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The Core Mass Function in NGC 6357

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5. Joint Astronomy Centre, Hilo, Hawaii
6. Osservatorio Astrofisico di Arcetri, Florence

The Initial Mass Function

Fundamental ingredient for study of star formation and galaxy evolution

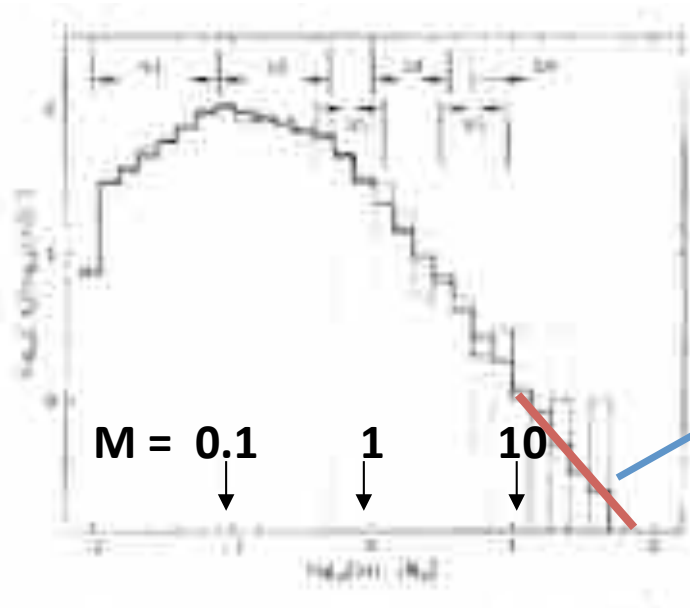
IMF: Frequency distribution of stellar masses at birth

Number of stars per unit of (logarithmic) mass:

$$\xi(\log m) \propto m^{\Gamma} \quad \text{or} \quad \xi(m) \propto m^{\gamma}$$

$$\xi(\log m) = (\ln 10) \cdot m \xi(m)$$

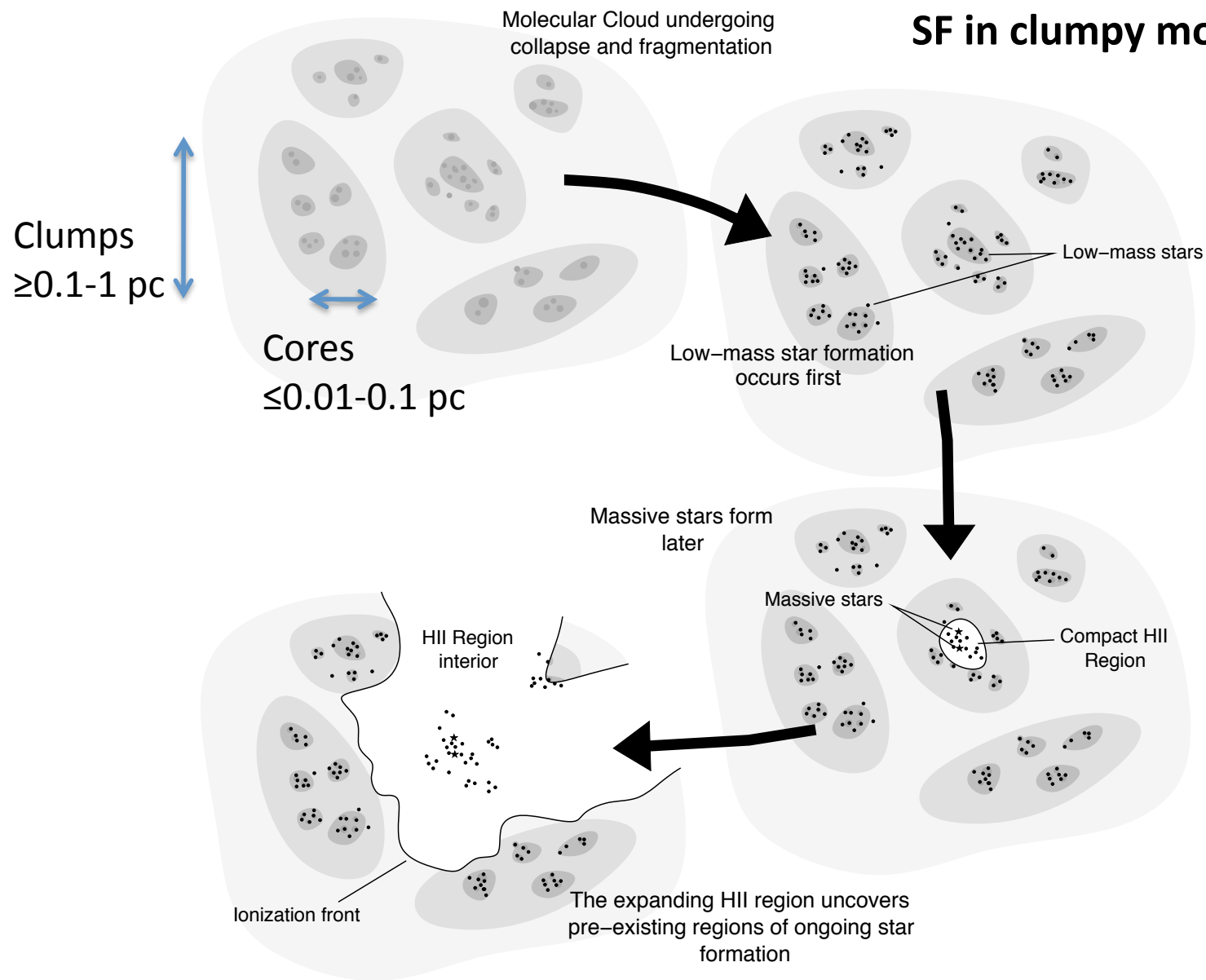
$\log[\xi(\log m)]$ vs. $\log m$



Scalo (1998): $\Gamma = -0.2 \pm 0.3$ for $0.1 < M < 1 M_{\odot}$
 $= -1.7 \pm 0.3$ for $1 < M < 10 M_{\odot}$
 $= -1.3 \pm 0.3$ for $10 < M < 100 M_{\odot}$

i.e.: $\gamma = -1.2 \pm 0.3$ for $0.1 < M < 1 M_{\odot}$
 $= -2.7 \pm 0.3$ for $1 < M < 10 M_{\odot}$
 $= -2.3 \pm 0.3$ for $10 < M < 100 M_{\odot}$

SF in clumpy molecular clouds I



Hester & Desch ASP 341, 2005

IN A NUTSHELL:

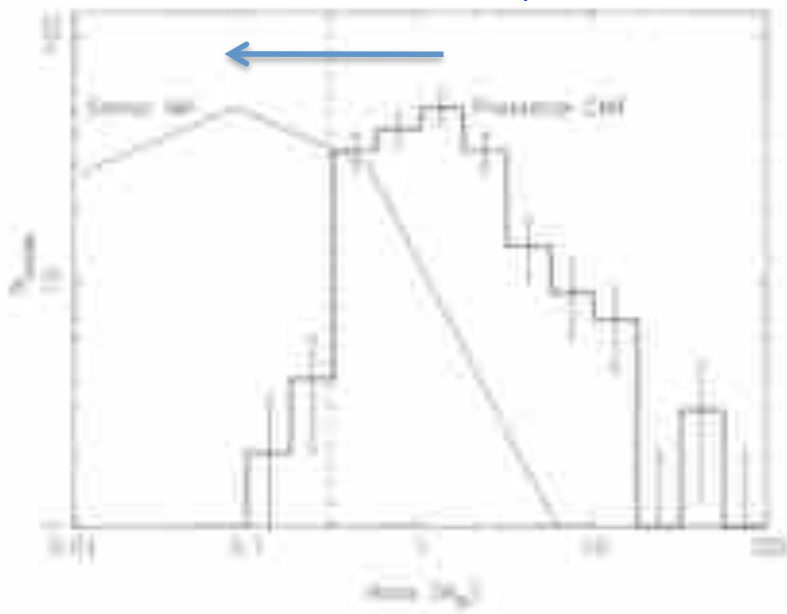
Stars form in cores.

Mass distribution cores (CMF) resembles that of stars (e.g. in Ophiuchus, Serpens, Orion, Pipe Neb.)

IMF determined early on, during the formation of clumps and cores in molecular clouds

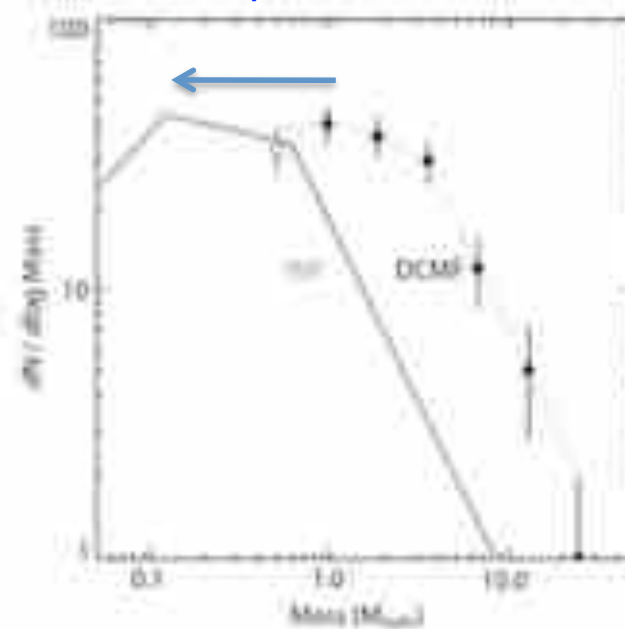
CMF is thus fundamental. May depend on environment. Different CMFs may lead to different IMFs, or do you somehow always get same IMF?

Orion, SFE $\approx 6\%$



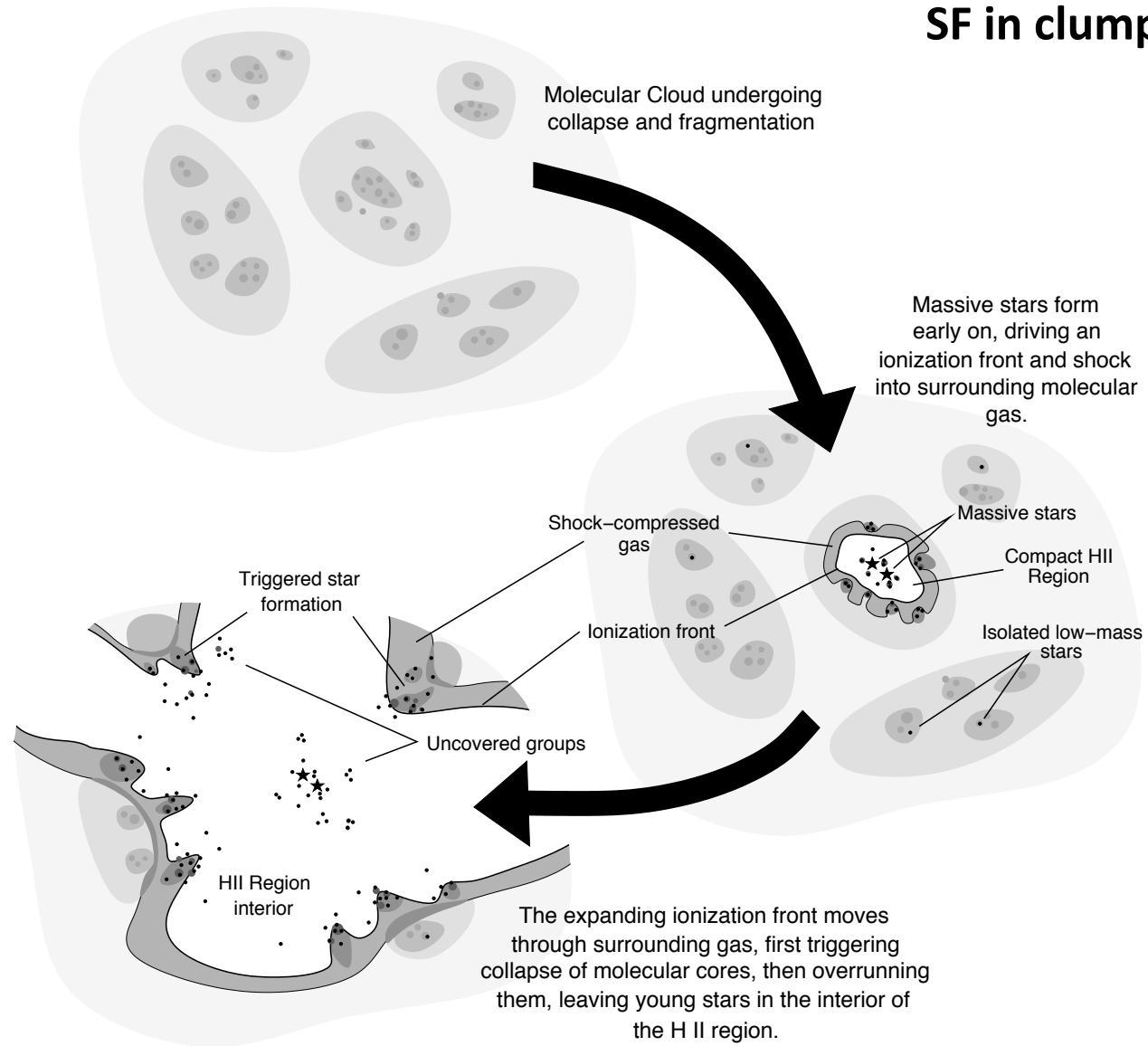
Nutter & Ward-Thompson 2007

Pipe Neb, SFE $\approx 30\%$



Alves et al. 2007

SF in clumpy molecular clouds II



Hester & Desch ASP 341, 2005

Massive stars ($M > 8 M_{\odot}$):

