THE PRESTELLAR CORE MASS DISTRIBUTIONS As a function of THE STRUCTURE OF THE PARENTAL CLOUD

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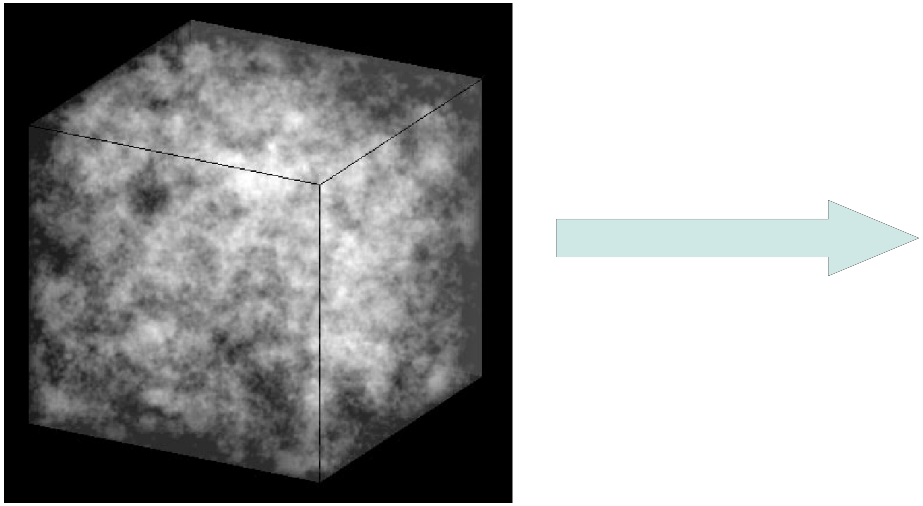
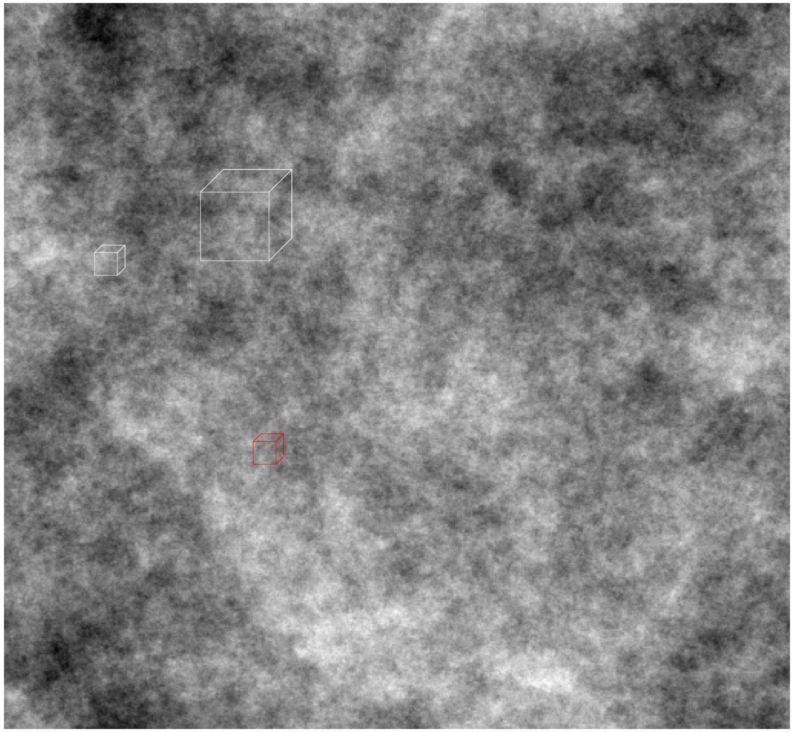


The Physics

- Gravitation
- Thermal support
- Turbulent support.



