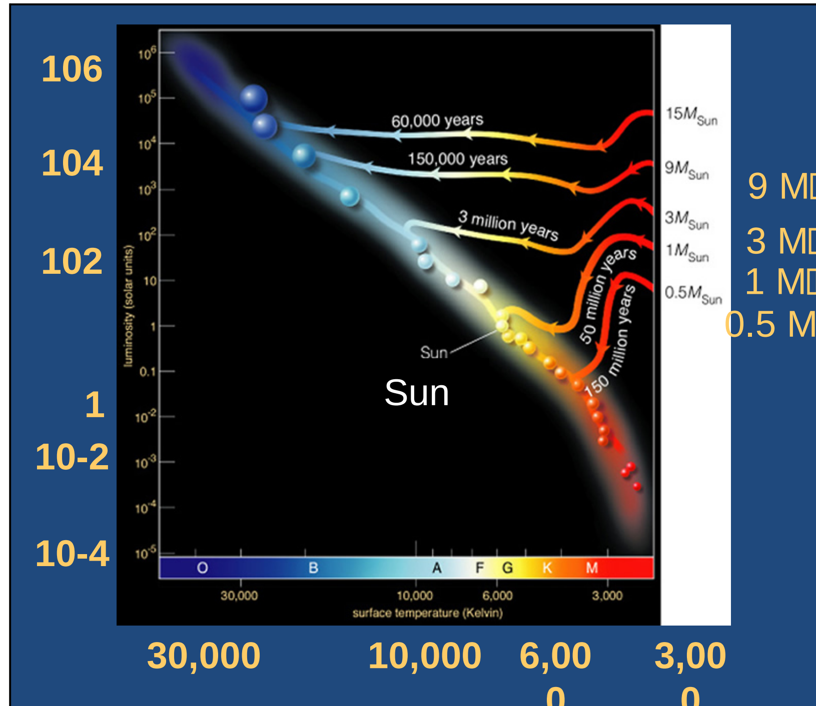
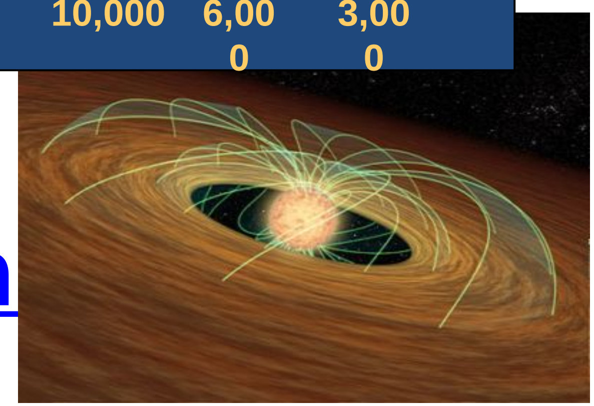
Proto-planetary discs in star burst clusters

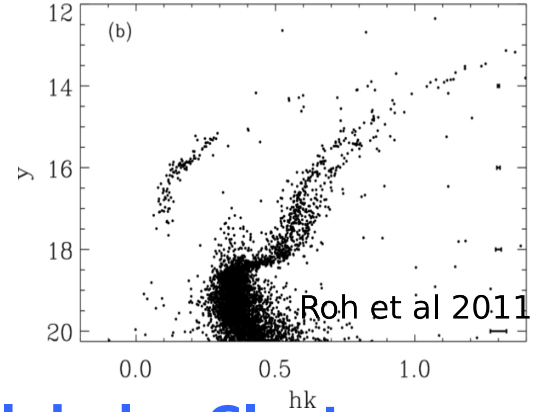




Giacomo Becca

-ESO, Vitacura (Chile)-

De Marchi, G.(ESA), Panagia, N. , Correnti, M. (STScI), Romaniello, M. , Manara, C.F., Testi, L. (ESO)

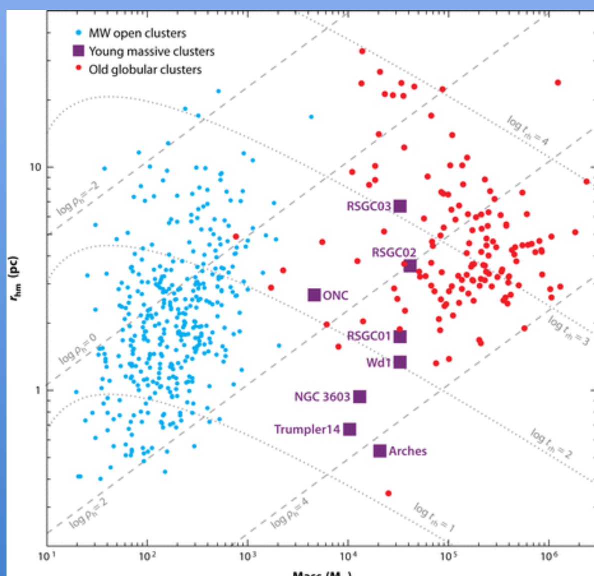


Can protoplanetary discs live longer than 3/5Myr?

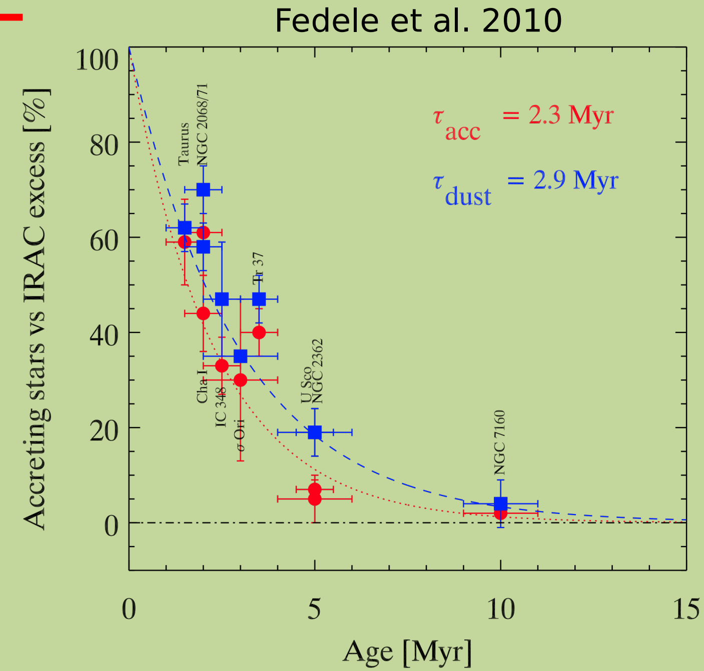
=Why?=

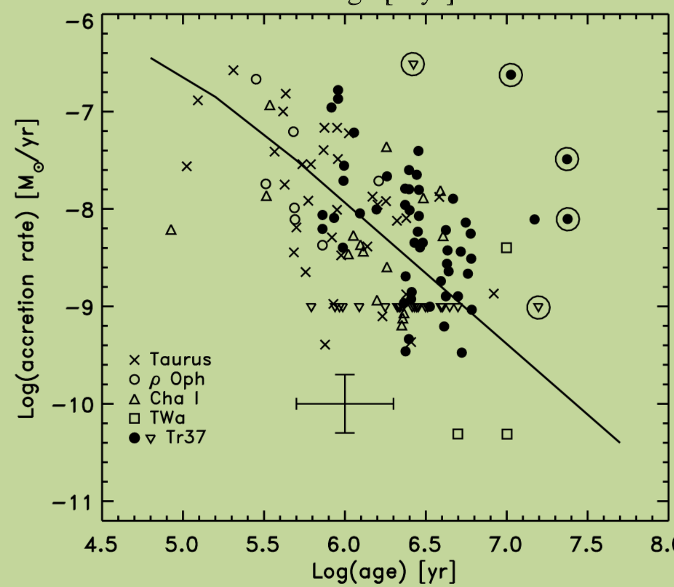
Globular Clusters = no SSP!!!

"…multiple populations should be expected in at least some young star clusters, but it is currently not known whether, or to what extent, this phenomenon occurs in observed YMCs."

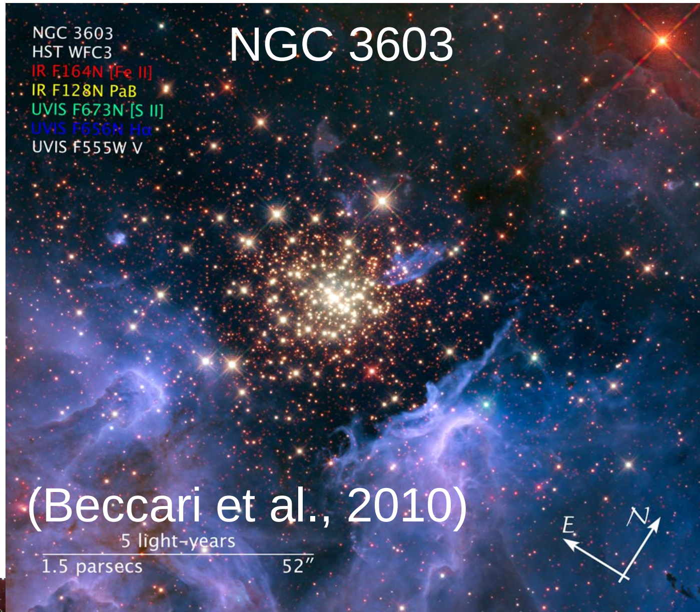


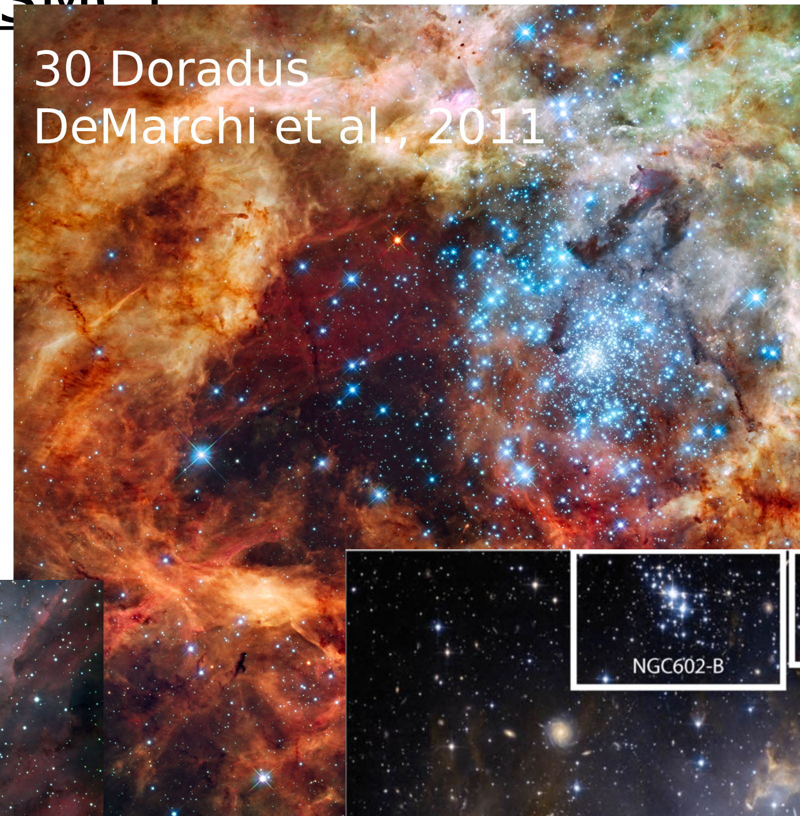
(review S. Portegies Zwart et al. 2010)

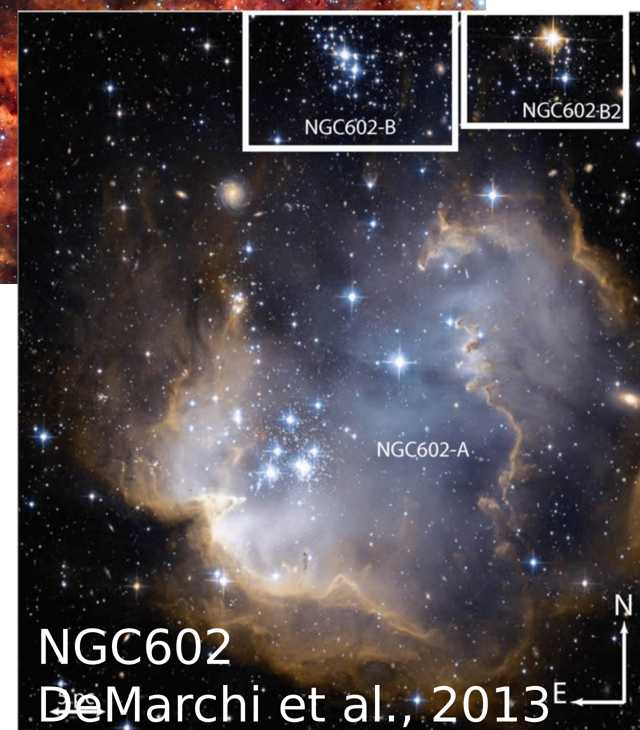




PMS objects in a number of star-burst clusters (MW, LMC, SMC)