- Produce large amounts of ionizing radiation that creates PDR in nearby molecular cloud
- In clumpy clouds UV radiation can penetrate deeply and affect large part of cloud.
UV radiation may thus affect the CMF in the exposed cloud:

by dispersing or partially evaporating parental molecular cloud via ionization, winds, supernova explosions, thus possibly preventing subsequent SF;

by accumulation of gas, swept up by expanding HII region; creation of cores; subsequent collapse leads to new generation of stars;

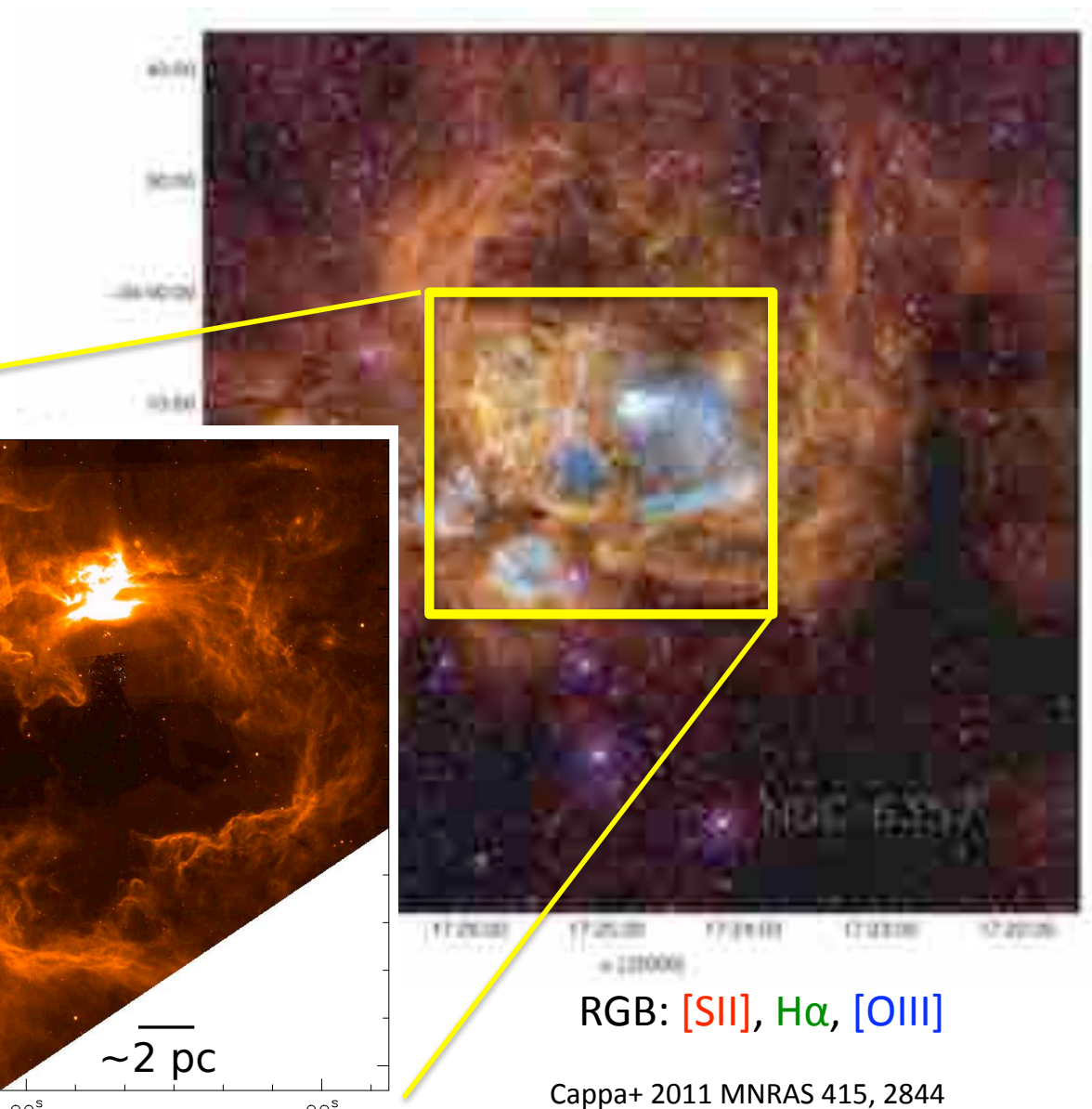
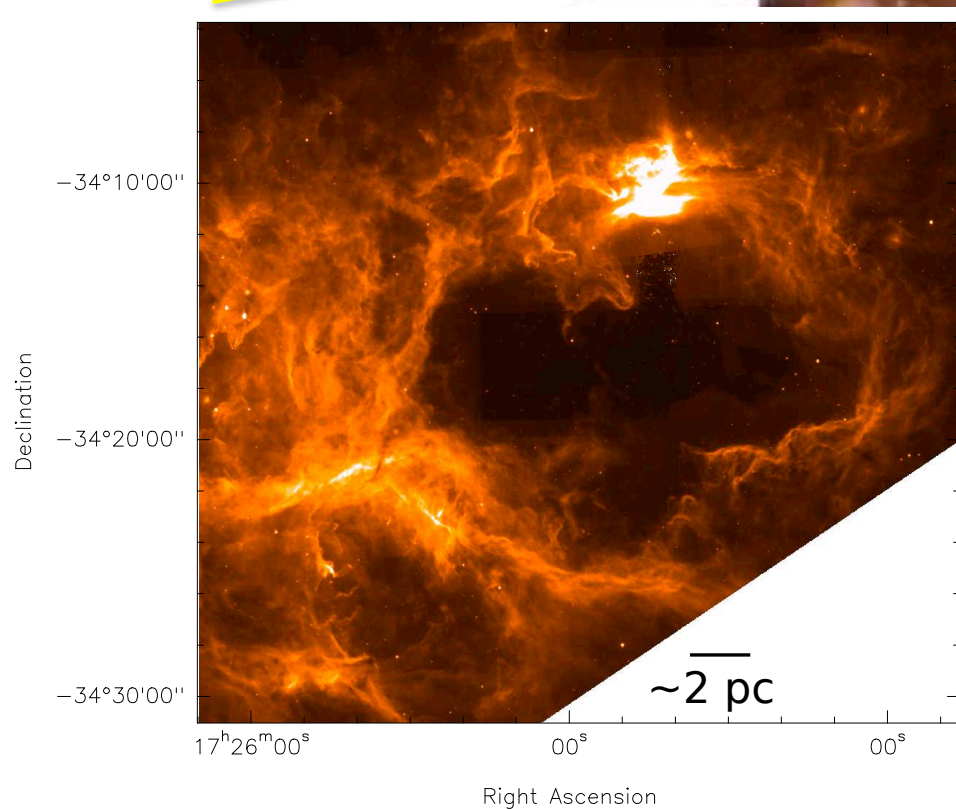
by compressing existing dense condensations, triggering SF.

A way of assessing these effects is to determine whether the CMF near to a PDR significantly departs from those observed in more quiescent (less exposed to intense stellar UV radiation) star forming regions.

NGC 6357

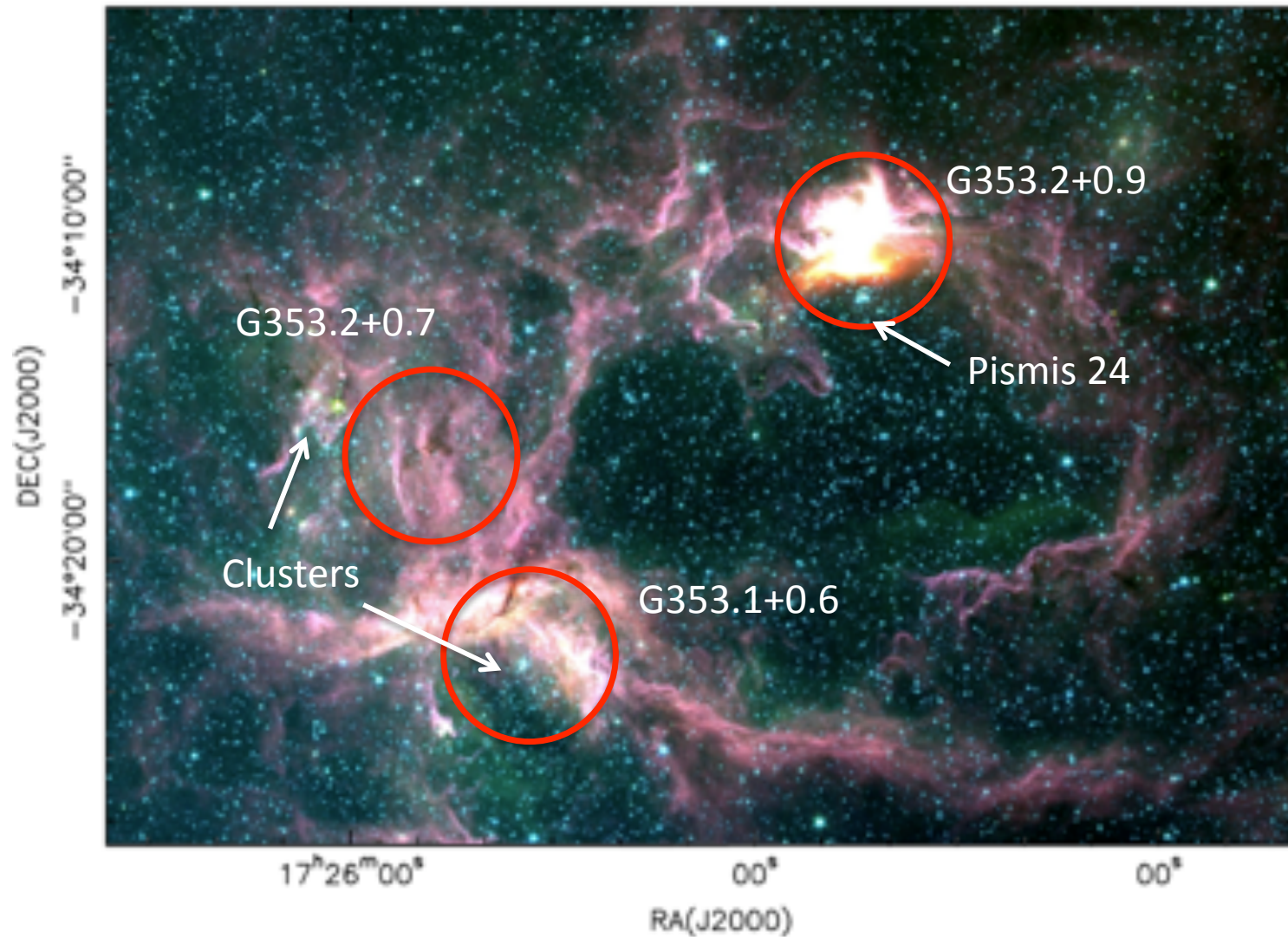
Distance = 1.7 ± 0.2 kpc

8 μm (GLIMPSE survey)



NGC 6357

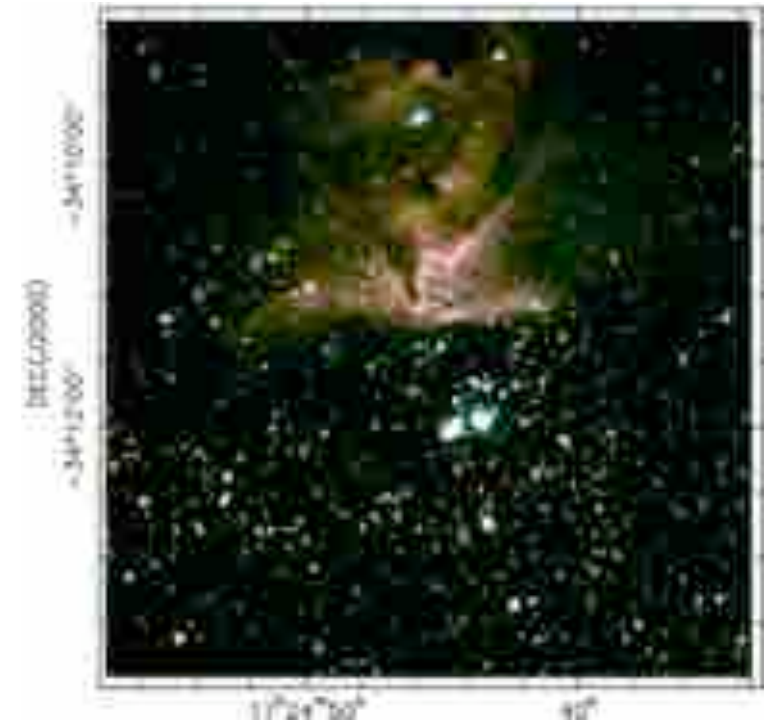
NIR (Spitzer) RGB: Red: 8 μm Green: 4.5 μm Blue: 3.6 μm





