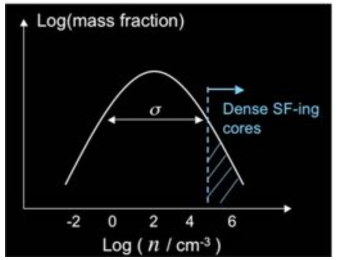
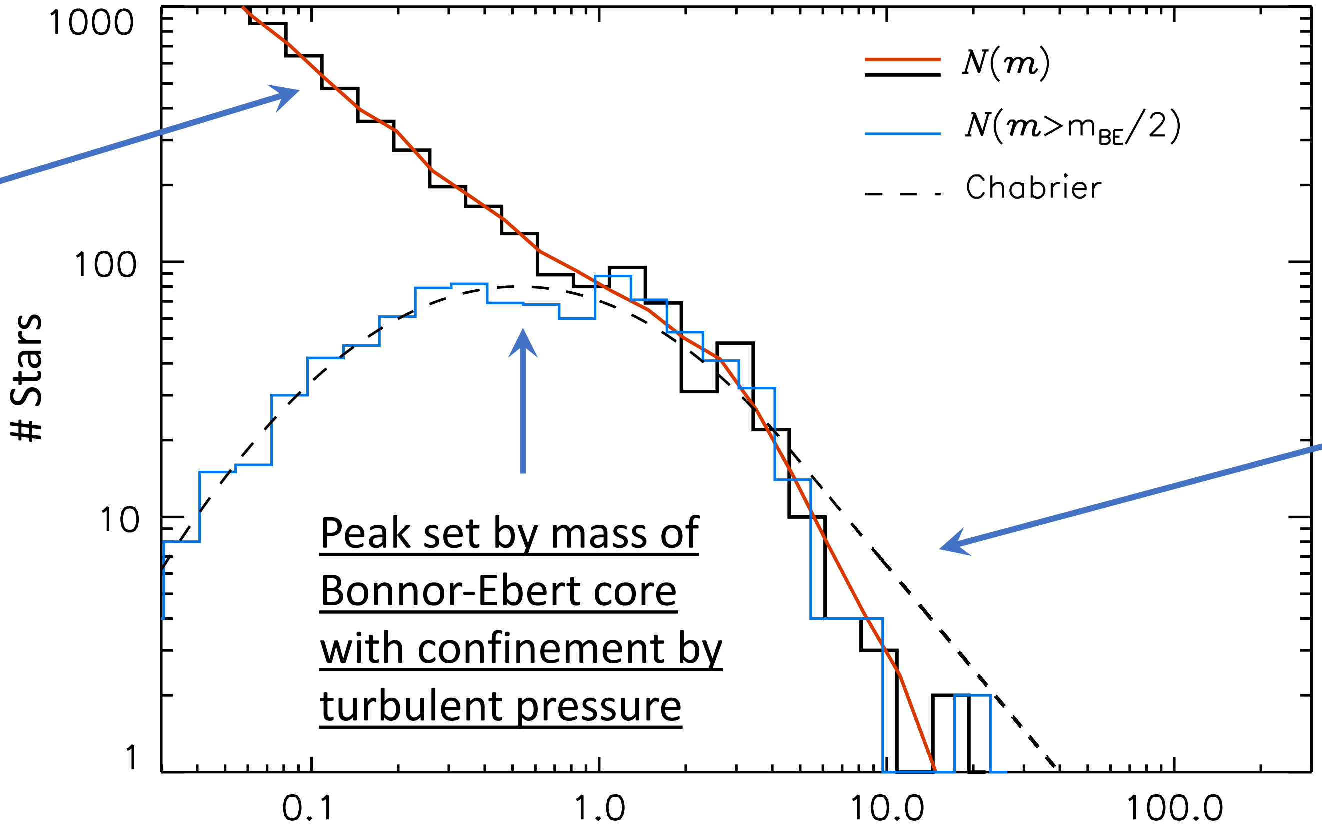
Variations of the IMF through environment

- Investigate the emergence of the IMF using high-resolution models of a piece of a molecular cloud
- Test predictions from turbulent fragmentation

- Only cores with high density unstable
- Turnover connected to distribution of dense gas





