Environmental Effects on Planet Formation in Cluster Gas Expulsion Phase

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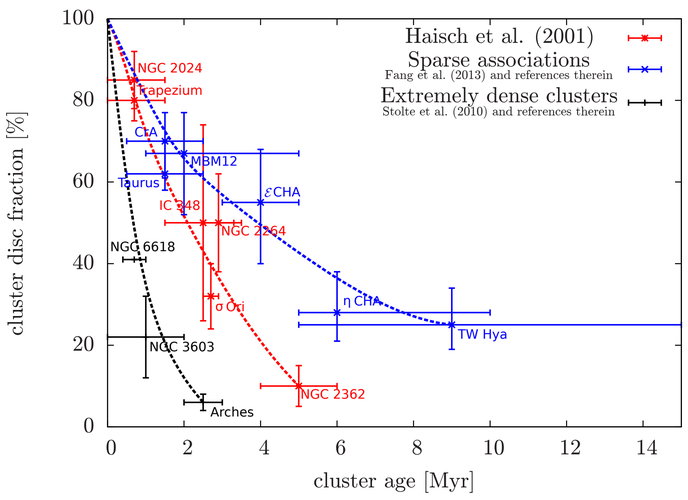
How the expulsion of the residual gas influences the interpretation of observed cluster disc fractions

Introduction



- Stars initially surrounded by circumstellar disc
- Discs seem to disappear with time
- **Effect depends on stellar density**

Motivation

Possible mechanisms for disc destruction:

Internal processes

- Dust growth (D'Alessio et al. 2006)
- Accretion (Balbus & Hawley 2002)
- Viscous spread (Shu et al. 1987)

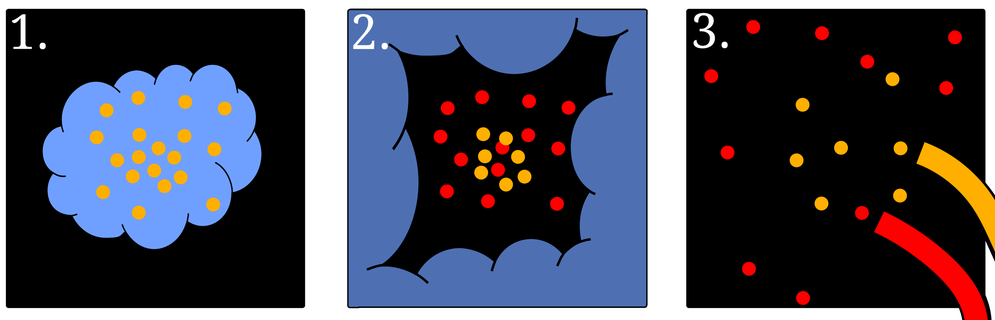
External processes

- Photoevaporation (Scally & Clarke 2001)
- Gravitational interactions (Pfalzner et al. 2004, Olczak et al. 2006)

Effect of cluster expansion after gas expulsion so far neglected

Method and Setup

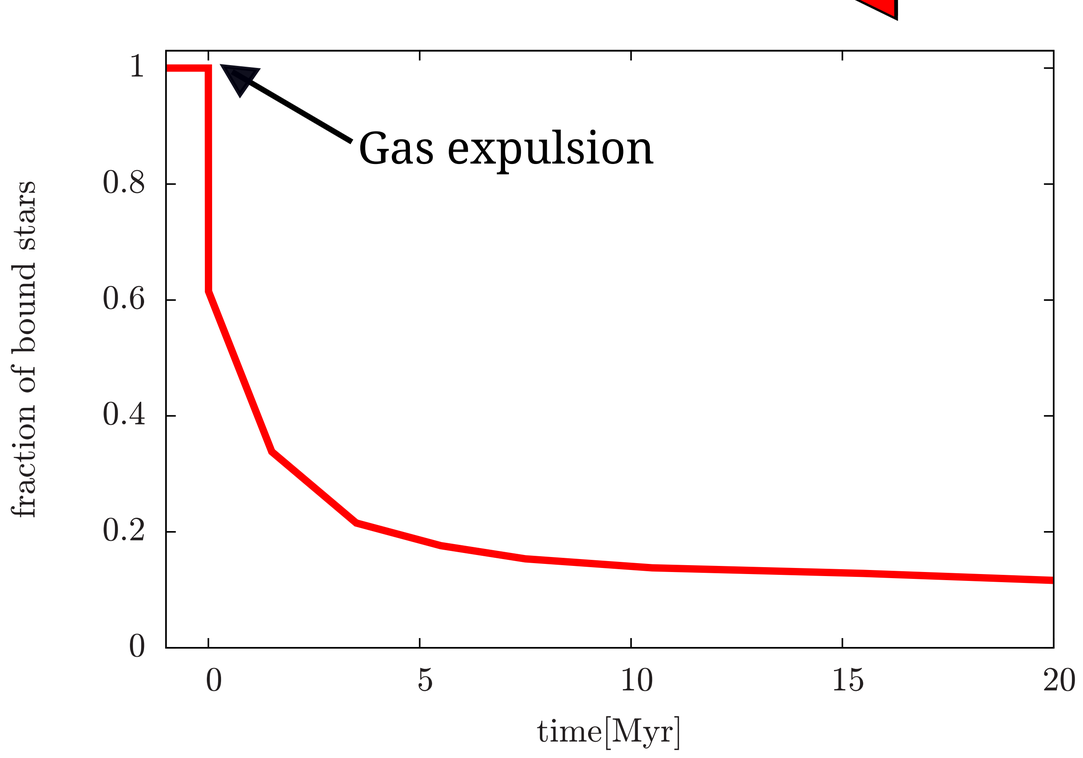
- NBODY6 simulations
- Simulating most massive clusters ($> 10^4\,M_\odot$) in Solar neighbourhood
- King density profile $W_0 = 9$
- Standard Kroupa (2001) IMF
- 30% star formation efficiency
- Instantaneous gas expulsion after 1 Myr
- Neglect primordial binaries and stellar evolution