$$M_{J,\mathrm{th}} = \frac{m_{\max}^{3/2}}{\sqrt{m_{\mathrm{cube}}/d^3}},$$

$$M_{J,\mathrm{turb}} = M_{J,\mathrm{th}} \frac{V_0^3}{3^{3/2} C_s^3} \left(\frac{R}{1\ \mathrm{pc}} \right)^{3\eta} = M_{J,\mathrm{th}} \left(\frac{d}{d_{\mathrm{eq}}} \right)^{3\eta}$$

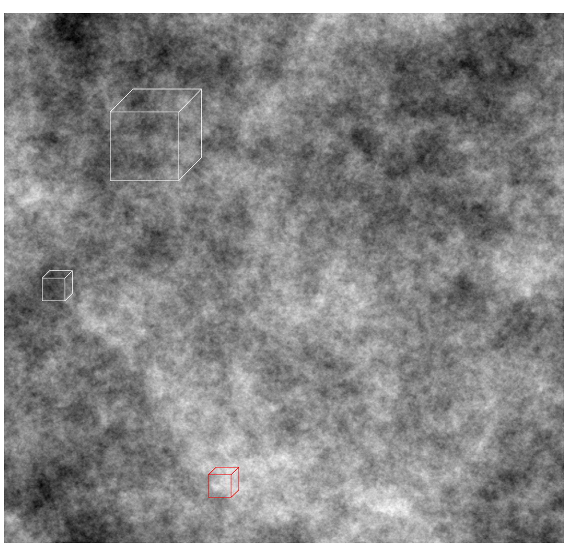
$$M_J = M_{J,\mathrm{th}} \left\{ 1 + \left(\frac{d}{d_{\mathrm{eq}}} \right)^{2\eta} \right\}^{3/2}$$

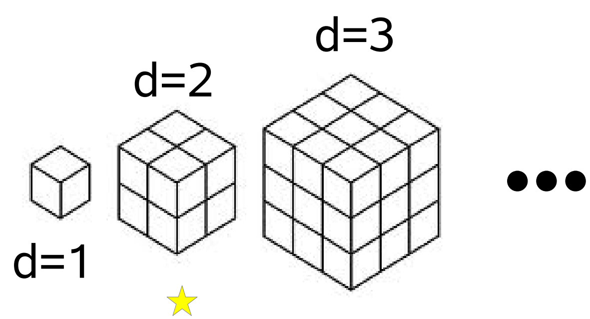
d_{eq} is the length at which the thermal support and the turbulent support are equal.
V_0 ~ 1 km/s is the turbulent rms velocity at 1 pc scale.
$\eta \sim 0.4$–0.45 is the exponent of Larson's (1981) velocity dispersion VS size relation.

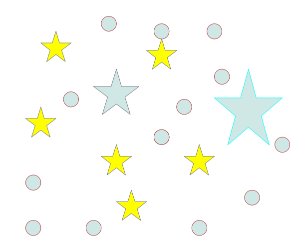
DISCRETE METHOD FOR A HIERARCHICAL COLLAPSING SEQUENCE

The mass distribution of prestellar cores is obtained for clouds with arbitrary internal mass distributions using a selection criterion based on the thermal and turbulent Jeans mass and applied hierarchically from small to large scales.

