Accretion and Formation of Nascent Solar Systems

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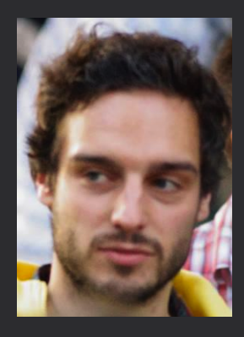


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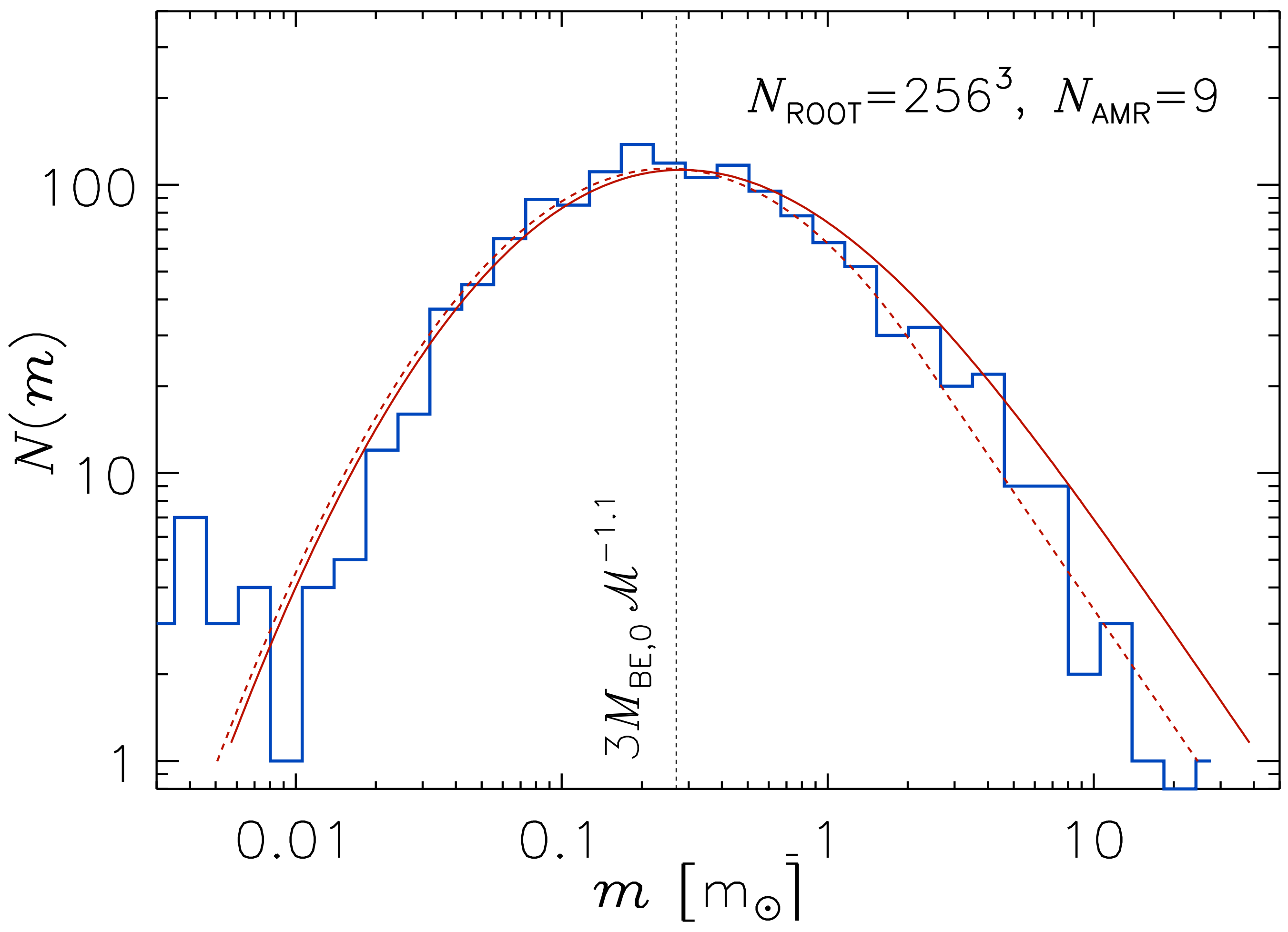
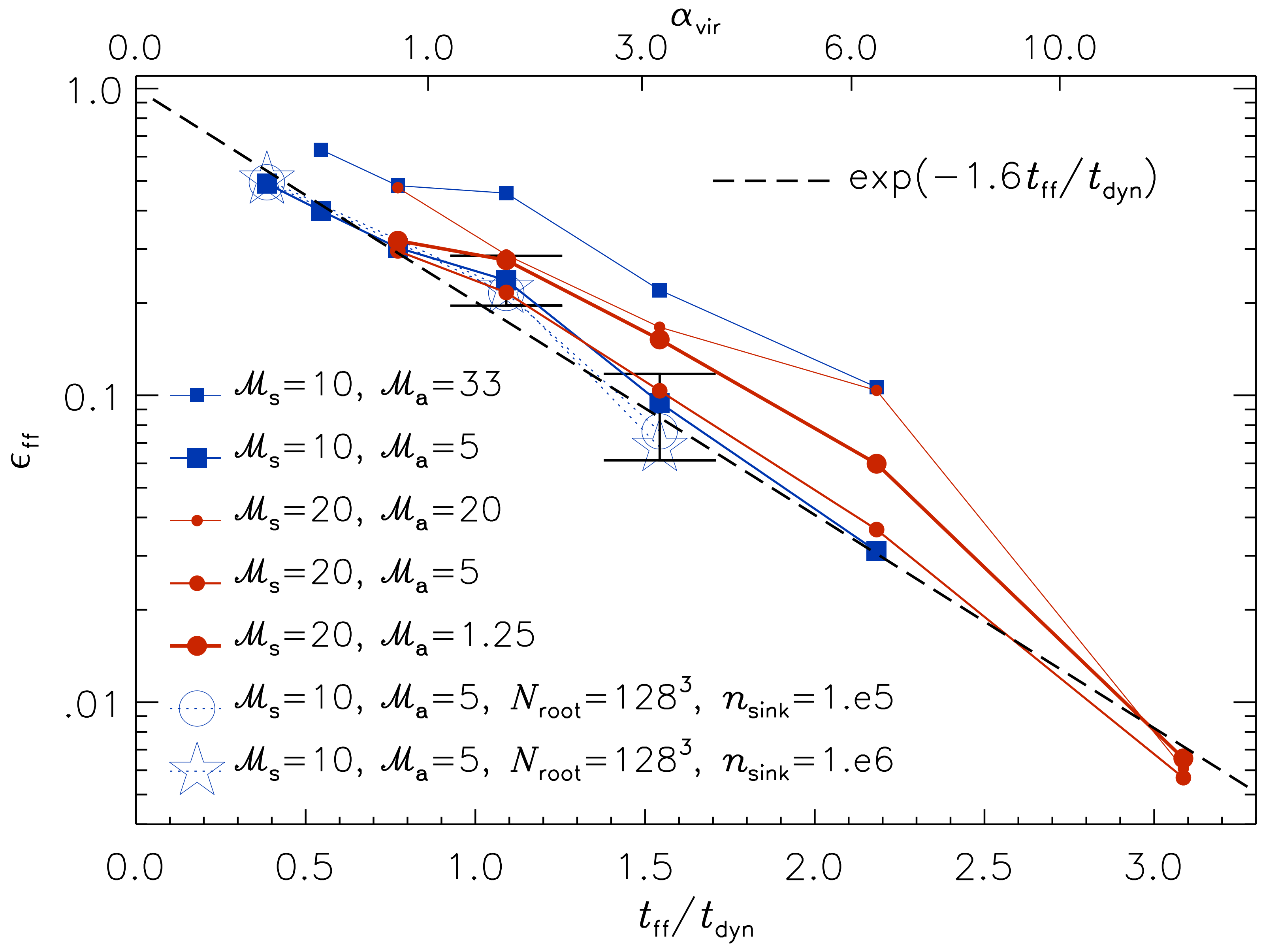
Introduction

Traditionally, models of protostellar systems have considered star formation isolated to an envelope or a cloud core. Using a locally optimized AMR code we can now simultaneously resolve molecular clouds and protostellar disks, and address the formation and evolution of protostellar systems from parsec to sub-AU scale.



