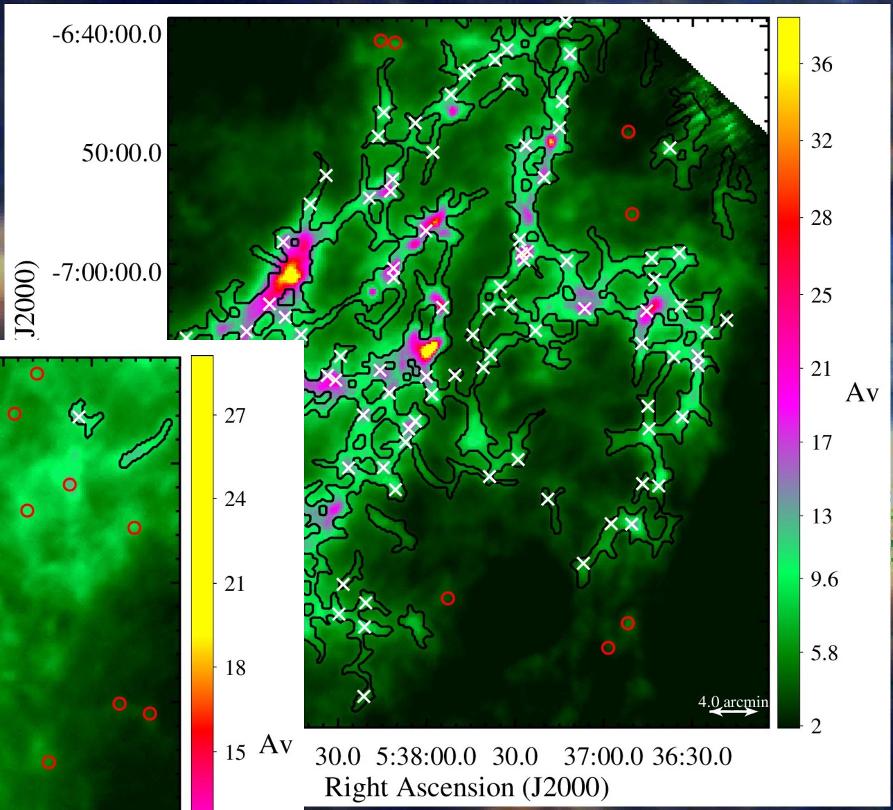

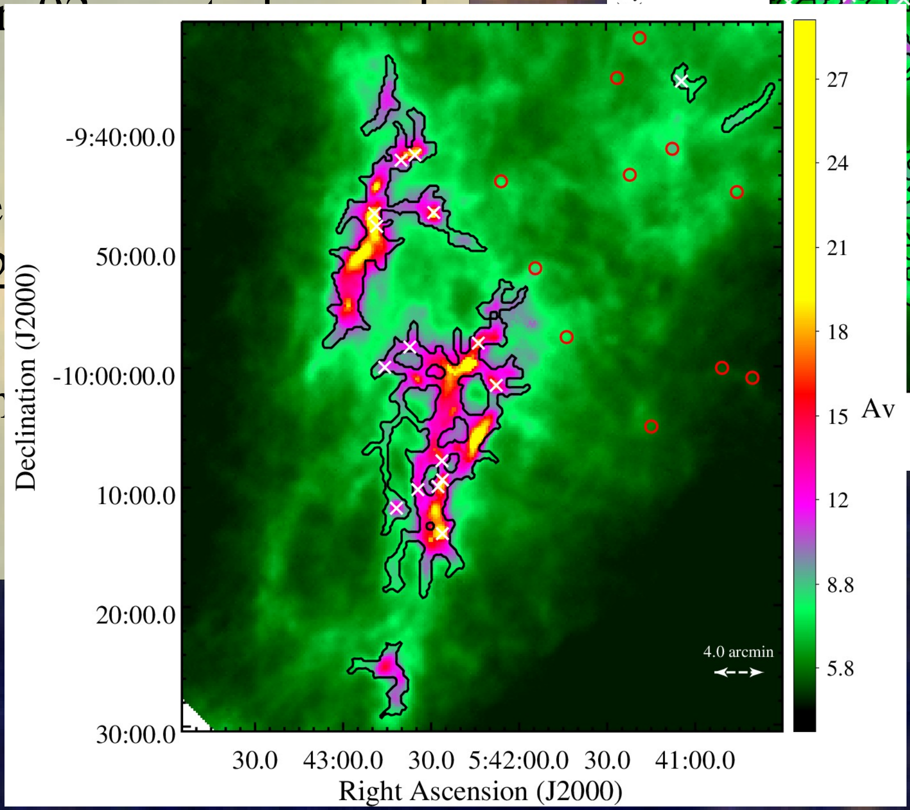

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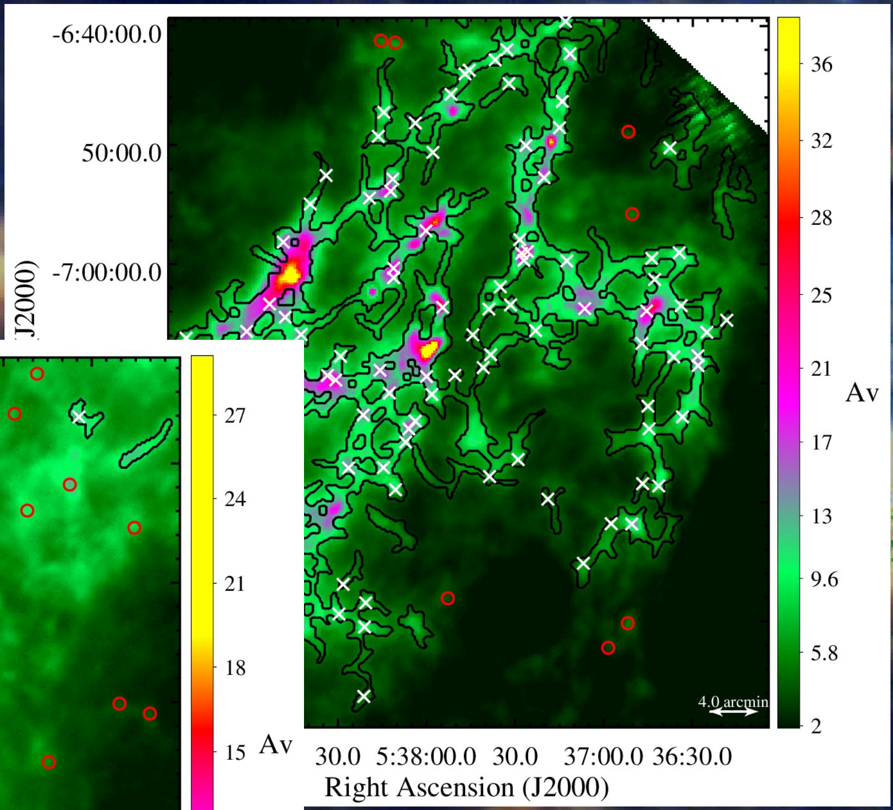