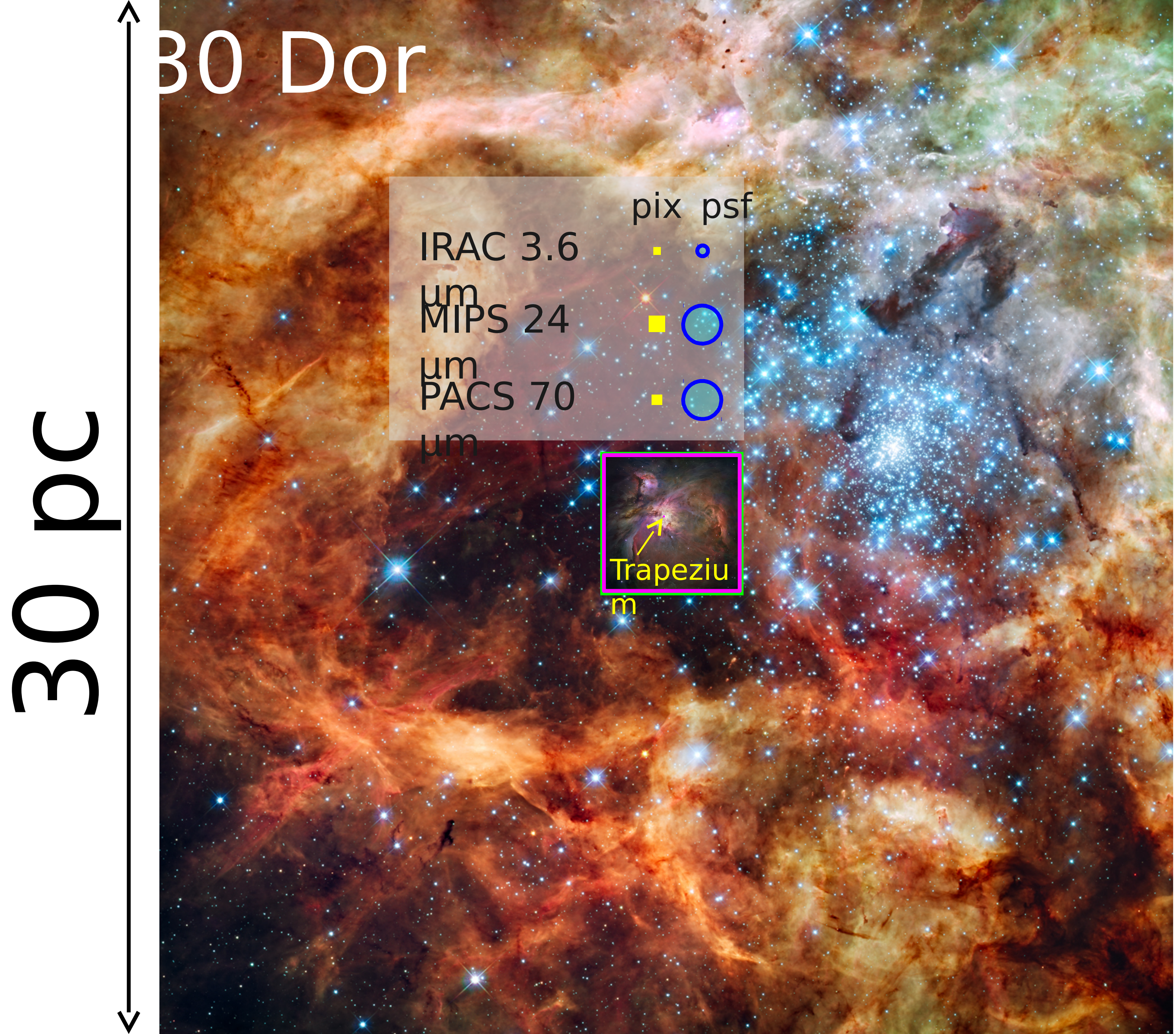


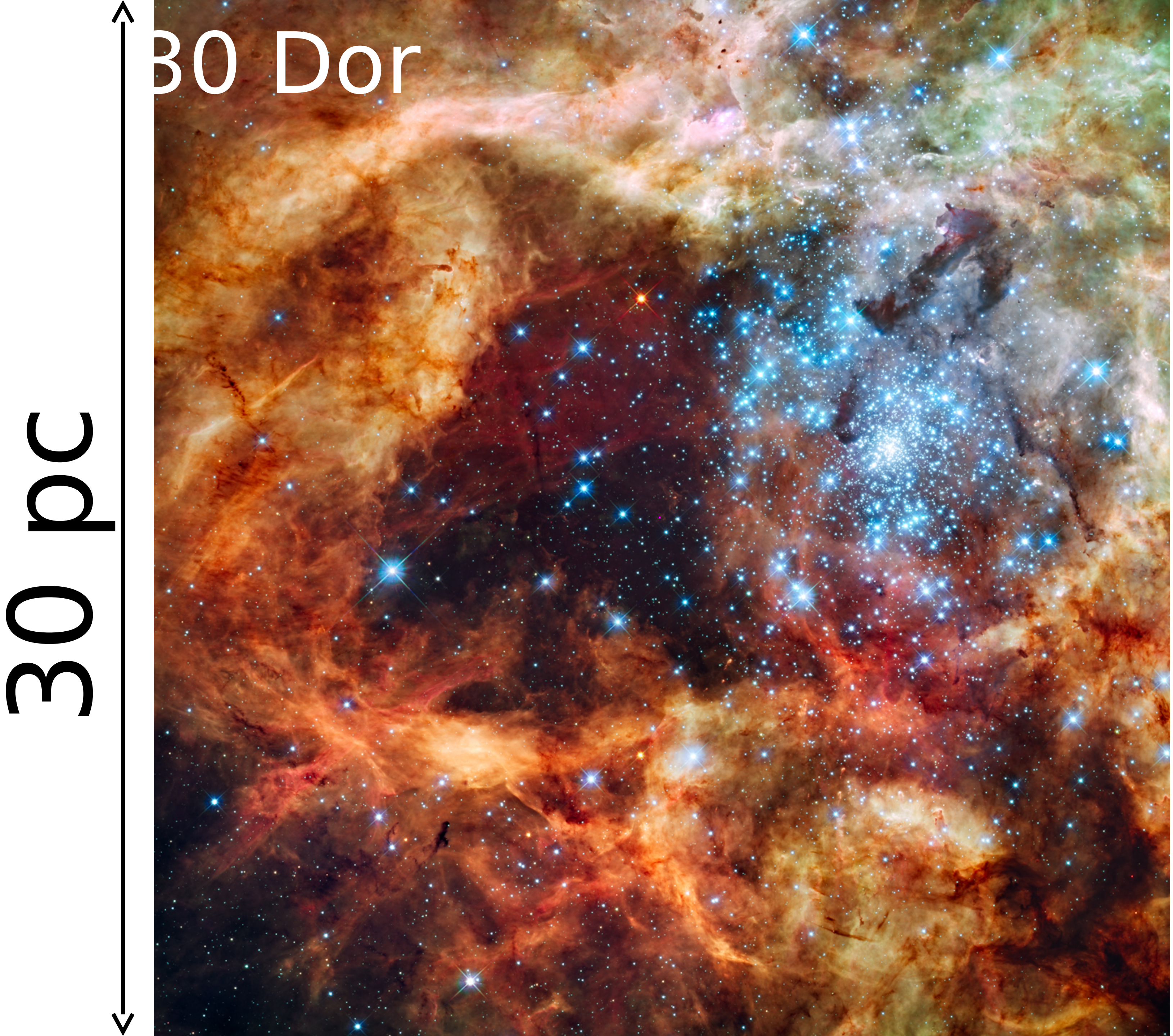


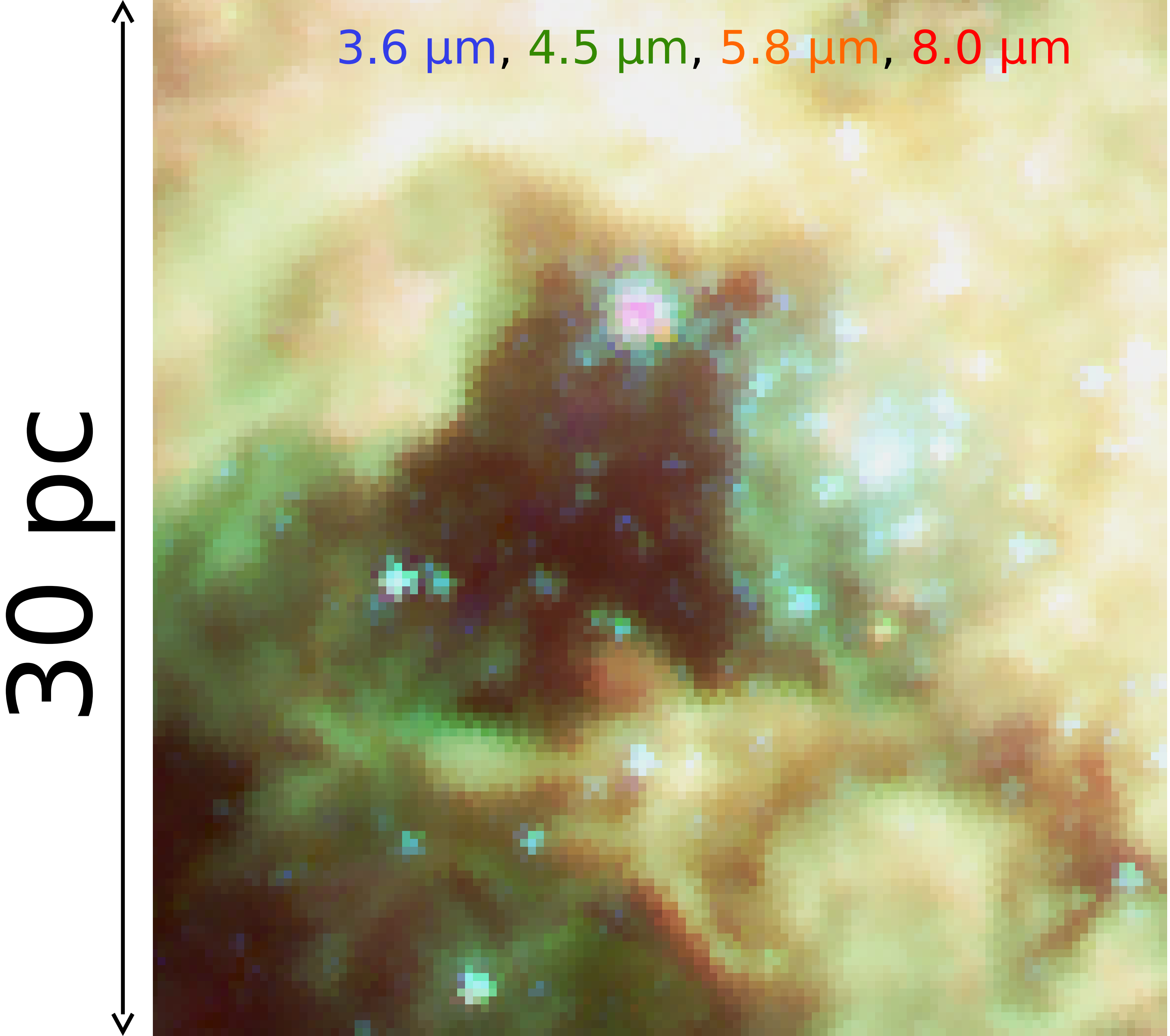



Orion
30’ = 4 pc


0.05 pc


30 Dor
pix psf
IRAC 3.6 μm
MIPS 24 μm
PACS 70 μm
Trapezium
30 pc

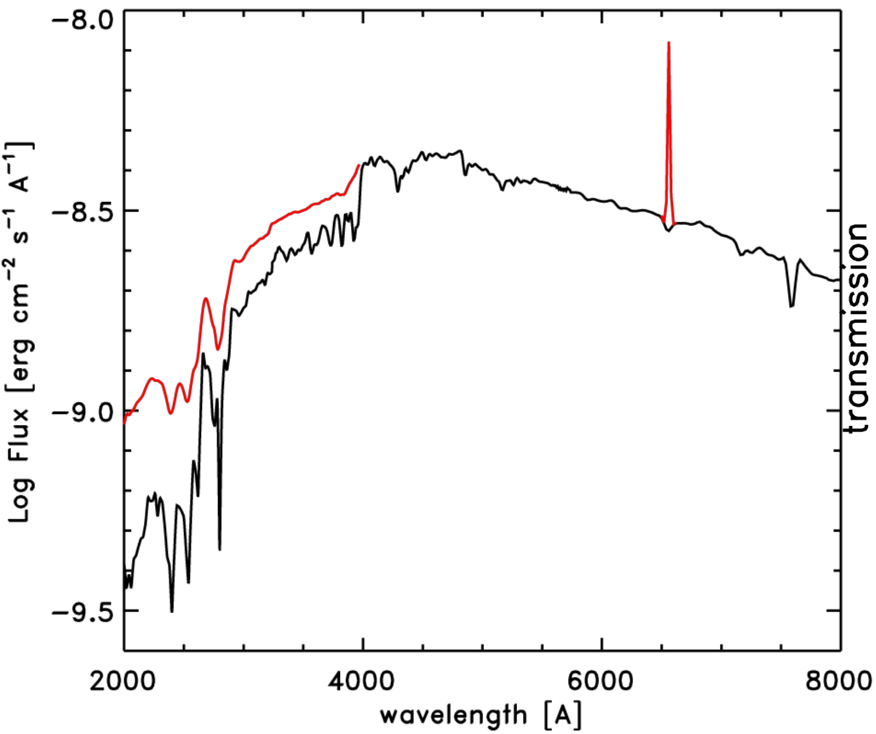

30 Dor
30 pc

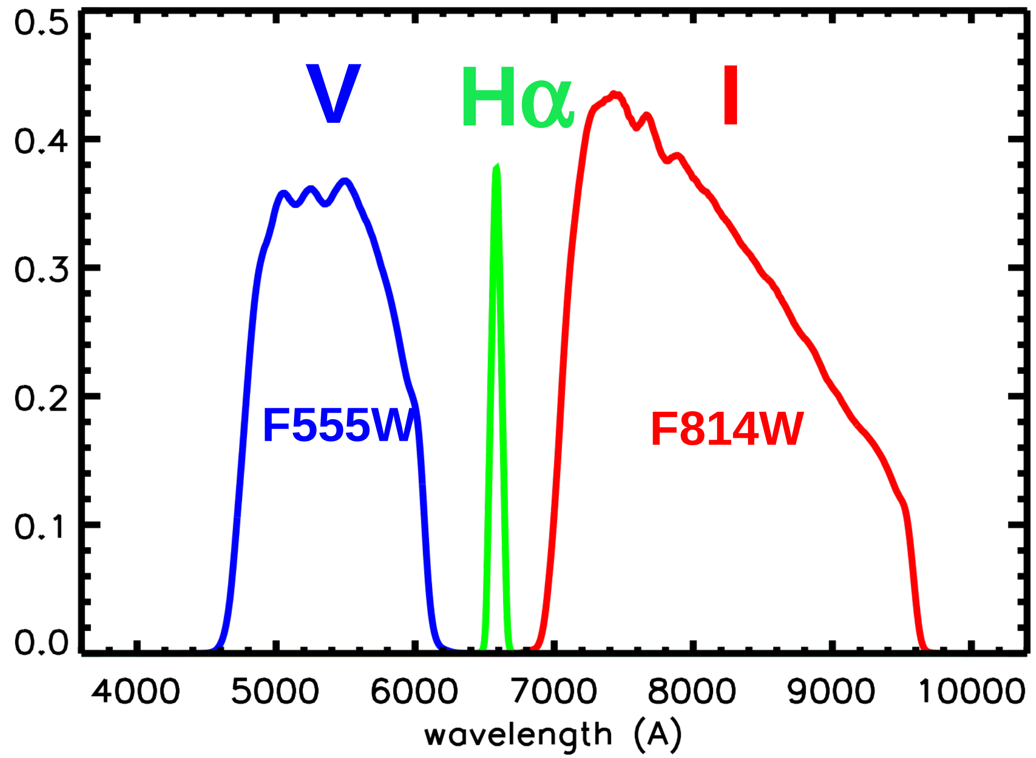


3.6 μm, 4.5 μm, 5.8 μm, 8.0 μm
30 pc

=How?=(1) Photometry

Typical signature:
UV, IR and Hα excess emission

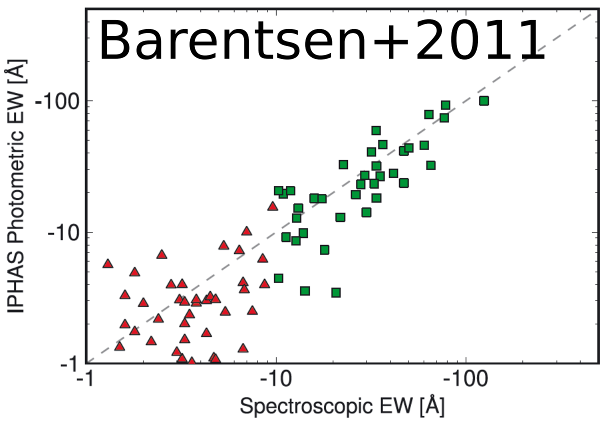




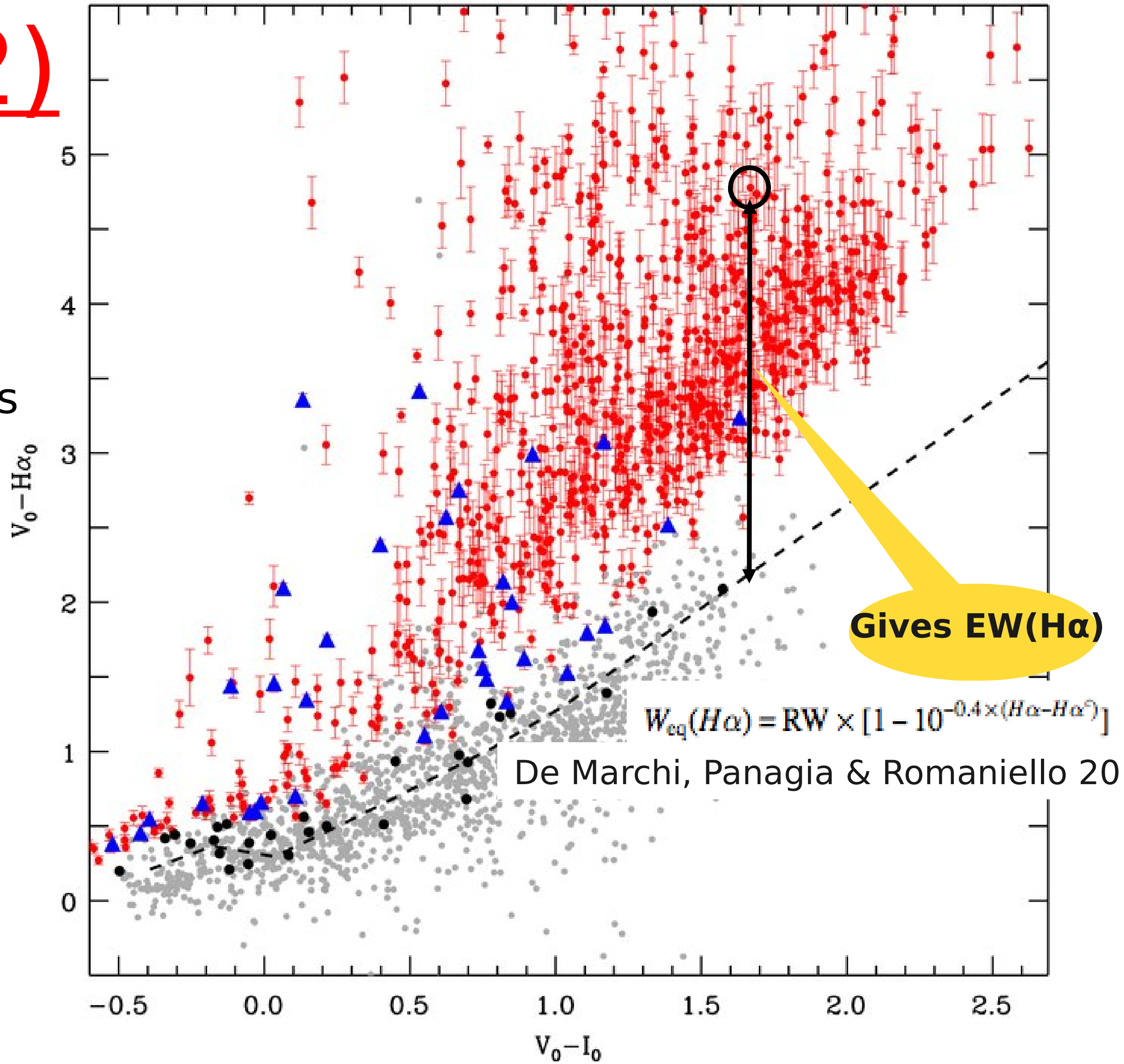
=How?=(2)

Stars with no Hα excess

Stars with Hα excess (distance in V-Hα from emp.law.> 5 combined V and Hα color error



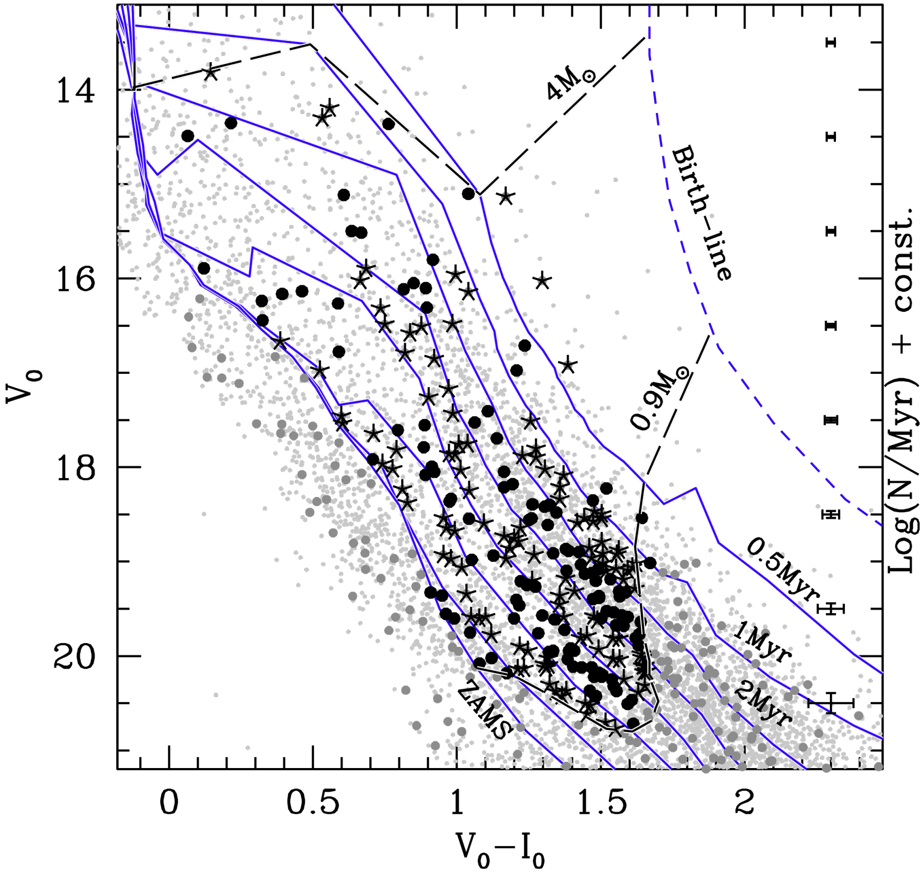
Beccari et al. 2010, ApJ, 720, 1108



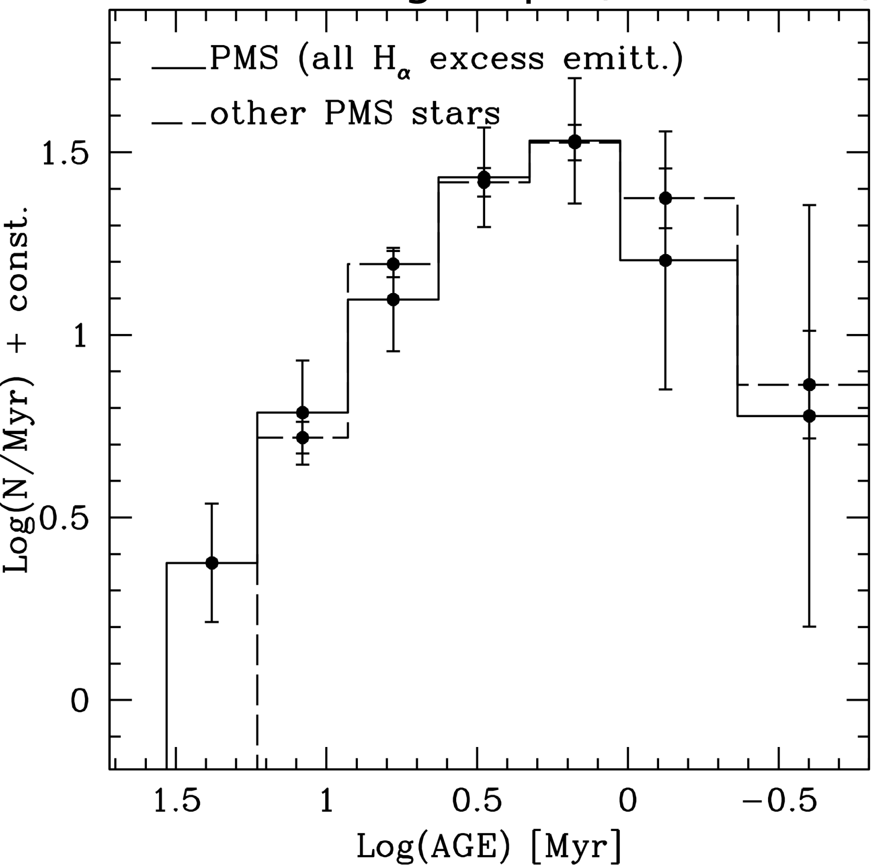
