Modelado de galaxias con espectro de líneas de emisión debido a formación estelar.

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Charla CCD. April 28 2010, IAA

Credit: N. Scoville (Caltech), T. Rector (U. Alaska, NOAO) et al., Hubble Heritage Team, NASA.

Credits: NOAO

M20 / TRIFID

Cluster mass: 190 $M_\odot$

(Lada &_ Lada, 2003)

Credits: NASA, ESA, Hubble Heritage (STScI/ AURA)-ESA/ Hubble Collaboration

NGC 3603

Cluster mass: ~10^4 $M_\odot$

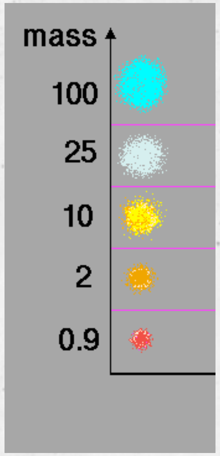
(Harayama et al., 2008)

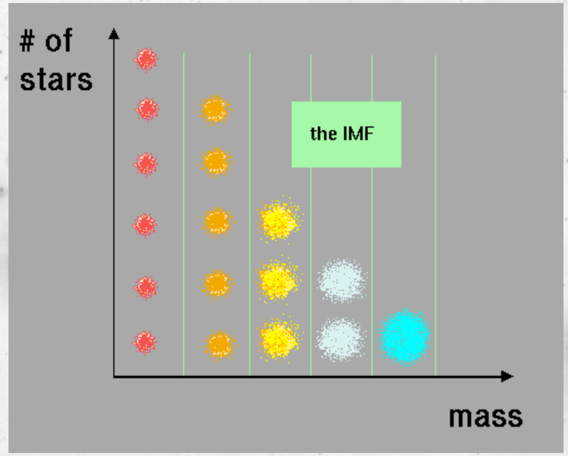
HII region models

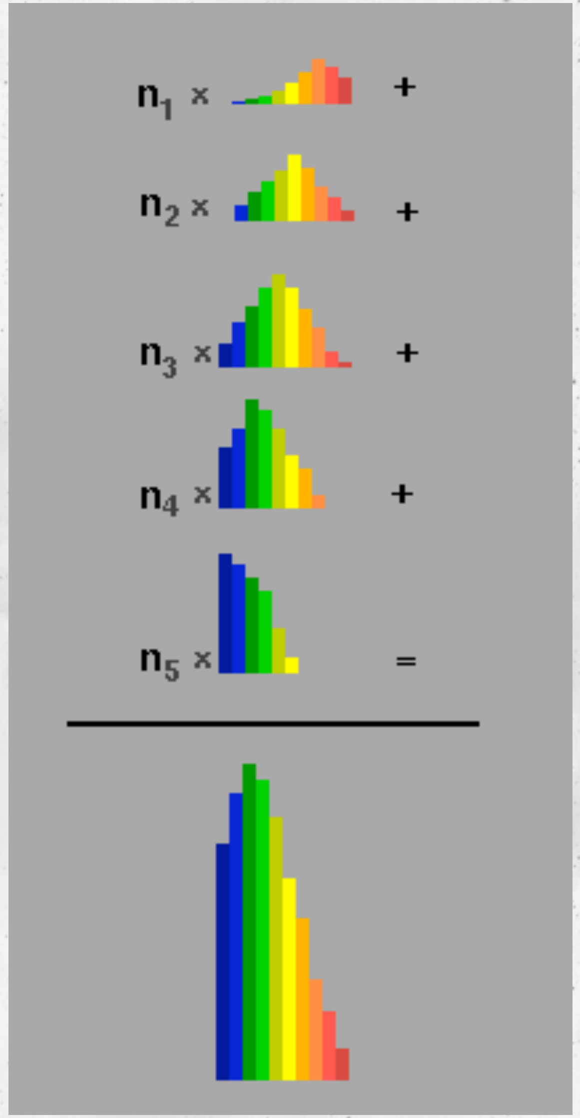
- 4000 HII region models (Cloudy 08.00)
  - –Z = 0.001, 0.004, 0.0028, 0.020 and 0.040
  - –8 Cluster masses (1 – 10^7 $M_{\odot}$)
  - –100 ages (0.1 – 10 Ma)
  - –Clusters SED obtained from synthesis models. (Sed@, Cerviño et al, 2002)

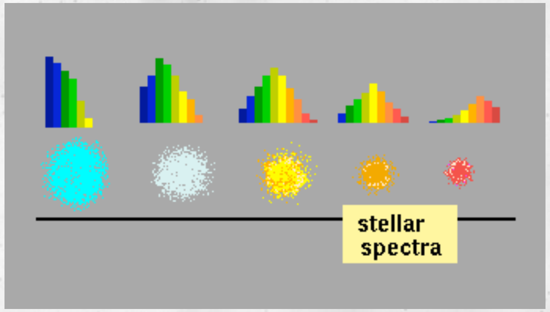
What is a synthesis model?

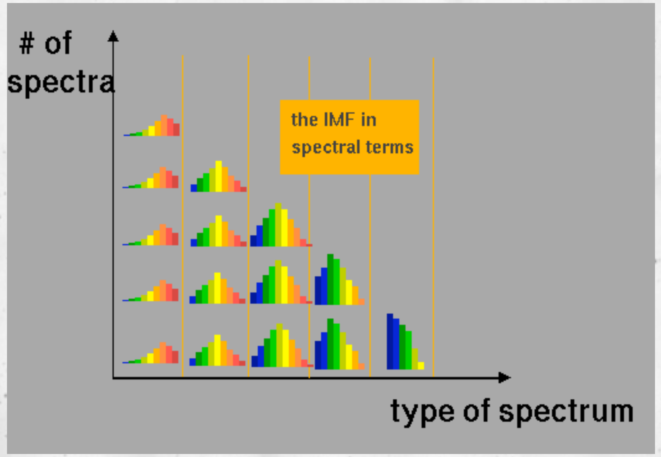
Luridiana & Cerviño (2007)