- All cores unstable
- IMF follows CMF
- Powerlaw from turbulence

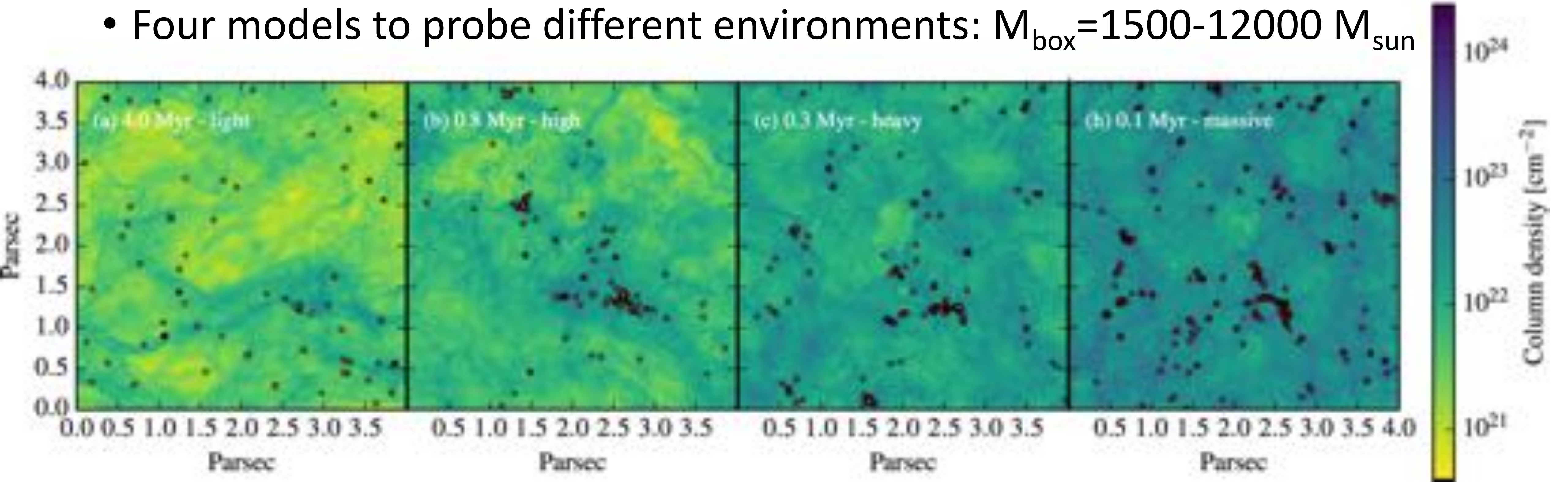
Haugbølle, Padoan, Nordlund (2018)