Gas expulsion process

1. Stars are initially embedded in natal gas
2. Residual gas is expelled by stellar feedback of massive stars
3. Due to lower binding energy stars separate in **unbound** and **bound** population

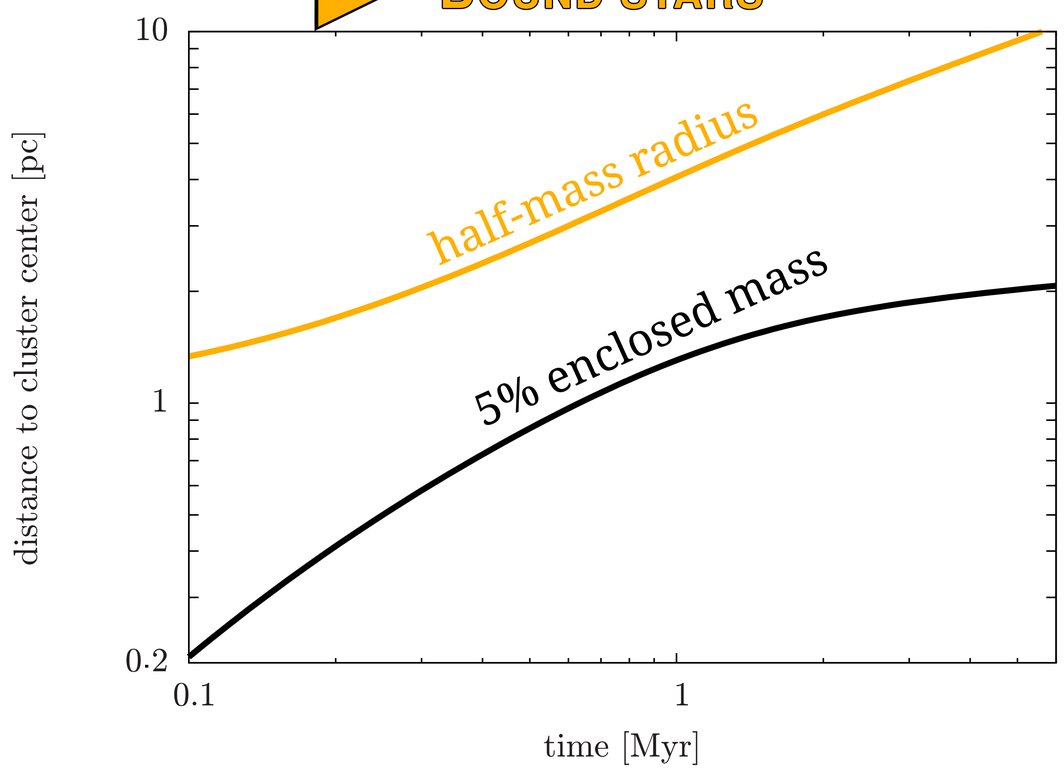
Unbound stars



- Preferentially stars from **sparse cluster outskirts** become unbound
- Only ≈ **10% of stars remain bound** as cluster

90% of stars are expelled into the field

Bound stars



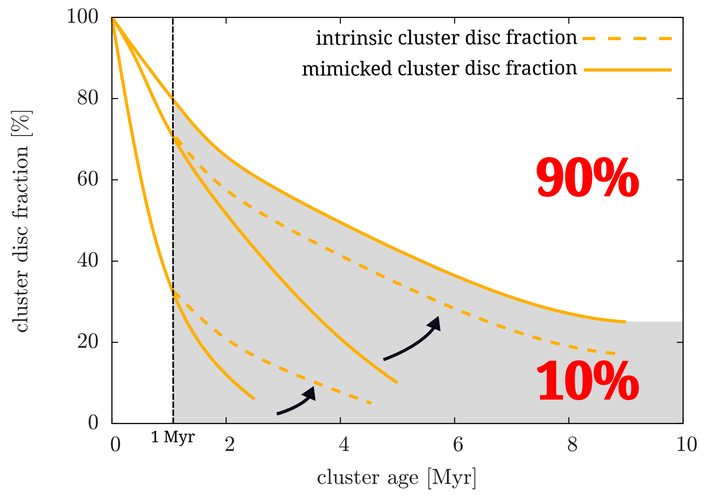
- Stars from **dense, innermost regions** (< 0.2 pc) characterise observed disc frequencies of remnant clusters
- Density drops ⇒ **Internal processes dominate** disc destruction after expulsion

Remnant cluster spreads rapidly by a factor of 10

Conclusion

Field star population likely higher disc frequency than observed in clusters

Field stars more suitable for forming planetary systems



Rapid expansion mimics drop in observed cluster disc frequency

Observed frequency strong lower limit for disc survival

For further information, check out
www.mpifr-bonn.mpg.de/staff/spfalzner