NGC6357-complex:
G353.2+0.9

HST

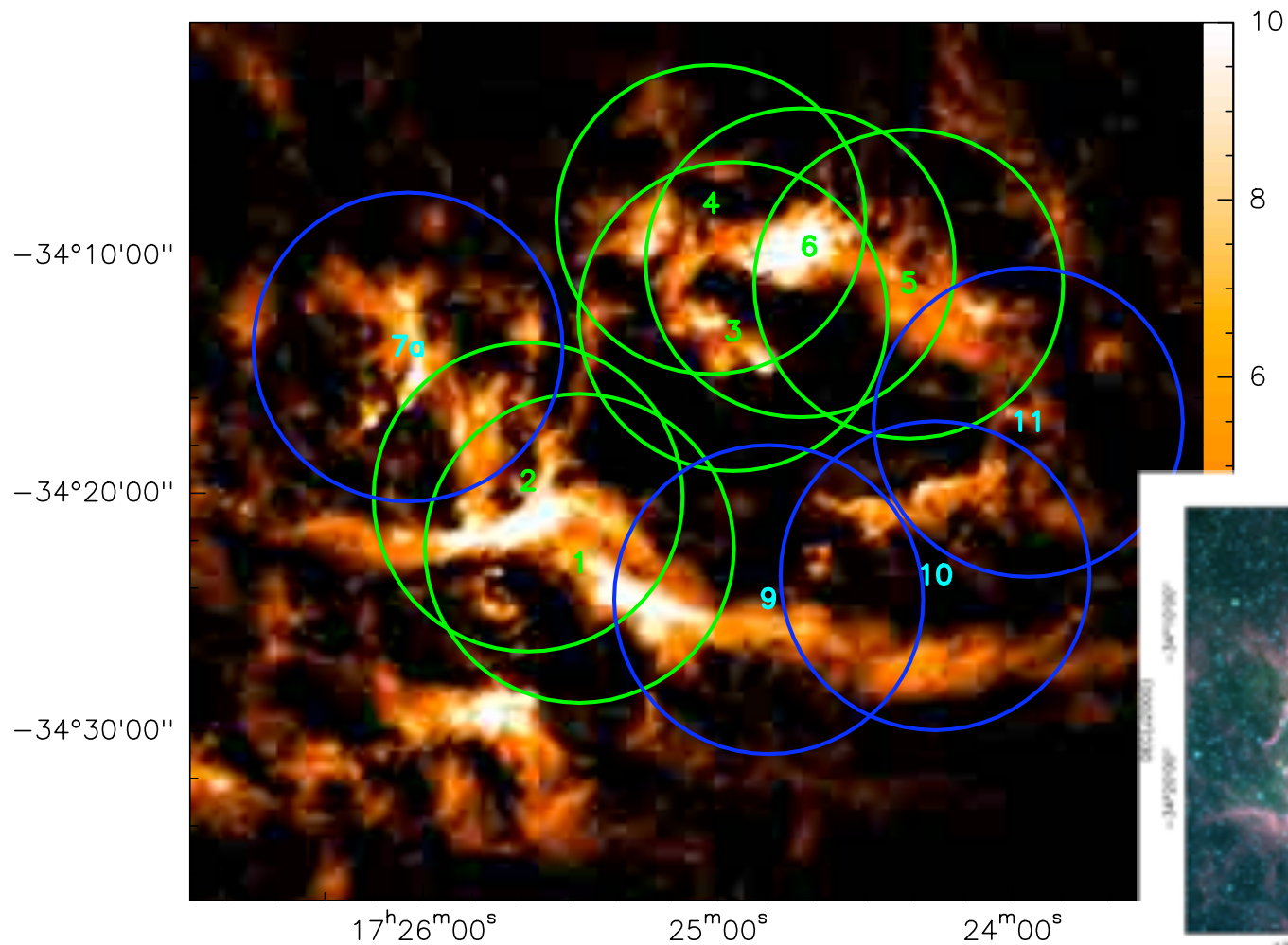


Massi F., Giannetti A., di Carlo E., Brand J., Beltran M.T., Marconi G.
Young open clusters in the Galactic star forming region NGC6357
[2015, *Astron. Astroph.* **573**, A95](#)

Giannetti A., Brand J., Massi F., Tieftrunk A., Beltran M.T.
Molecular clouds under the influence of massive stars in the Galactic
HII region G353.2+0.9 [2012, *Astron. Astroph.* **538**, A41](#)

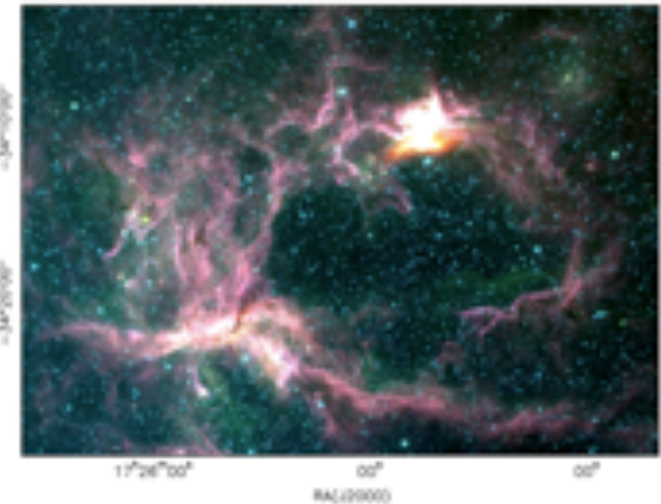
Massi F., Brand J., Felli M.
Molecular Cloud/HII Region Interfaces in the Star Forming Region
NGC6357 [1997 *Astron. Astroph.* **320**, 972](#)

Pismis 24:
30-40 OB stars (2 O3.5)



OBSERVATIONS

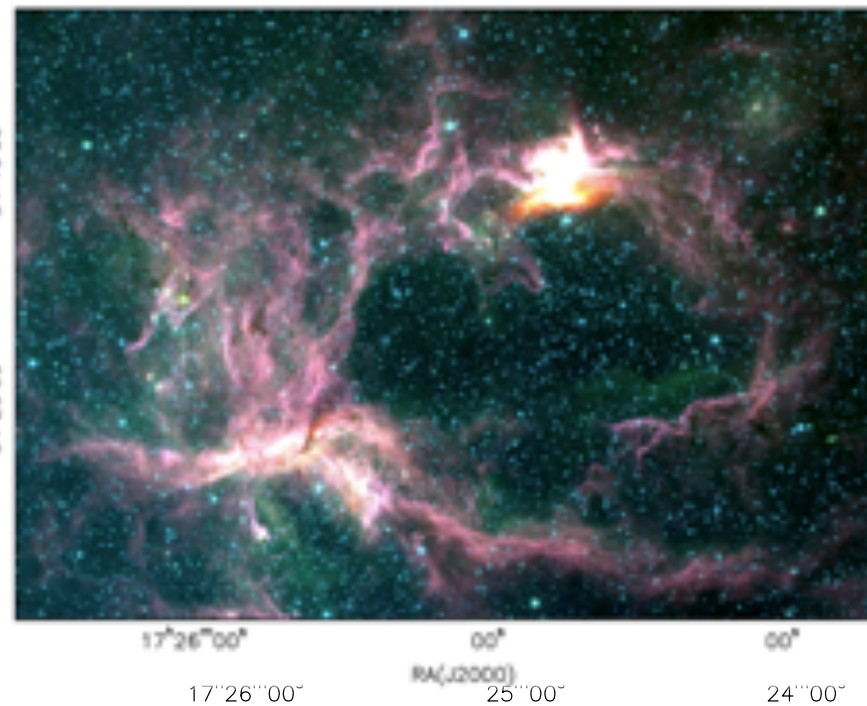
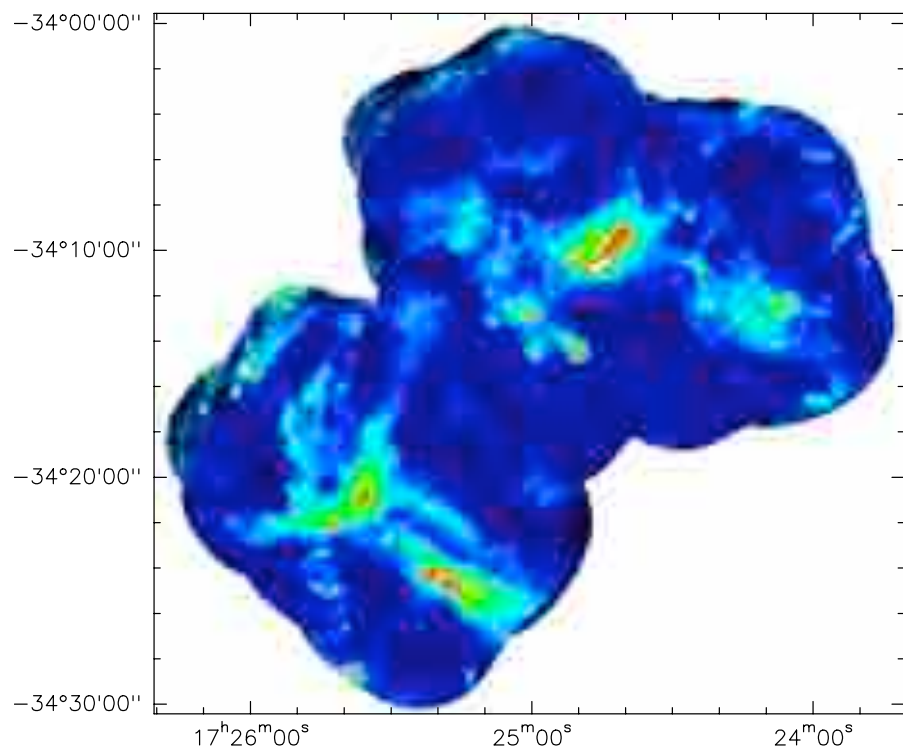
Herschel 160 μm map
with daisy fields
SCUBA2 overlaid.



We used SCUBA2 at the JCMT to observe, at 450 μm and 850 μm, the dust associated with the molecular clouds in a 30' x 30' (15 pc x 15 pc) region containing three HII regions. We assess the radiative and mechanical influence of the stars that excite the HII regions on the molecular gas, by determining the CMF near the HII regions and comparing it with that in more quiescent (less exposed to intense stellar feedback) parts of the complex.

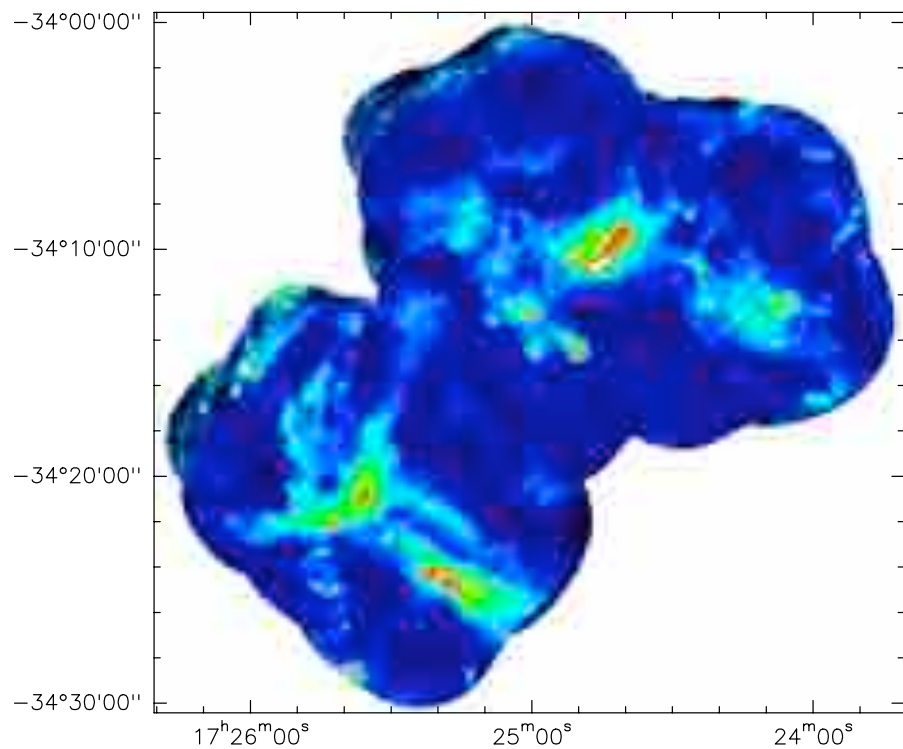
RESULTS: Maps of dust continuum emission