Initial Mass Function

The number of new born stars as a function of mass is observationally found to be universal. For the first time (left panel) we find a numerically converged IMF from brown dwarfs to massive stars, and the models can be compared with confidence to observations.



Star Formation Rate

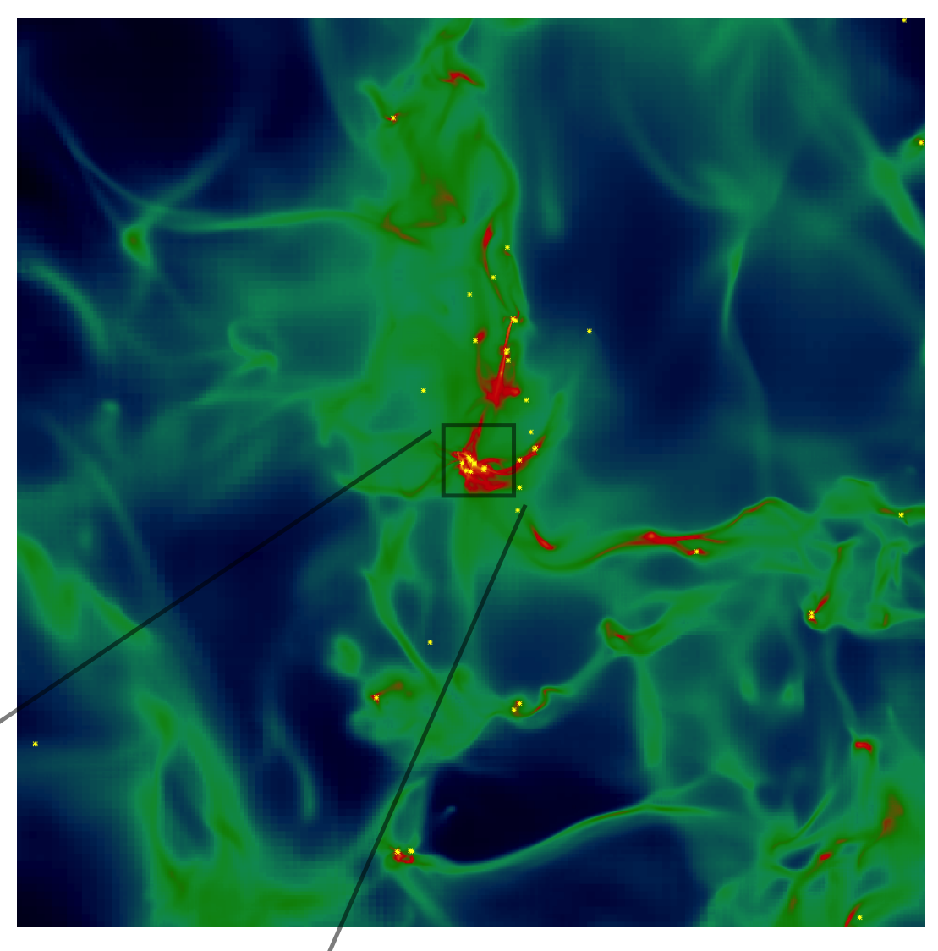
The SFR can be expressed as an efficiency factor: $\dot{\rho}_{\rm stars} = \varepsilon_{\rm ff}\, \rho_{\rm stars} / t_{\rm ff}$, where $t_{\rm ff}=(3\pi/32G\rho)^{1/2}$