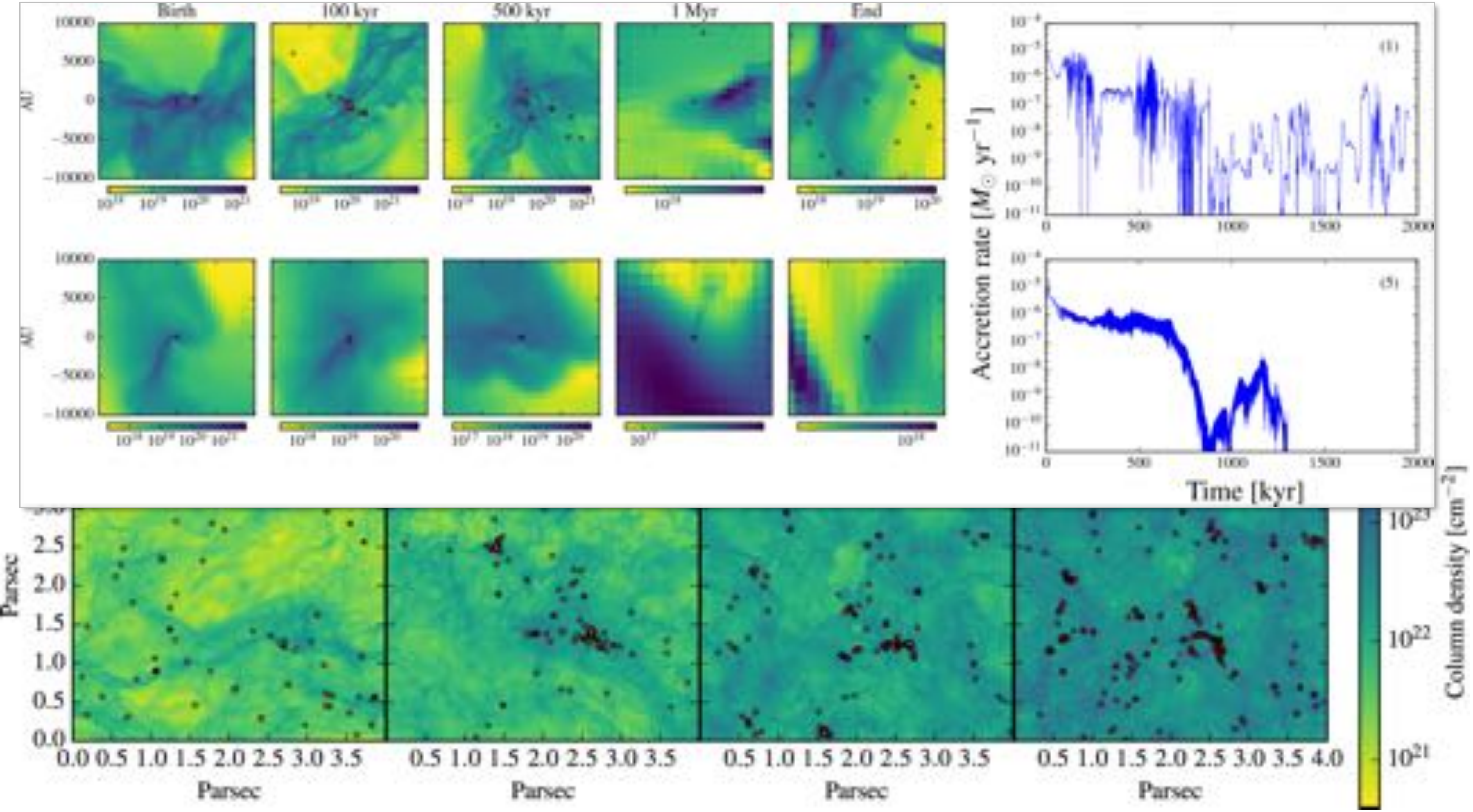
Numerical model

- RAMSES with essential ingredients

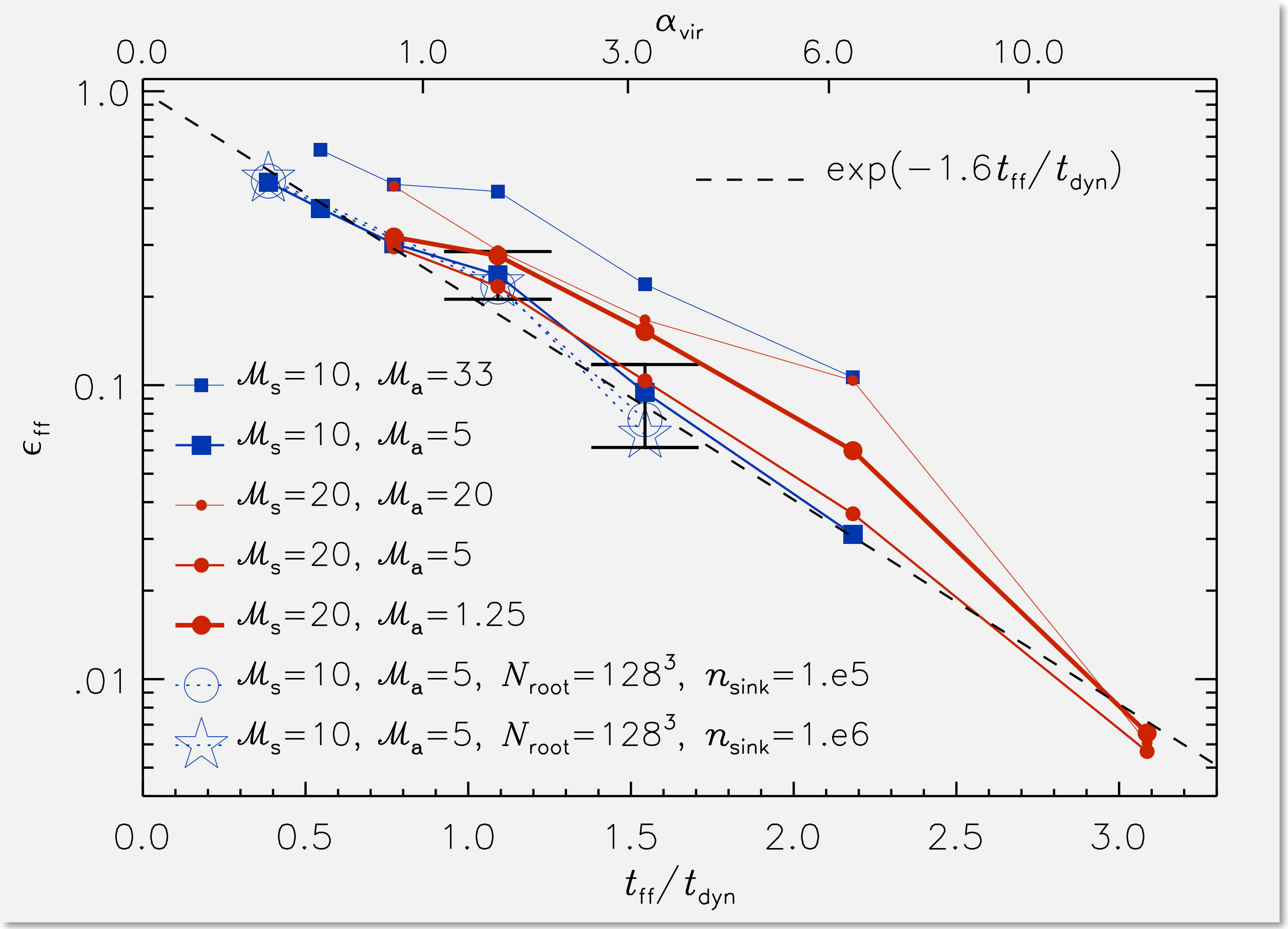
  Turbulence + Gravity + Magnetic Fields