Spitzer NIR RGB

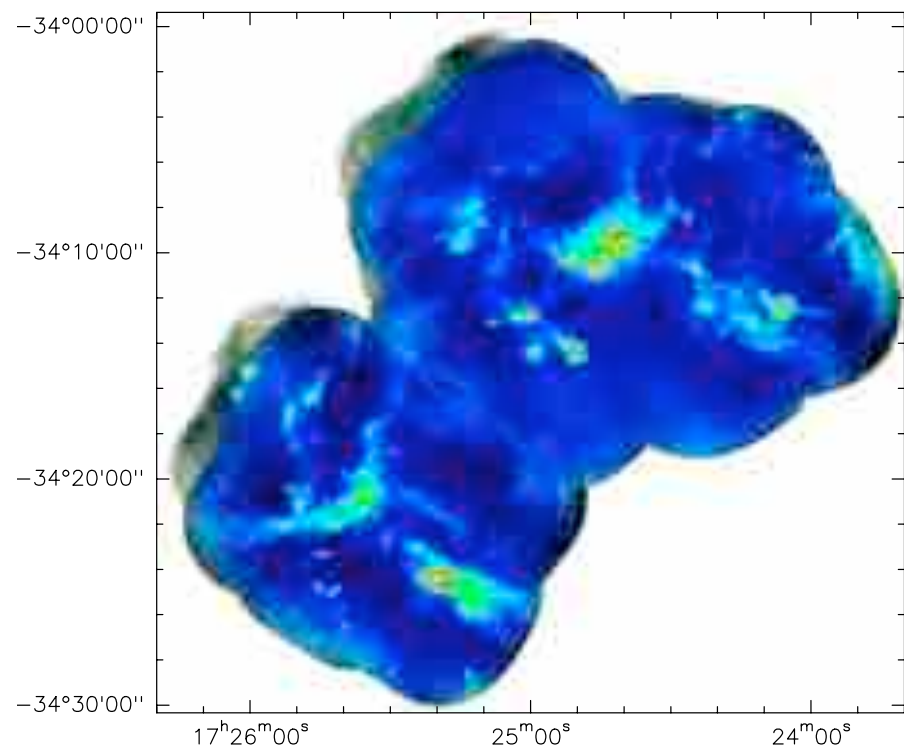


Mosaic at 850 μm ; hpbw 14"

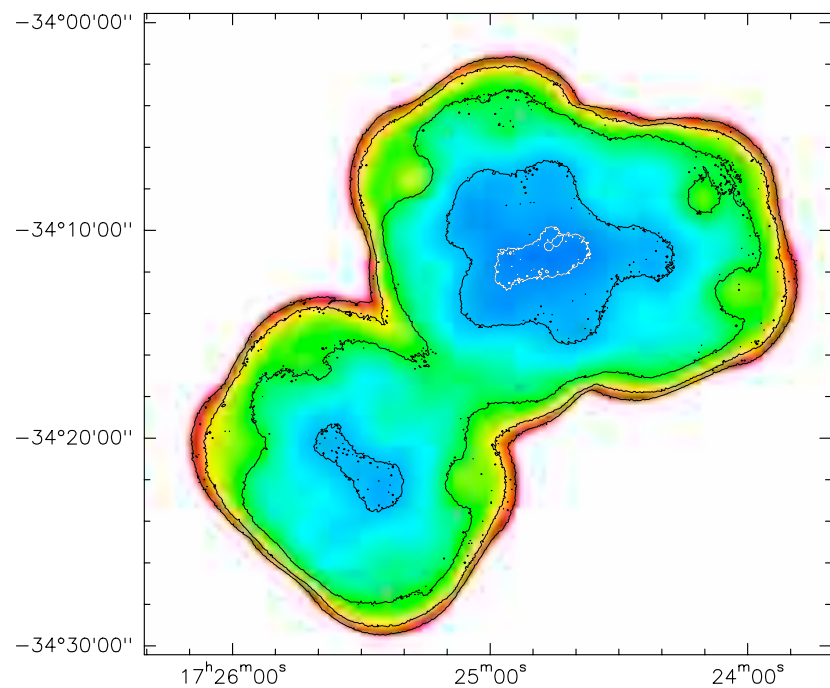
RESULTS: Maps of dust continuum emission



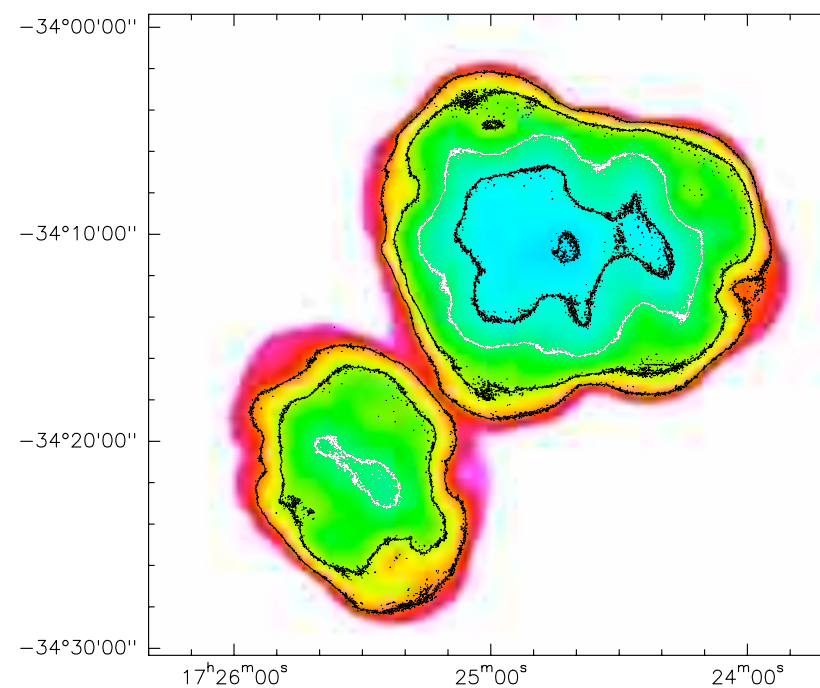
Mosaic at 850 μm ; hpbw 14"



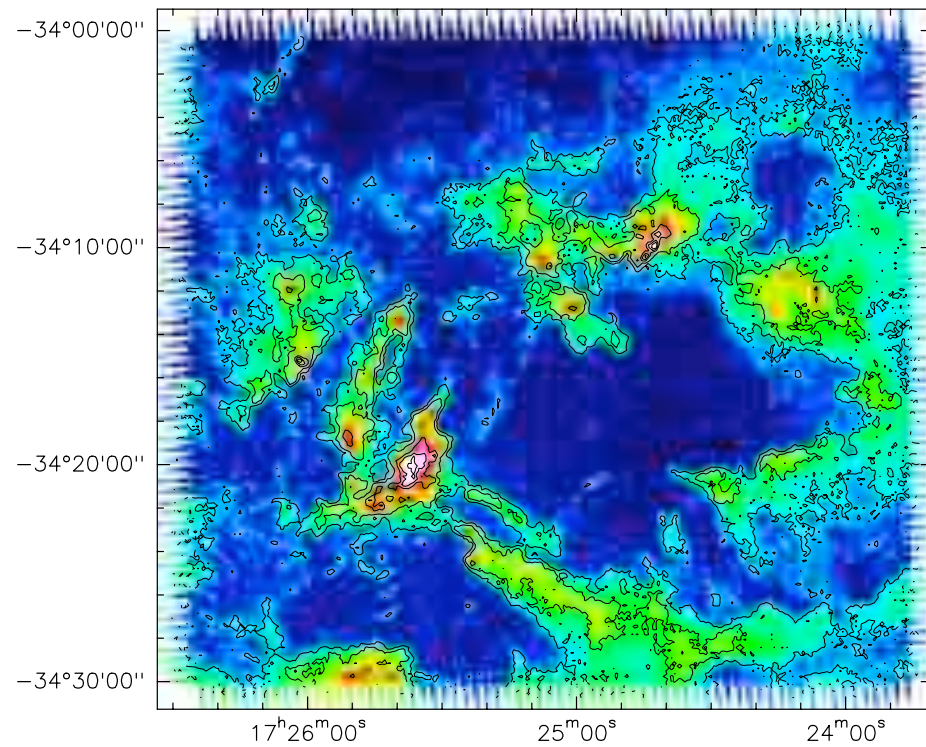
Mosaic at 450 μm ; hpbw 7"



Left: errormap 850 μm . Levs (mJy/bm):
4 (white), 5, 10, 15, 20



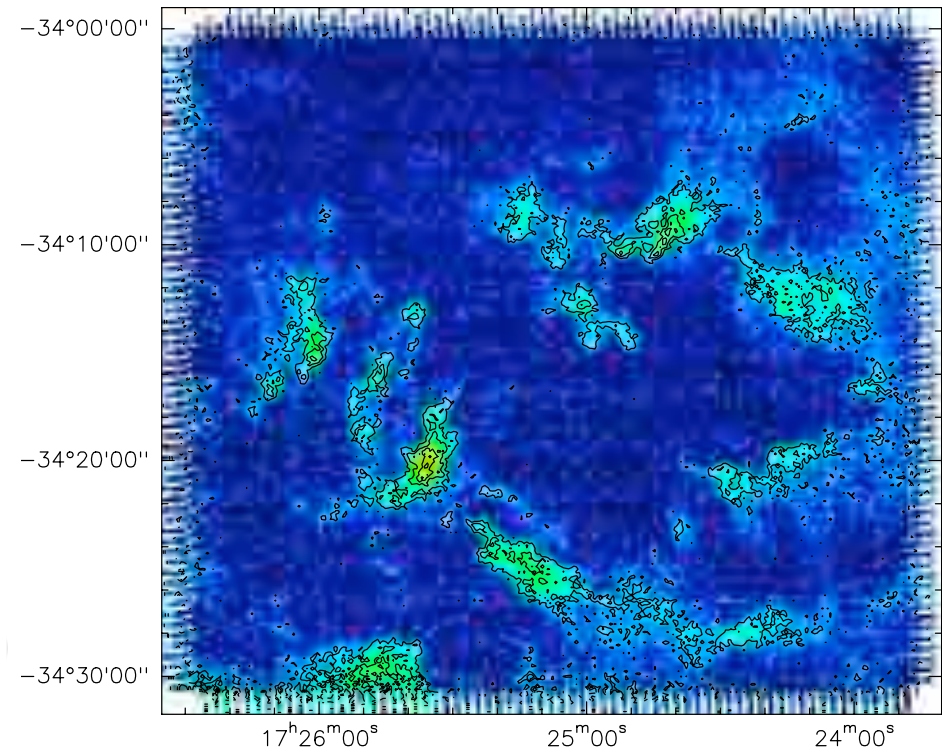
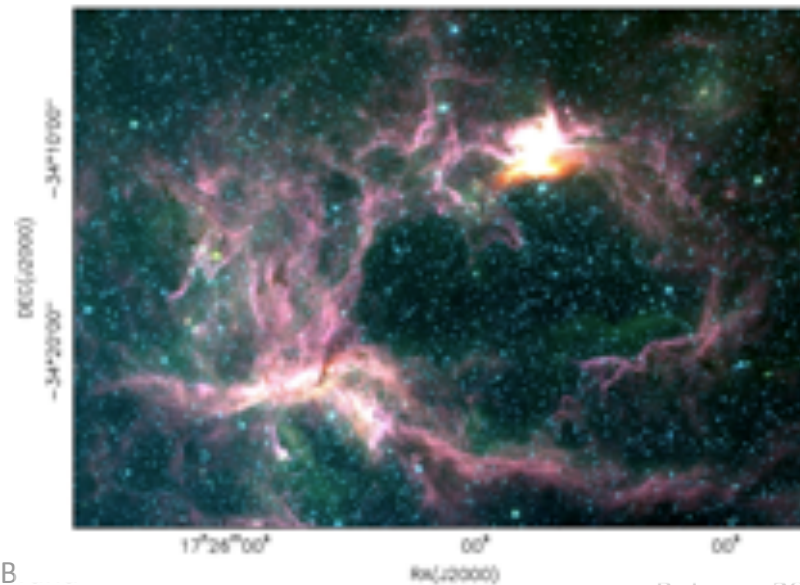
Right: errormap 450 μm . Levs (mJy/bm):
60, 75, 100 (white), 150, 200