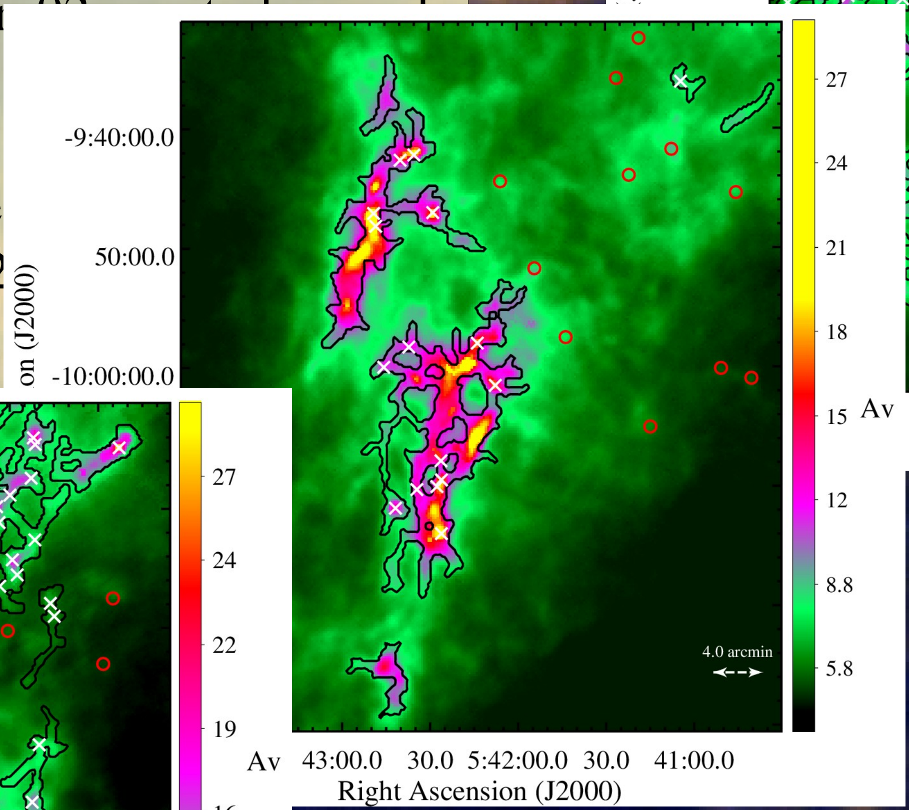

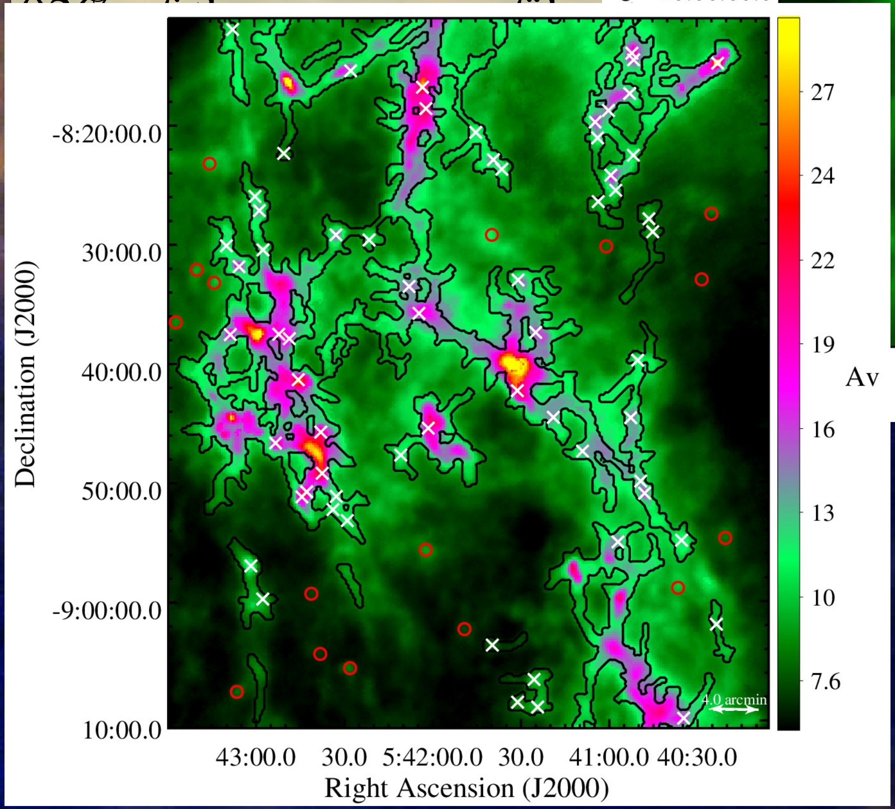