- Resolution: 4 parsec → 50 AU. Extensive convergence study.
- Four models to probe different environments: M_{box}=1500-12000 M_{sun}




Birth
100 kyr
500 kyr
1 Myr
End
AU
Accretion rate [$M_\odot$ yr^{-1}]
(1)
(5)
Time [kyr]
Parsec
Column density [cm^{-2}]

Virial parameter regulates evolution

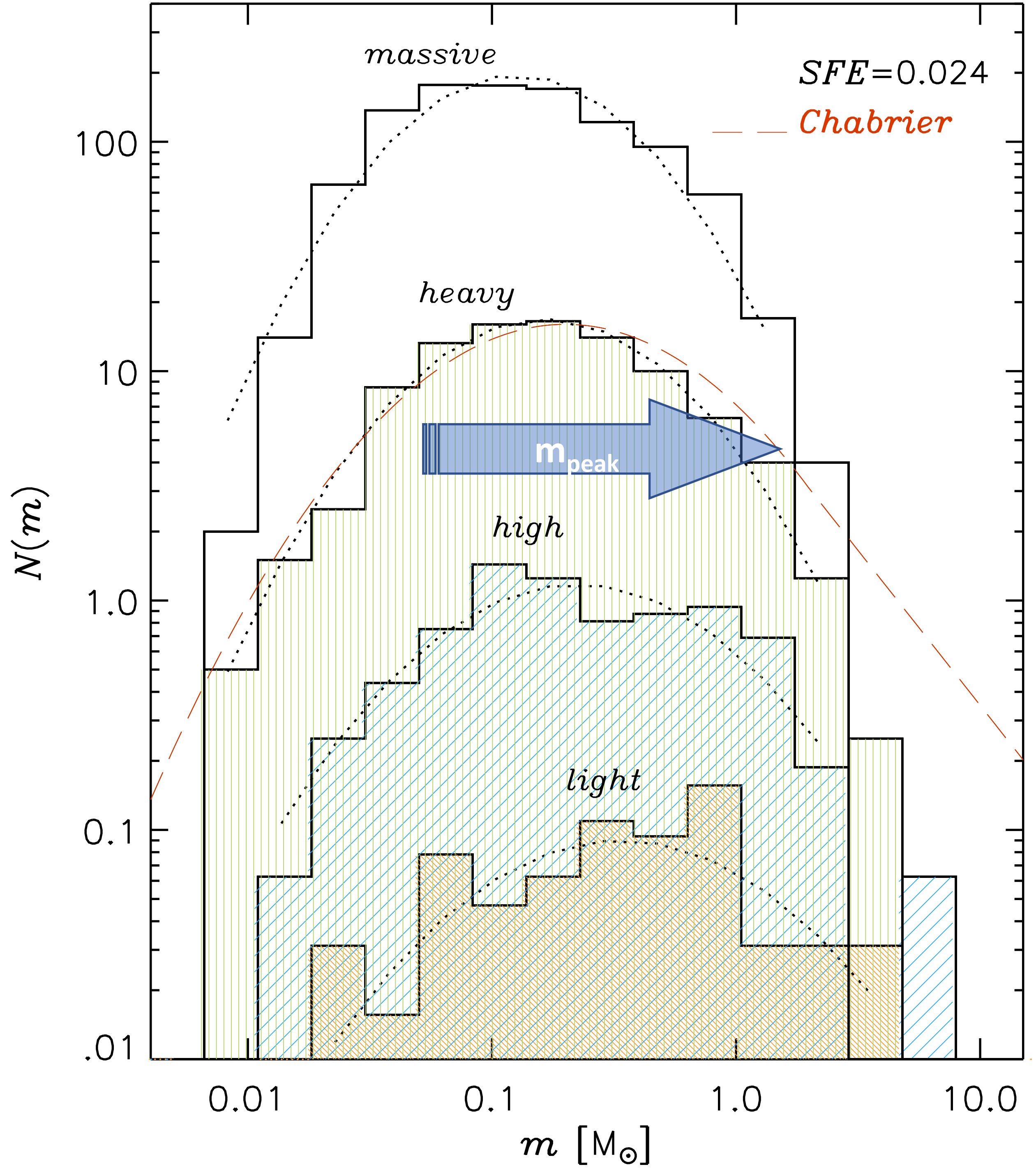


$$\alpha_{vir} = \frac{2E_{kin}}{E_{grav}}$$

$SFR_{ff} \approx ½ \exp(-1.38\ \alpha_{vir}^{½})$