CONTAMINATION

$^{12}\text{CO}(3-2)$ map, JCMT. Used to correct
850 μm dust continuum

Typical contamination <10-25%



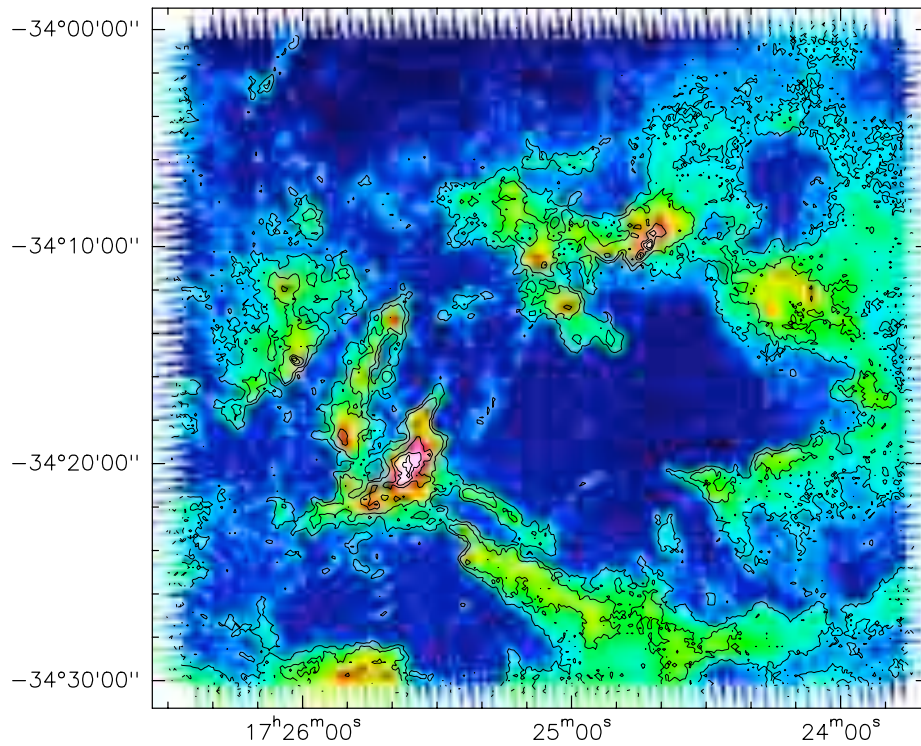
Jan B

m-workshop
Bologna 20 January 2015

CONTAMINATION

$^{12}\text{CO}(3-2)$ map, JCMT. Used to correct
850 μm dust continuum

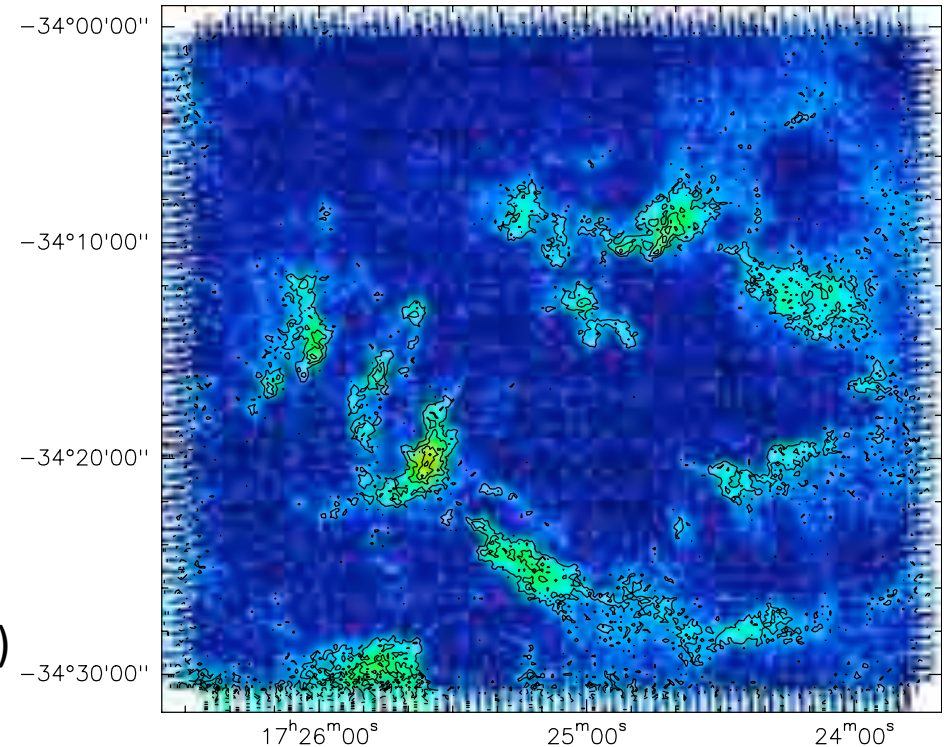
Typical contamination <10-25%



Also have $^{13}\text{CO}(3-2)$ map



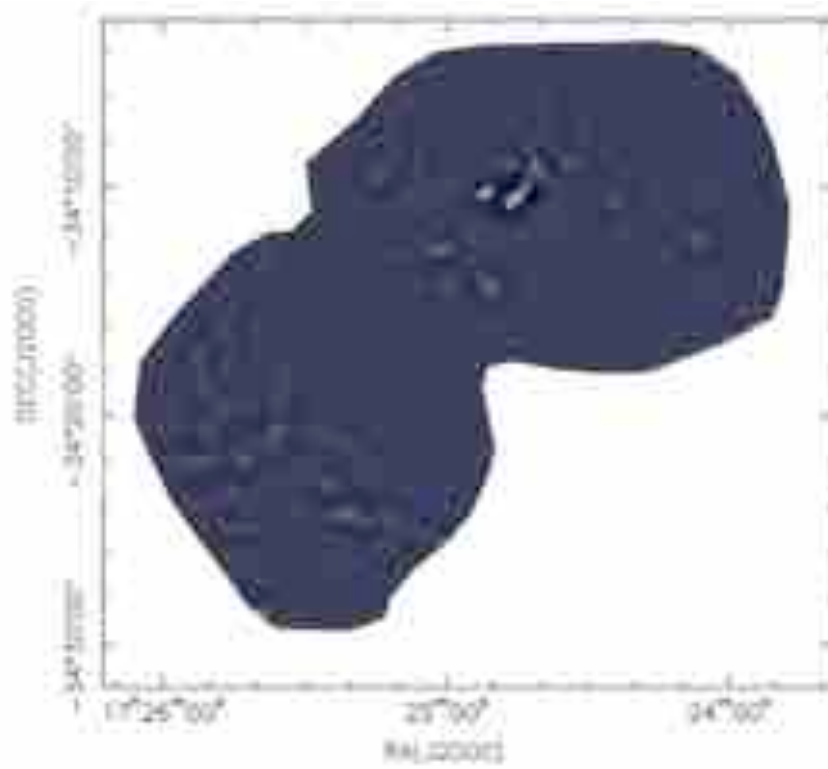
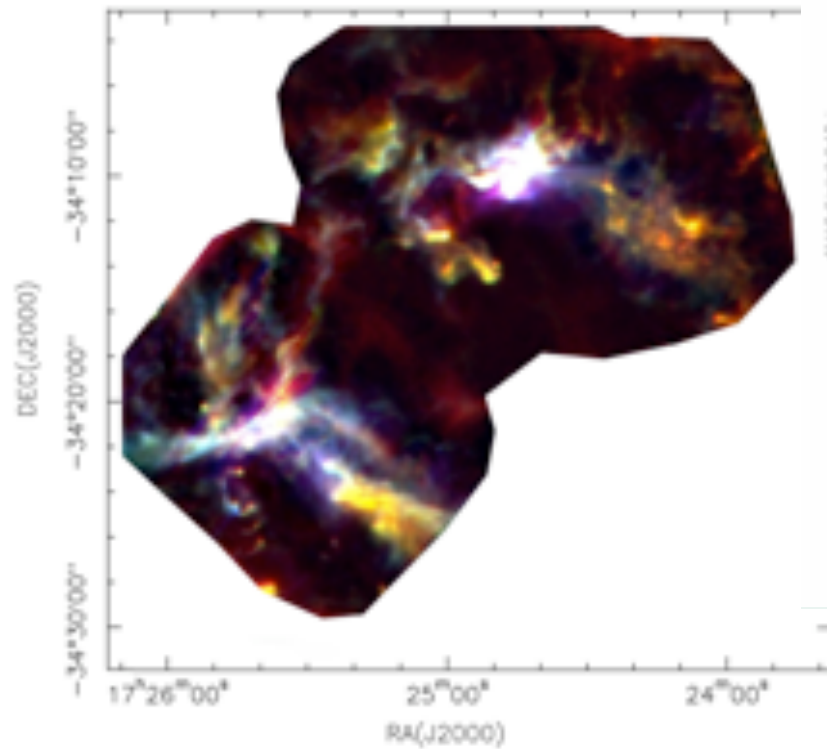
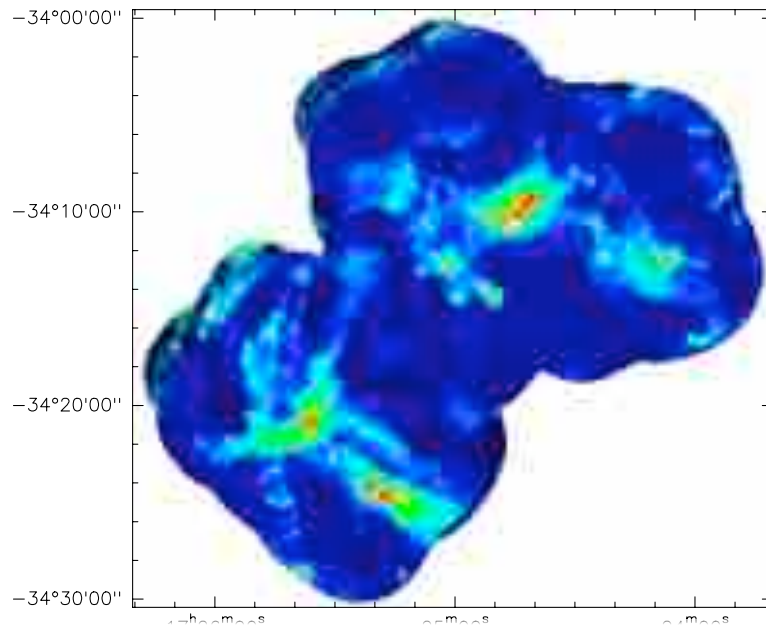
$^{13}\text{CO}(3-2)$



REMOVING DIFFUSE EMISSION

SCUBA2 850 μm

RGB: Herschel 70, 160, SCUBA2 850 μm



RGB, background removed

CORE IDENTIFICATION

We identified 361 *bona fide* cores in the background-subtracted 850 μm image.

Masses: $M = \gamma (S d^2) / (k_\nu B[\nu, T])$, where

S : integrated flux of the (Gaussian) core

d : distance

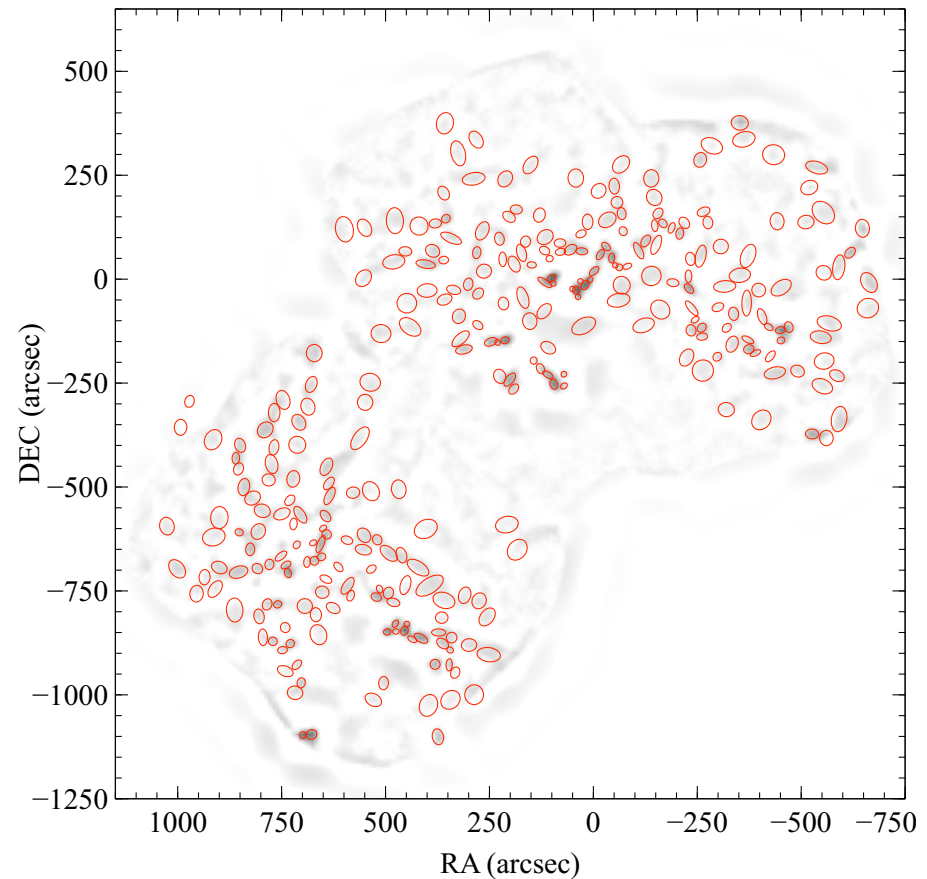
$B[\nu, T]$: Planck function at (dust) temperature T and frequency ν

k_ν : dust absorption coefficient: $k_\nu = k_0(\nu/\nu_0)^\beta$.

We use $k_\nu = 1.93 \text{ cm}^2 \text{ g}^{-1}$, derived from
 $k_0 = 1.85 \text{ cm}^2 \text{ g}^{-1}$ at $\nu_0 = 345 \text{ GHz}$ and $\beta = 1.8$.