EW(Hα)>20AA !no chromosphere activity (CA)!

=How?=(3)

●★ PMS (Hα excess emitters)



Solid line: age distribution with constant log steps (factor of 2)



Beccari et al. (2010)

Stars physical parameters for more that 1000 PMSs

- **Hα luminosity $L_{H\alpha}$ gives accretion luminosity L_{acc} via relationship calibrated using spectroscopic data** (e.g. Dahm 2008)

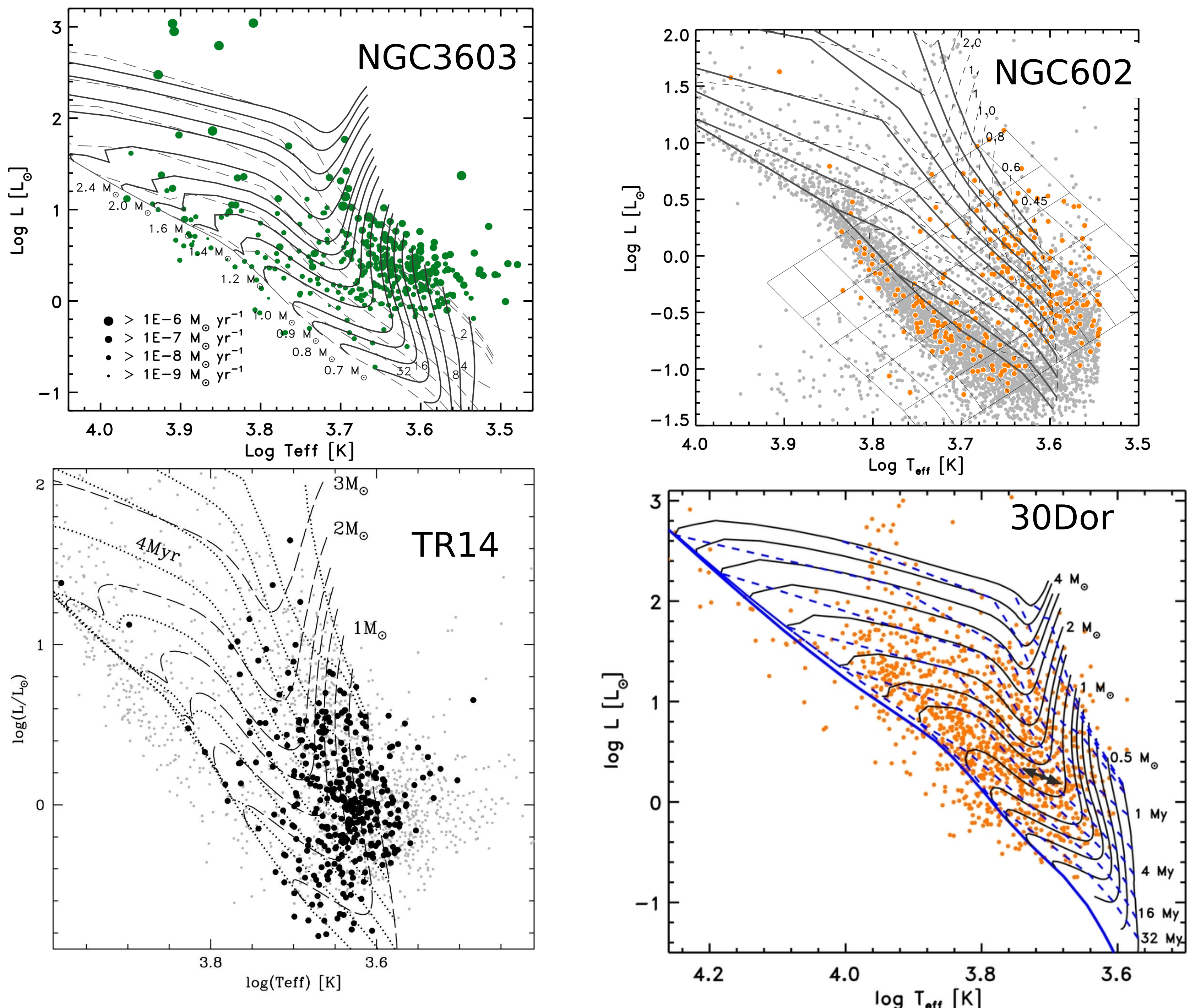
$$\mathrm{Log}\,(L_{acc}) = \mathrm{Log}\,(L_{H\alpha}) + (1.72 \pm 0.25)$$

- **Mass M radius R and age t from PMS isochrones in HR diagram**
- **Free fall equation gives mass accretion rate $\dot{M}$**

$$L_{acc} \simeq \frac{G M_* \dot{M}}{R_*}\left(1 - \frac{R_*}{R_{in}}\right)$$

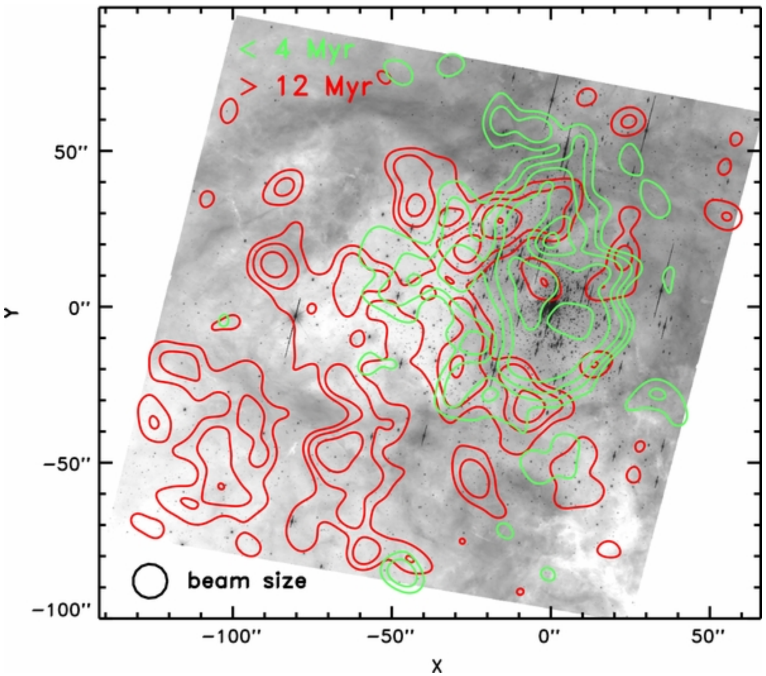
- **We can study how star formation has proceeded in space and time**