α_{vir} = 0.21, 0.42, 0.83, 1.67

Padoan+2011, Padoan+2012, Federrath+2012. See also Poster P7



Variation of IMF with environment

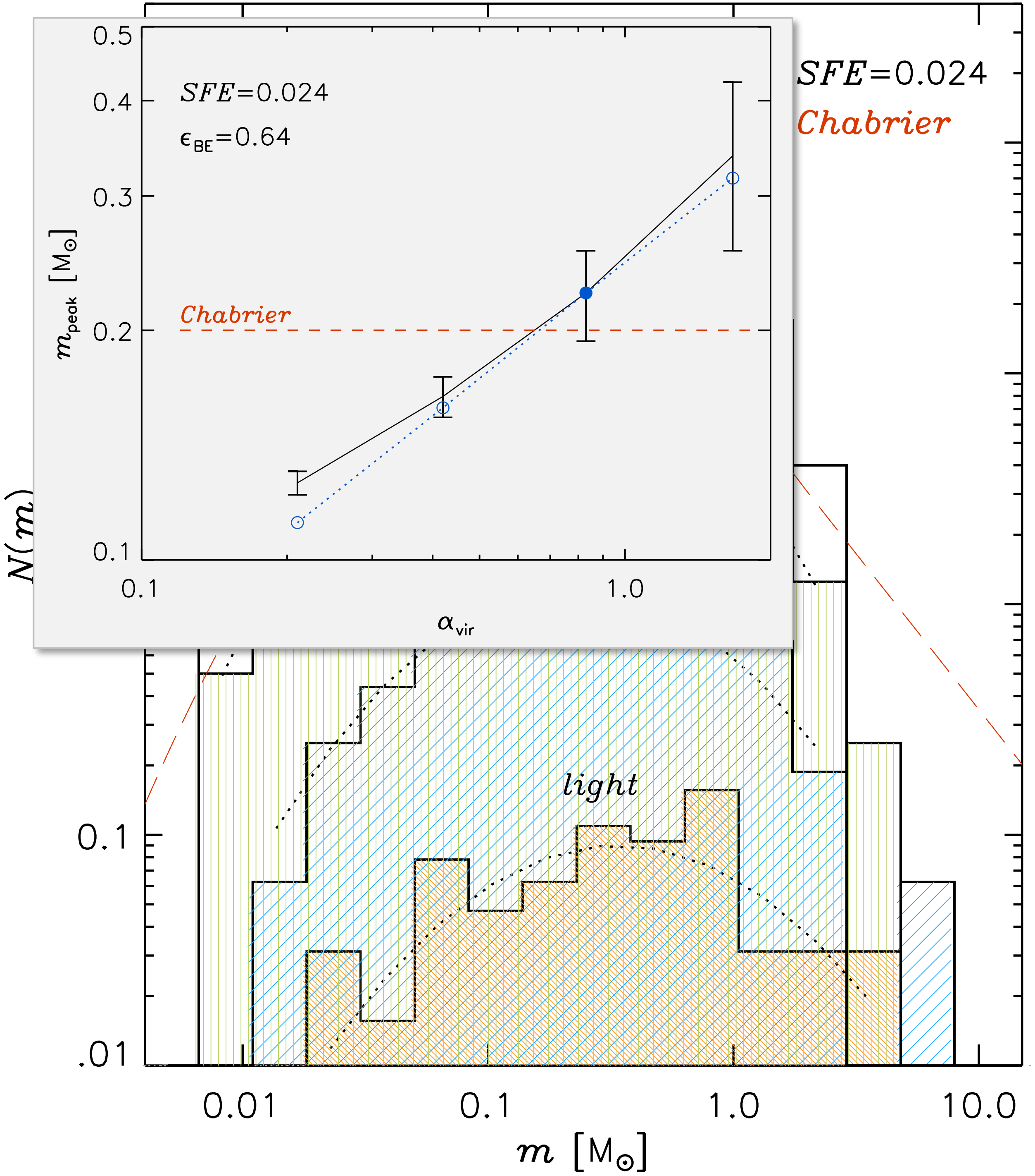
Assumption: cores are confined by turbulent pressure

$$m_{\rm peak} \equiv \epsilon_{\rm BE}\, M_{\rm BE,t}$$

$$M_{\rm BE,t} \approx \frac{1.182\,\sigma_{\rm th}^4}{G^{3/2} P_0^{1/2}}$$

This gives

$$m_{\rm peak} \approx 1.124\, M_{\rm tot} \mathcal{M}_{\rm s}{}^{-4} \alpha_{\rm vir}^{3/2},$$