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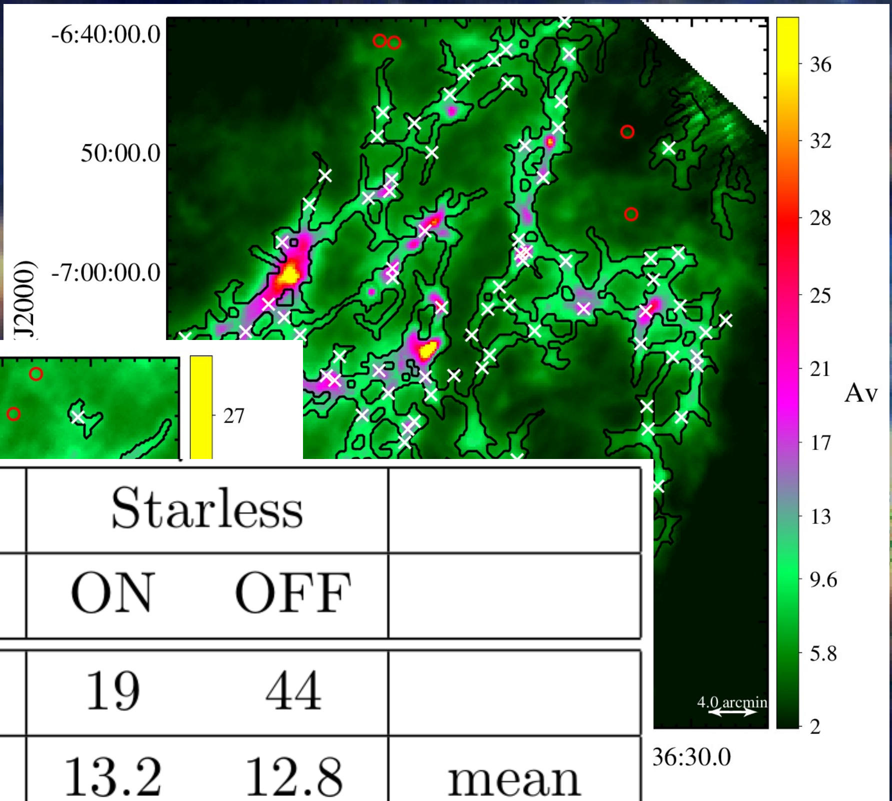