Method

SED from synthesis models

↓

Photoionization model

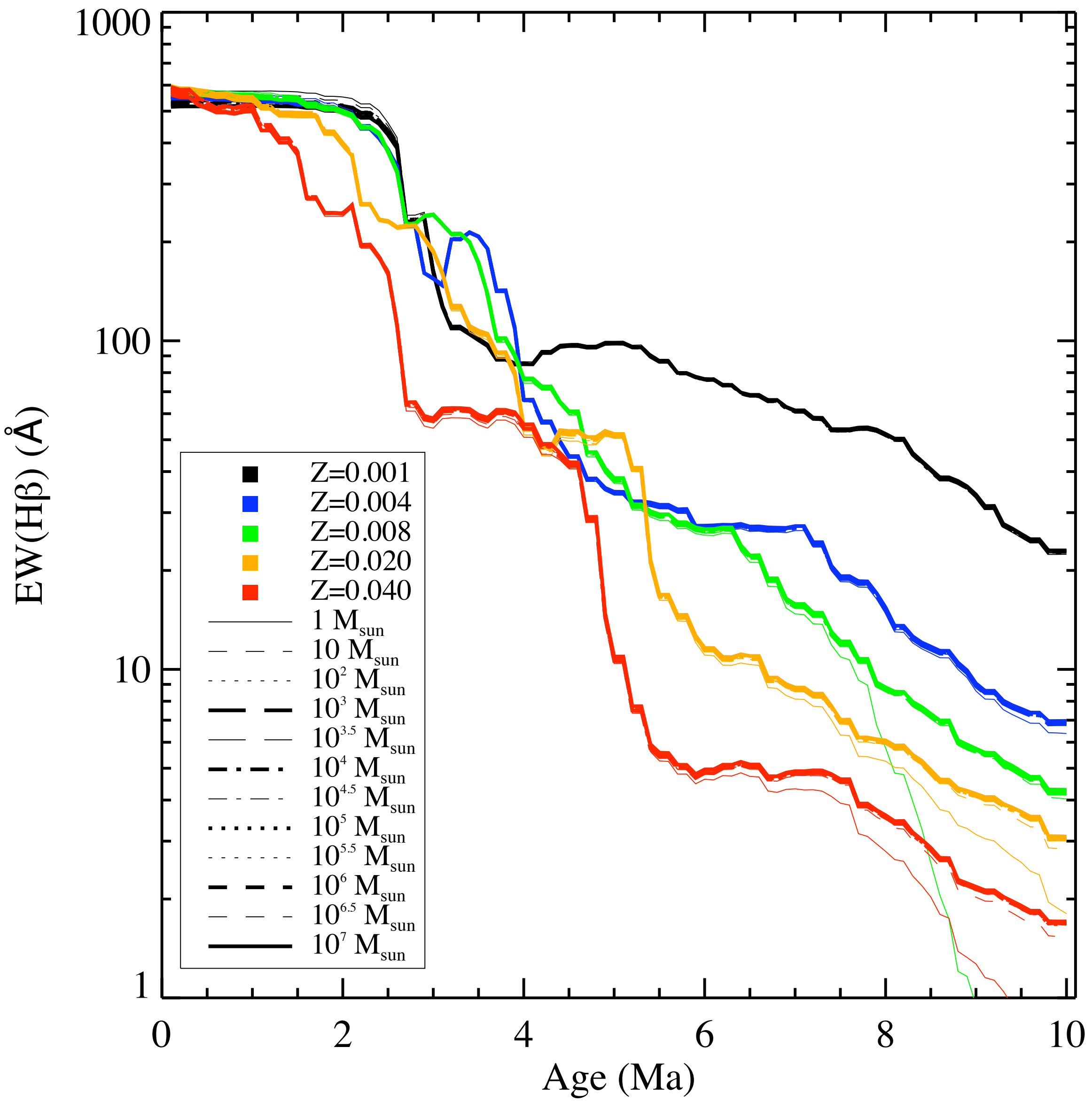
↓

Emission lines intensities

↓

Linear regressions

$\log(L) = \alpha + \beta\log(M) \Rightarrow L = A \cdot M^{\beta}$

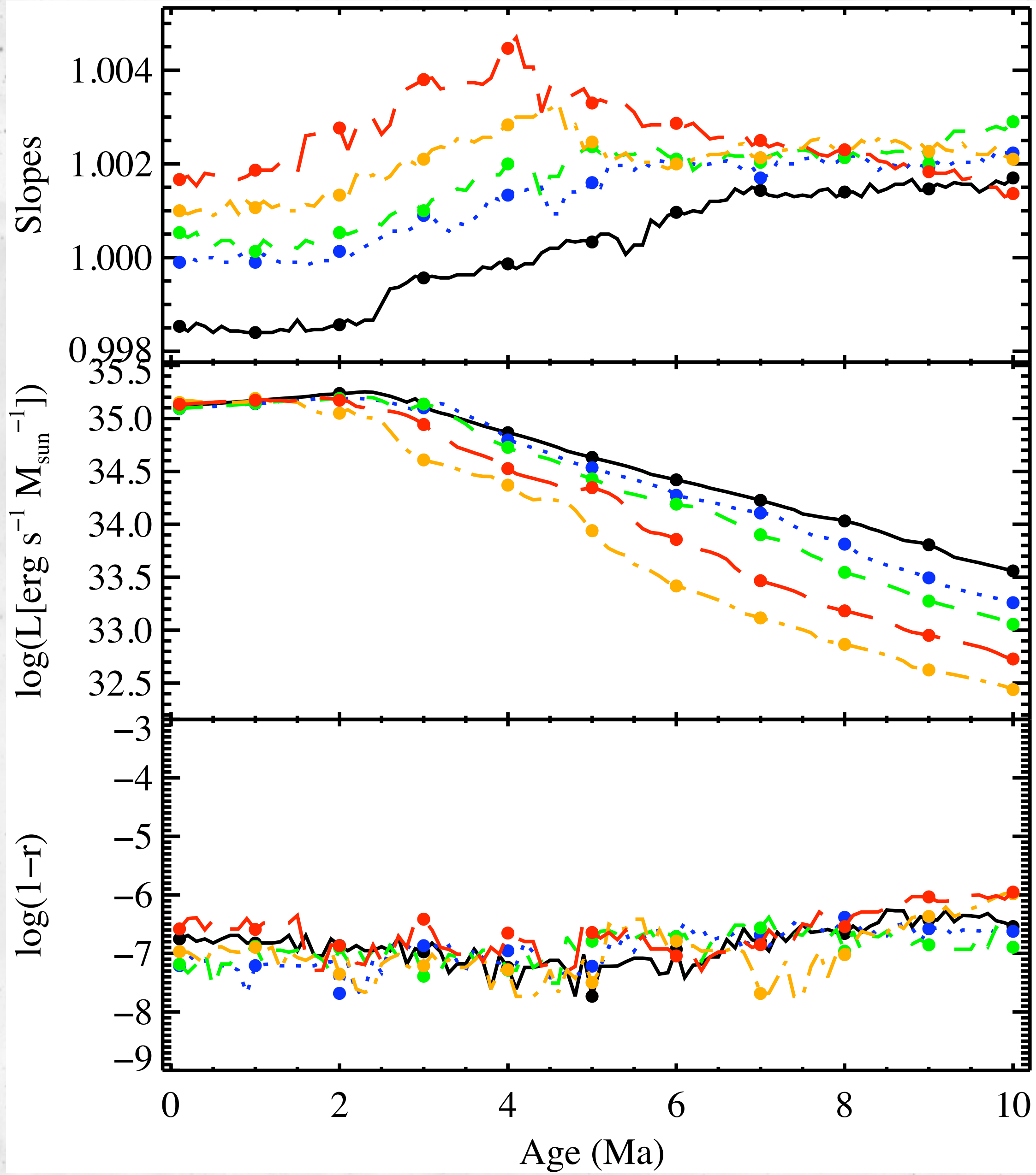


1000
100
10
1
0
2
4
6
8
10
Age (Ma)
EW(Hβ) (Å)
Z=0.001
Z=0.004
Z=0.008
Z=0.020
Z=0.040
1 M_sun
10 M_sun
10^2 M_sun
10^3 M_sun
10^3.5 M_sun
10^4 M_sun
10^4.5 M_sun
10^5 M_sun
10^5.5 M_sun
10^6 M_sun
10^6.5 M_sun
10^7 M_sun