Results (1): 10-30Myr age spreads

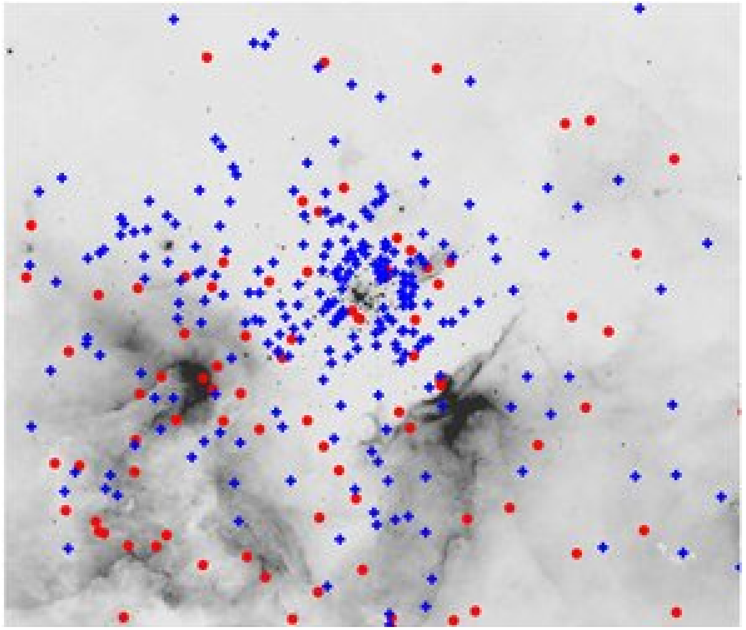

NGC3603
Log L [L⊙]
Log Teff [K]
2.4 M⊙
2.0 M⊙
1.6 M⊙
1.4 M⊙
1.2 M⊙
1.0 M⊙
0.9 M⊙
0.8 M⊙
0.7 M⊙
> 1E−6 M⊙ yr−1
> 1E−7 M⊙ yr−1
> 1E−8 M⊙ yr−1
> 1E−9 M⊙ yr−1
NGC602
Log L [L⊙]
Log Teff [K]
0.8
0.6
0.45
TR14
log(L/L⊙)
log(Teff) [K]
3M⊙
2M⊙
1M⊙
4Myr
30Dor
log L [L⊙]
log Teff [K]
4 M⊙
2 M⊙
1 M⊙
0.5 M⊙
1 My
4 My
16 My
32 My

Results (2): Different generations have different spatial distribution

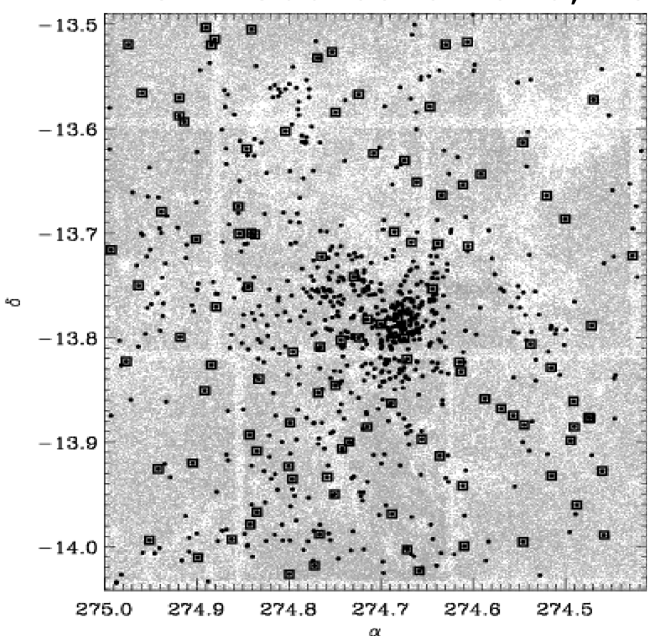
30 Dor - De Marchi et al. 2011b



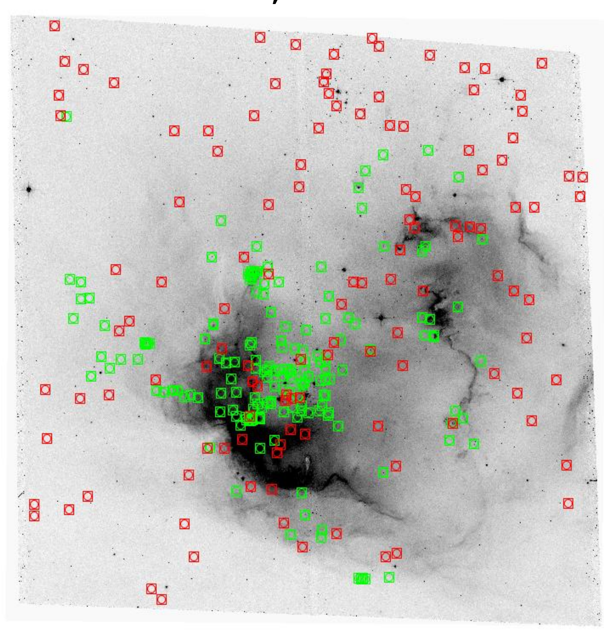
NGC 3603 - Beccari et al. 2010



EAGLE NEBULA Guarcello 2010, A&A, 521, 18



NGC 602 – DeMarchi, Beccari et al. 2013



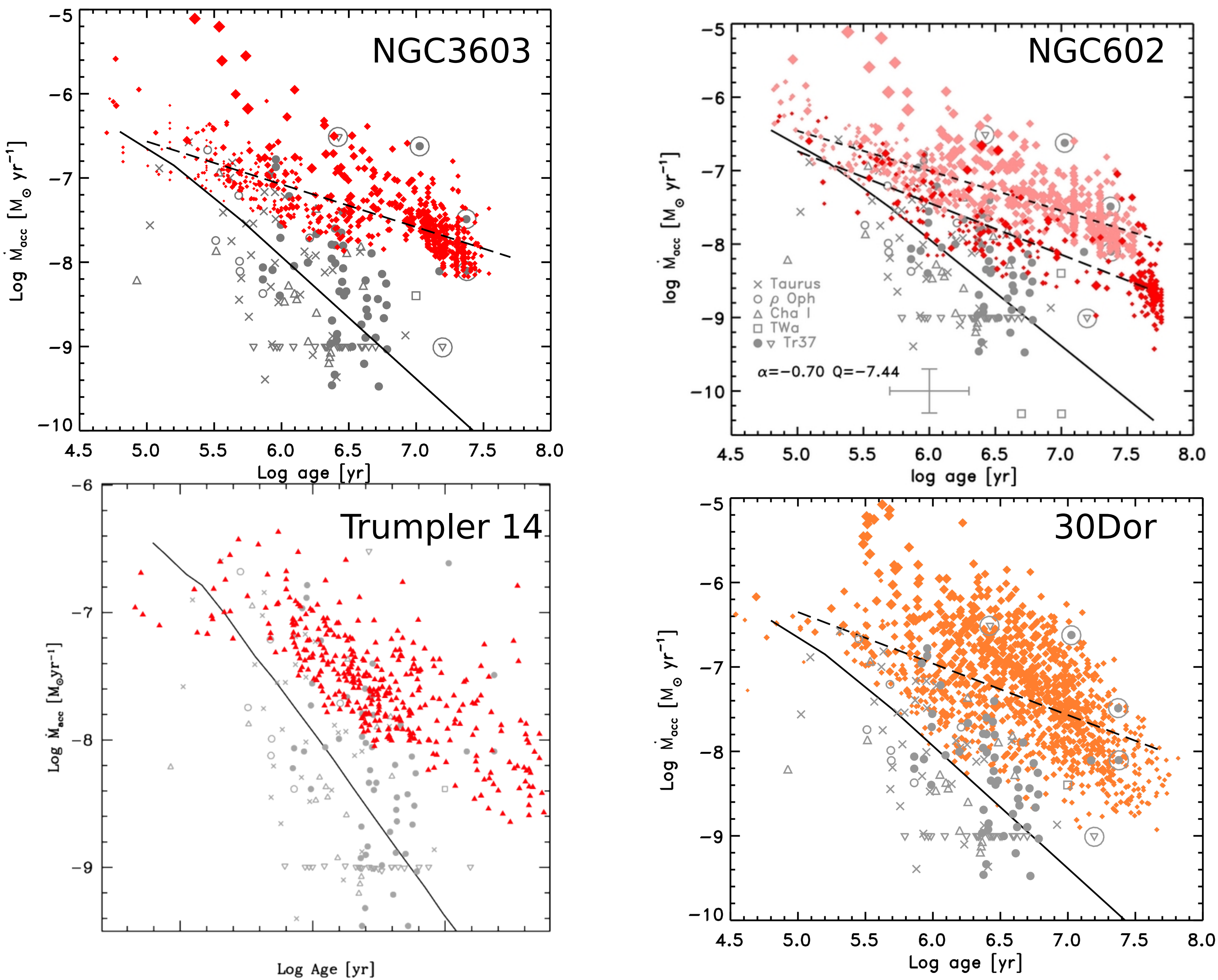
Results (3): Evolution of Macc(t,M*,Z)

t = ~0Myr to ~30 Myr

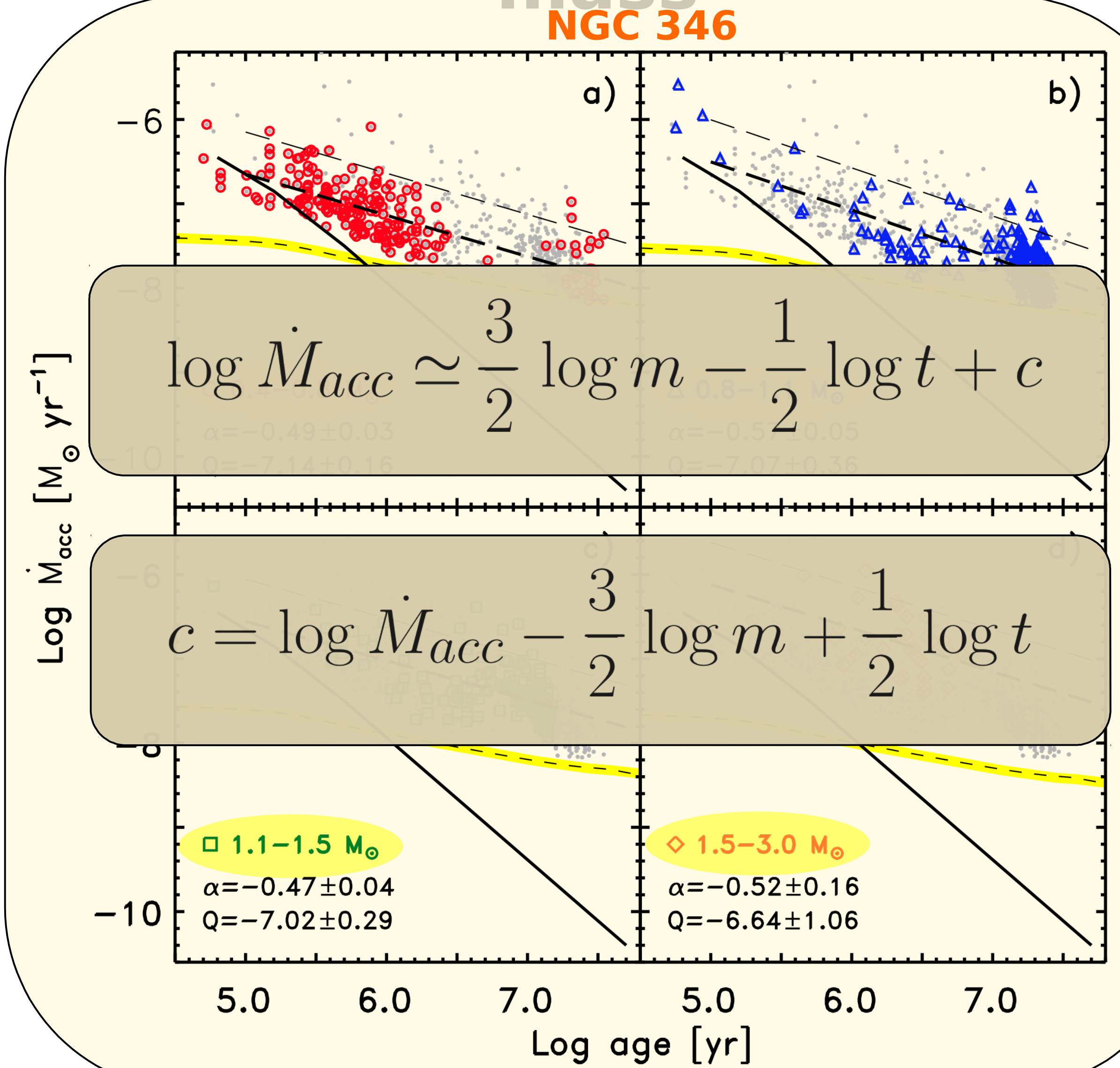
M*= ~0.8Msun to ~3 Msun

Z = 0.002 (SMC) - 0.007 (LMC) - 0.019 (MW)

$$\log \dot{M}_{\rm acc} = a \times \log t + b \times \log m + c$$


NGC3603
Log $\dot{M}_{acc}$ [$M_\odot$ yr^{-1}]
Log age [yr]
NGC602
log $\dot{M}_{acc}$ [$M_\odot$ yr^{-1}]
log age [yr]
× Taurus
○ ρ Oph
△ Cha I
□ TWa
● ▽ Tr37
α=−0.70 Q=−7.44
Trumpler 14
Log $\dot{M}_{acc}$ [$M_\odot yr^{-1}$]
Log Age [yr]
30Dor
Log $\dot{M}_{acc}$ [$M_\odot$ yr^{-1}]
Log age [yr]