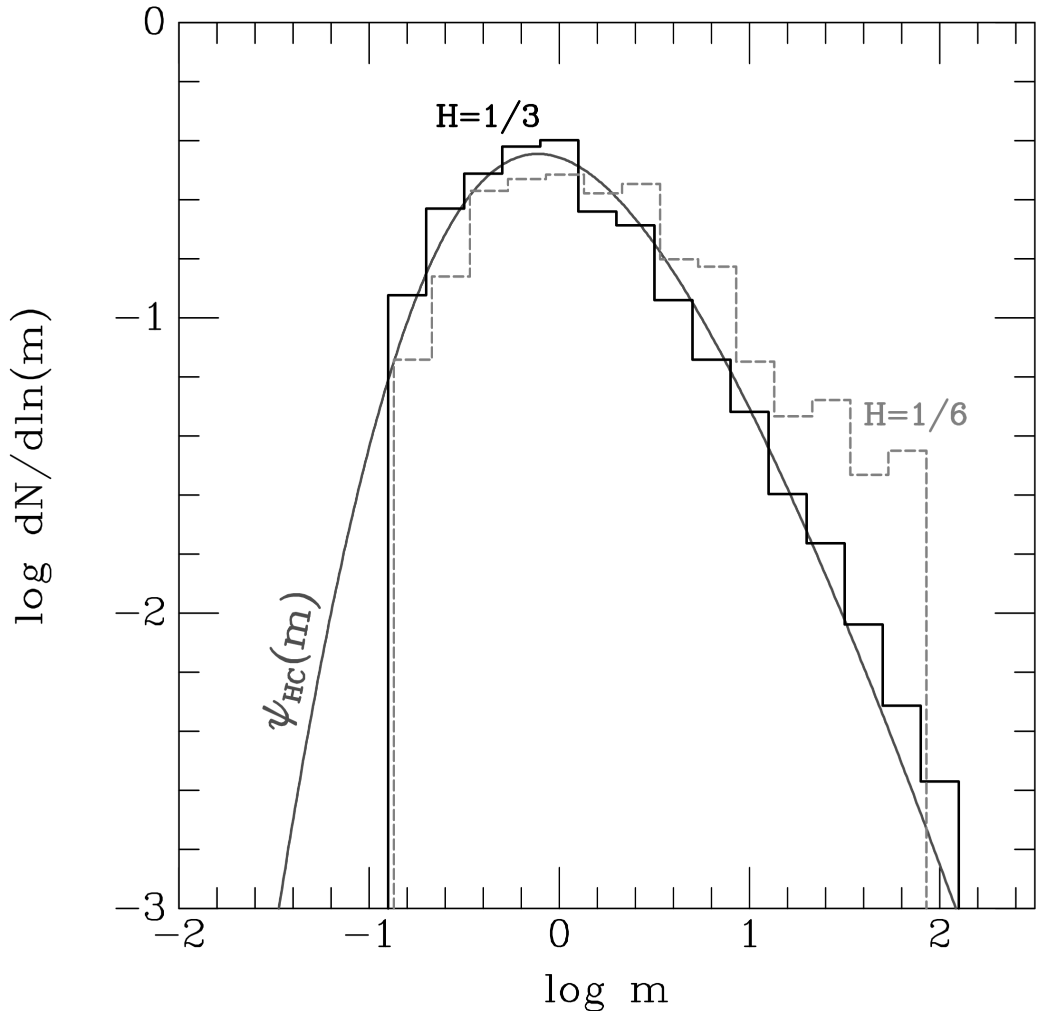
$$M_J = M_{J,\mathrm{th}} \left\{ 1 + \left(\frac{d}{d_{\mathrm{eq}}} \right)^{2\eta} \right\}^{3/2}$$







Mass distribution of cores in 20 different simulations of fBm clouds



- The solid (dashed) line histogram corresponds to the mass function of fBm clouds with H = 1/3 (H = 1/6).
- The parameter values are Nvox = 2**8 , m_{max} = 0.07 M , T = 10 K, and a cloud with a mass of 860 Mo.