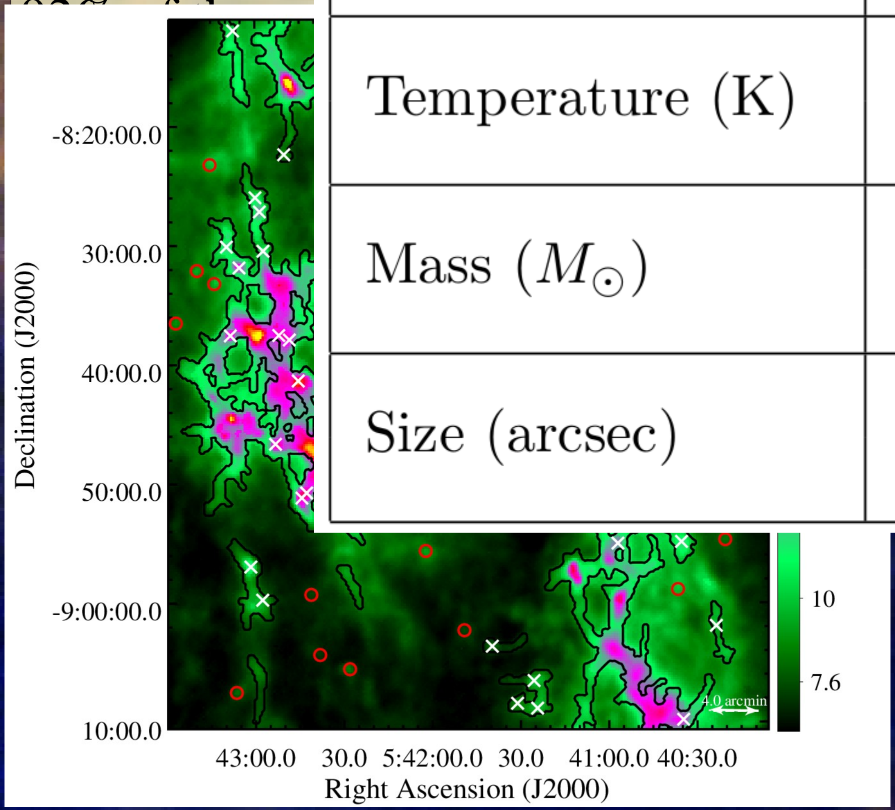
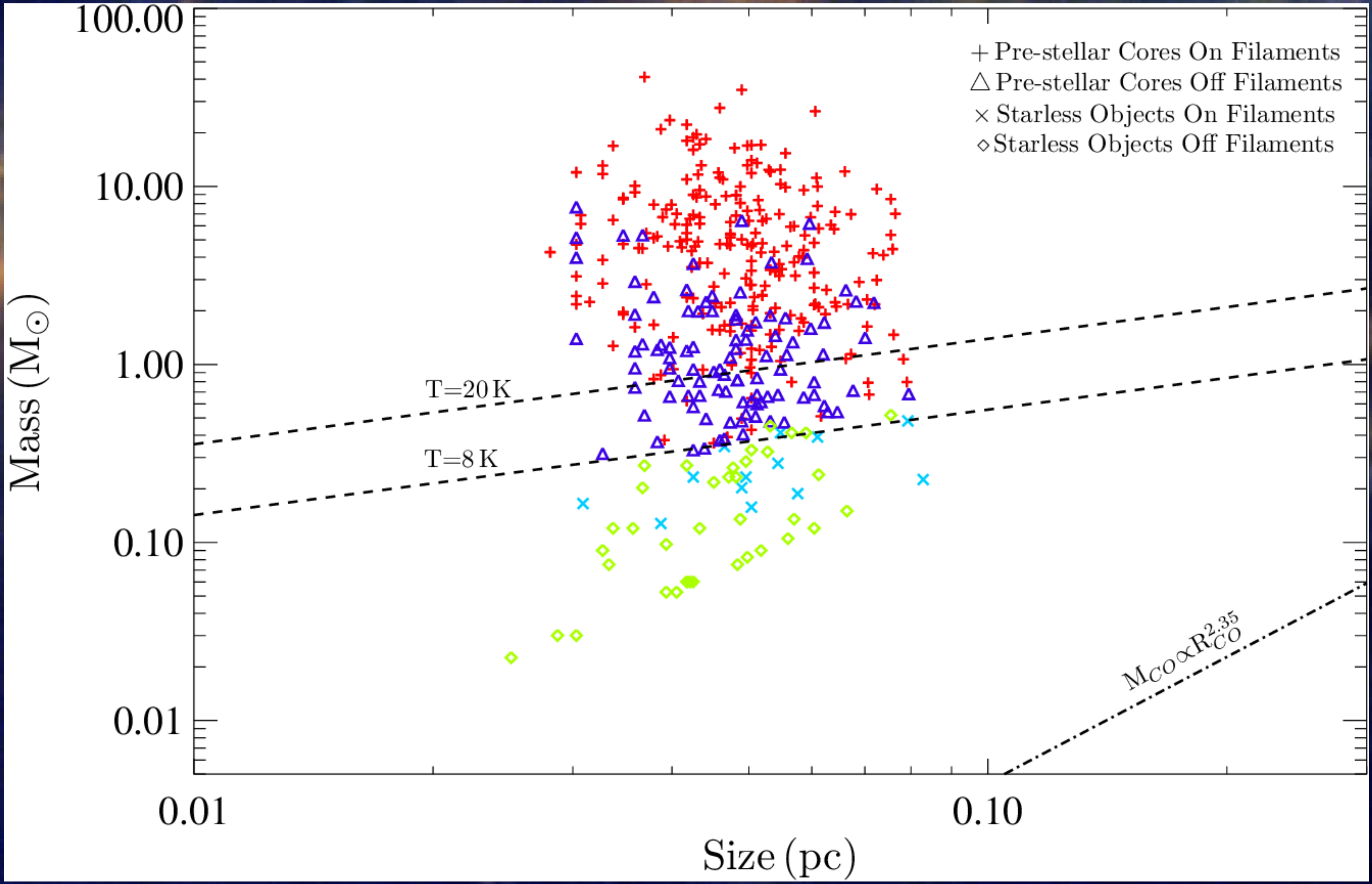