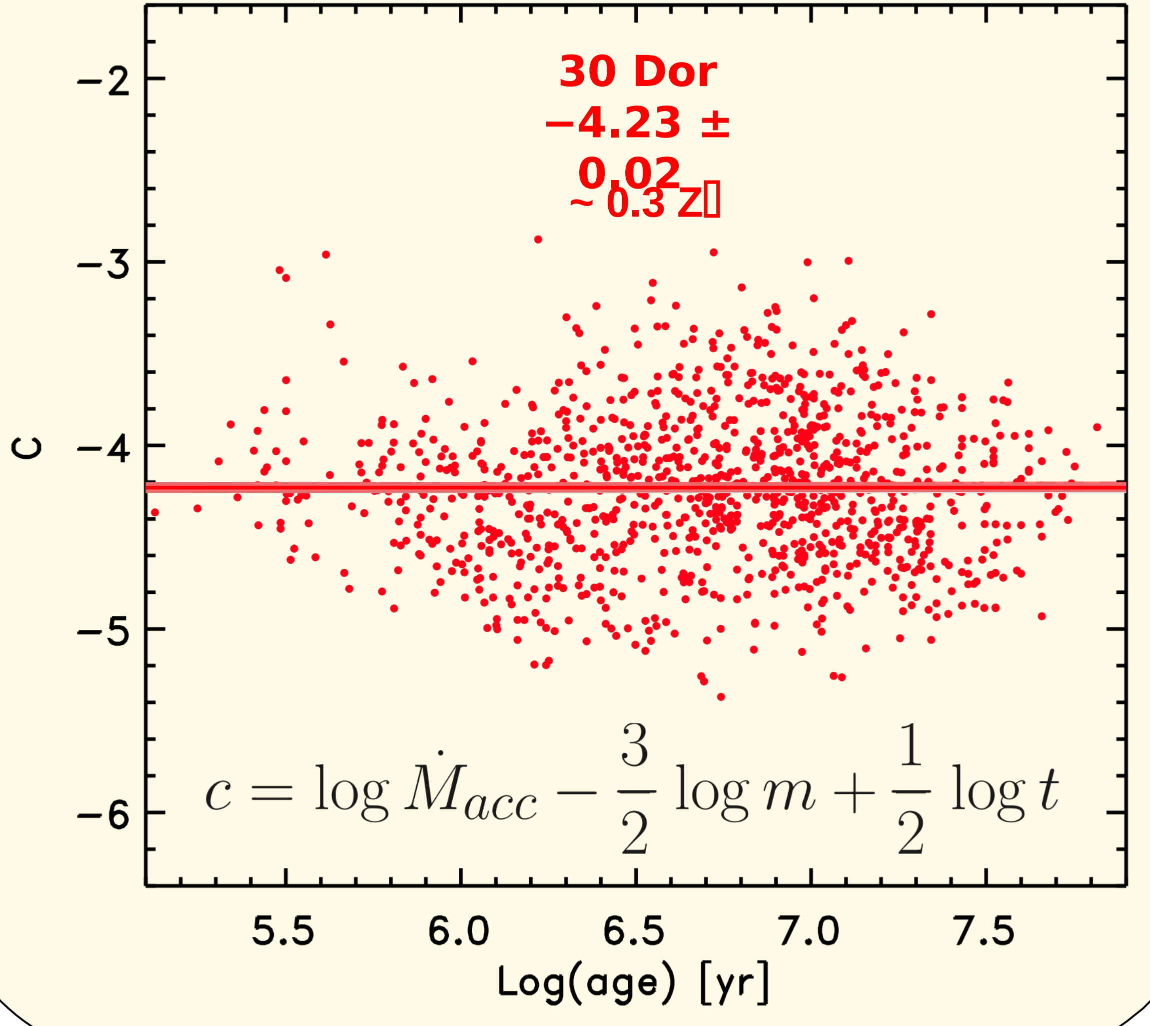
Accretion evolution with time & mass



$$\log \dot{M}_{acc} \simeq \frac{3}{2}\log m - \frac{1}{2}\log t + c$$

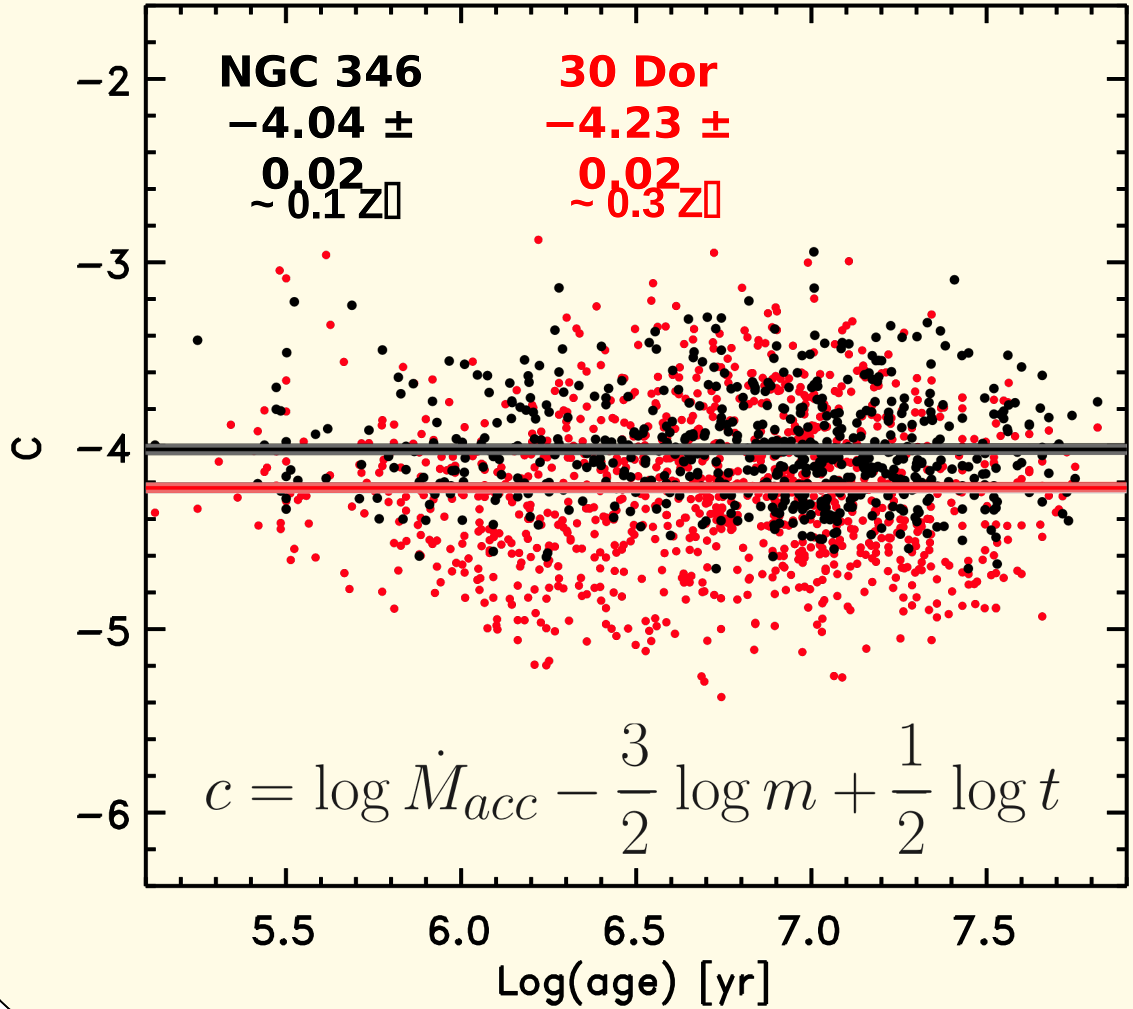
$$c = \log \dot{M}_{acc} - \frac{3}{2}\log m + \frac{1}{2}\log t$$

Accretion rate and metallicity

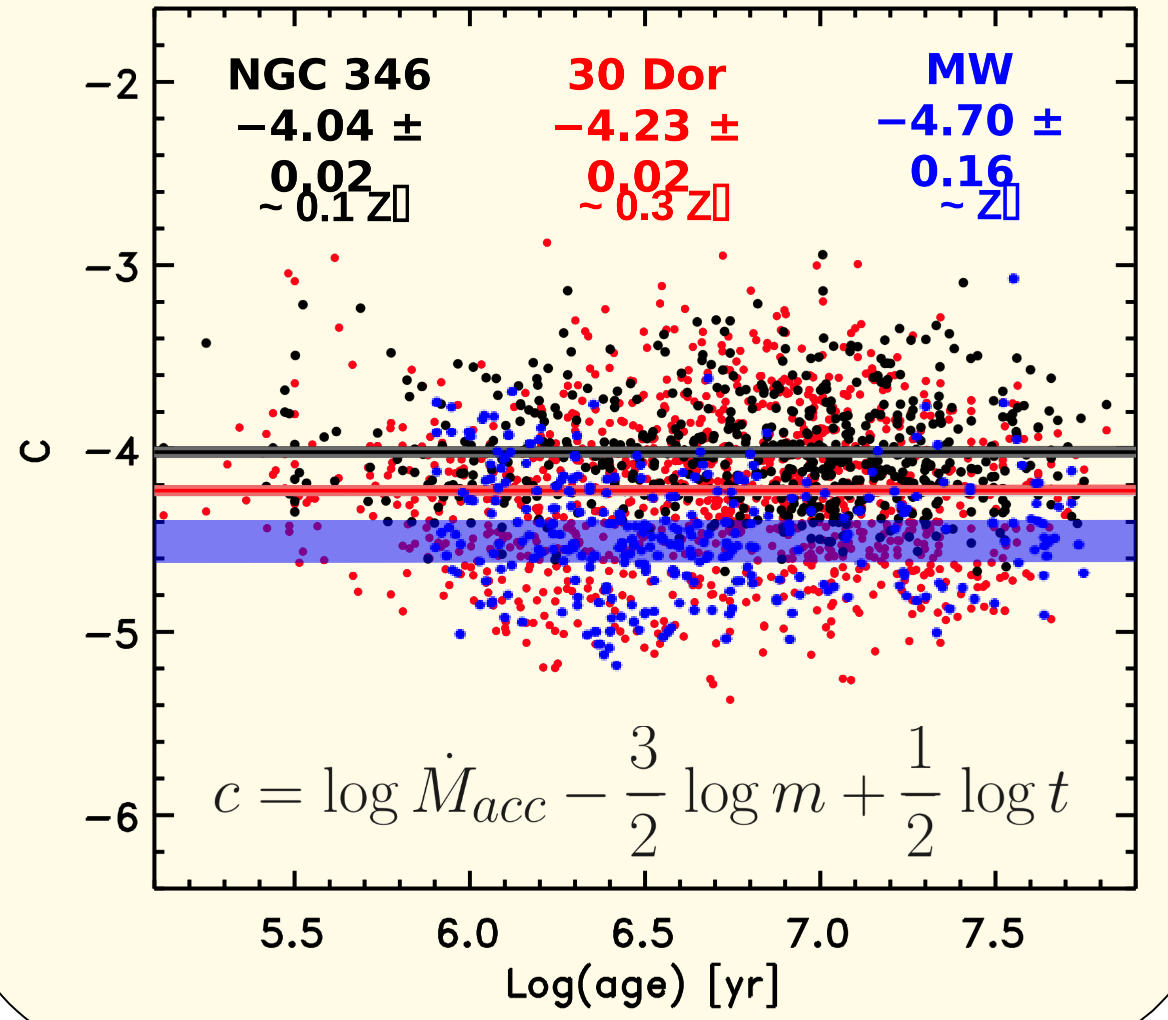


$$c = \log \dot{M}_{acc} - \frac{3}{2} \log m + \frac{1}{2} \log t$$

Accretion rate and metallicity

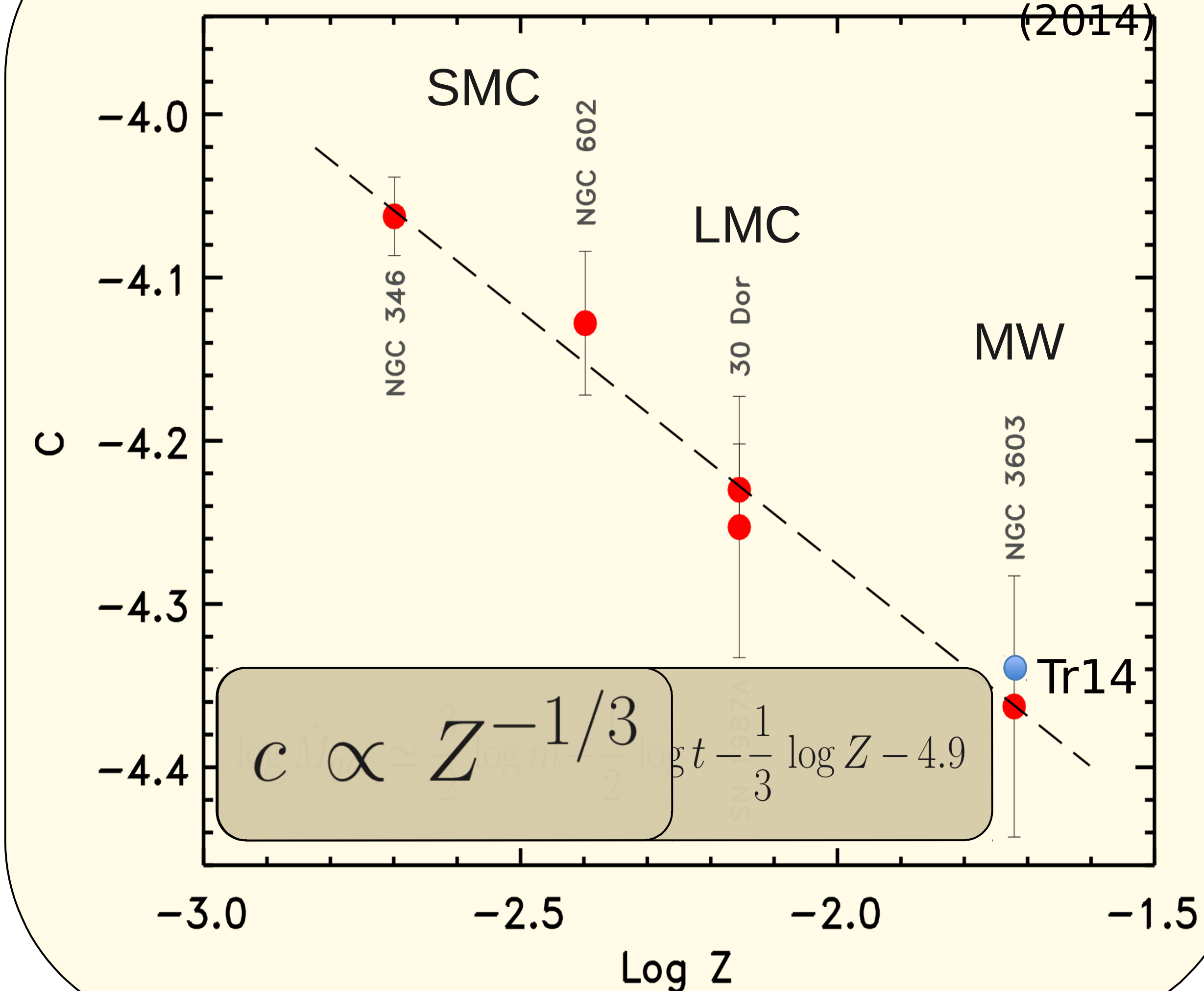


Accretion rate and metallicity



Accretion rate and metallicity

De Marchi, Panagia & Beccari (2014)



$$c \propto Z^{-1/3}$$

$$\ldots t - \frac{1}{3}\log Z - 4.9$$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JWST webinar
RSSD
two-body
SMAC
TSE
Intranet
IDL Help
Simbad
Dictionaries
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Google
star formation
made in europe
Guido De Marchi
Nino Panagia
Martino Romaniello
Giacomo Beccari
Francesco Paresce
Loredana Spezzi
Elena Sabbi
Marco Sirianni
Morten Andersen
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mail
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Paper I
Paper II
Paper III
Paper IV
Paper V
STScI May Symposium
Paper VI
Paper VII
Paper VIII
Paper IX
Older papers
2004
2002
2000
1998
1994
Introduction
We are a group of European scientists interested in the star formation properties of young clusters in the Local
Group, mostly the Galaxy and Magellanic Clouds ... provides a selection of our papers. Some are
published, others have been submitted and ... are still being written. You can scroll down or use the
navigation bar on the left to select ... that you want to see. If you want to know more about a paper,
please write to us at
Recent papers
Paper I (2010)
Photometric determination of the mass accretion rates of pre-main sequence stars. I.
Method and application to the SN1987A field
Guido De Marchi (ESA), Nino Panagia (STScI, INAF-CT, Supernova Ltd), Martino Romaniello (ESO)
www.starformation.eu