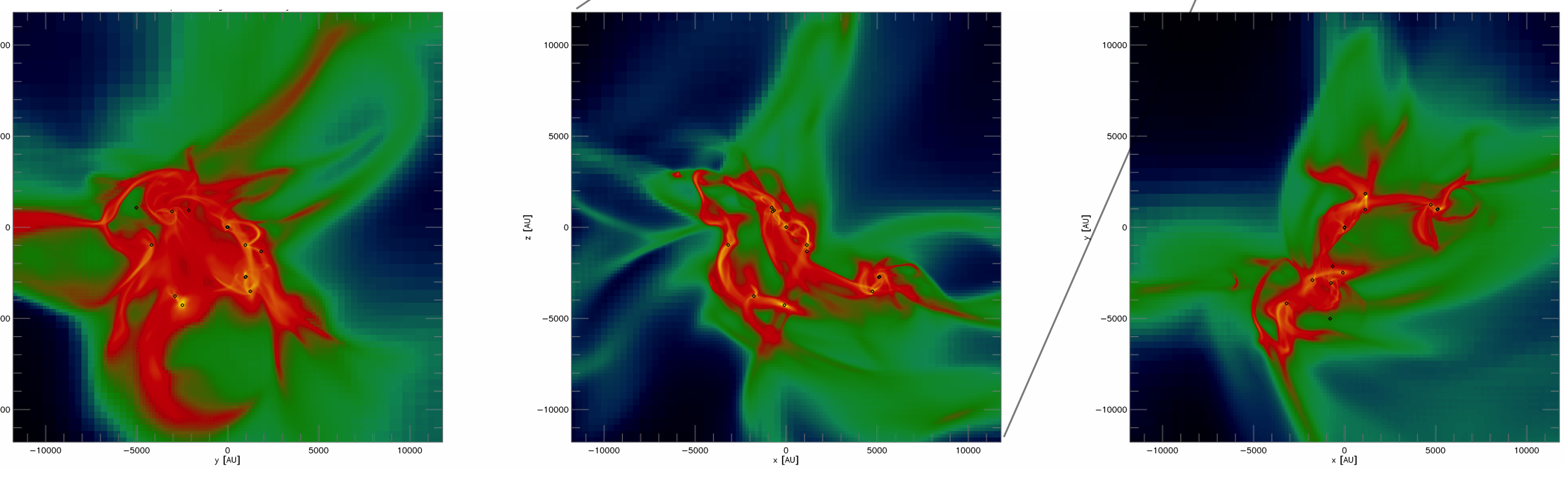
We find: $\varepsilon_{\rm ff} \sim \exp[-1.4\, \alpha_{\rm virial}] = \exp[-1.6\, t_{\rm ff} / t_{\rm dyn}]$,

where $\alpha_{\rm virial}$ is the virial number, and $t_{\rm dyn} = R / \sigma_{\rm vel,3D}$ The SFR is lowered by at least factor of five when including realistic magnetic field strengths compared to pure hydrodynamics.

