FORMATION MECHANISMS – CLUSTERS

- Required: a region that contains many thermal Jeans masses.

- Problem: molecular cloud regions on moderate scales (1 parsec) appear to be supported against collapse by magnetic turbulence

- 1. The density is high enough so that ambipolar diffusion time of gas with respect to magnetic field is relatively short (10^6 yr), so magnetic effects could become dynamically unimportant in the whole region. But the required density is 4×10^{-19} g cm^{-3}.

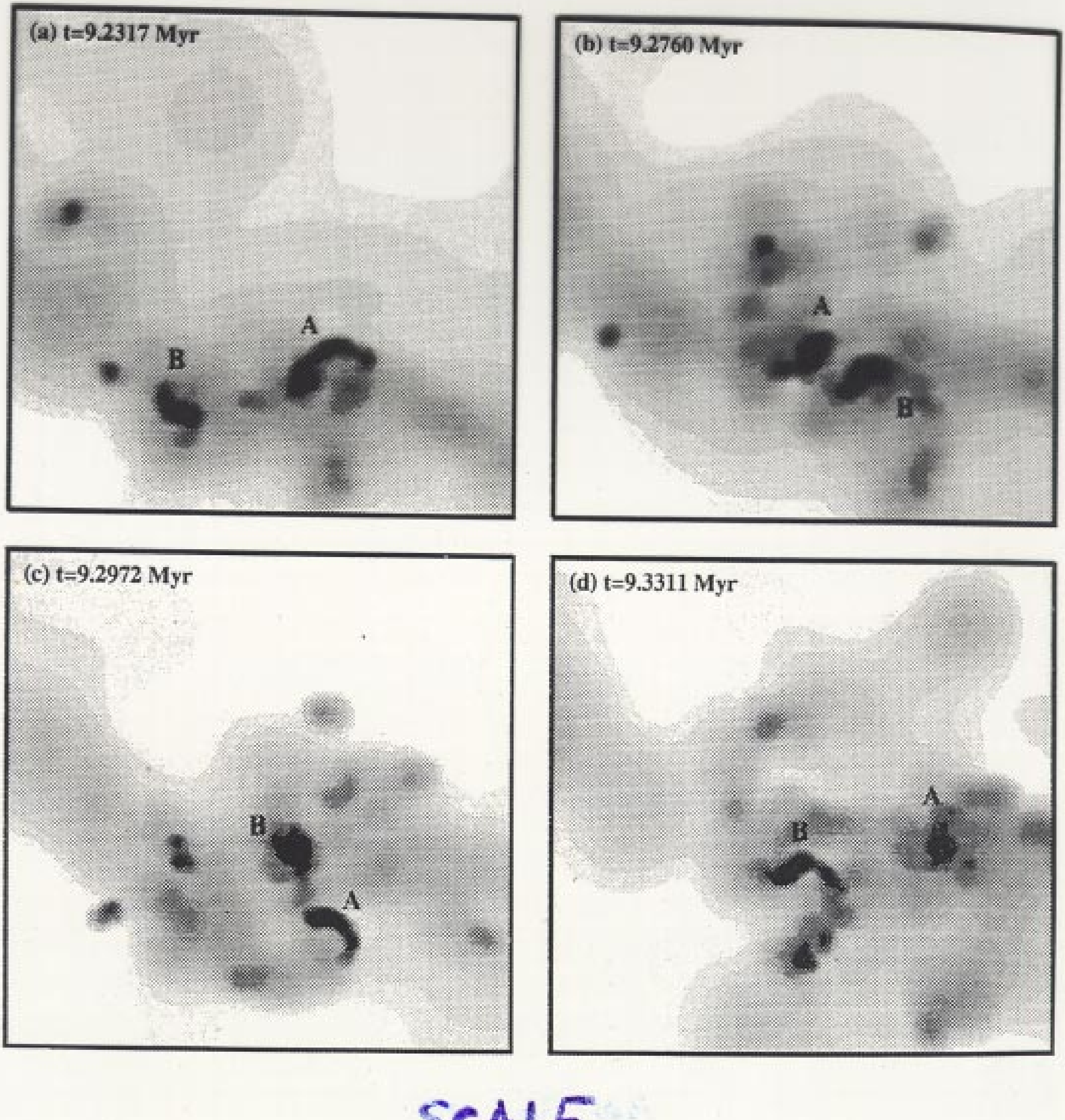
- Increase in density could be caused by passage of a shock wave through a cloud, or collision of two clouds followed by cooling in the dense layer behind the shock. Or sudden removal of ionizing flux and cosmic rays from a region causes enhanced magnetic diffusion.