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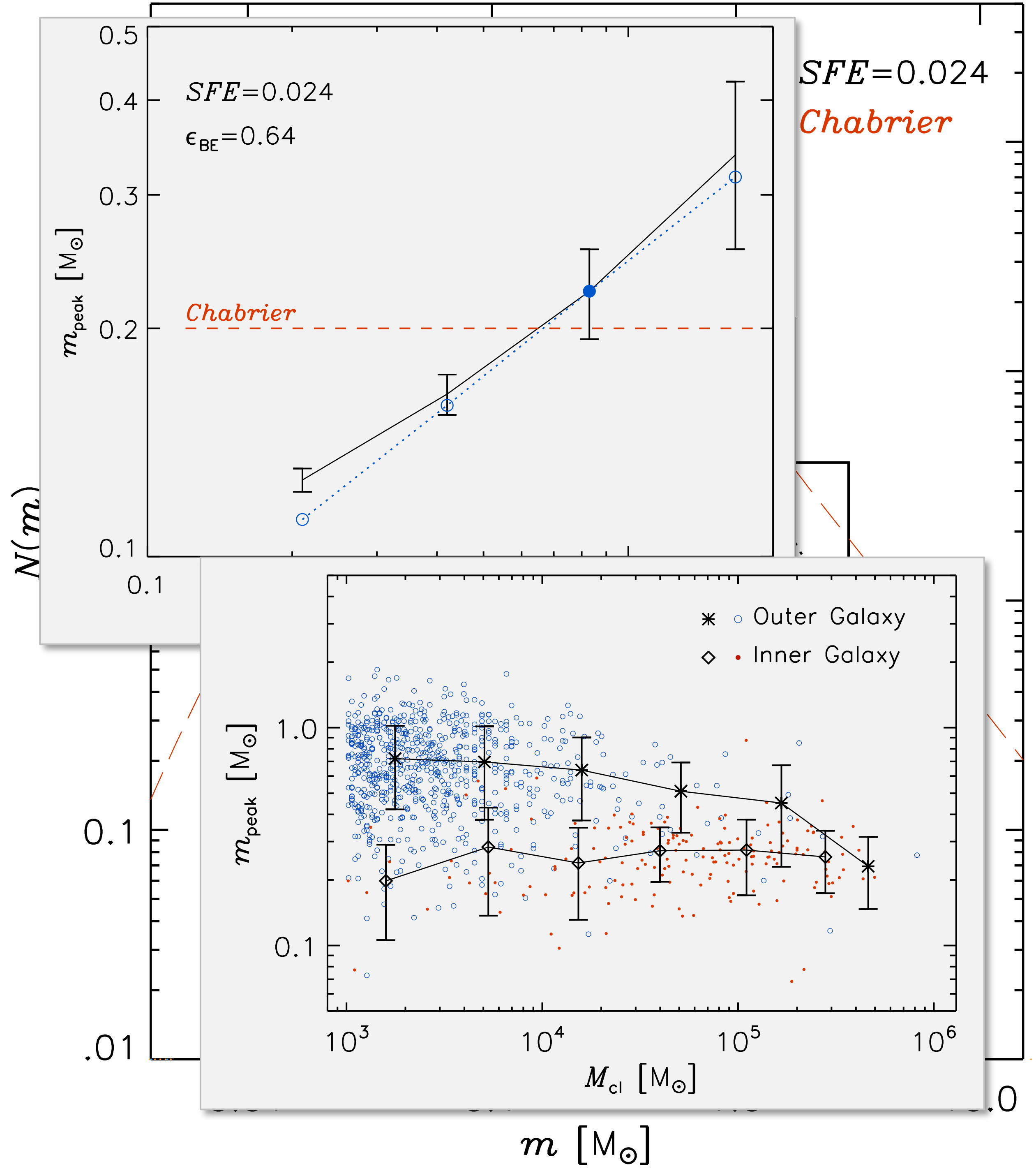

