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# The Core Mass Function in NGC 6357

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# **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:

 $\xi$  (logm)  $\propto m^{\Gamma}$  or  $\xi$  (m)  $\propto m^{\gamma}$ 

 $\xi$  (logm) = (ln10).m  $\xi$  (m)

log[ξ(logm)] vs. logm





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?



#### Molecular Cloud undergoing collapse and fragmentation Massive stars form early on, driving an ionization front and shock into surrounding molecular gas. Massive stars Shock-compressed gas Compact HII Region • Triggered star formation Ionization front Isolated low-mass stars Uncovered groups HII Region interior The expanding ionization front moves through surrounding gas, first triggering collapse of molecular cores, then overrunning them, leaving young stars in the interior of the H II region.

### SF in clumpy molecular clouds II

#### Hester & Desch ASP 341, 2005

# Massive stars (M > 8 M<sub>o</sub>):

- 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

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



Bologna 20 January 2015



NGC6357-complex: G353.2+0.9



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 <u>2012</u>, *Astron. Astroph.* **538**, **A41** 

Massi F., Brand J., Felli M.

Molecular Cloud/HII Region Interfaces in the Star Forming Region NGC6357 <u>1997 Astron. Astroph. **320**, 972</u>

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



We used SCUBA2 at the JCMT to observe, at 450  $\mu$ m and 850  $\mu$ m, 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 $\mu$ m; 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







## **CORE IDENTIFICATION**

We identified 361 *bona fide* cores in the background-subtracted 850 µm image. **Masses:**  $M = \gamma$  (S d<sup>2</sup>) / (k<sub>v</sub> B[v,T]), where S: integrated flux of the (Gaussian) core d : distance B[v,T]: Planck function at (dust) temperature T and frequency v  $k_v$ : dust absorption coefficient:  $k_v = k_0 (v/v_0)^{\beta}$ . 500 We use  $k_v = 1.93 \text{ cm}^2 g^{-1}$ , derived from 250  $k_0 = 1.85 \text{ cm}^2 \text{ g}^{-1}$  at  $v_0 = 345 \text{ GHz}$  and  $\theta = 1.8$ . The gas-to-dust ratio  $\gamma = 100$ . DEC (arcsec) -250 -500 Need the dust temperature: use Herschel Hi-GAL data -750-1000-12501000 750 500 250 -250-500 -750 0 RA (arcsec)

### **TEMPERATURE OF CORES**

from SED fit to fluxes at 70, 160  $\mu$ m (Herschel Hi-GAL) and 450, 850  $\mu$ m (SCUBA2)





Jan Brand

Third Italian mm-workshop Bologna 20 January 2015

**Core Mass Distribution** 



Jan Brand

### **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**





#### **Core Mass Distribution**





**Core Mass Distribution (starless cores)** 



Starless cores do show a difference?

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



# UKIRT JHK,H<sub>2</sub> data WFCAM



#### G353.2+0.9

# 2 (rejected) ALMA Cvcle 2 proposals on this subject.

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

In 20%-40% range

JAN	BRAND		2	2013	.1.010	18.S
PROJECT TITLE:	The core ma	ss function of	a cloud in the	far-ou	ter Galaxy	
PRINCIPAL INVESTIGATOR NAME:	Jan I	Brand	PROJECT CODE:		2013.1.01018	3.S
SCIENCE CATEGORY:	ISM, star for and astroche	rmation mistry	ESTIMATED 12M TIME: 5	5.3 h	ESTIMATED ACA TIME:	0.0 h
CO-PI NAME(S): (Large Proposals only)			· · · · ·			
CO-INVESTIGATOR NAME(S):	Andrea Gian Jan Wouterlo	netti; Loris Ma bot; Davide Eli	agnani; Luca O a	lmi; Se	ergio Molina	ari;
	NA : EU :	0 100	STUDENT PRO (Yes/No)	JECT?	No	)
EXECUTIVE SHARES[%]:		0	RESUBMISSI (Yes/No)	ON?	No	)

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

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

C-1

In bottom 30%

Third Italian mm-workshop Bologna 20 January 2015 But we try again in Cycle 3!