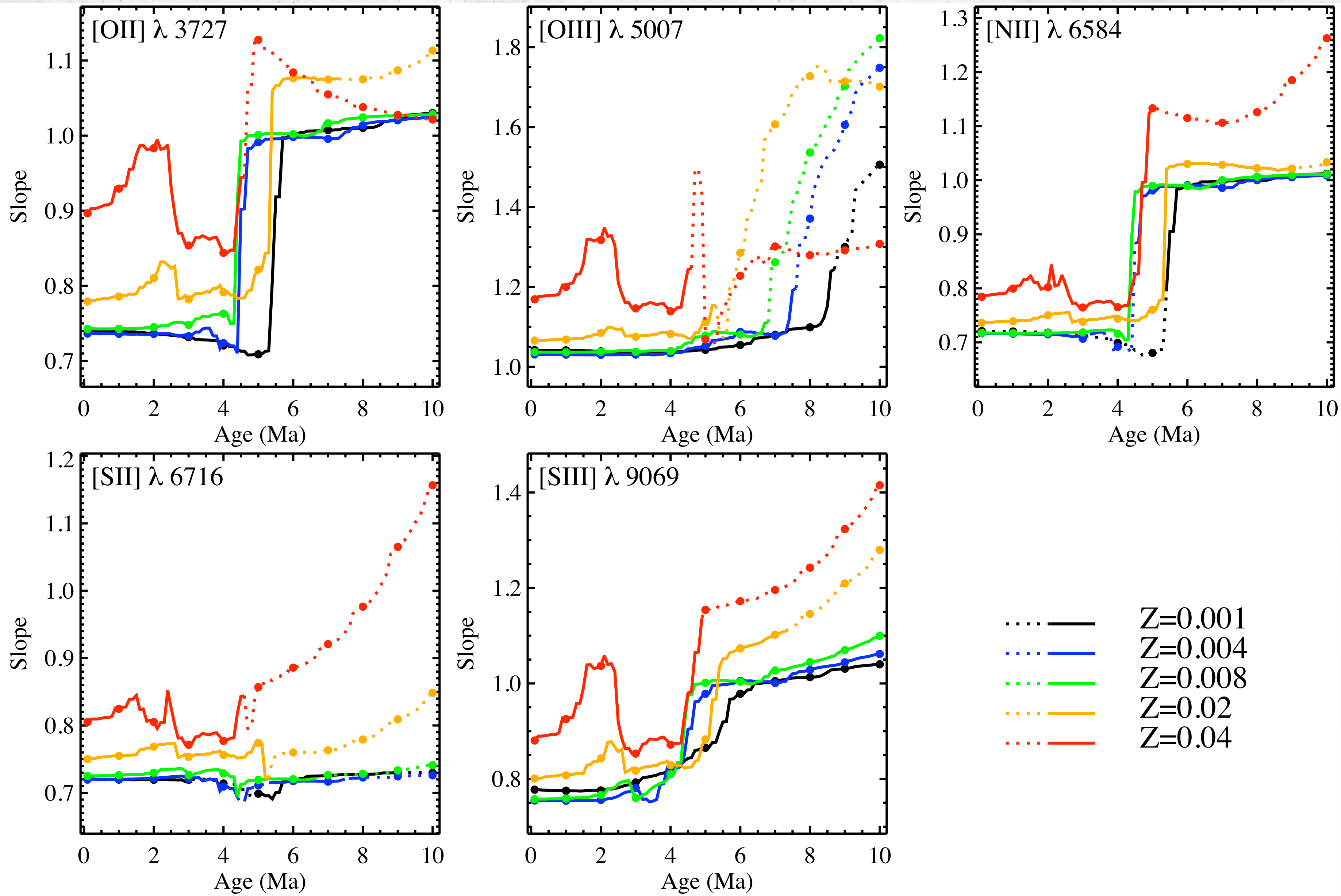
Hβ (recombination lines)

