The high-mass slope of the IMF at sub-solar metallicities Simon Glover (ITA, Heidelberg)

## Collaborators

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The Stellar Initial Mass Function Main features:

– Characteristic mass scale at ~ 0.25 – 1 M $_{\odot}$ 

- Power law slope above this scale, with index  $\alpha = 1.35$  (Salpeter, 1955)

– Possible high mass cutoff at ~ 150 Mo

Question: does the IMF vary with metallicity?

 There's little evidence for evolution down to metallicities ~ 0.01 Z⊙ (Globular clusters). But what about at lower Z? If the gas cools quickly, then we can build up many Jeans masses of cold gas before any can collapse

Many Jeans masses => many fragments

Fragments compete for available gas mass, in a process called competitive accretion

Larger fragments accrete faster: "the rich get richer"

Resulting IMF has a power-law slope that is close to the Salpeter value

## Requirements for competitive accretion

Gas inflow

Bonnell & Bate (2006):

 Need a situation where gravity dominates the dynamics

• A collapsing, highly Jeans unstable region creates a situation where competitive accretion is **unavoidable** 



Omukai et al, 2005

Two cooling regimes: - Low density, due to  $H_2$ , HD, C, O, [CO?] - High density, due to dust Both might give you fragmentation BUT: difficult to get low mass fragments in the low density regime

#### $\odot$ CMB temperature floor: T<sub>CMB</sub> ~ 3 (1 + z)

- Once the gas reaches T<sub>CMB</sub>, can't cool further, so no more fragmentation
- If cooling is too rapid, we reach T<sub>CMB</sub> while still at low density => still large Jeans mass
- If cooling too slow, stay well above T<sub>СМВ</sub>, so again get large Jeans mass
- At high redshift, this gives us a fine-tuning problem; very limited range of metallicities that will give us low mass fragments



B. Smith, private communication

Dust doesn't have this problem

- Generally, once dust cooling becomes important, we cool to T<sub>dust</sub>
- Typically, Tdust > TCMB
- But cooling and fragmentation occur at much higher densities, so the Jeans mass stays low
- Sounds good, but does it actually work...?

Clark, Glover & Klessen 2008: Tabulated equation of state The second sec Good mass resolution: Mres = 0.002 Msun Sink particles Small amount of initial rotation, turbulence





CGK08

# Problems

- Are our simulations realistic?
  Do we have enough dust?
  Will radiative feedback suppress fragmentation?
- What about magnetic fields?
- Will collisions/mergers change the IMF?



Omukai et al, 2005



See poster by G. Dopcke





### Conclusions

Competitive accretion yields a power-law IMF even at very low metallicity, provided that gas can cool quickly enough

Two cooling mechanisms => two fragmentation regimes; these may or may not coexist in practice

CMB a big problem for producing low mass stars at high redshift by low density cooling