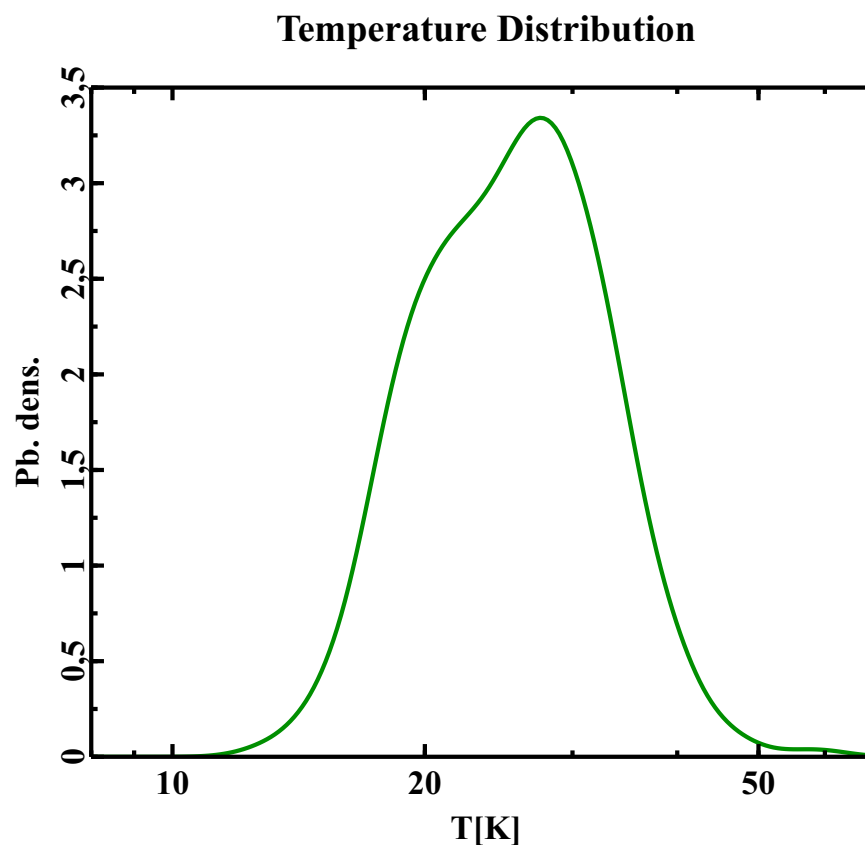
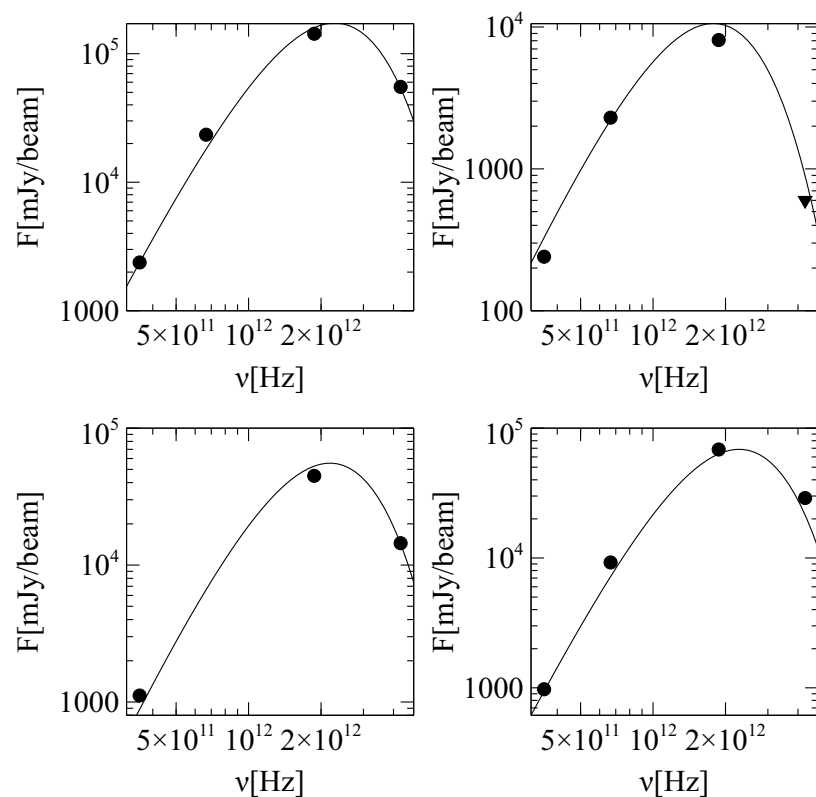
The gas-to-dust ratio $\gamma = 100$.

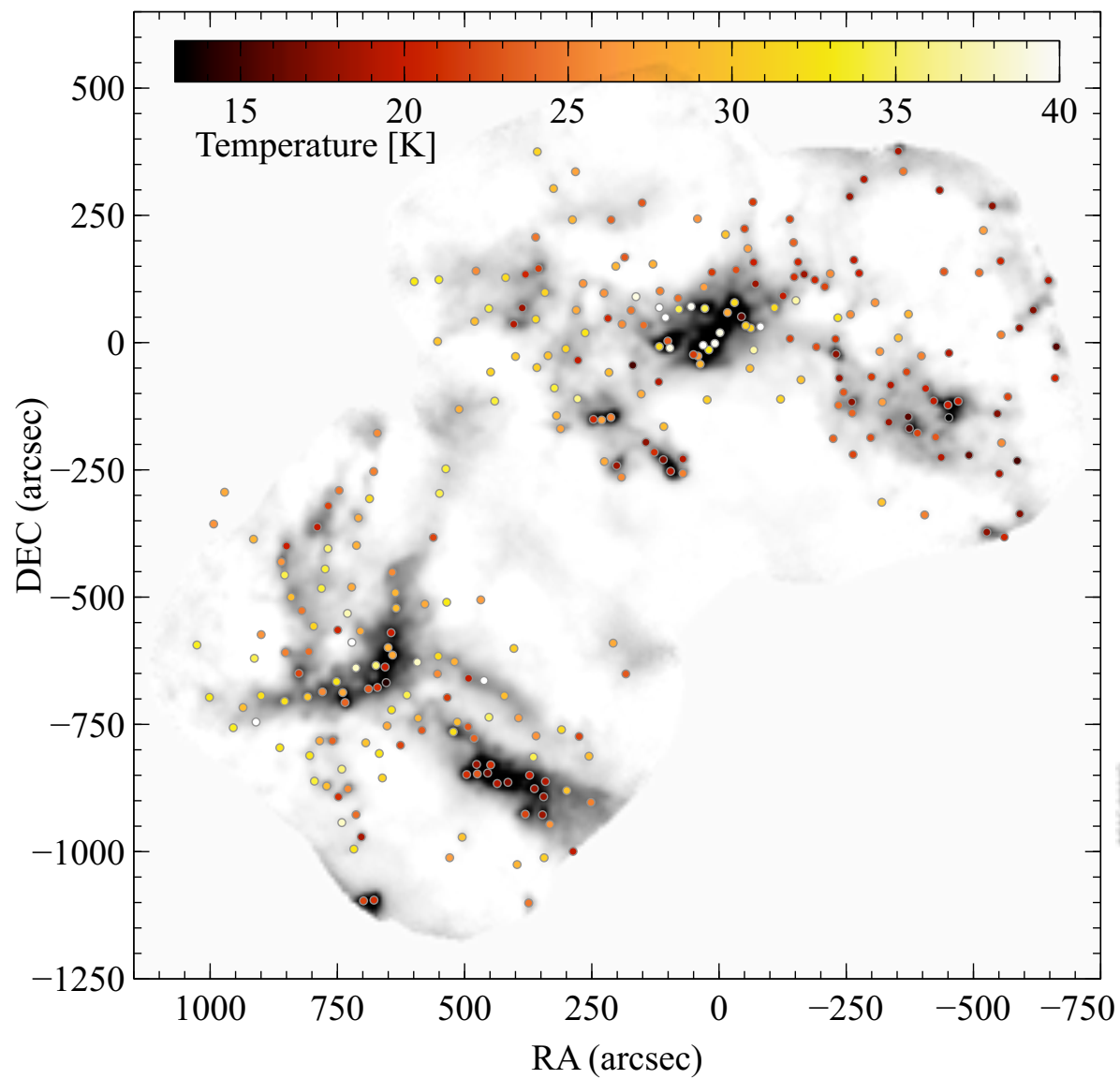
Need the dust temperature:
use Herschel Hi-GAL data



TEMPERATURE OF CORES

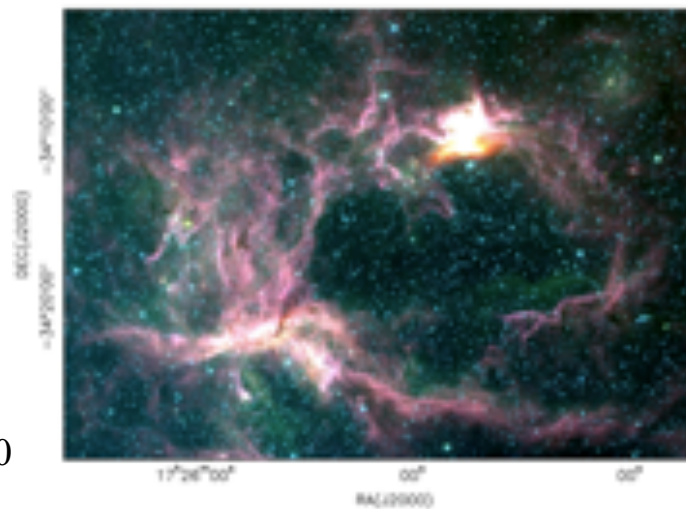
from SED fit to fluxes at 70, 160 μm (Herschel Hi-GAL)
and 450, 850 μm (SCUBA2)