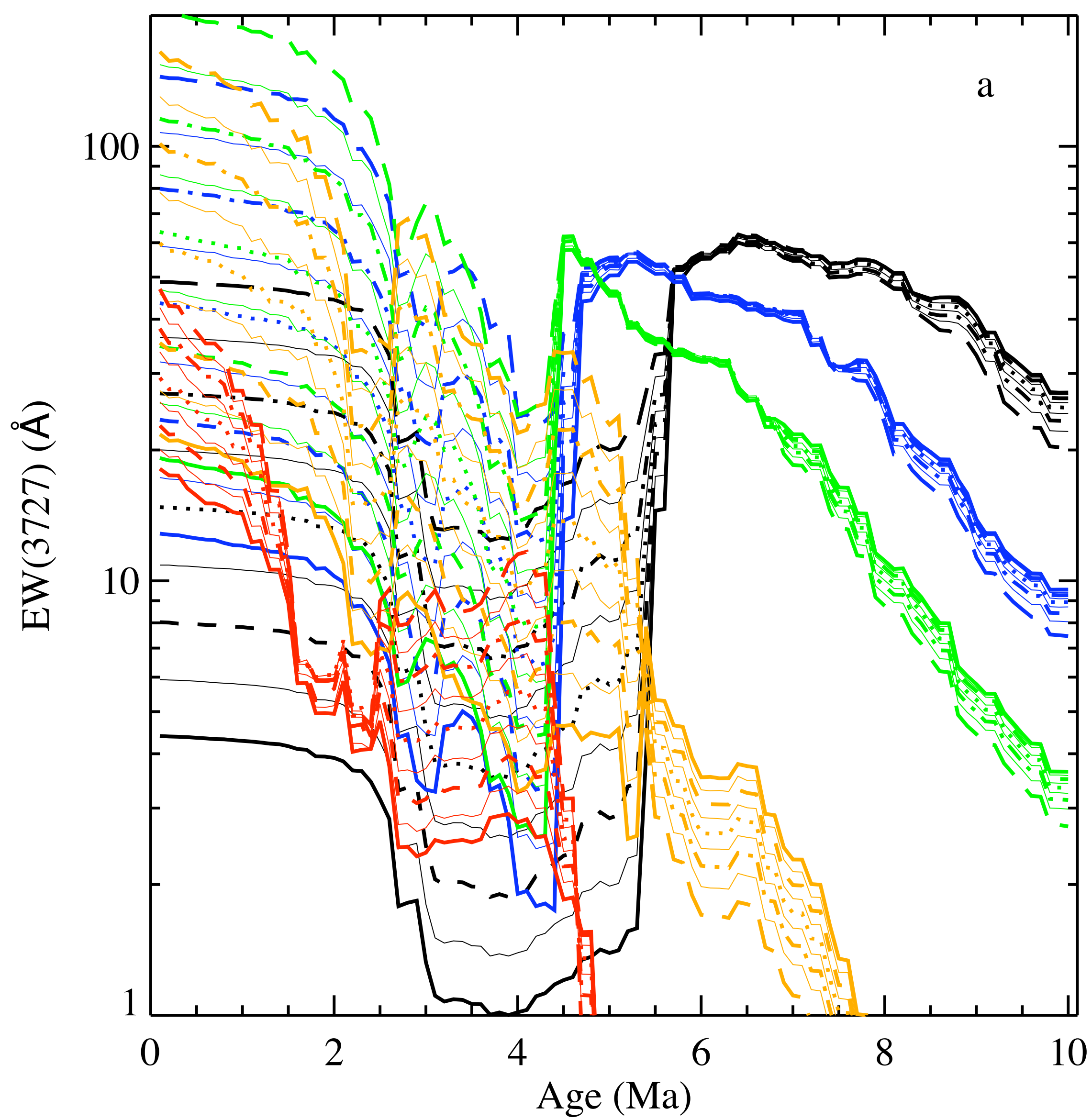
$\beta = 1$

$L(H\beta) = A \cdot M$



Collisional lines





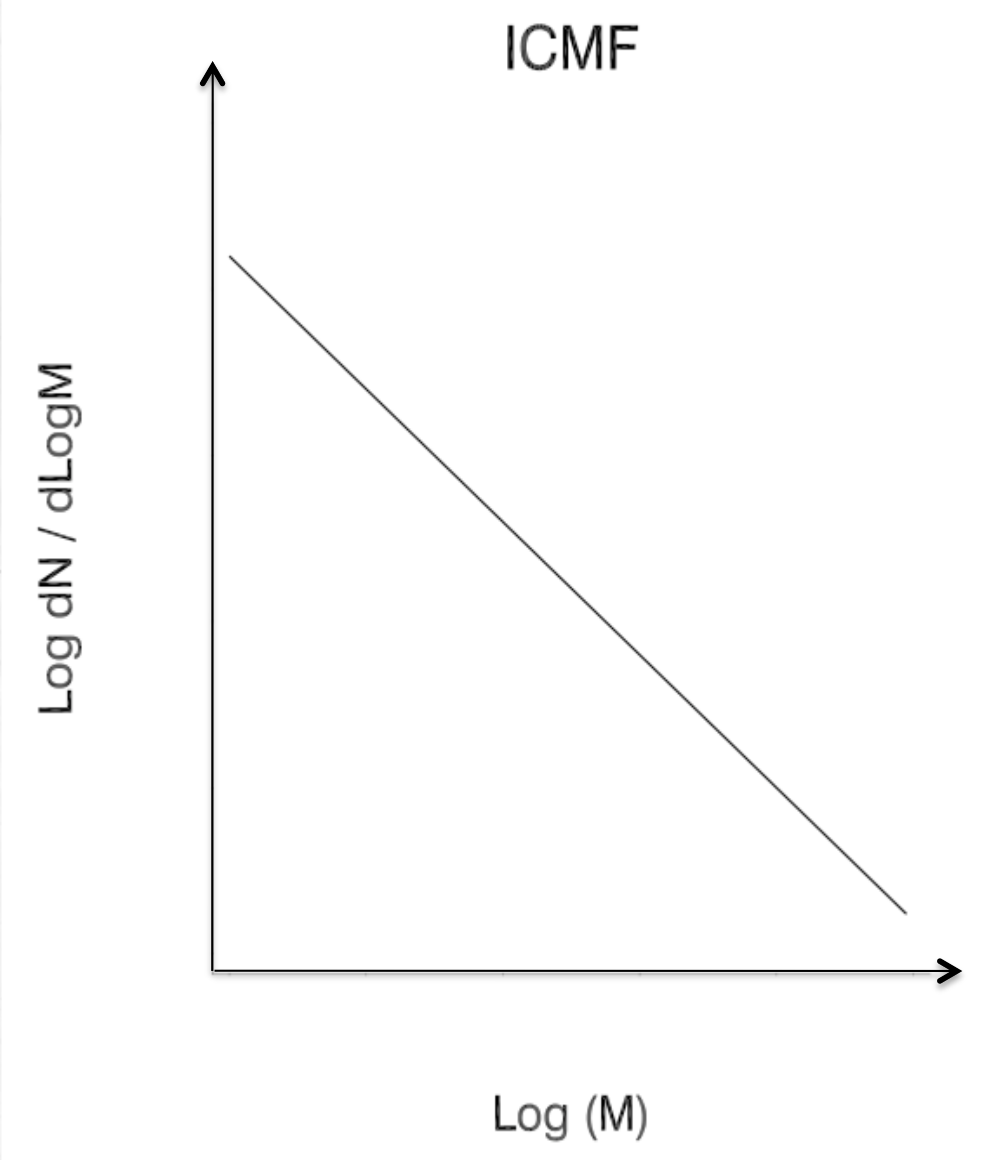
a
100
10
1
EW(3727) (Å)
0
2
4
6
8
10
Age (Ma)

Initial Cluster Mass Function

- Lada & Lada (2003)

$$\frac{dN}{dM} \propto M^{-2}$$

- Zhang & Fall (1999)
  Hunter et al. (2003)
  Dowell et al. (2008)