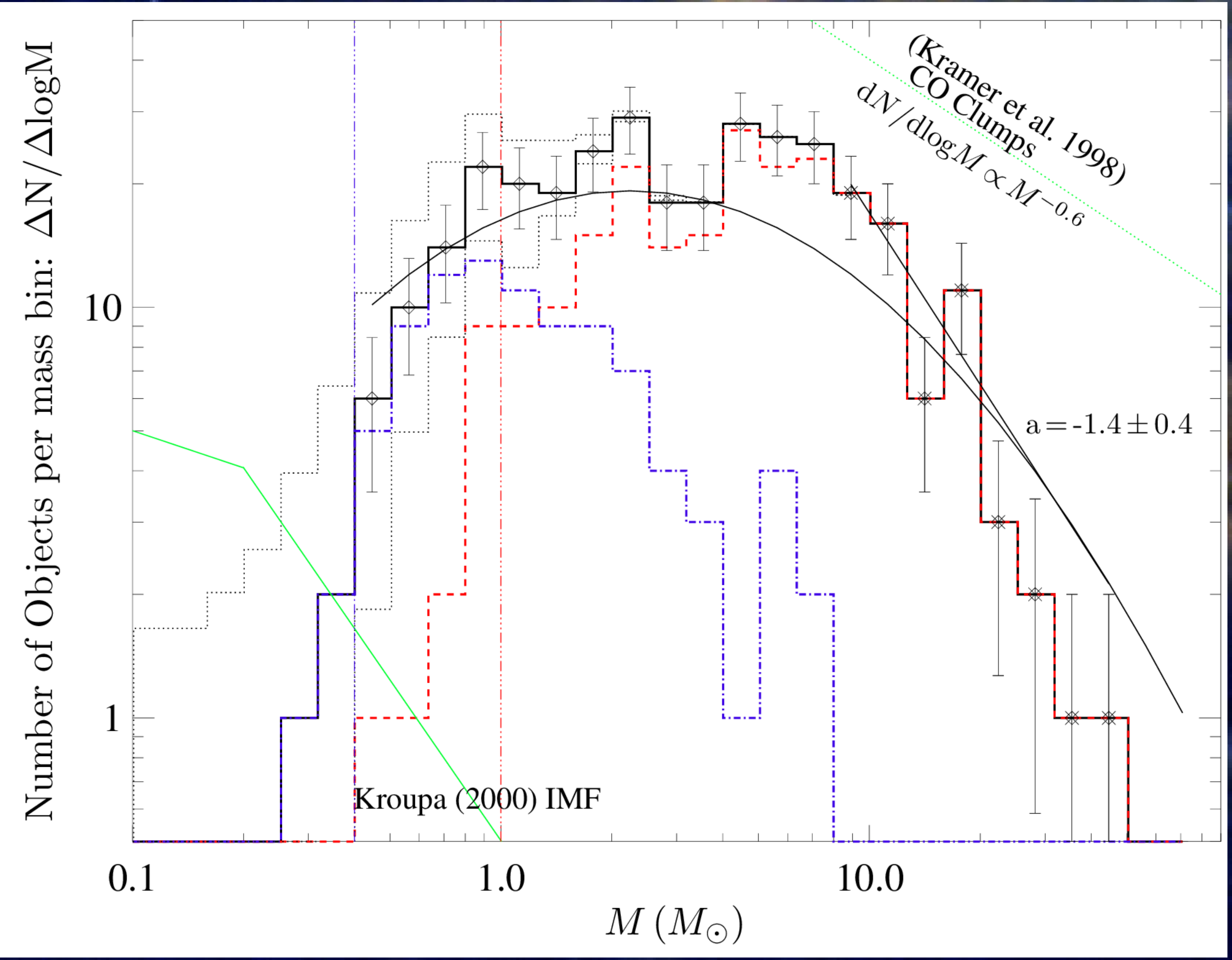
	Pre-stellar		Starless		
Filament Location	ON	OFF	ON	OFF	
Source Counts	229	92	19	44	
Temperature (K)	8.7	8.8	13.2	12.8	mean
	8.5	8.7	12.9	12.7	median
Mass ($M_\odot$)	6.3	1.6	0.3	0.2	mean
	4.7	1.4	0.3	0.2	median
Size (arcsec)	24.7	23.7	26.5	23.8	mean
	24.4	24.0	25.1	23.8	median