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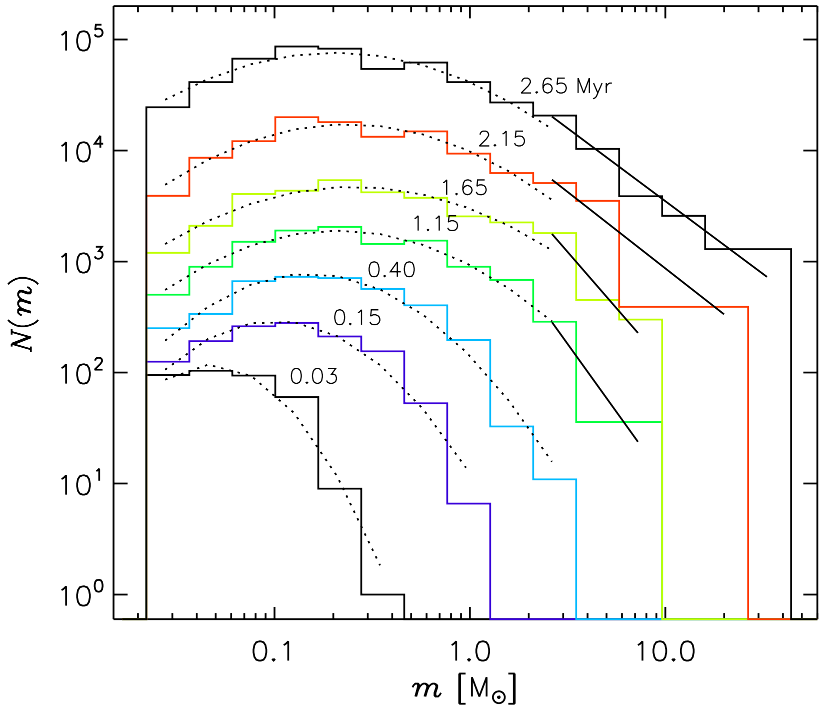
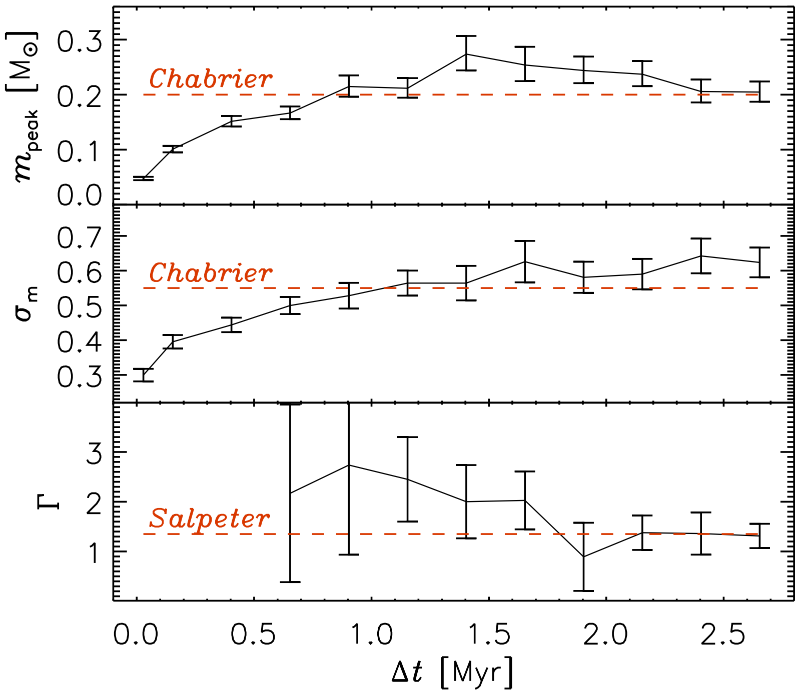
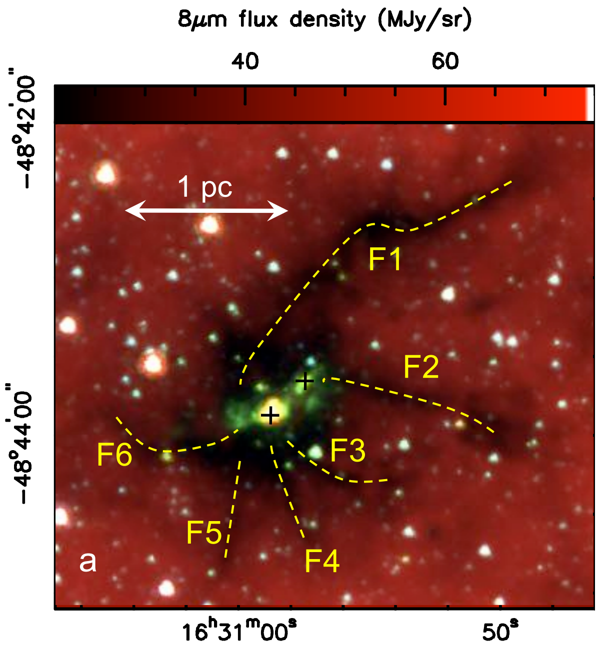
Notice that $M_{tot}\ \mathcal{M}_s^{-4}$ ≈ constant if on Larson relations.