Dependence on the Hurst Exponent

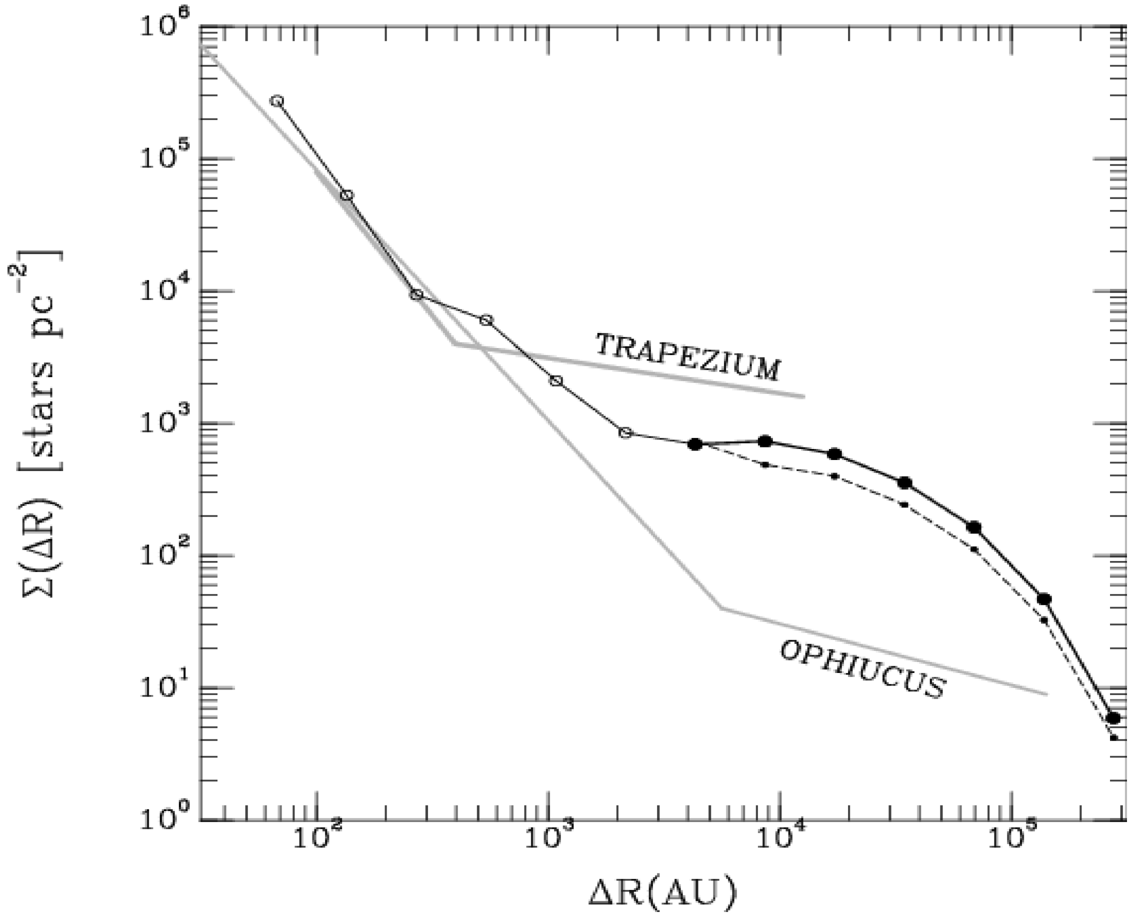
N_{vox}	T (K)	m_{max} ($M_\odot$)	d_{eq}	M_{cl} ($M_\odot$)	L (pc)	$\bar{n}_H$ (cm^{-3})	σ_0	$\mathcal{M}$	$\mathcal{M}_*$	m_J^0 ($M_\odot$)
256	10	0.070	8.83	862	2.69	1831	1.64	7.43	1.40	2.52

Average Properties of the Cores in fBm Clouds

H	$\mathcal{N}_{cores}$ [a]	$\bar{m}_{core}$ [b]	$F_{m,c/g}$ [c]	$F_{h,ms}$ [d]
0	28 ± 6	16.28 ± 4.90	0.49 ± 0.06	0.13 ± 0.05
1/6	89 ± 25	5.07 ± 1.96	0.47 ± 0.06	0.022 ± 0.02
1/5	101 ± 29	4.47 ± 1.78	0.47 ± 0.07	0.017 ± 0.013
1/4	132 ± 38	3.43 ± 1.43	0.47 ± 0.06	0.009 ± 0.009
1/3	201 ± 57	2.42 ± 0.87	0.51 ± 0.06	0.005 ± 0.005
1/2	405 ± 110	1.31 ± 0.42	0.57 ± 0.06	0.0006 ± 0.0015
3/4	797 ± 177	0.76 ± 0.17	0.67 ± 0.05	0.0000 ± 0.0000