Pre-stellar sources *on & off* filaments



The Core Mass Function



The Core Mass Function

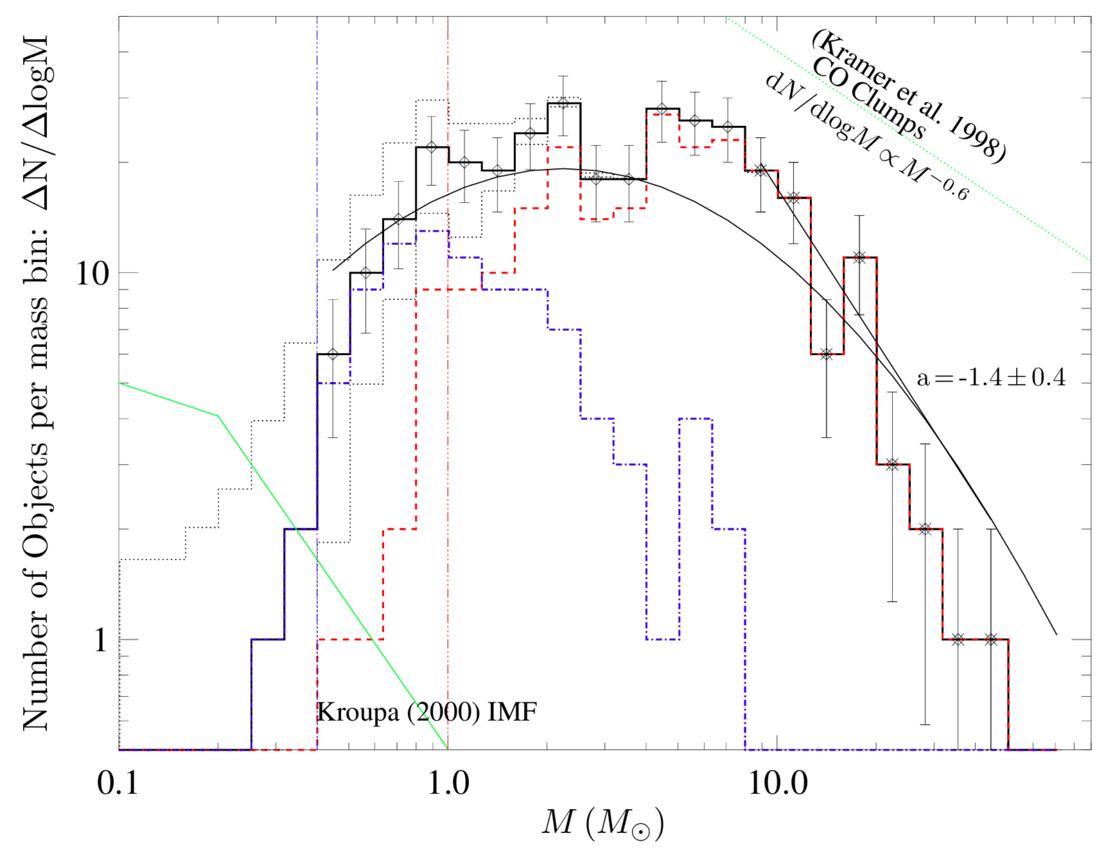
The masses of the pre-stellar cores range between 0.2 and 55 $M_{\odot}$. The distribution flattens between 1$M_{\odot}$ and 4$M_{\odot}$ (Padoan & Nordlund 2011). The power law fit to the high-mass end of the CMF (-1.4±0.4) agrees very well with previous estimates for Orion A (slope -1.3; Ikeda, Sunada & Kitamura 2007).

In red we plot the pre-stellar cores *on* filaments (71%) and in blue those *off* them (29%). The distributions peak at 0.8$M_{\odot}$ and 4.0$M_{\odot}$ for cores off and on the filaments.

The slope of the CMF is driven by the sources located *on* the filaments, while the flattening of the CMF is a result of the sources located *off* the filaments.

→ Due to the difference of column densities between the filaments and the rest of the cloud, we estimate 2 completeness limits.

For the filaments we find that our core sample is complete (@ the 80% level) down to 1.0$M_{\odot}$ while off the filaments we are complete down to 0.4$M_{\odot}$.