- 2. Magnetic turbulence in molecular clouds decays on a time scale less than the free-fall time according to detailed numerical simulations by Mac Low et al. (1998), Padoan (1998), Stone, Ostriker, and Gammie (1998), Mac Low (1999) unless there is external energy input.

- 3. Turbulence does not decay, but self-gravitating "kernals" can form on a small scale which are cut off from MHD waves in the core (Myers 1998).

Result of collision of 2 clouds, 750 $M_\odot$ each

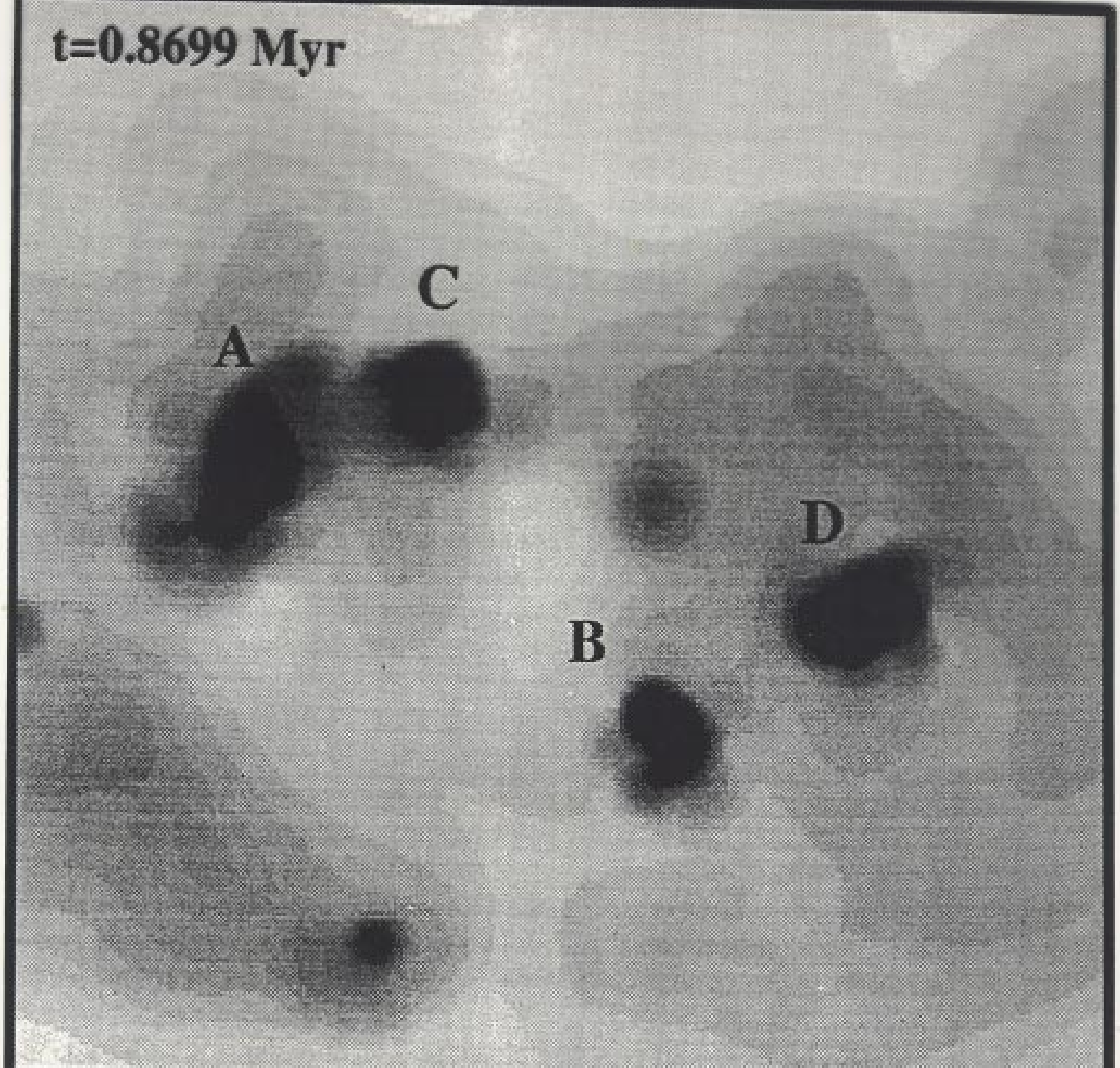
Whitworth et al. MN 277, 727 (1995)