Conclusions

- **Multiple generations always seen, Δt ~ 10 Myr**

  Star formation episodes not spatially correlated

  Younger generation usually more concentrated

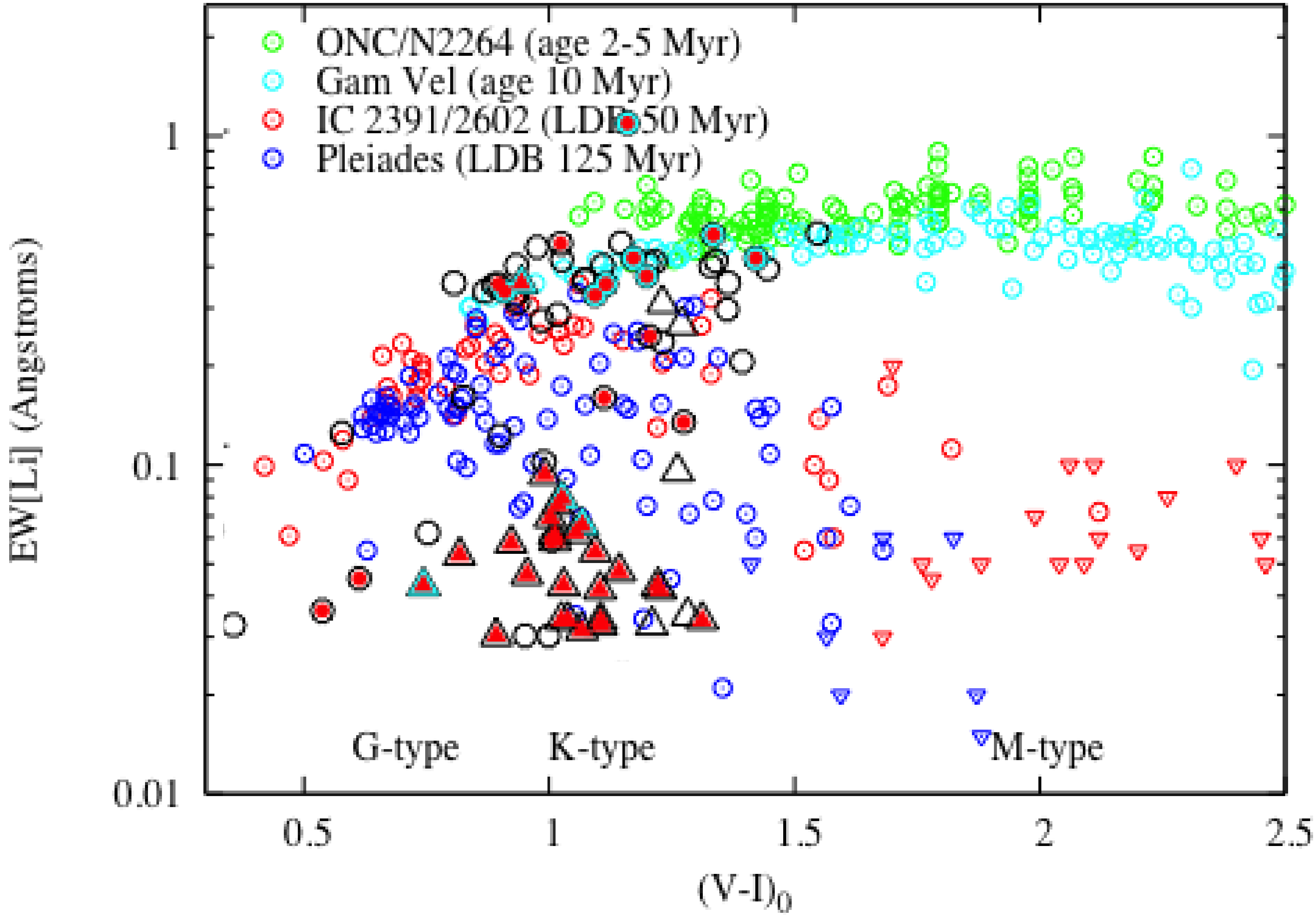
- **At low Z accretion process stronger and longer**

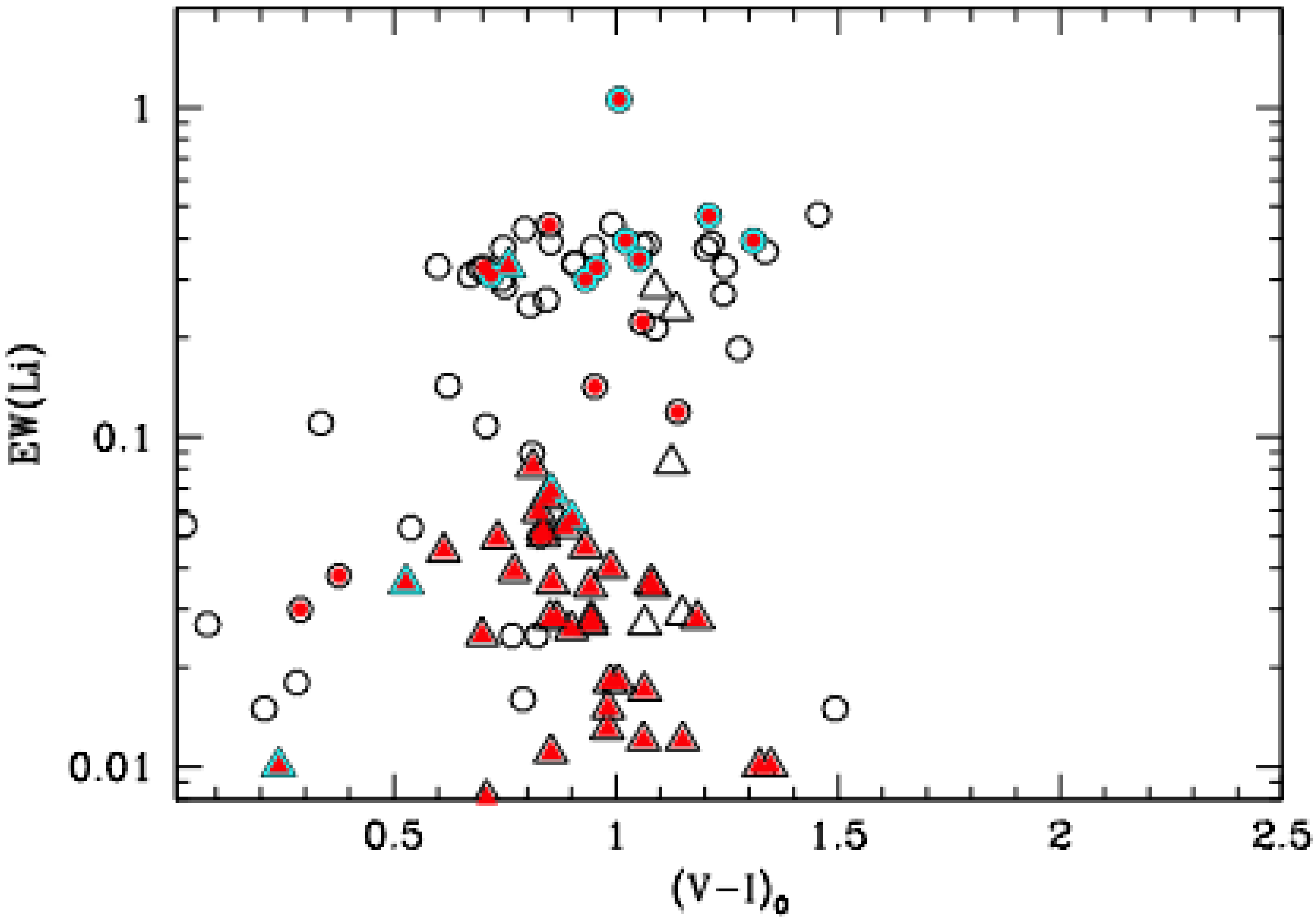
$$\log \dot{M}_{acc} \simeq \frac{3}{2} \log m - \frac{1}{2} \log t - \frac{1}{3} \log Z - 4.9$$

important constraints for theory of star formation

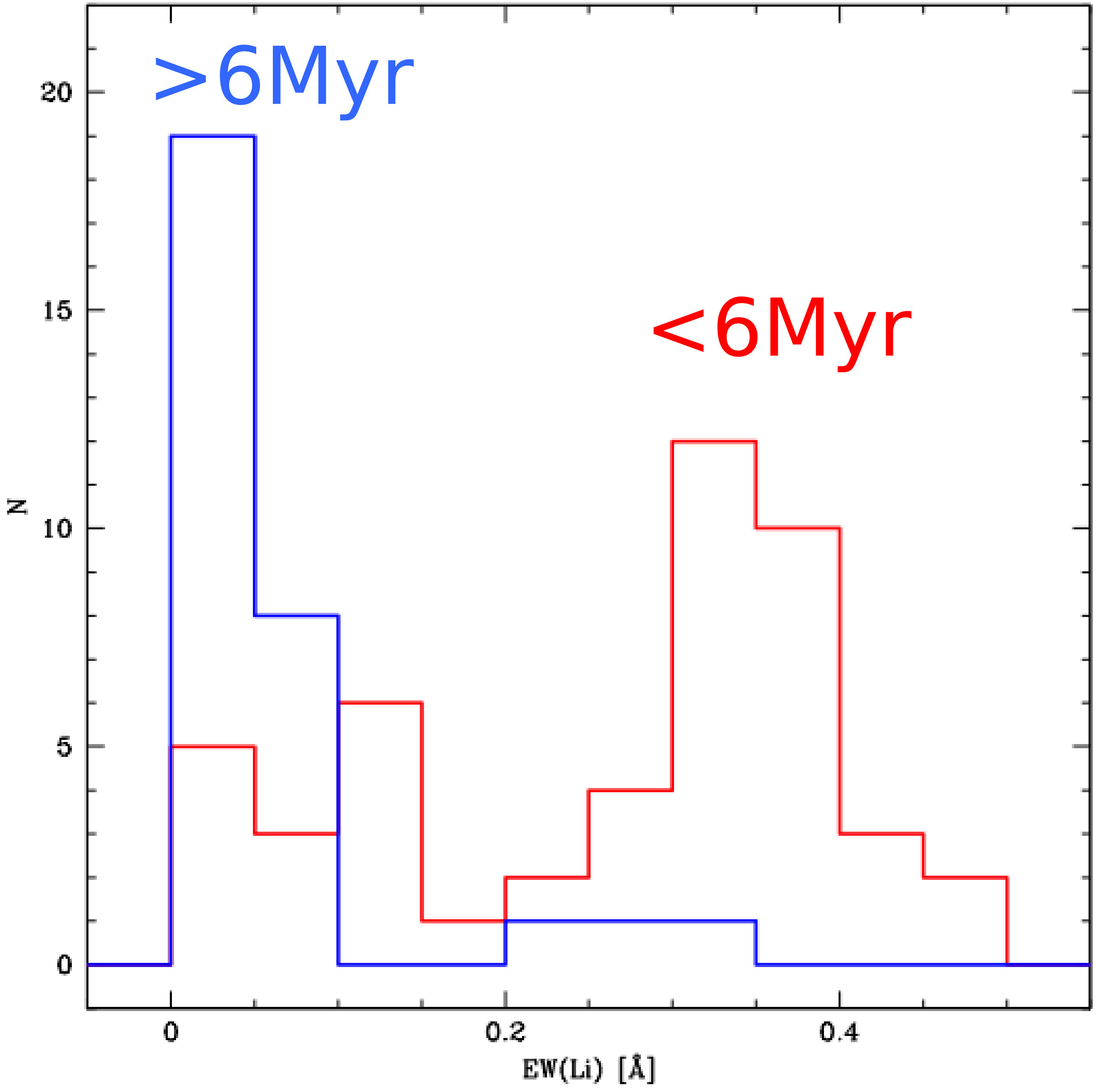
 We have 24 HST orbits (WFC3) and 7 nights at 2.2ESO/MPI (WFI)+ FLAMES spectra to perform a survey of YMC in the Hα

Soderblom et al. 2013, PPVI Chapter “Ages of Young Stars”