Column Density & Mass

Derived from pixel-to-pixel SED fitting of the 160, 250, 350 and 500 μm bands. The white contours trace extinction higher than 2 magnitudes.

Using a distance of 414 pc and

$N_{H_2} = 9.4 \times 10^{20} A_V$ (Bohlin et al. 1978)

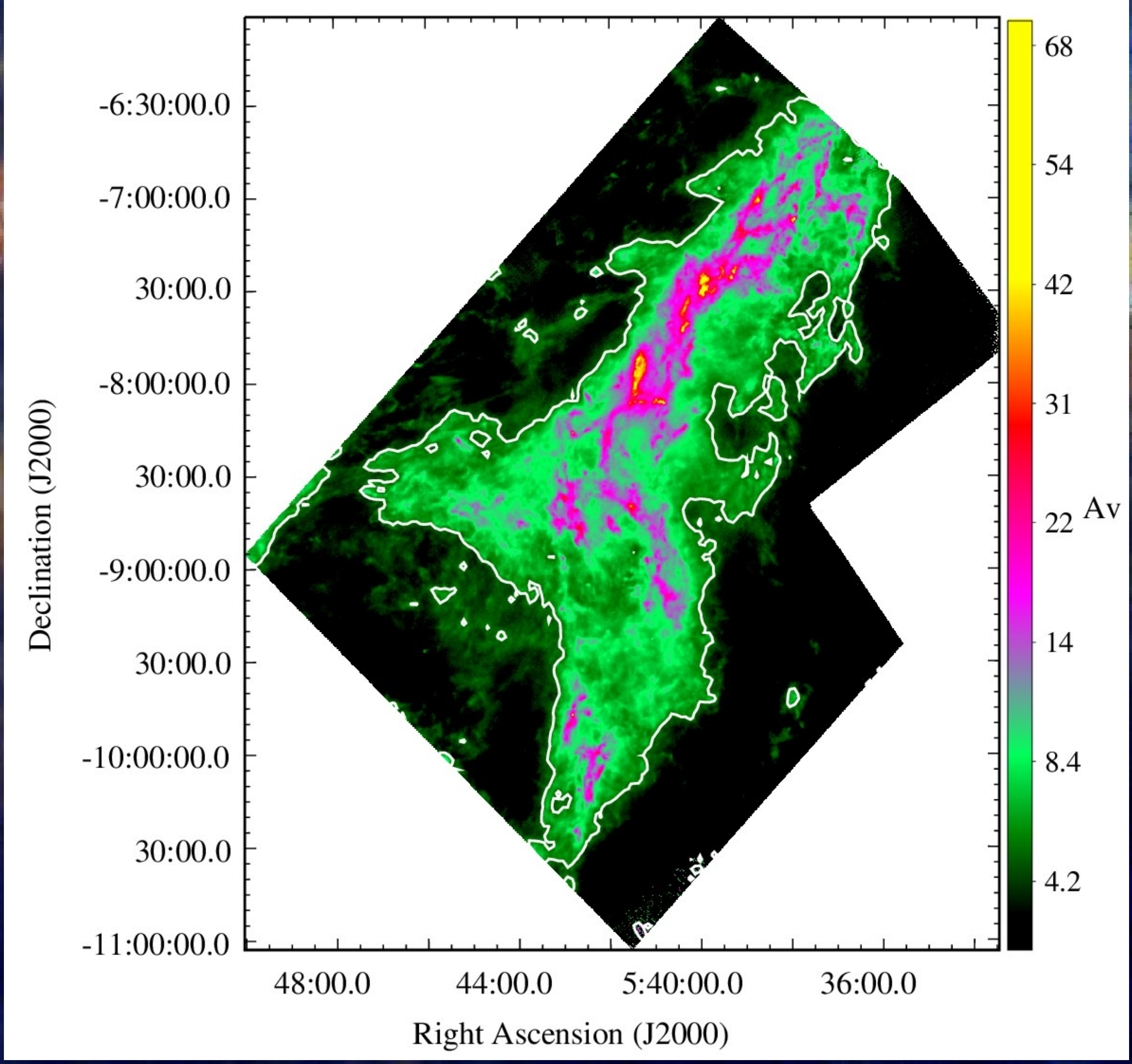
we get a mass of 3.7×10^4 M$_\odot$.

Within the filaments the total mass is estimated around 1.16×10^4 M$_\odot$ which represents 31.4% of the total mass of the L1641 clouds.

Using the standard CFE equation:

$M_{cores} / (M_{cloud} + M_{cores})$

we calculate that the CFE of the L1641 MCs is **4%**. This value increases to **12%** for dense cores *on* filaments as well as the total mass within these filaments.



What does all this mean?

That we find more gravitationally bound cores *on* filaments can be explained twofold:

→ Filaments are regions of strong emission in a localised space in the clouds. **Fainter objects**, potentially unbound, are **not easy to detect towards filaments** (i.e. higher mass completeness limit).