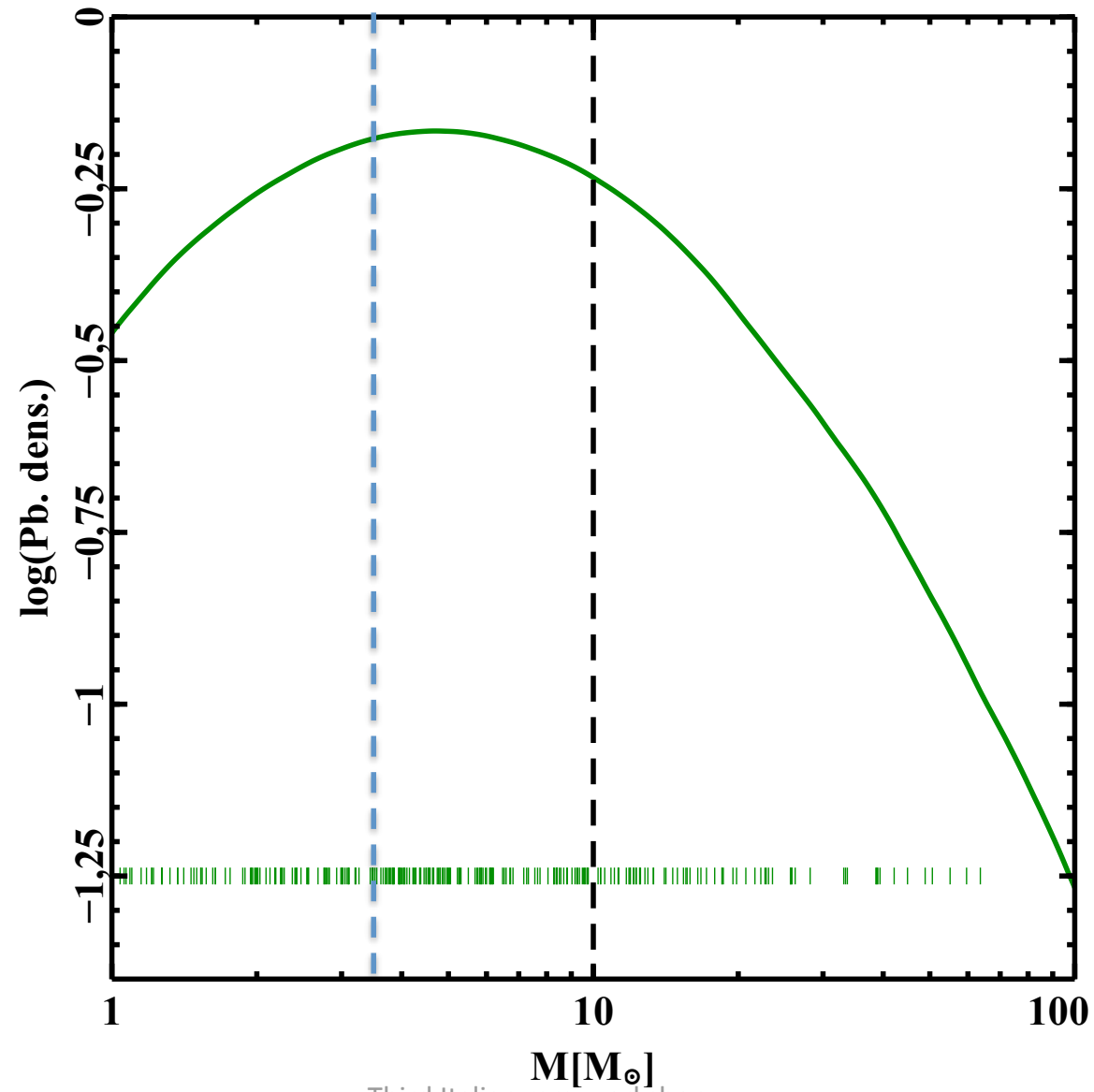


TEMPERATURE MAP

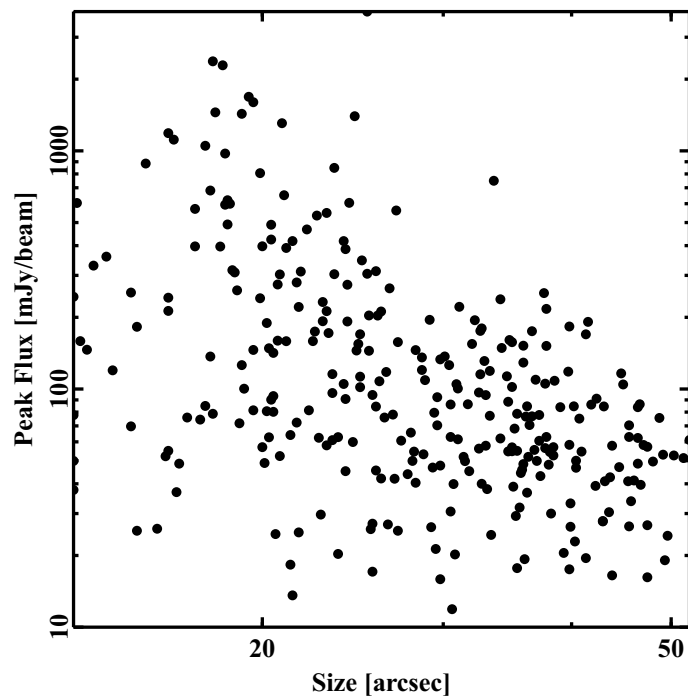
302 cores



Core Mass Distribution

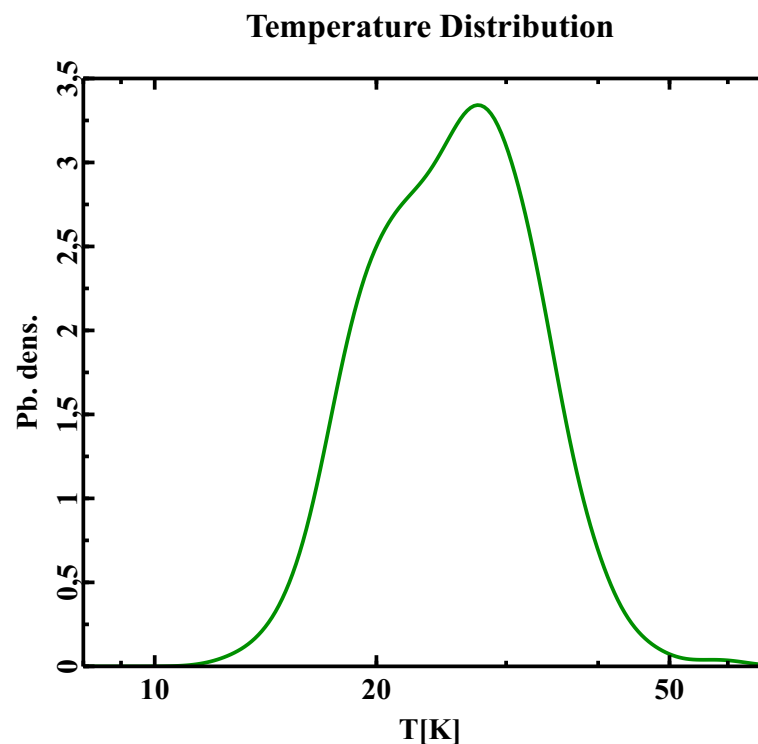


COMPLETENESS I

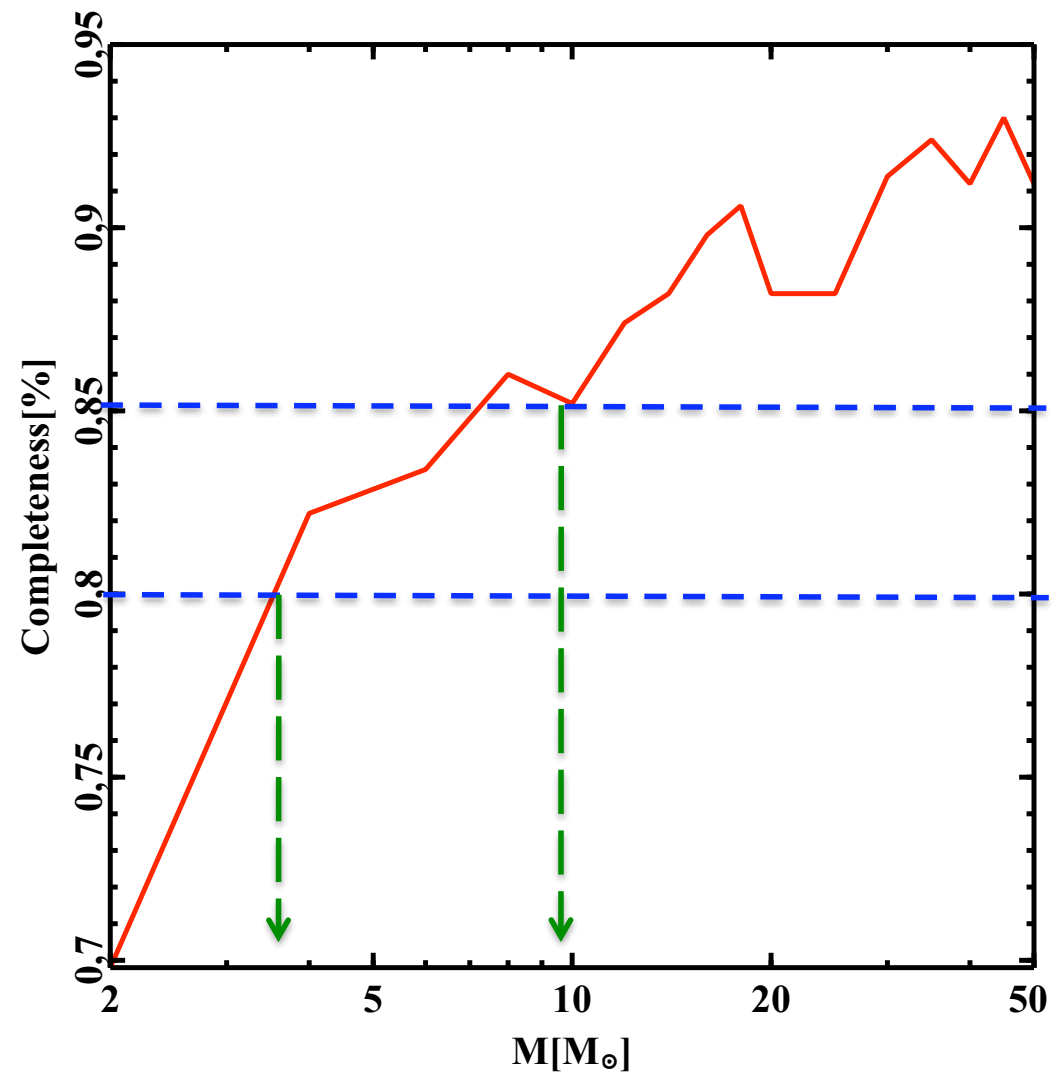


For range of masses ($2 - 50 M_{\odot}$) create artificial cores, using parameter space of cores actually found.

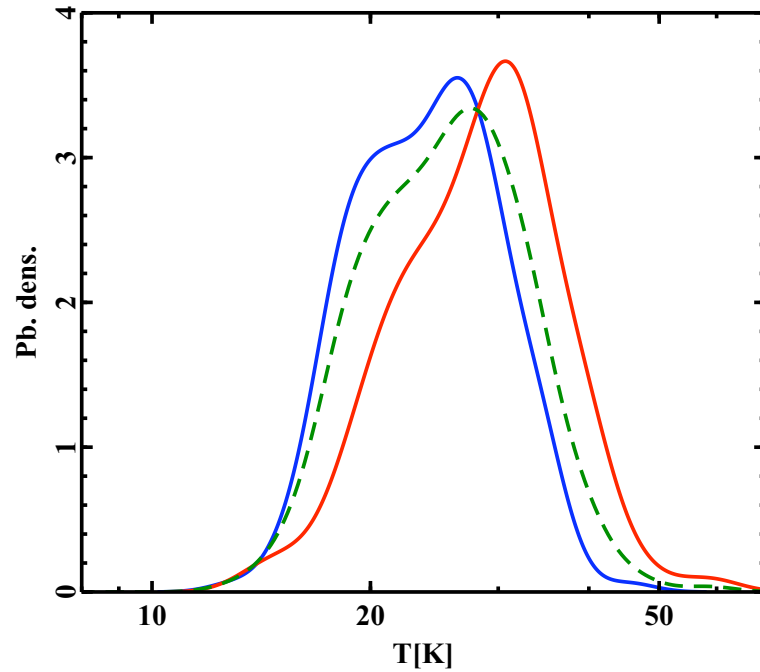
Insert artificial cores into original data, then proceed as before, and see how many are found. Repeat many times for each mass.



COMPLETENESS II



Temperature Distribution



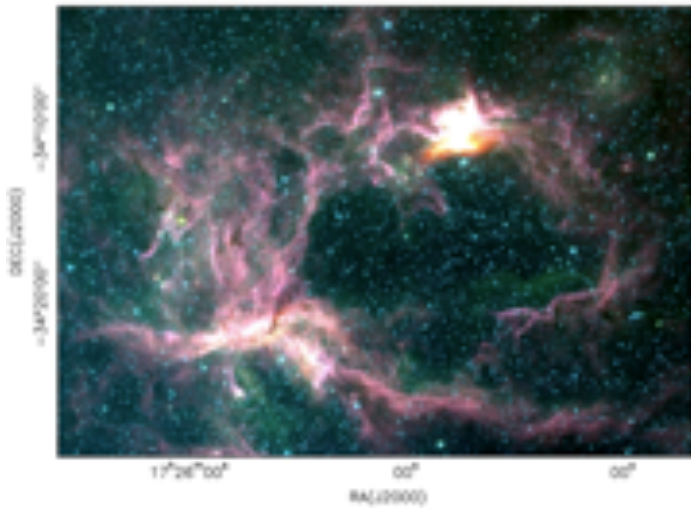
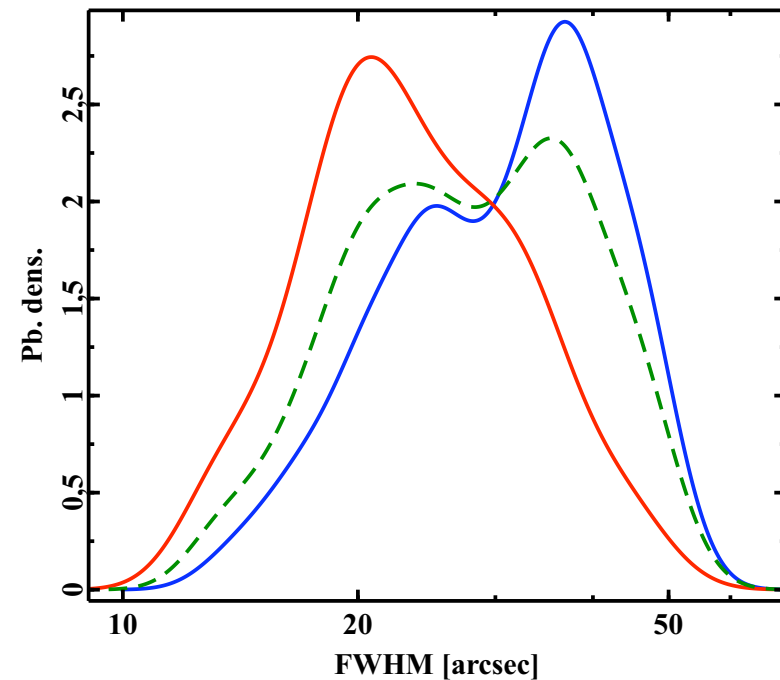
Divide sample into:

cores near star clusters (**UV+** ; **N = 108**)