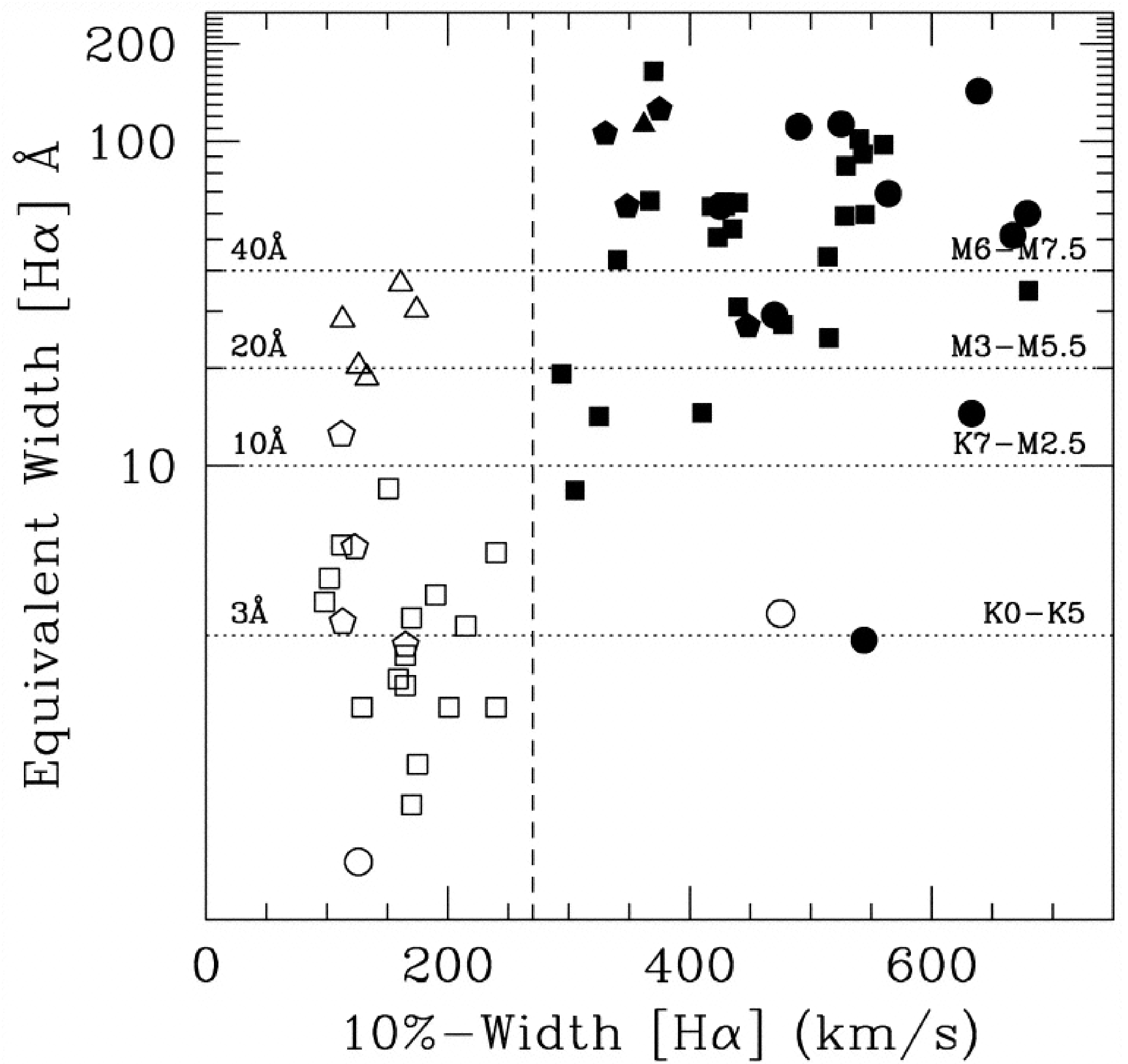


1
0.1
0.01
EW(Li)
0.5
1
1.5
2
2.5
(V−I)0



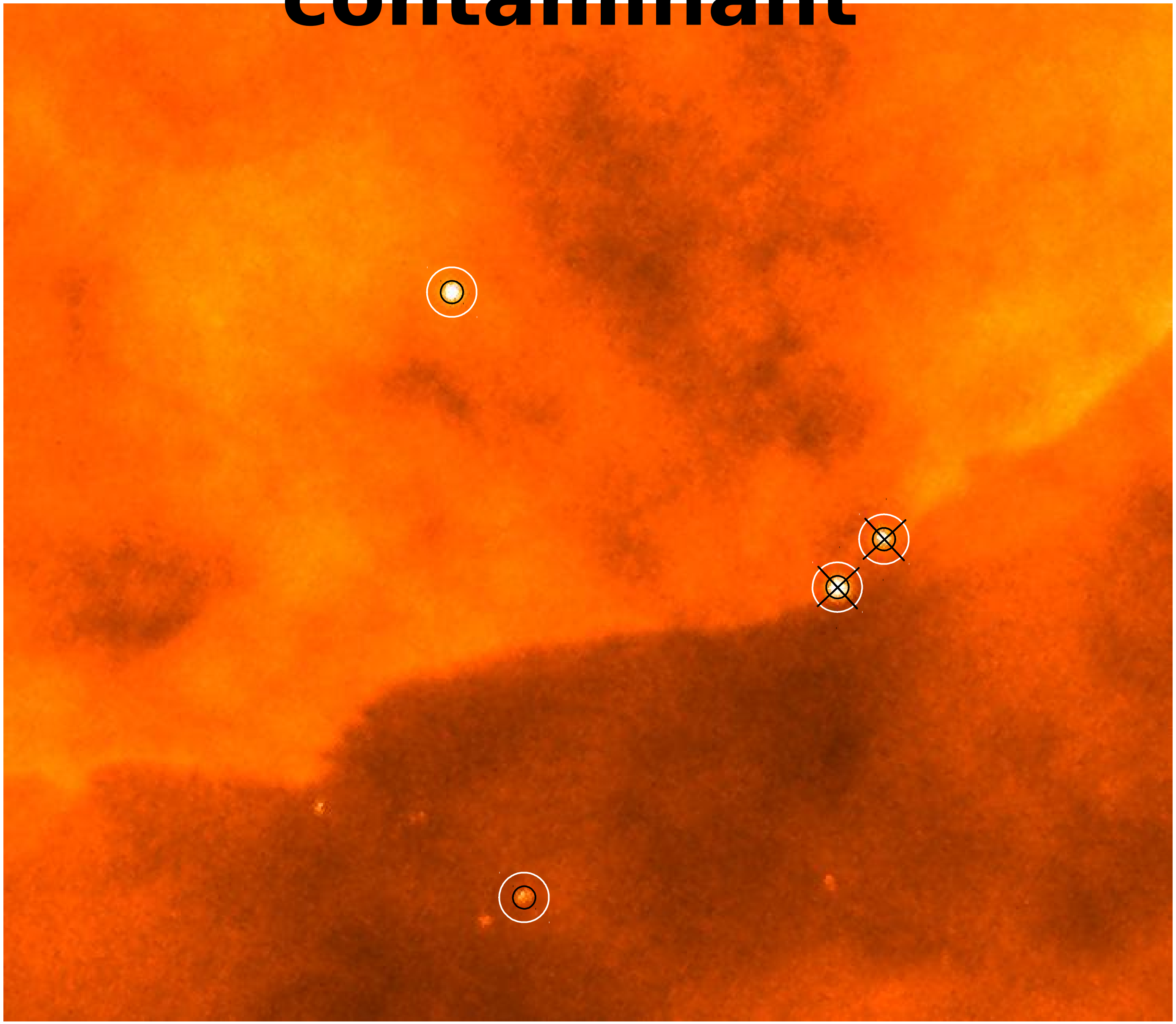
>6Myr
<6Myr
N
EW(Li) [Å]
0
5
10
15
20
0
0.2
0.4

Accretion vs CA: EW(Hα)!

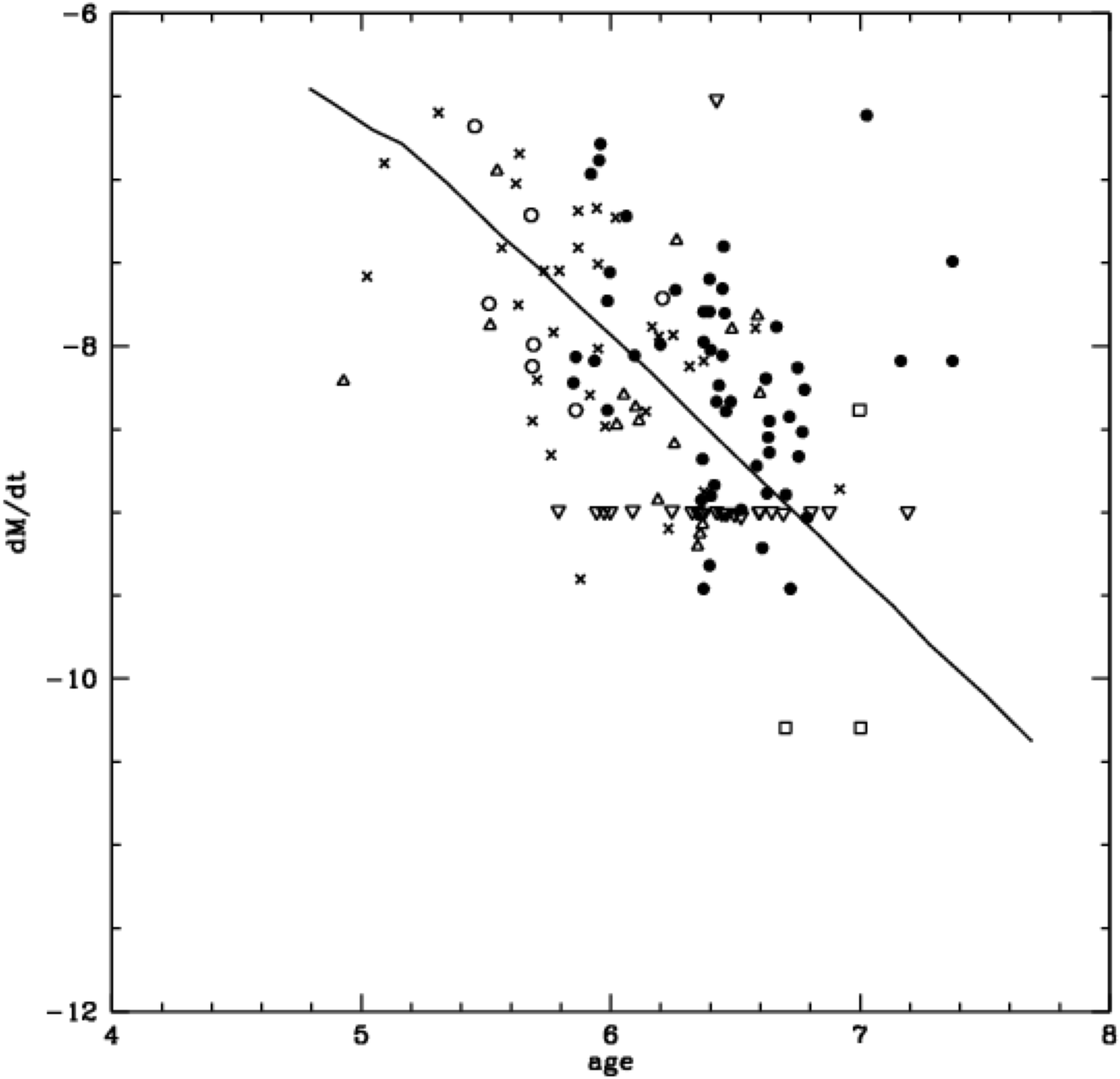


White & Basri, 2003, ApJ, 582, 1109

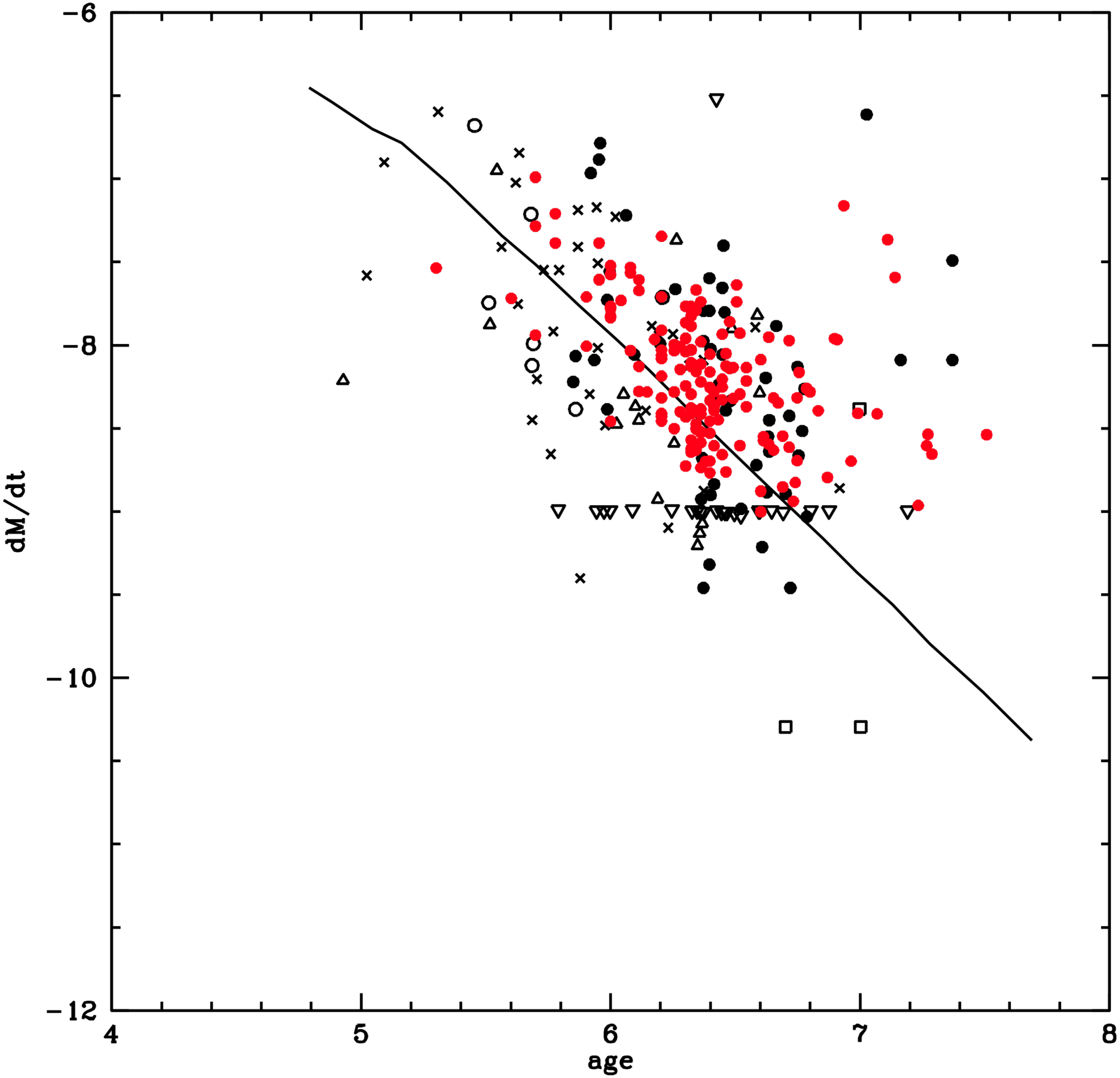
Background emission as contaminant



Macc in TRUMPLER 14?



Macc in TRUMPLER 37: The test-bench



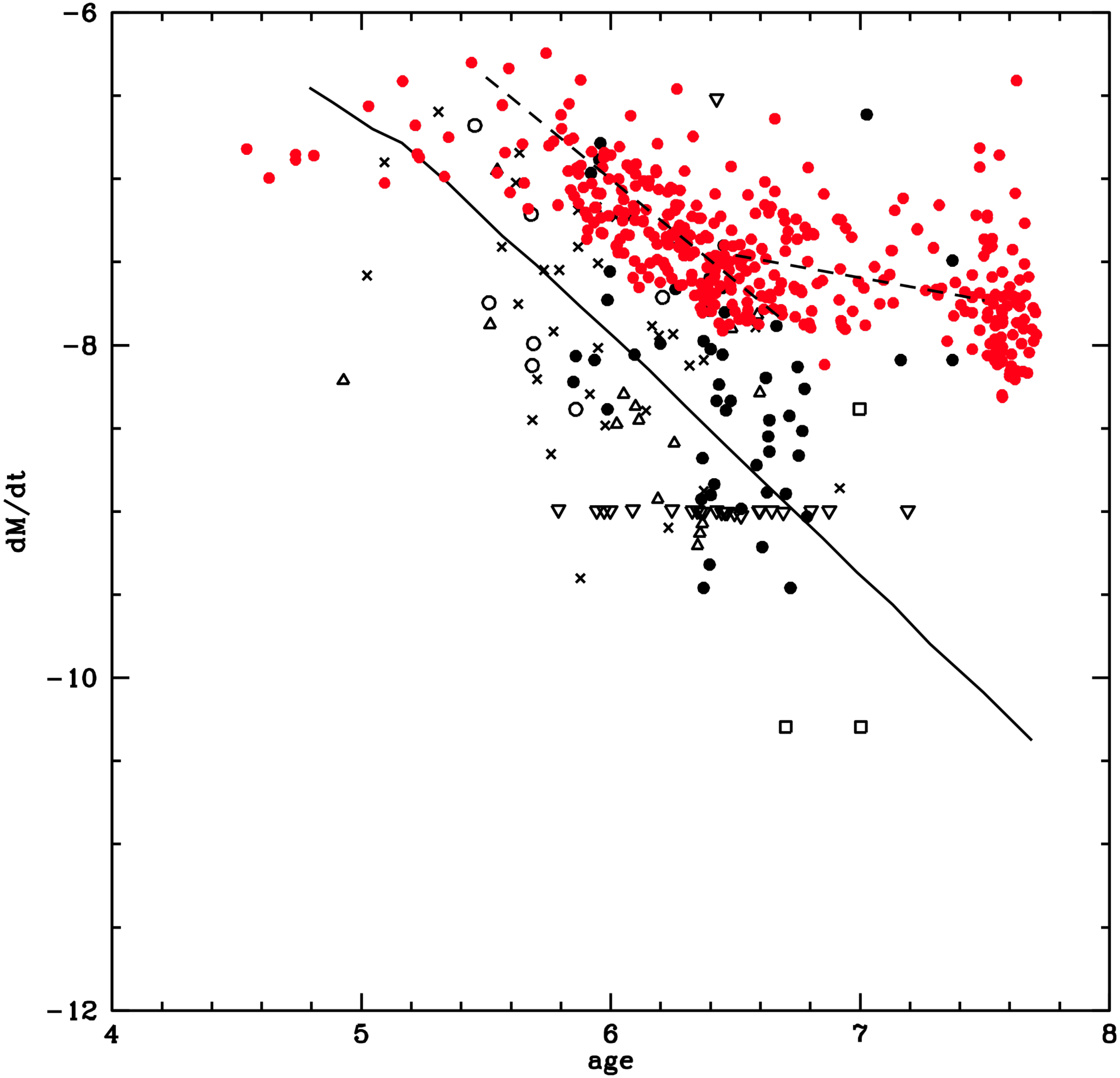
- All black symbols are Macc of PMS stars in TR37 from spectroscopic data - Fig 11 of Sicilia-Aguilar et al. 2006.

