New insights into the non-universality of the IMF

The influence of supersonic turbulence

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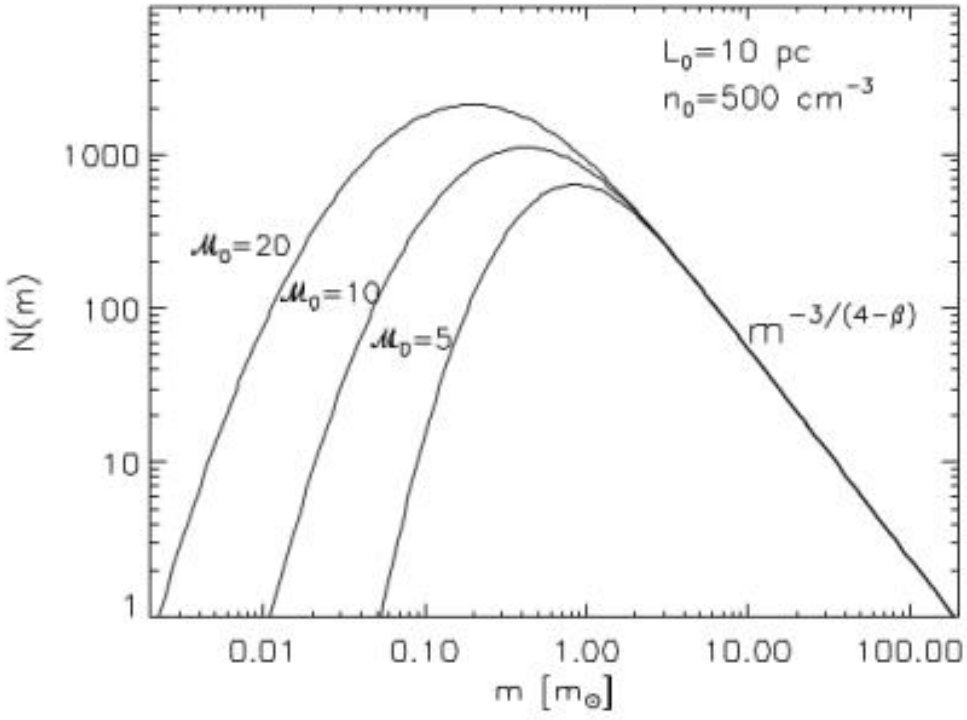
Motivation

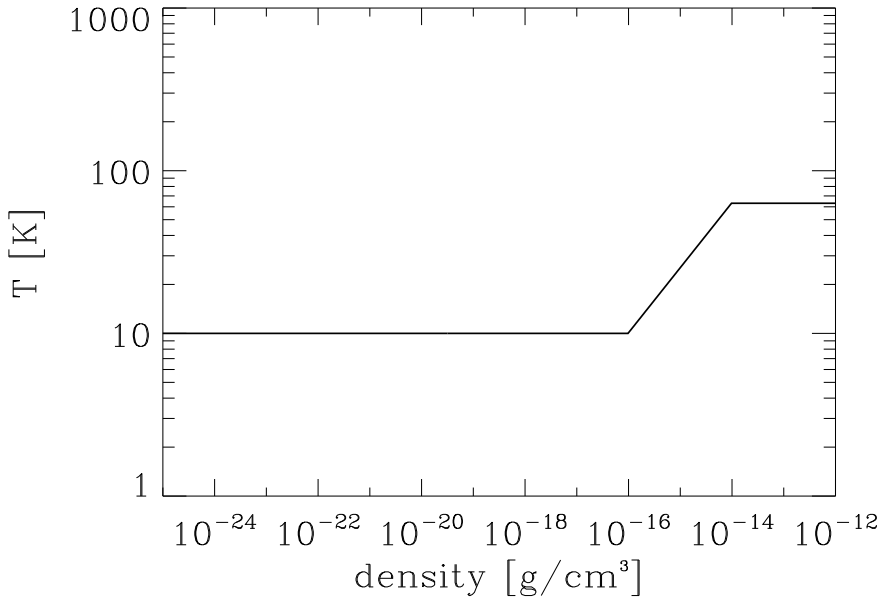
- Growing evidence of non-universal IMF
- Studies about the dependence of the IMF on the turbulent Mach number (Padoan&Nordlund 2002, Hennelbelle&Chabrier 2008)
- Expectation: shift of the peak towards lower masses for increasing Mach number