Clustered Star Formation

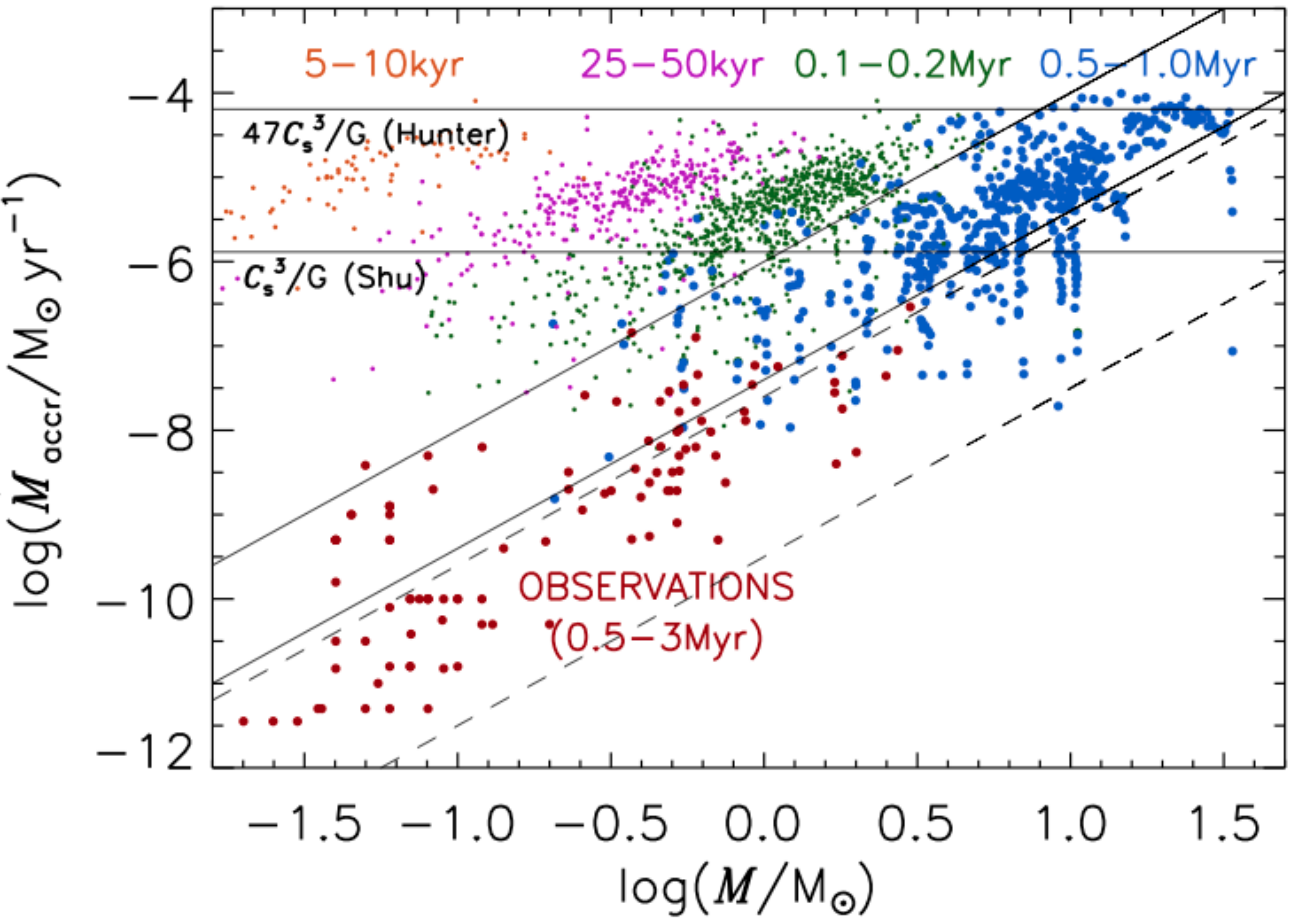
Simulating a part of the interstellar medium we naturally account for the clustered nature of star formation. In the panels below is an example of a star cluster seen in three projections. The supersonic MHD turbulence, characteristic of the interstellar medium, drives formation of filaments, and where multiple filaments cross groups of stars are formed.





Accretion in protostellar systems

Accretion of gas to star particles is regulated by distance and density criteria. Setting the density criteria well above densities created by the turbulence, our models reproduce the observed $\dot{M} \propto M^2$, and respect the theoretical limits on accretion rates.



Main Points

- The filamentary structure of a molecular cloud prevails all the way to the scale of protostellar systems
- Cosmic variance can be accounted for by modelling entire molecular clouds
- Accretion of mass to the disk is non-symmetric and non-steady
- For the first time we have modeled a full IMF in agreement with observations

Other posters with results from our models:
1G021: Tracing Protostellar Evolution Using Gas Kinematics
1H002: Zooming in on the Formation of Proto-Planetary Disks
1H003: Zooming in on Protoplanetary Disks
1H009: Understanding Disk Formation: Bridging the Gap from Theory to High Res Observations