→ Cores located *on* filaments find themselves in a much different environment than cores *off* them. It is possible that **the larger external pressure** from the filament coupled with the **larger reservoir of gas** available allows for **more cores to gravitationally collapse**.

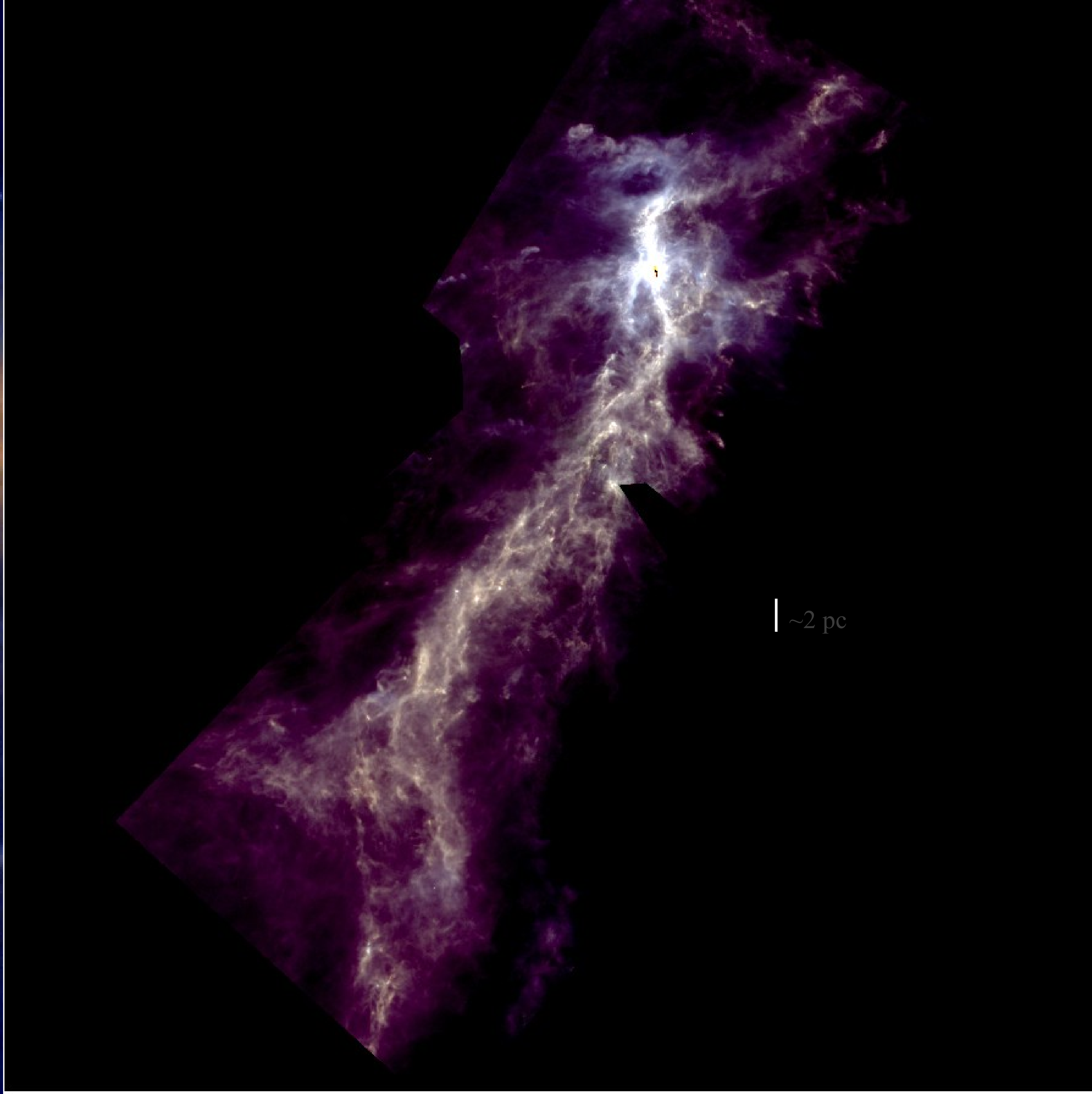
We also find that there are two separate mass distributions of the pre-stellar cores *on* and *off* filaments.

As **filaments have higher column densitie**s than the rest of the cloud, objects formed in situ have a **larger reservoir of mass** to accrete from, forming in general **higher-mass objects**, than those *off* them.

The dense **cores** may still **form in the same general way *on* or *off* the filaments**, but the **different environments** these cores find themselves in may result in **different mass distributions**.

→ This results in the **higher core formation efficiency** measured **on the filaments** with respect to the whole of the cloud, making the filaments the **preferred, but not unique, star formation site**.

Soon to come



Size & Temperature