(Padoan&Nordlund 2002)

Simulations

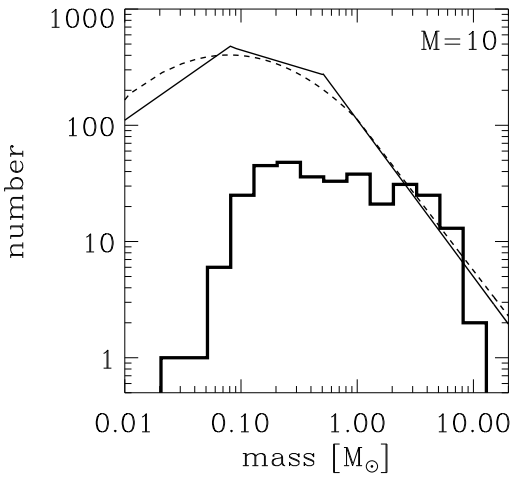
- SPH code Gadget 2
- Periodic box
- $L = 10\text{pc}$
- $M_* = 5750\text{M}_\odot$
- $\rho \sim 4 \cdot 10^{-22}\text{g/cm}^3$
- $\sim 2 \cdot 10^7$ SPH particles
- metallicity $Z \sim Z_\odot$
- Polytropic equation of state

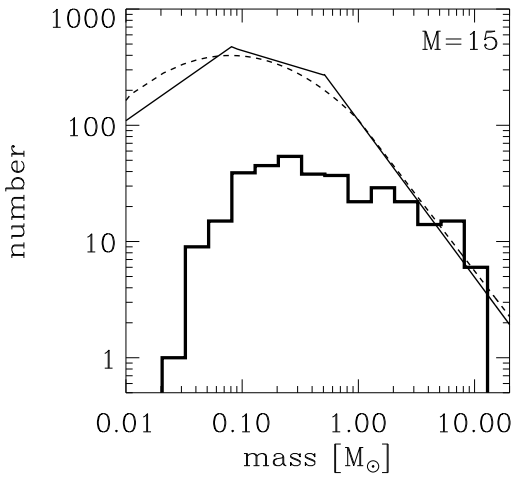


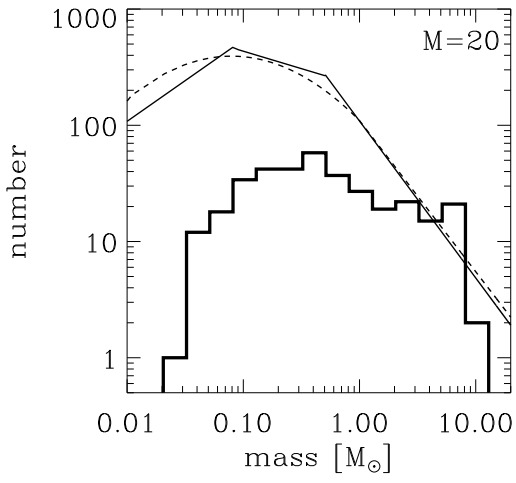
Decaying turbulence

- Interpolate initial turbulence field with particle grid
- $M = 10$, $M = 15$, $M = 20$
- Run stops when approximately 10% of the total mass of the cloud has been accreted into stars