For each value of H, the values quoted correspond to the average over 20 simulations of fBm clouds with different random phase but identical parameter values N_{vox} = 2^8 , m_{max} = 0.07 M , T = 10 K and η = 0.4, that correspond to L = 2.7 pc, Mcl = 860 M , σ_0 = 1.64

Surface density of companions $\Sigma(\Delta R)$



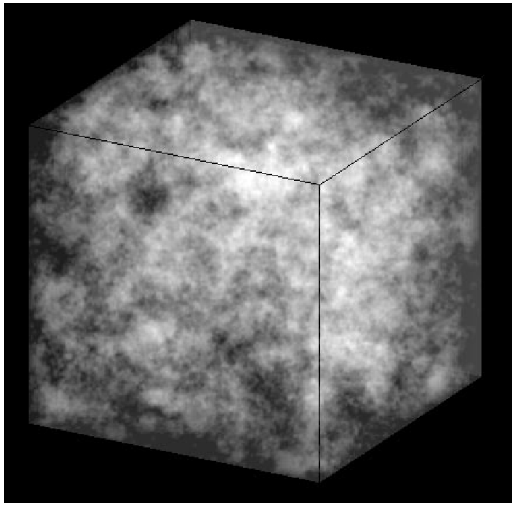
$\Sigma(\Delta R)$ for a single simulation of fBm clouds with H = 1/3. The large dots connected by solid lines correspond to $\Sigma(\Delta R)$ for systems (ΔR > lvox). The open circles connected by light lines correspond to$\Sigma(\Delta R)$ for stars assuming that the binary separation ΔR is less than lvox with a probability distribution p(R) ∝ ΔR**{−1/2} . The two segment power-law gray lines represent $\Sigma(\Delta R)$ for the Orion Trapezium and Ophiuchus star formation regions (Simon 1997).

Conclusions

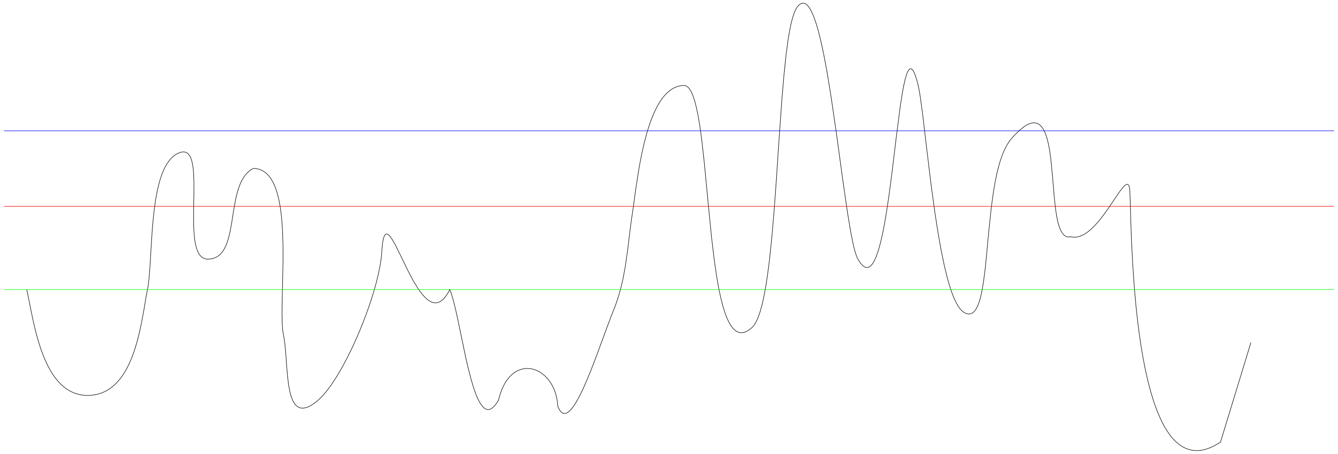
1) We have proposed a procedure that enables to connect the parental cloud structure with the mass distribution of the cores and their spatial distribution, providing an efficient tool for investigating the physical properties of the molecular clouds that give rise to the observed prestellar core distributions.