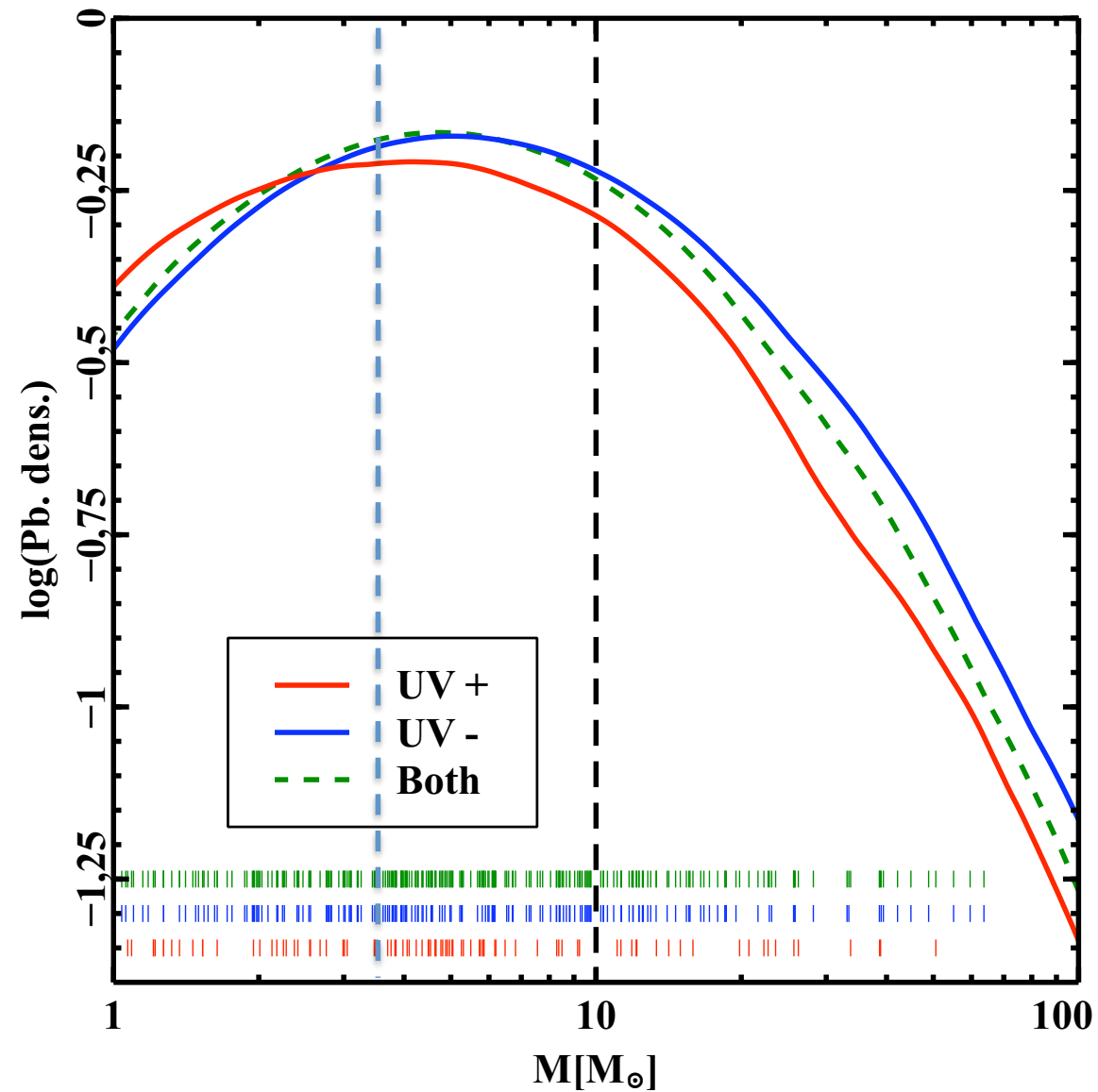
cores away from clusters (**UV-** ; **N = 194**)

UV+ warmer and more compact

Size Distribution



Core Mass Distribution



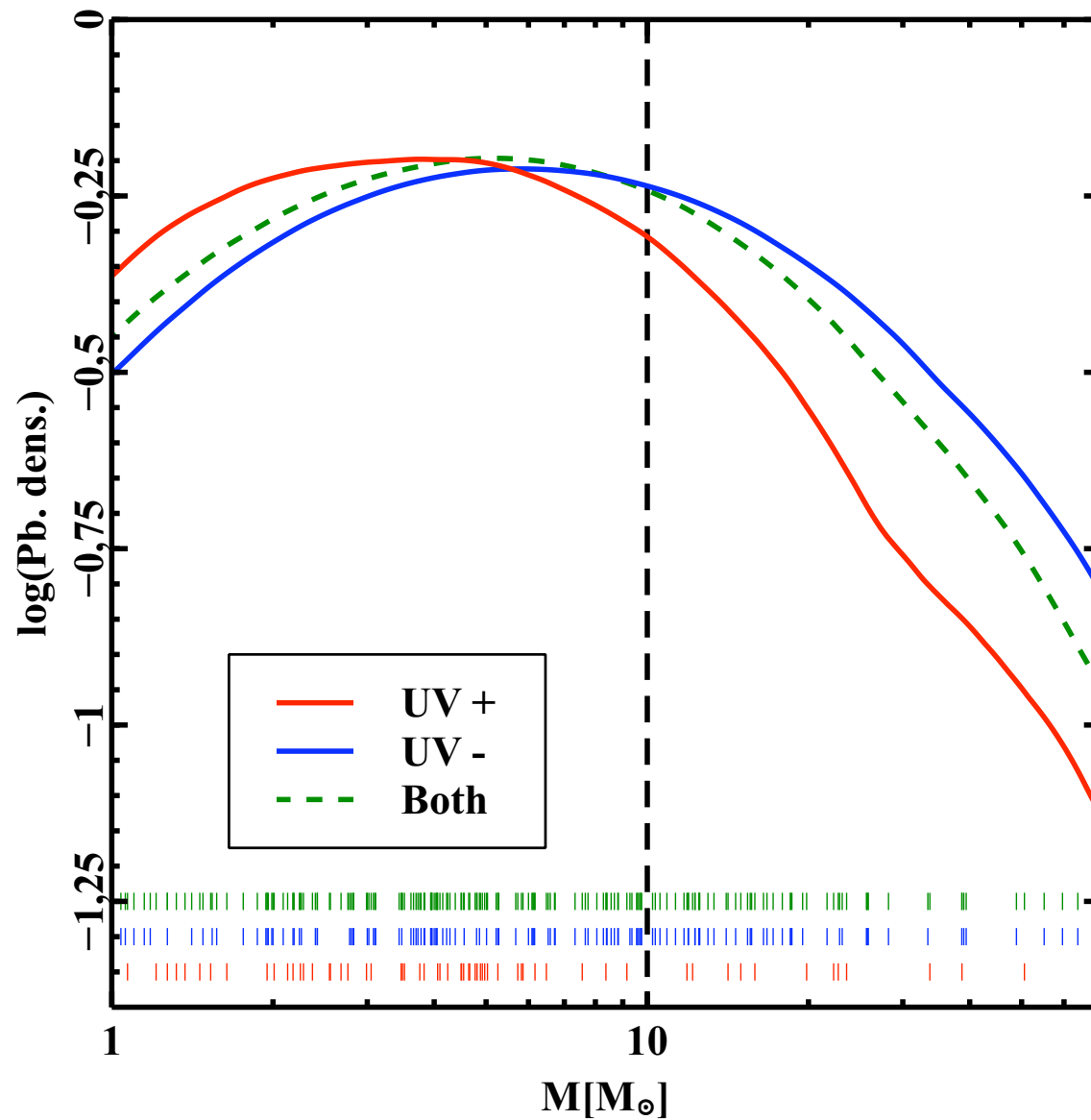
No difference between CMFs:

* Influence of UV field on CMF
is not that great

or

* UV-field is so pervasive that
being near or far from cluster
makes no difference

Core Mass Distribution (starless cores)

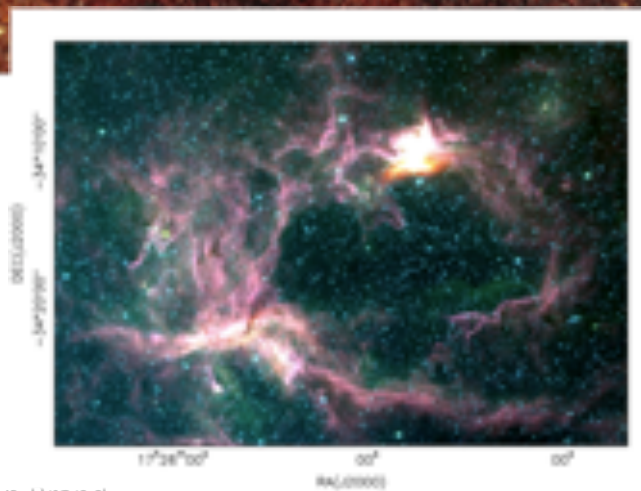
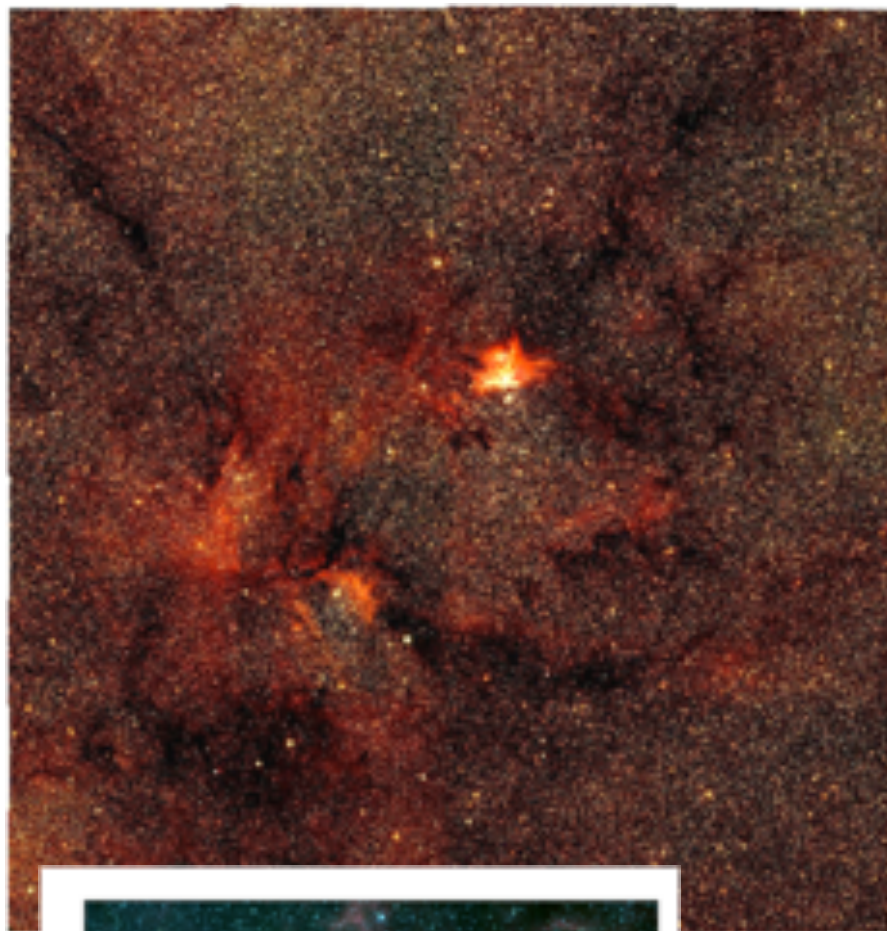


But wait...

Starless cores do show a difference?

(UV+ N = 73; UV- N = 143)

UKIRT JHK,H₂ data WFCAM



Jan Brand



G353.2+0.9

Third Italian mm-workshop
Bologna 20 January 2015

2 (rejected) ALMA Cycle 2 proposals on this subject.

The core mass function
of a cloud in the
far-outer Galaxy

In 20%-40% range

		JAN BRAND		2013.1.01018.S	
PROJECT TITLE:	The core mass function of a cloud in the far-outer Galaxy				
PRINCIPAL INVESTIGATOR NAME:	Jan Brand		PROJECT CODE:	2013.1.01018.S	
SCIENCE CATEGORY:	ISM, star formation and astrochemistry		ESTIMATED 12M TIME:	5.3 h	ESTIMATED ACA TIME: 0.0 h
CO-PI NAME(S): (Large Proposals only)					
CO-INVESTIGATOR NAME(S):	Andrea Giannetti; Loris Magnani; Luca Olmi; Sergio Molinari; Jan Wouterloot; Davide Elia				
EXECUTIVE SHARES[%]:	NA :	0	STUDENT PROJECT? (Yes/No)	No	
	EU :	100			
	EA :	0	RESUBMISSION? (Yes/No)	No	
	CL :	0			
	OTHER :	0			

		LUCA OLMI		None Assigned	
PROJECT TITLE:	Identifying the transition phase of the clump mass function toward the IMF				
PRINCIPAL INVESTIGATOR NAME:	Luca Olmi		PROJECT CODE:	None Assigned	
SCIENCE CATEGORY:	ISM, star formation and astrochemistry		ESTIMATED 12M TIME:	7.3 h	ESTIMATED ACA TIME: 0.0 h
CO-PI NAME(S): (Large Proposals only)					
CO-INVESTIGATOR NAME(S):	Davide Elia; Sergio Molinari; Jan Brand; Alvaro Sanchez-Monge; Michele Pestalozzi				
EXECUTIVE SHARES[%]:	NA :	0	STUDENT PROJECT? (Yes/No)	No	
	EU :	100			
	EA :	0	RESUBMISSION? (Yes/No)	No	
	CL :	0			
	OTHER :	0			

Identifying the transition
phase of the clump mass
function to the IMF

In bottom 30%