- Red points are Macc Measured using the photometric catalogue from Barentsen et al. 2011 and using our photometric approach.

<u>Our measurements of Macc(and also EW(Halpha) and Lacc) are in perfect agreement with Barentsen (and Sicilia-Aguilar) measurements</u>

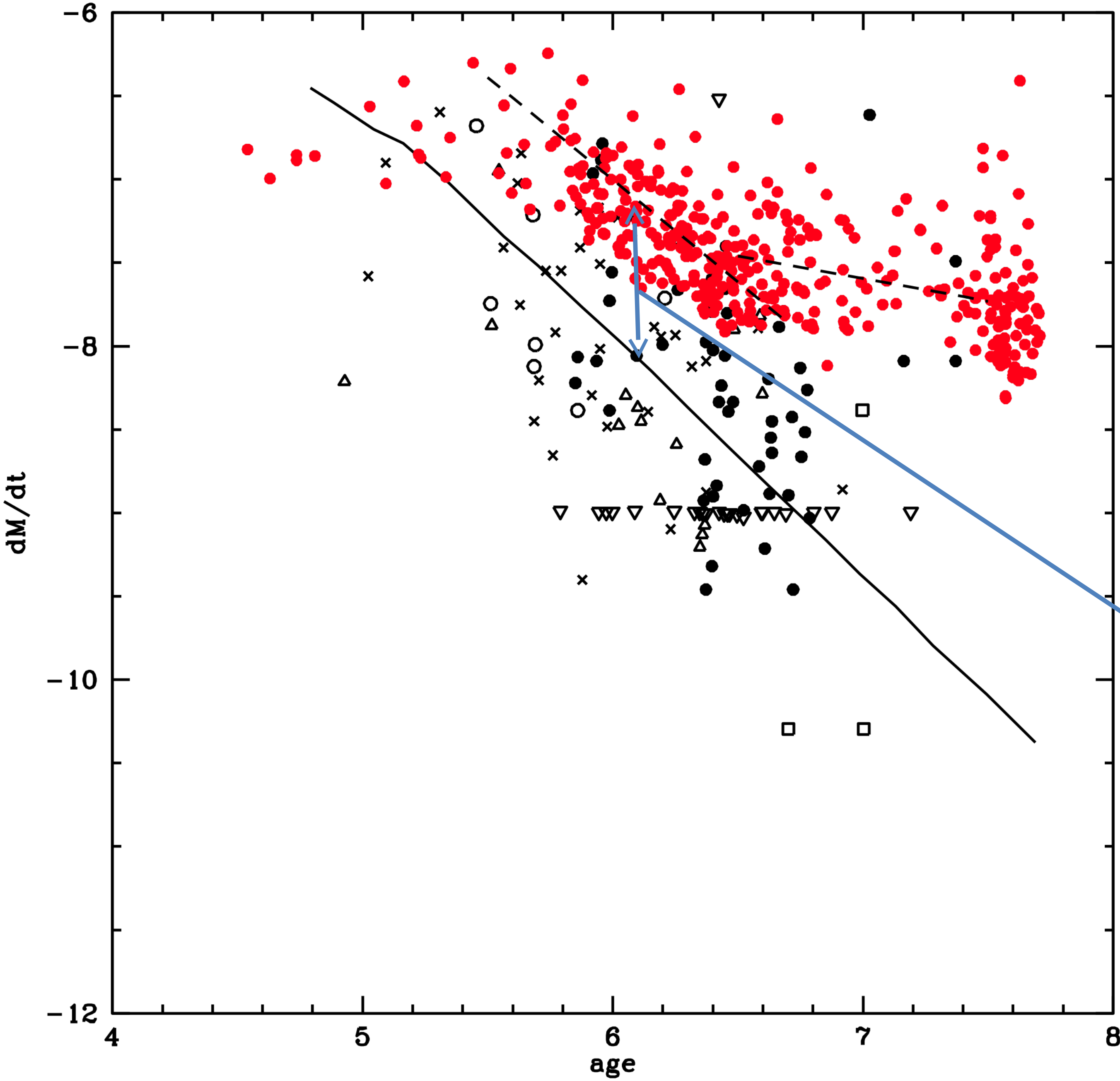
<u>.....GOOD NEWS ....</u>

Macc in TRUMPLER 14?



Red points are Macc measured for the H-alpha emitters of TR14 (bona fide PMS stars) using the WFI photometric catalogue and with our photometric approach.

Macc in TRUMPLER 14?

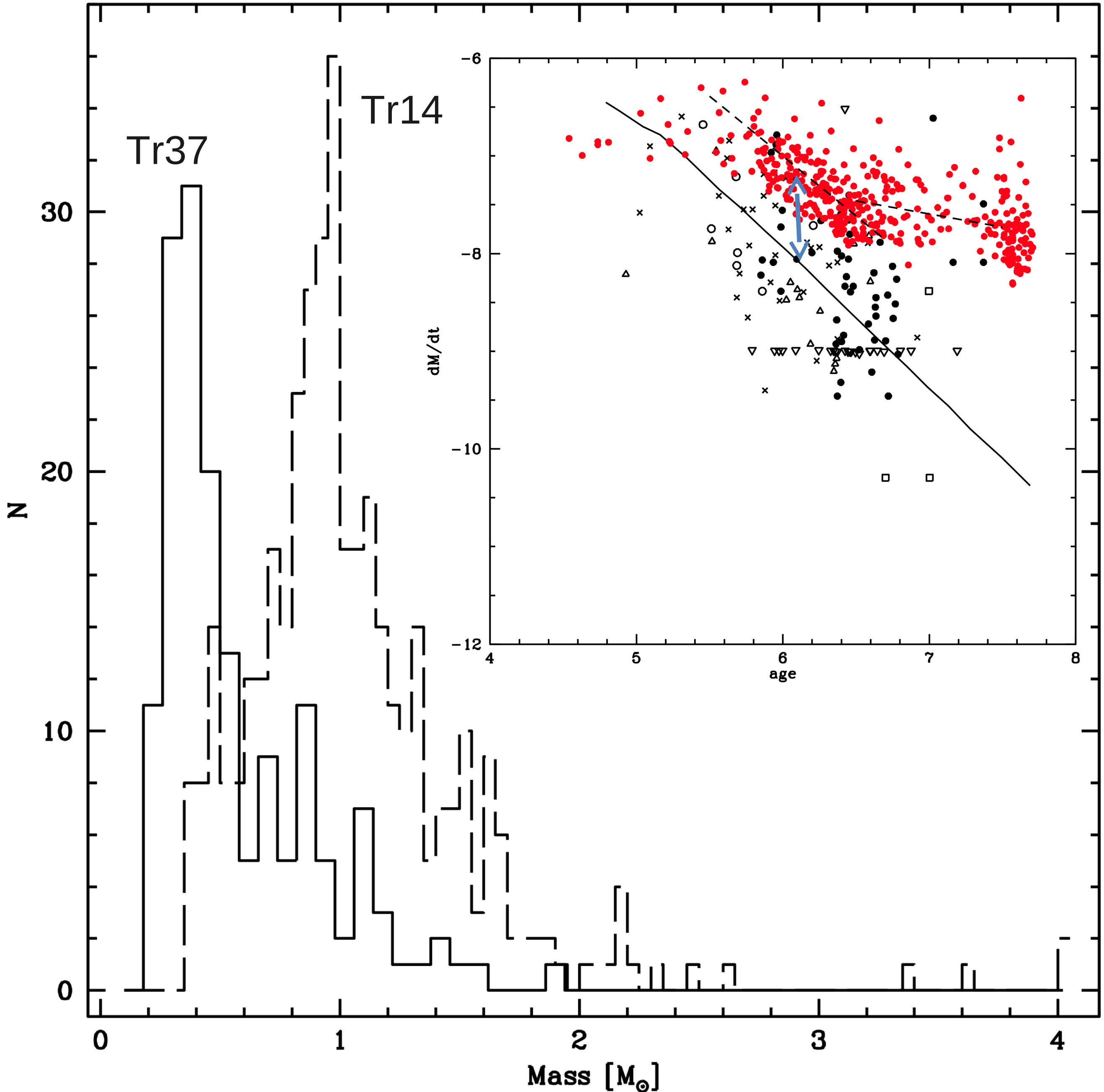


Red points are Macc measured for the H-alpha emitters of TR14 (bona fide PMS stars) using the WFI photometric catalogue and with our photometric approach.

In the range of ages sampled with TR37 data (~0-5Myrs), the slope of the Macc of the stars in TR14 (dashed line) is the same as for the Hartmann viscous disc evolution models (solid line) but is factor ~10 higher…why??

The change of slope at age>5Myr is induced by the decrease of photometric completeness

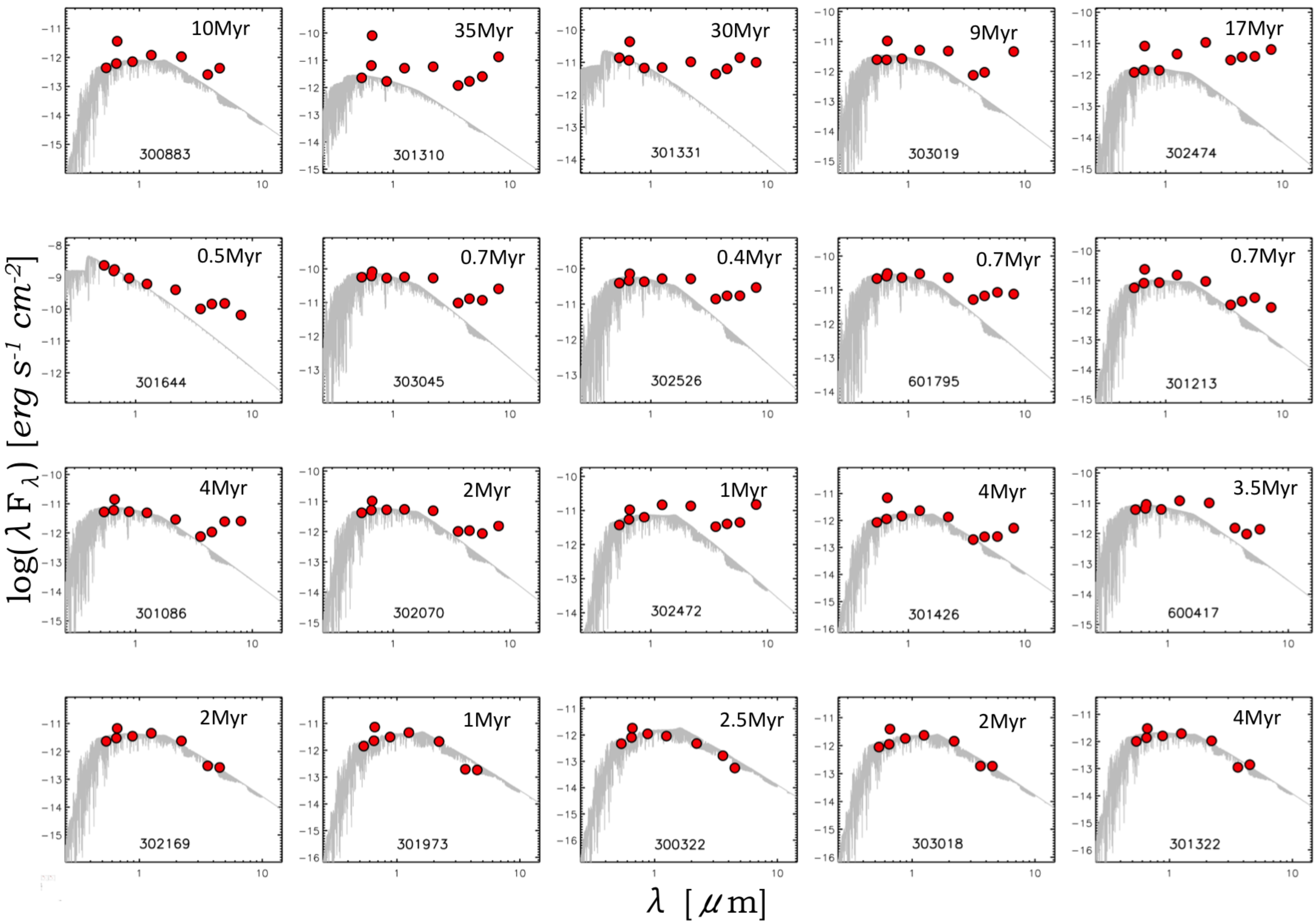
Possibility: Difference in the sampled masses!!!



In the simplistic assumption that Macc goes with M^3/2:

$$\left(\frac{< M^* > tr14}{< M^* > tr37} \right)^{3/2} \approx 10$$

In agreement with the factor ~10 difference seen in the Macc of TR14 compared to Macc TR37



10Myr
300883
35Myr
301310
30Myr
301331
9Myr
303019
17Myr
302474
0.5Myr
301644
0.7Myr
303045
0.4Myr
302526
0.7Myr
601795
0.7Myr
301213
4Myr
301086
2Myr
302070
1Myr
302472
4Myr
301426
3.5Myr
600417
2Myr
302169
1Myr
301973
2.5Myr
300322
2Myr
303018
4Myr
301322
log(λ F_λ) [erg s^-1 cm^-2]
λ [μm]