Low-mass cluster contribution

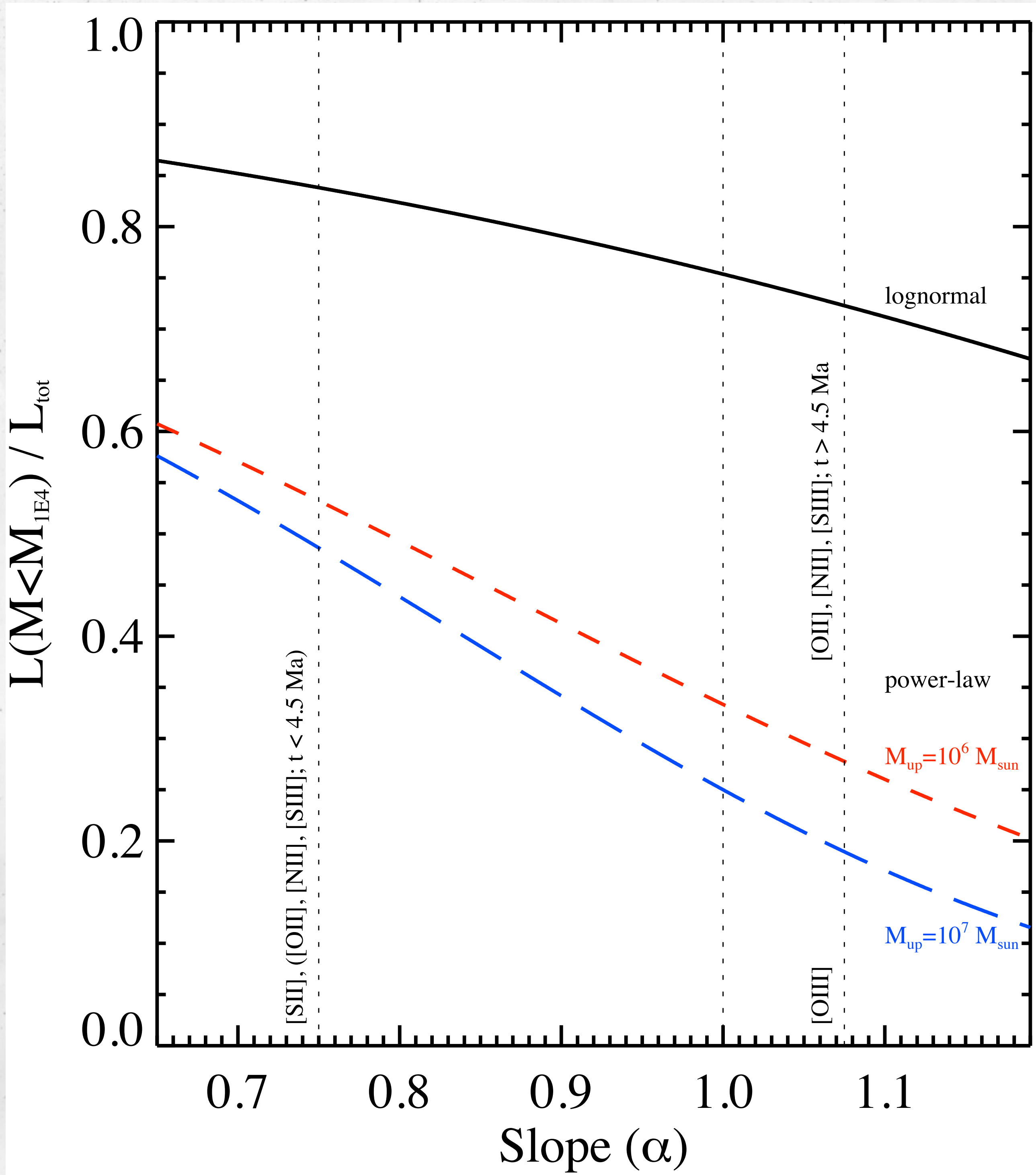
ICMF: $P(M) = C \cdot M^{-2}$

Scale relation: $L(M) = A \cdot M^{\beta}$

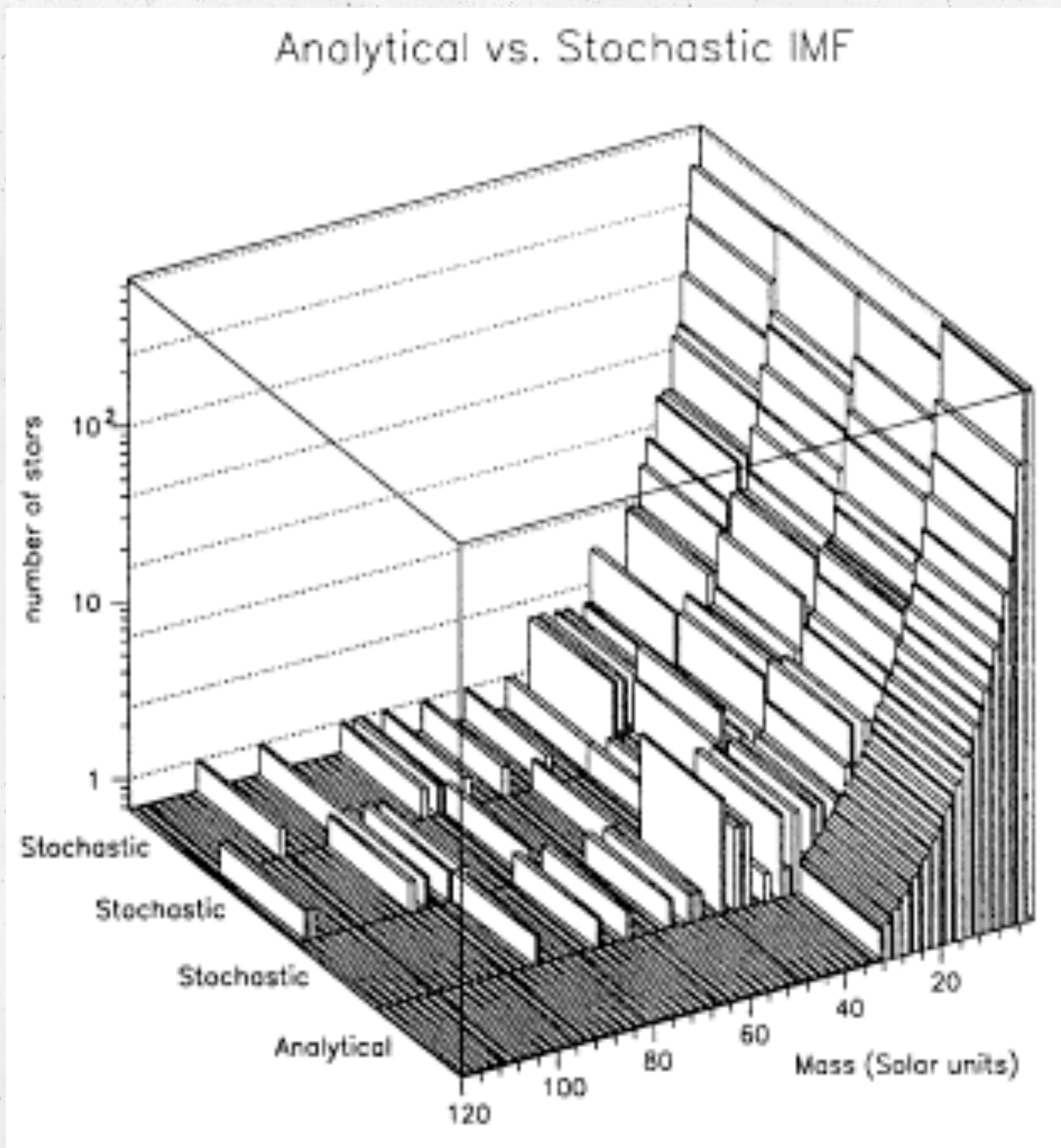
$$\int_{M_{low}}^{M_x} L(M)P(M)\mathrm{d}M = \int_{M_{low}}^{M_x} AM \cdot CM^{-2}\mathrm{d}M =$$

$$= A \cdot C(M_{low}^{\beta-1} - M_x^{\beta-1})$$

$$\frac{L(M < M_{1E4})}{L_{tot}} = \frac{M_{low}^{\beta-1} - M_{1E4}^{\beta-1}}{M_{low}^{\beta-1} - M_{up}^{\beta-1}}$$



L(M<M$_{1E4}$) / L$_{tot}$
Slope (α)
lognormal
power-law
M$_{up}$=10^6 M$_{sun}$
M$_{up}$=10^7 M$_{sun}$
[SII], ([OII], [NII], [SIII]; t < 4.5 Ma)
[OII], [NII], [SIII]; t > 4.5 Ma
[OIII]