2) The method is applied to fractal fBm clouds for which the mass in the densest voxel m_{max} is equal to the Jeans mass and that the cloud as a whole is marginally stable. The resulting IMF is a power law at large masses and a log-normal cutoff at low masses that agree with the average IMF derived from observations.

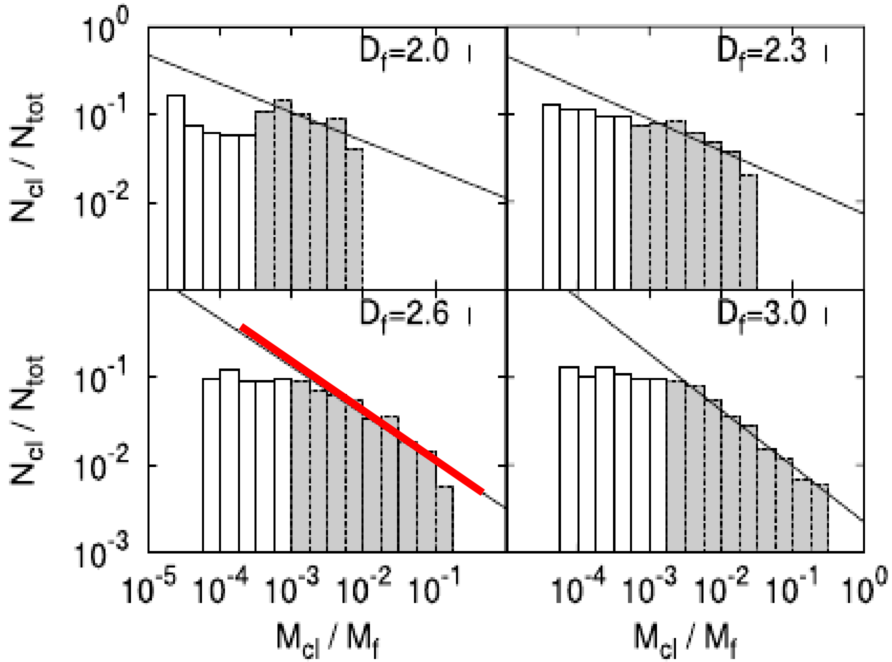
3) The method can be applied to clouds with arbitrary internal mass distributions.



A FRACTAL ORIGIN FOR THE MASS SPECTRUM OF INTERSTELLAR CLOUDS. II. Cloud models and Power-law slopes. Elmegreen ApJ 564 : 773, 2002