SCALE
0.2 pc

Result of collision of 2 clouds, 75 $M_\odot$ each

Whitworth et al. MN 277, 727 (1995)



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Klessen and Burkert

CALCULATIONS OF CLUSTER FORMATION

- **Assumptions:** isothermal cloud with gas pressure and gravity

- **Initial conditions:** uniform-density cloud with 222 Jeans masses. Gaussian random density fluctuations are superimposed with power spectrum $P(k) \propto 1/k^2$

- Numerical technique : SPH, 500,000 particles

- Smoothing length variable in space and time such that the number of "nearest neighbors" for each particle is about 50

- GRAPE hardware for solving Poisson equation

- Periodic boundary conditions

- When a highly condensed core forms it is replaced by a single "sink" particle which continues to accrete gas

- Results: formation of knots and filaments, 61 molecular cloud cores appear, with a mass spectrum peaking at the overall Jeans mass for the system

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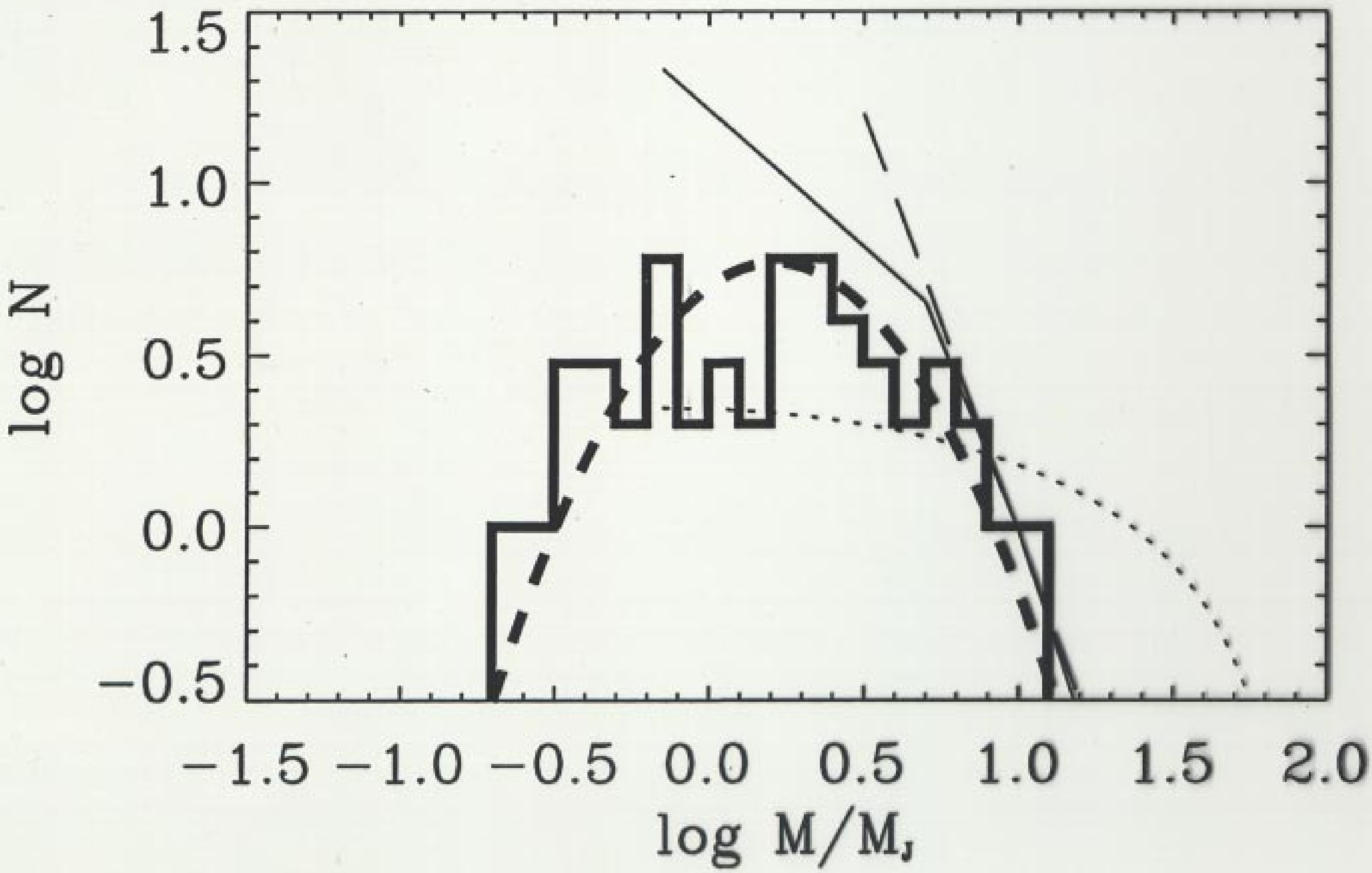
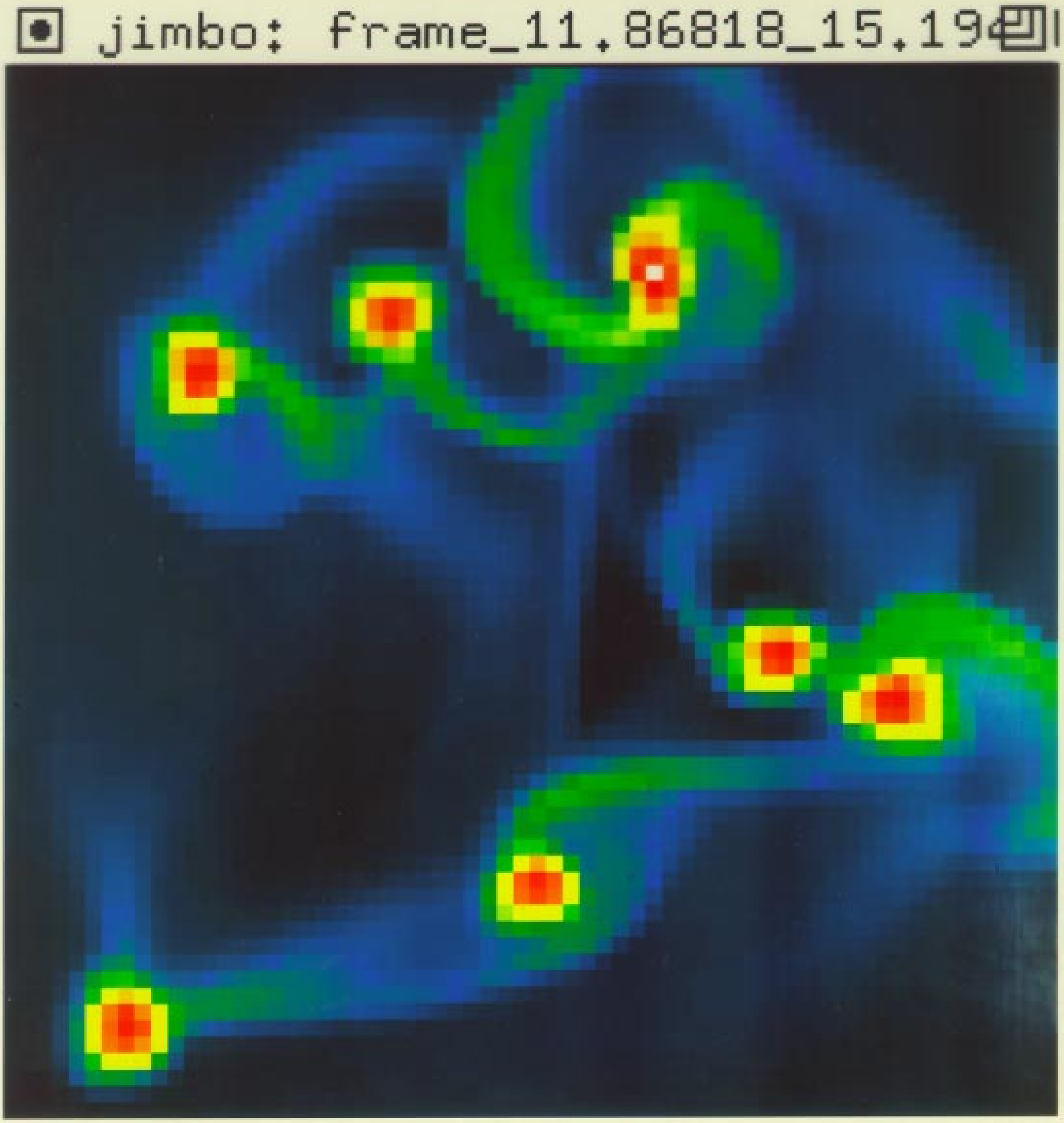
Klessen and Burkert 1998

Distribution of core masses

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