Resulting IMF







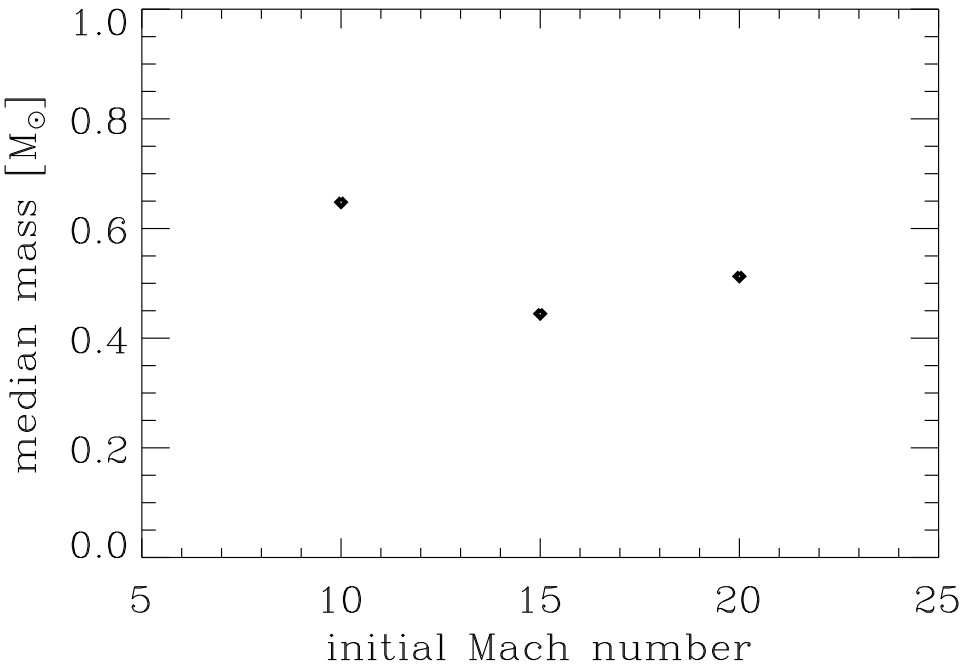
dotted line: Chabrier 2003

solid line: Kroupa 2001

(Bertelli Motta et al. in prep.)

Mach number dependence

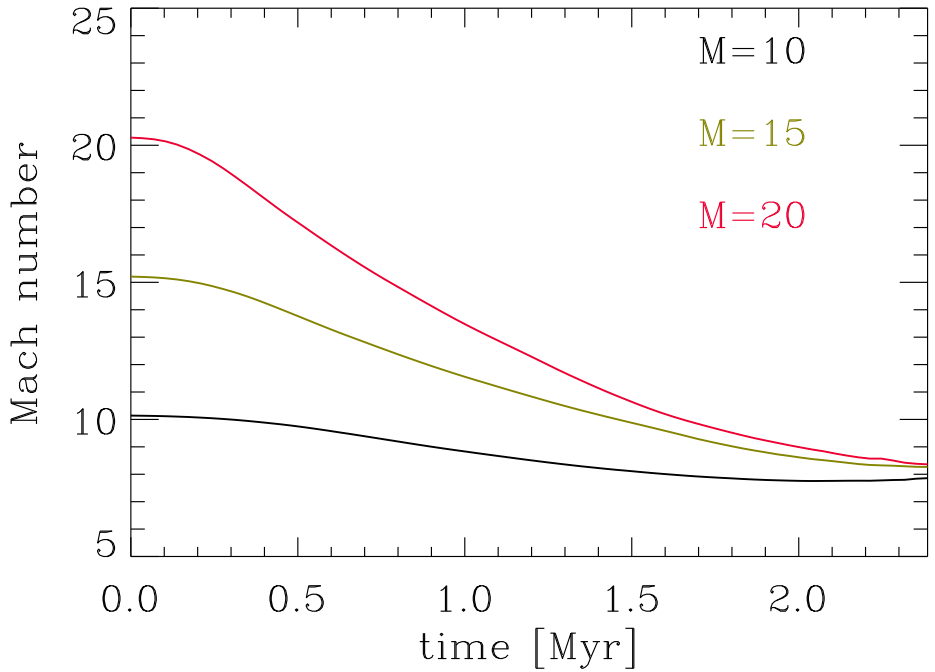
- No observable dependence of the characteristic mass on the initial Mach number



(Bertelli Motta et al. in prep.)