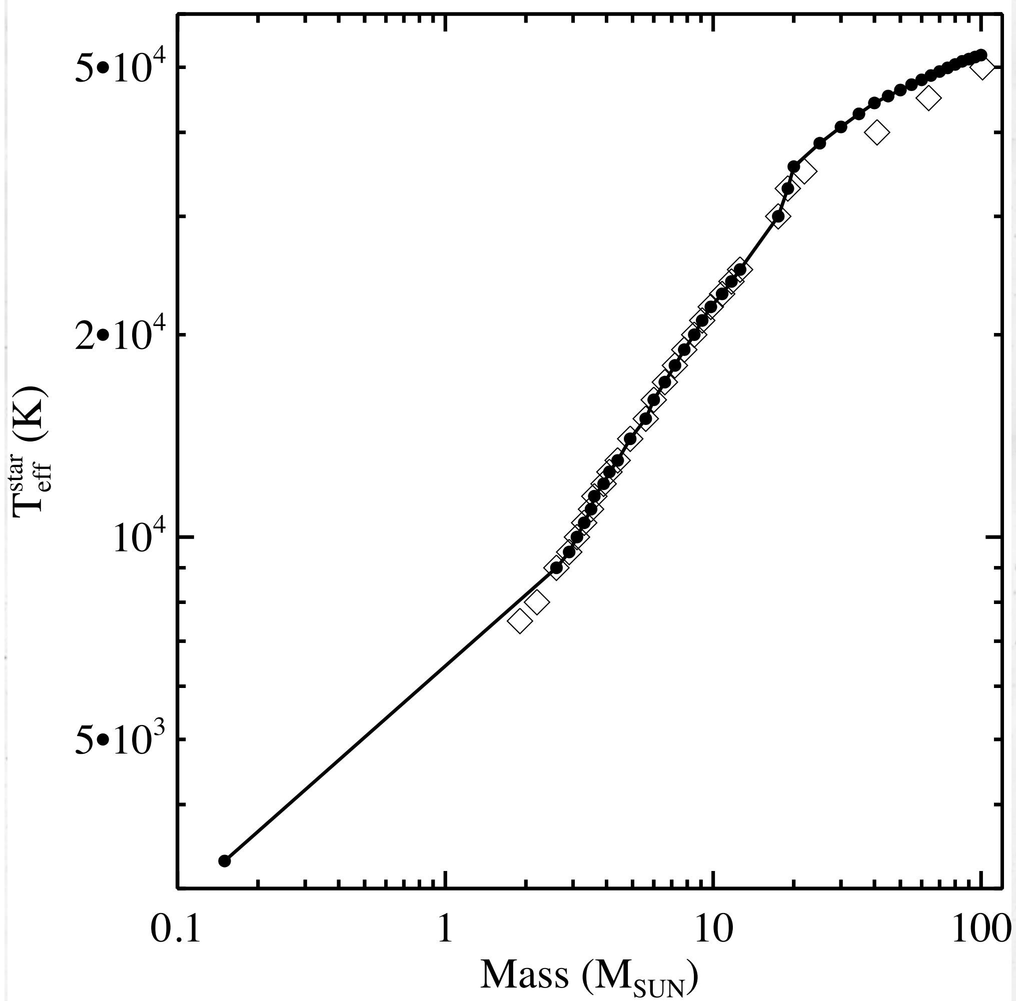


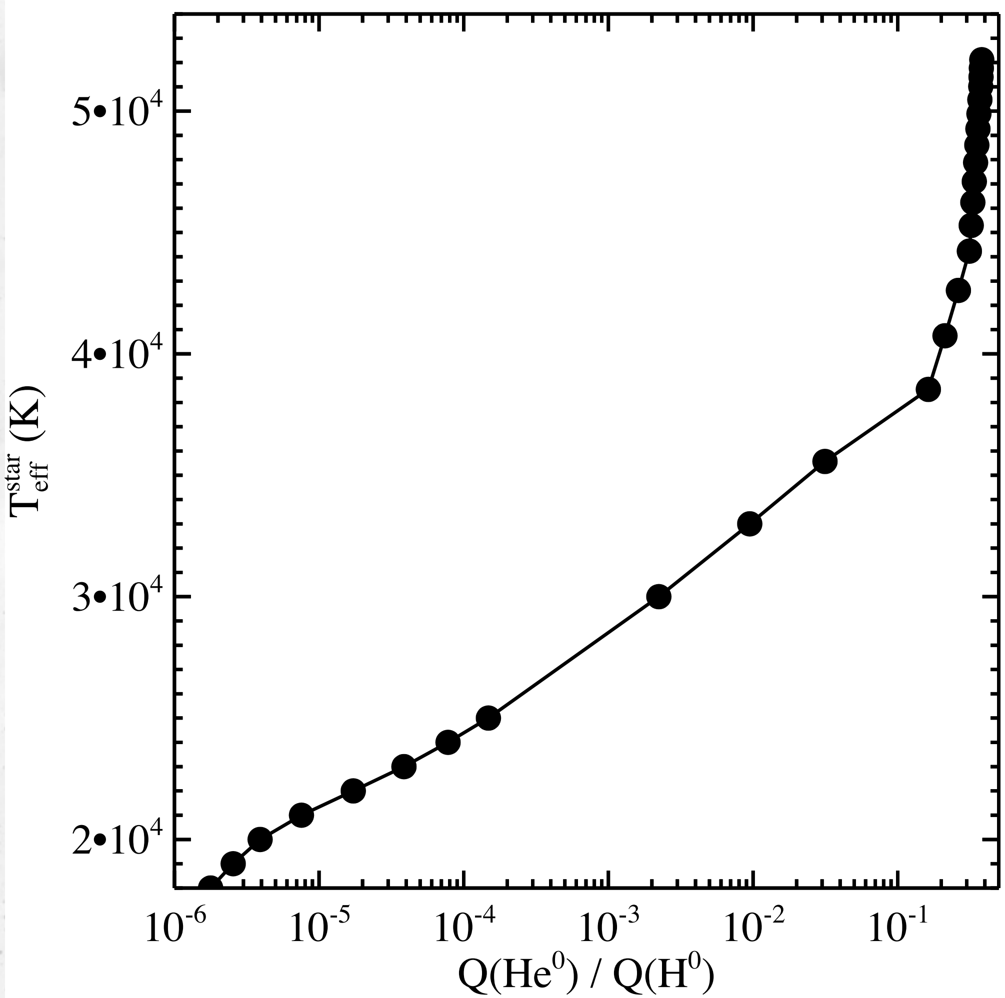
Cerviño & Mas Hesse (1994)

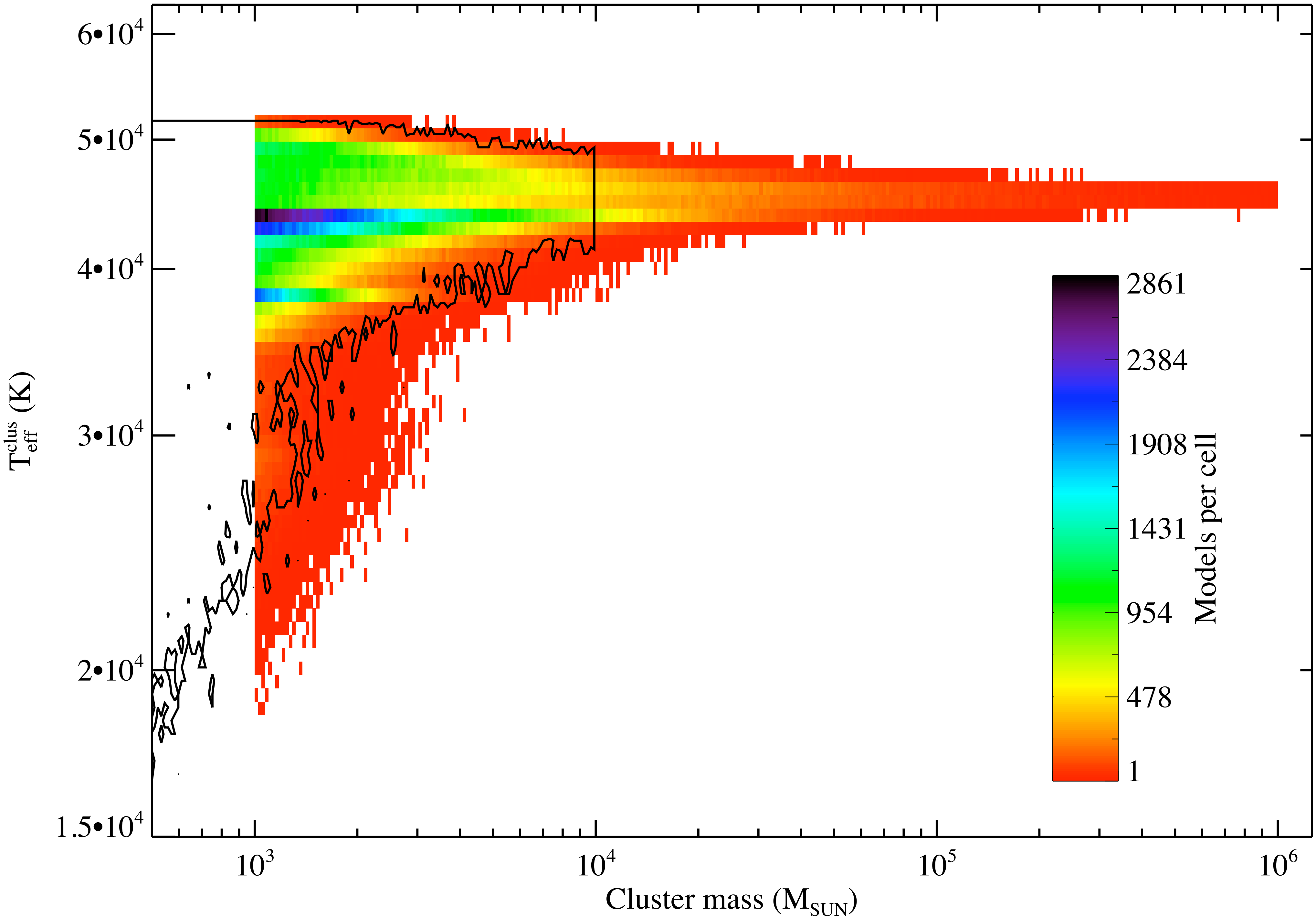
Monte Carlo simulations

- 2 million simulations:
  - Solar metallicity and ZAMS
  - Cluster masses between 20-10^4 $M_{\odot}$ (low mass set)
  - Cluster masses between 10^3-10^6 $M_{\odot}$ (high mass set)
- ICMF $\propto M^{-2}$ (Lada & Lada, 2003; Zhang & Fall, 1999; Hunter et al., 2003)
- IMF $\propto M^{-2.35}$ (Salpeter, 1955)
- Distributions of:
  - Number of stars
  - Cluster masses
  - Q(Ho)
  - Cluster Teff as a function of cluster Q(He)/Q(H)