Time Evolution of IMF and Growth of Stellar Mass





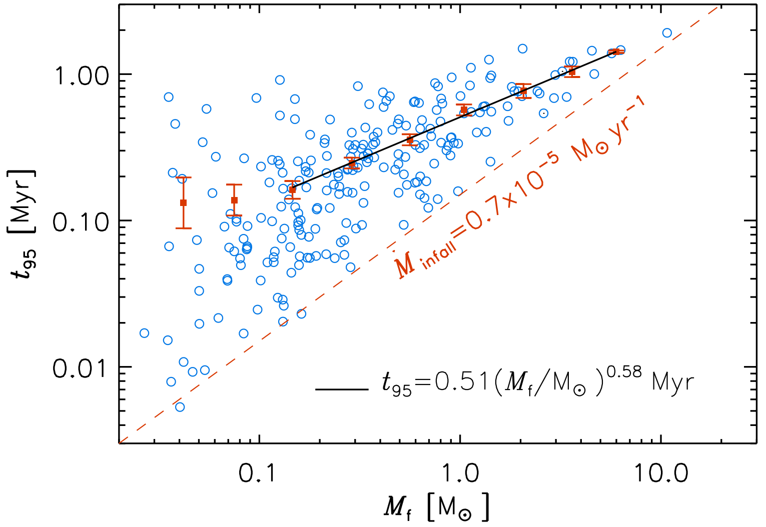


Perrotto+ 2013

It takes time for a star to form:

- Massive stars do not form through massive cores
- Massive stars are not due to competitive accretion

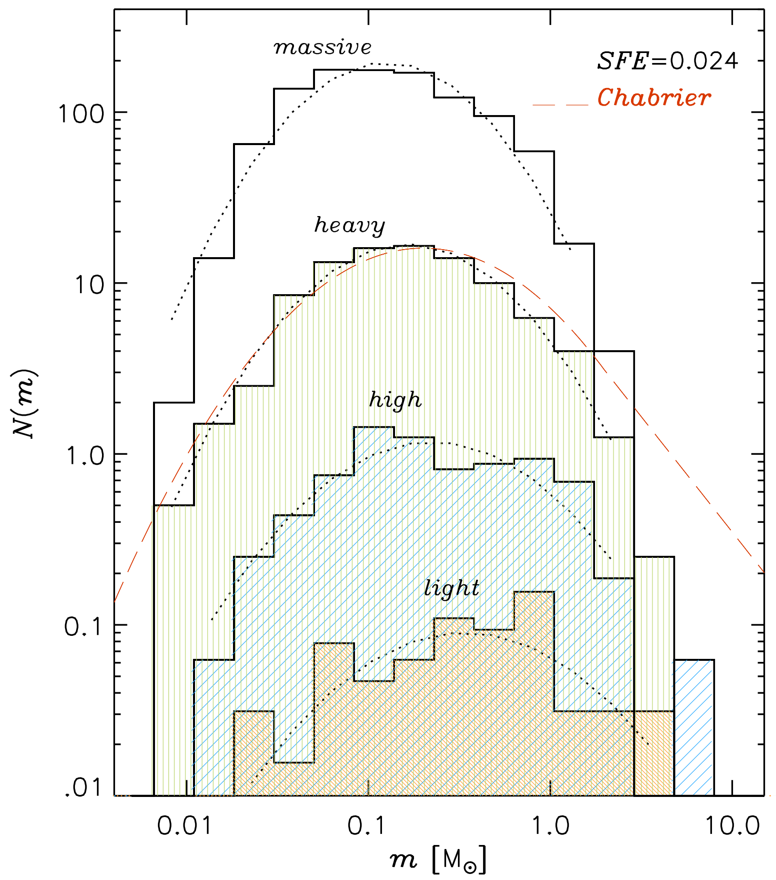
Rather we find that matter is fall in through inertial flows and there is a maximum accretion rate that can be sustained – *<u>see poster P30 and talk by Padoan</u>*



<u>Consequence: the IMF only emerges after ≈1.5 – 2 Myr</u>

Discussion points

- We find numerical evidence that the IMF is not universal, but depends on environment.
- The environmental dependence of the peak can be understood in the framework of turbulent fragmentation → there is a "simple" connection between cores and low-mass stars?
- Can we observe the time-dependence of the IMF; what does it tell us about accretion time-scales?
- Extreme star formation regions may be an interesting window to test our theories for the IMF. But important locally driven feedback (radiation, outflow) may limit applicability.



Numerical Convergence

- Non-trivial to reach convergence – high resolution needed
- In addition, multiple systems will show up with increasing resolution
- Convergence debated! Guszejnov+ 2018, Lee & Hennebelle 2018a,b, suggest continous fragmentation, BUT only include HD
- B-field regulating small fragments by ”non-thermal” pressure floor?