Decaying turbulence

- When the first stars form (at $\sim 1.5 \cdot 10^6$yr) the Mach number has decreased to similar values for all the runs



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Driven turbulence

- Turbulence continuously driven during the run
- Kinetic energy decay (Mac Low 1999):

$$\dot{E}_{kin} = -\eta_v m k v_{rms}^3$$

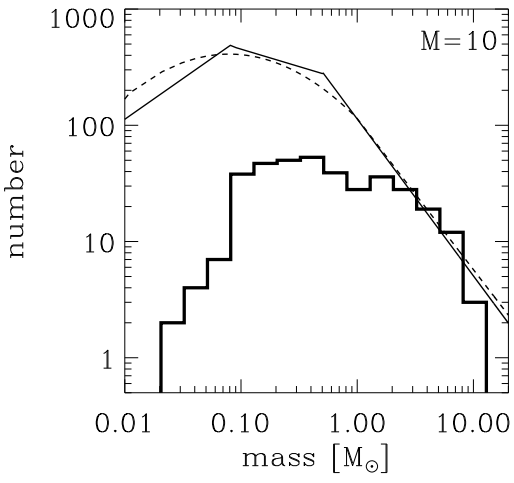
$\eta_v = 0.21/\pi$

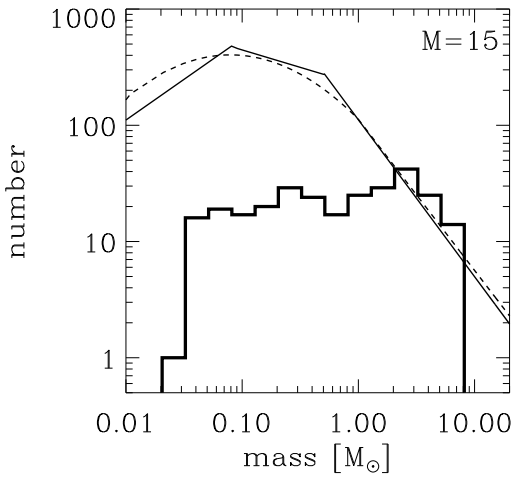
m: mass of the cloud

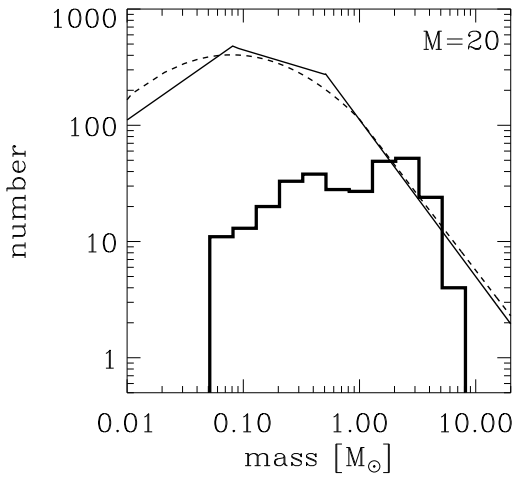
k: driving wavenumber

v_{rms}: root mean square velocity of the gas

Resulting IMF







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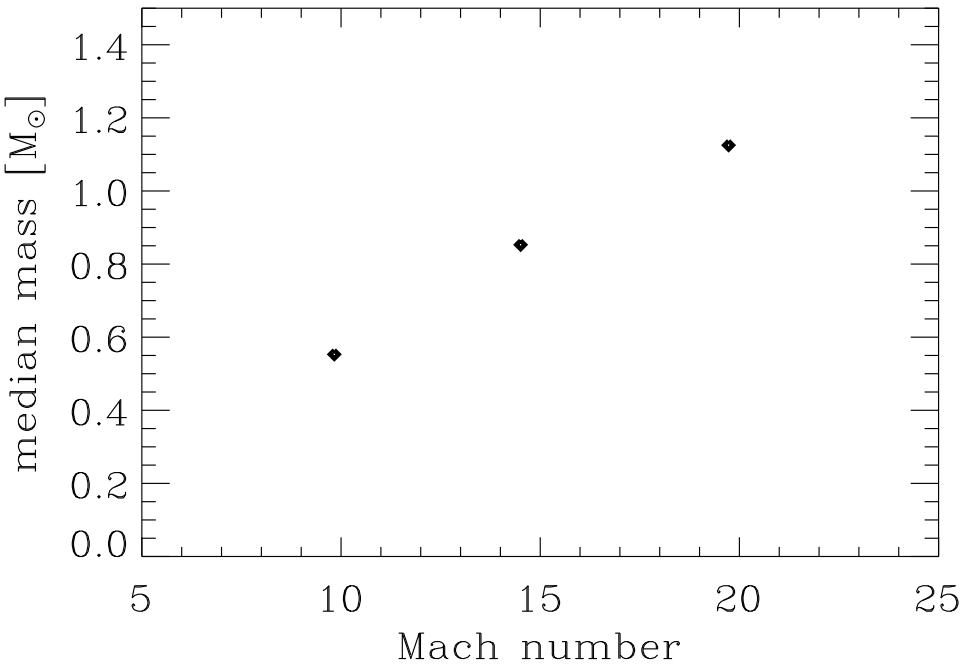
Mach number dependence