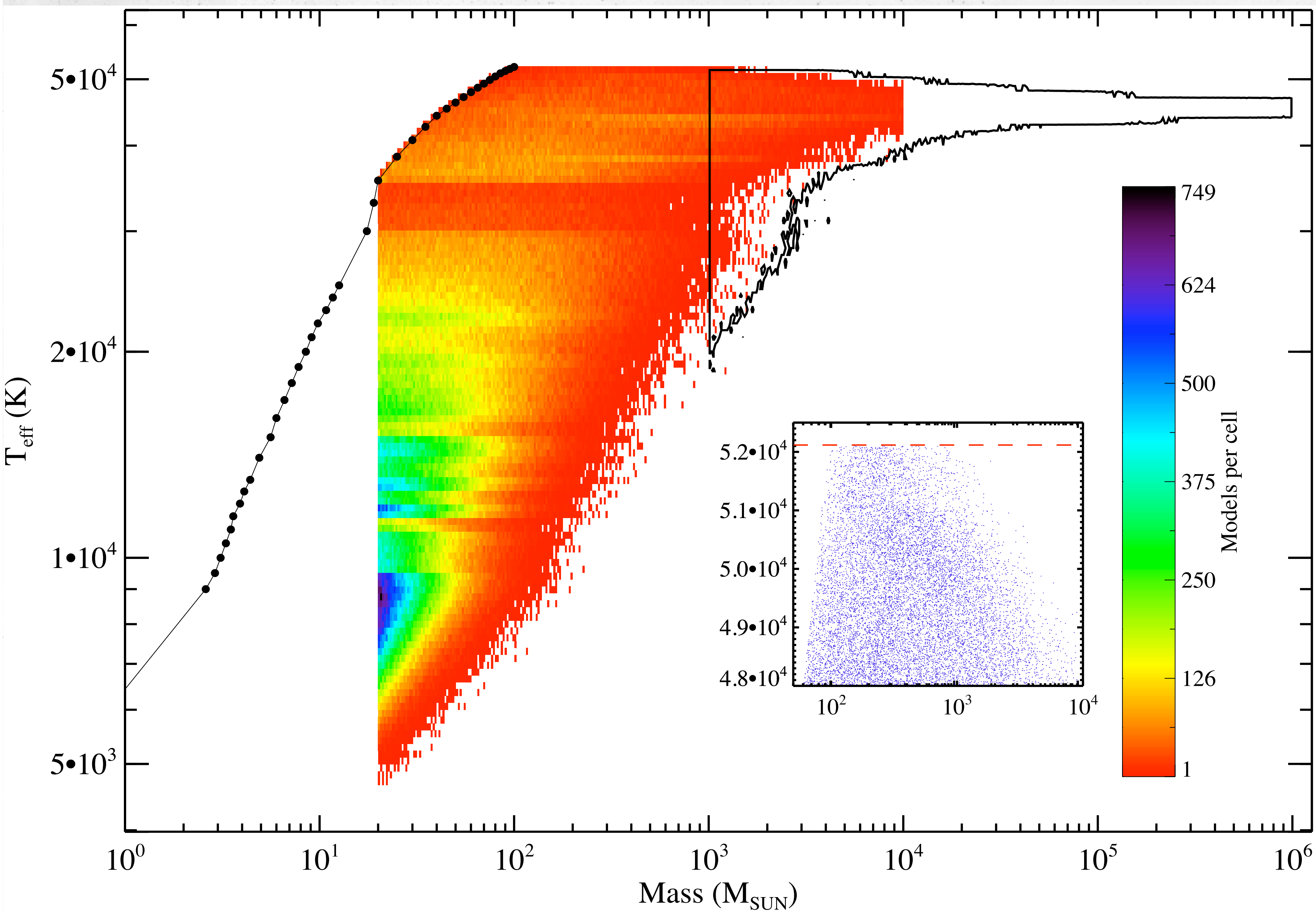
T_{eff} calibration



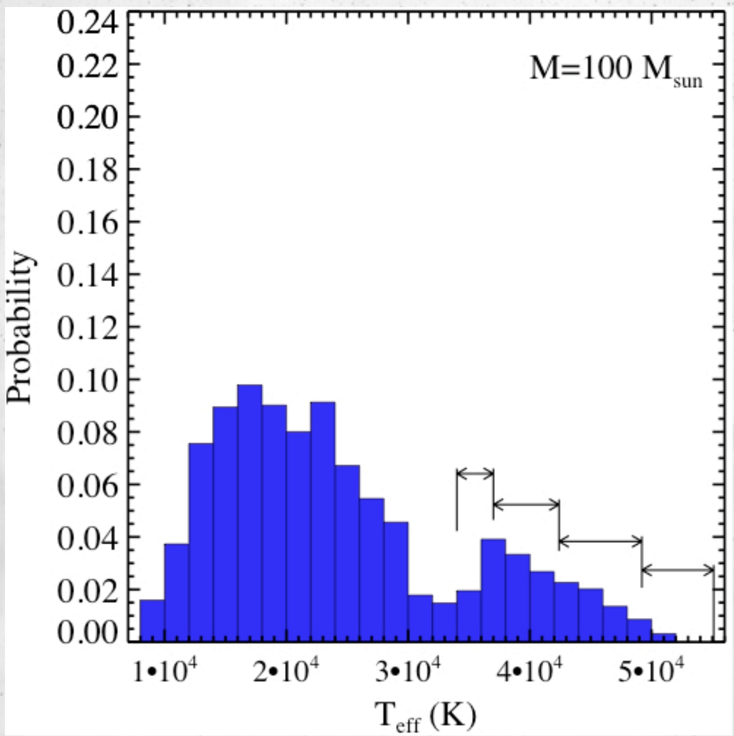


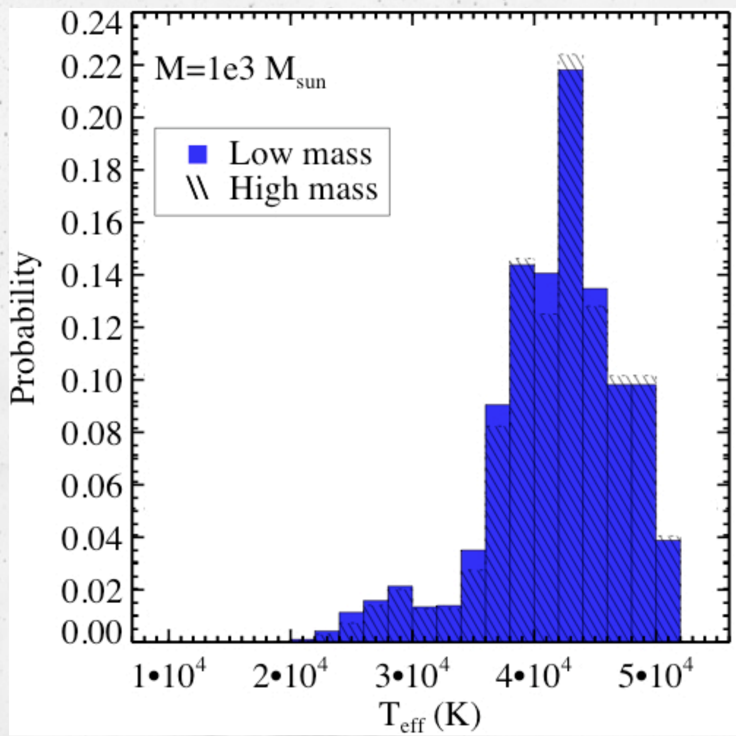


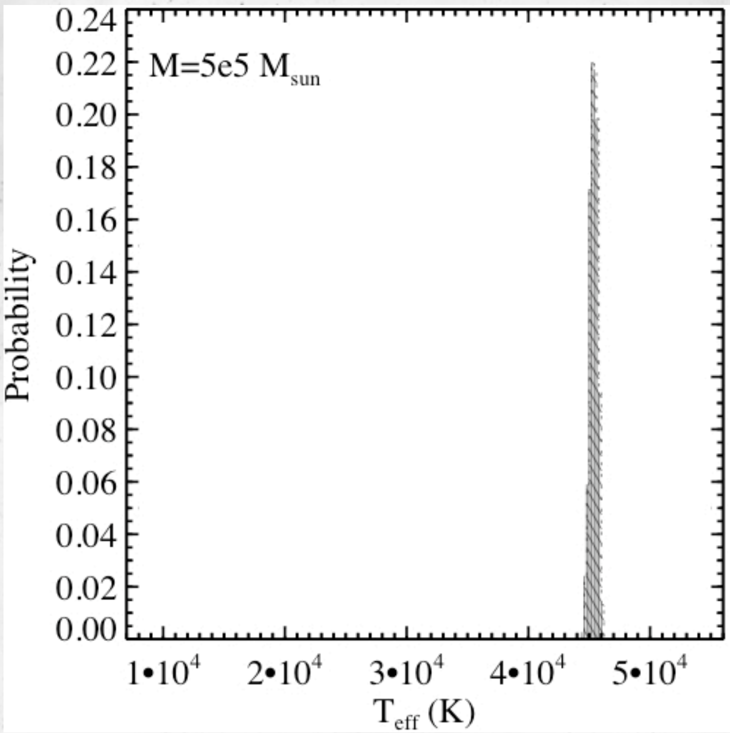
6•10^4
5•10^4
4•10^4
3•10^4
2•10^4
1.5•10^4
T_{eff}^{clus} (K)
10^3
10^4
10^5
10^6
Cluster mass (M_{SUN})
2861
2384
1908
1431
954
478
1
Models per cell



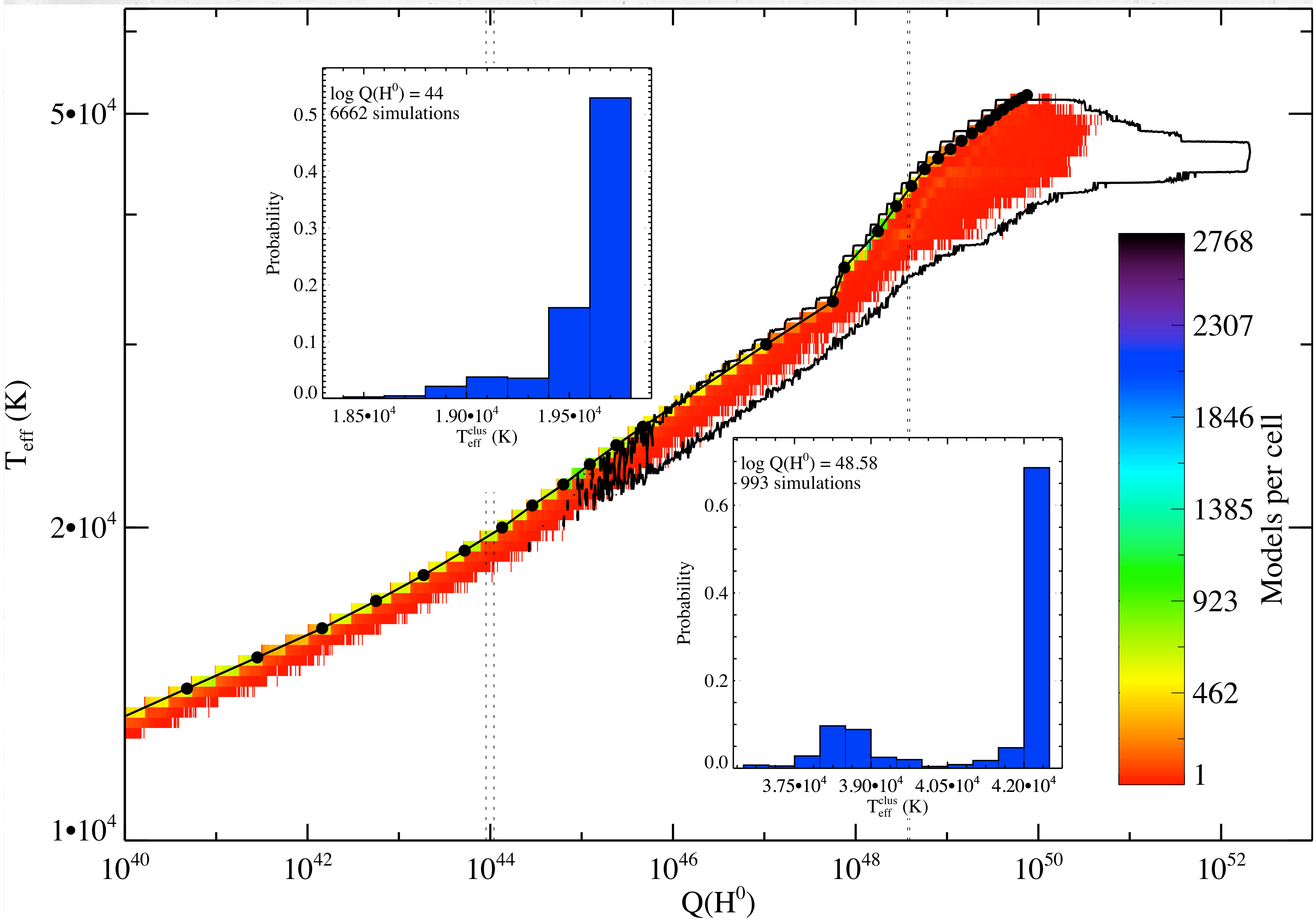
$5{\bullet}10^4$
$2{\bullet}10^4$
$1{\bullet}10^4$
$5{\bullet}10^3$
T_{eff} (K)
10^0
10^1
10^2
10^3
10^4
10^5
10^6
Mass (M_{SUN})
$5.2{\bullet}10^4$
$5.1{\bullet}10^4$
$5.0{\bullet}10^4$
$4.9{\bullet}10^4$
$4.8{\bullet}10^4$
749
624
500
375
250
126
1
Models per cell







80 % of 100 $M_{\odot}$ clusters do not generate HII regions.



log Q(H^0) = 44
6662 simulations
Probability
T_{eff}^{clus} (K)
log Q(H^0) = 48.58
993 simulations
Probability
T_{eff}^{clus} (K)
T_{eff} (K)
$Q(H^0)$
Models per cell
2768
2307
1846
1385
923
462
1

Conclusions

- Different lines have different contributions from different HII region.
- To study low-mass cluster contribution, sampling effects must be taken into account.
- Only 20% of clusters with M~100 $M_{\odot}$ can generate an HII region.
- Strong correlation between $Q(H^0)$ and T_{eff} for $M < 10^4$ $M_{\odot}$.
- $M < 10^4$ $M_{\odot}$ better represented by a single star.
- Low-mass clusters are suitable for hot-star atmospheres studies.


THANK YOU