- For increasing Mach number the peak of the IMF shifts towards higher masses
- Result against the expectations



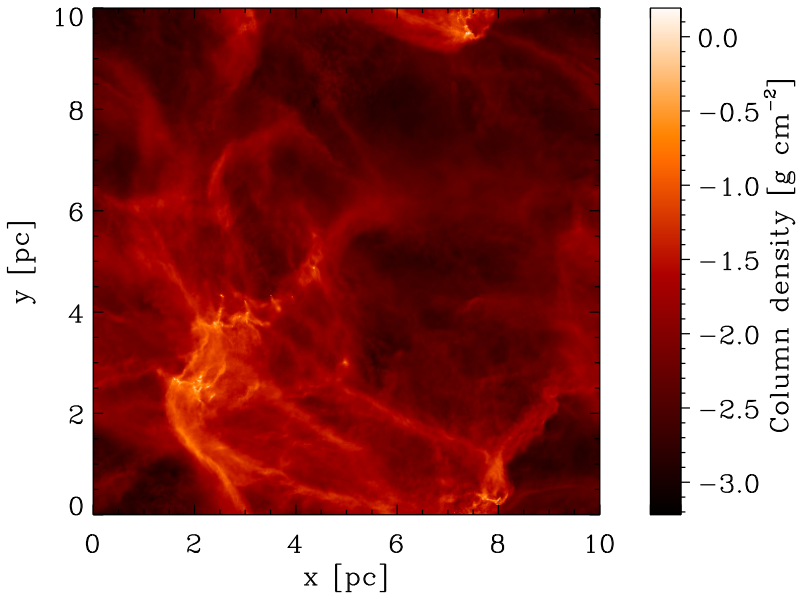
(Bertelli Motta et al. in prep.)

Cloud structure

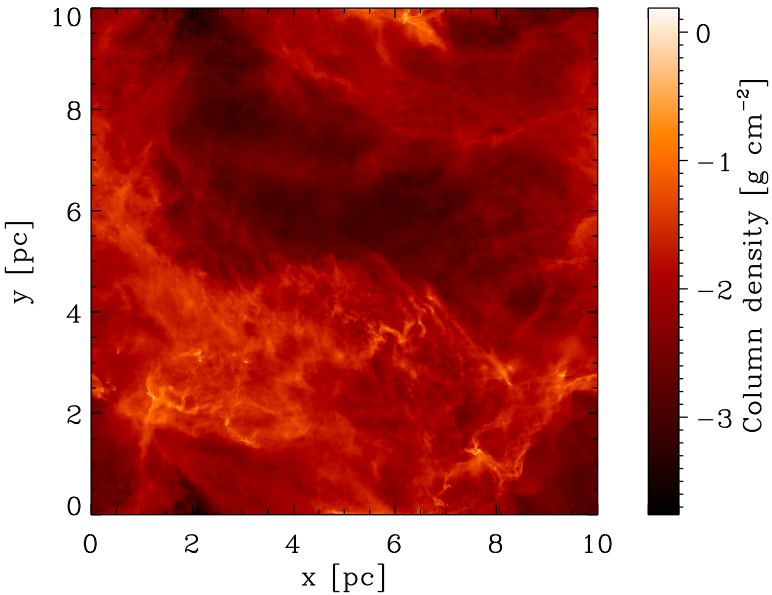
- Strongly supersonic turbulence prevents the formation of stellar clusters (birth environment of low-mass stars, Bonnell et al. 2008)

  $\Longrightarrow$ Few stars form and continue to accrete

M=10



M=20



Conclusions

- A dependence of the IMF on the turbulent Mach number can only be achieved by continuously driven turbulence
- The IMF becomes top-heavy for increasing Mach number