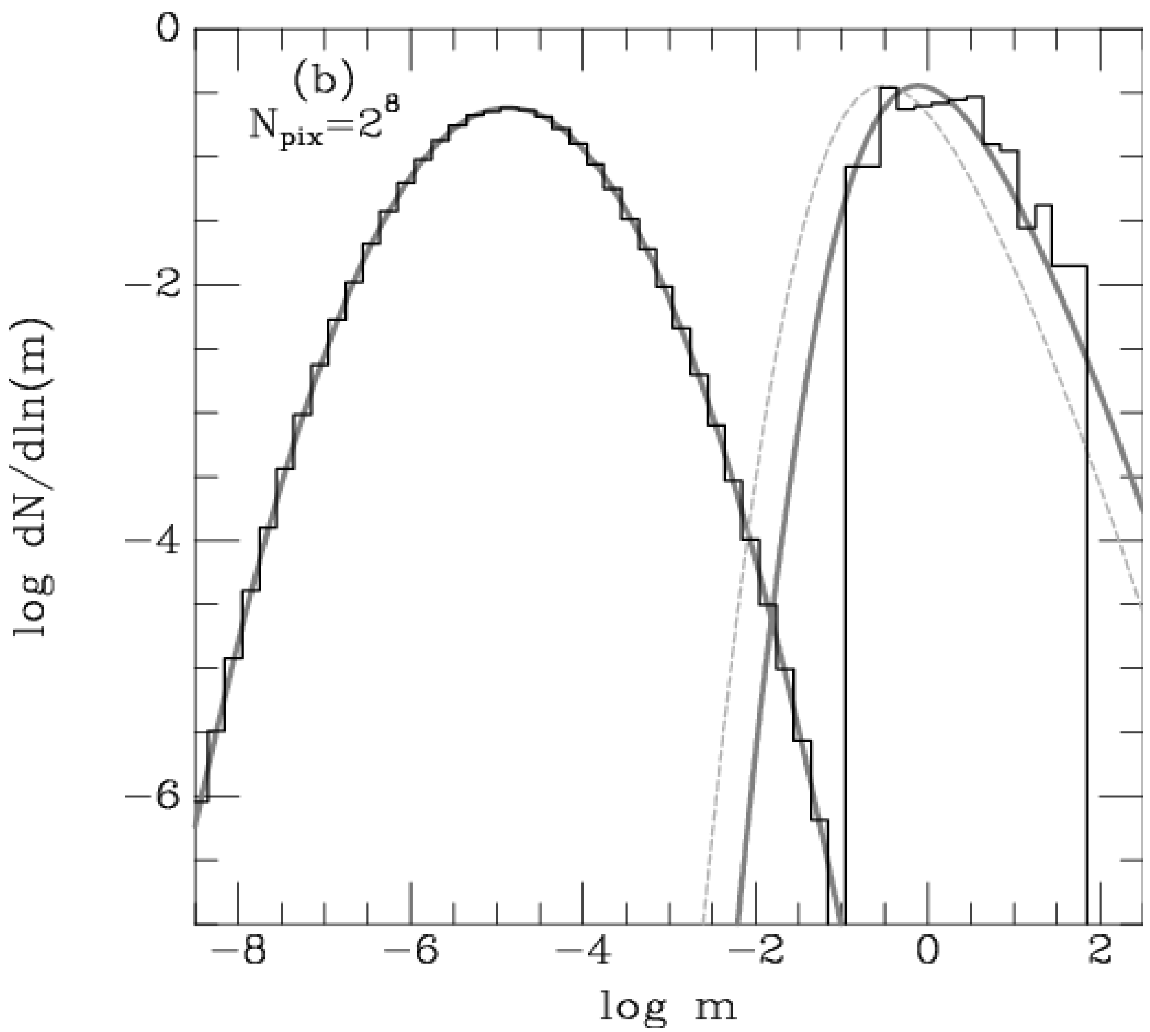


The mass function of the highest peaks is similar to the Salpeter initial mass function, suggesting that stellar masses may be determined in part by the geometry of turbulent gas.



PROPERTIES OF FRACTAL CLOUD COMPLEXES
Sanchez et al 2006, ApJ 641: 347

Histograms of the PDF of mass in voxels and the resulting CMF



- The continuous gray curve at the left of each panel is a log-normal with the appropriate values σ0 and mmax .
- The continuous gray curve at the right of each panel is ψHC (m) and the dashed gray curve is the normalized HC08 IMF ψHC (m/m0).

Including both thermal and nonthermal motions, the Jeans mass can be expressed as

$$M_J = M_{J,\mathrm{th}} \left\{ 1 + \left(\frac{d}{d_{\mathrm{eq}}} \right)^{2\eta} \right\}^{3/2}$$

η is related to the three-dimensional power spectrum index of the velocity field.

From high-resolution hydrodynamic simulations **η ~ 0.4 – 0.45**

Kritsuk et al. (2007), Schmidt et al. (2009), Federrath et al. (2010)

- Compared to the CMF, the mass function of stellar systems seems to be shifted to lower masses by a factor that does not depend on the core mass. The currently favored conversion efficiency value of the progenitor core mass to the stellar system is ∼1/3. However, the origin of this conversion efficiency is still controversial (Adams & Fatuzzo 1996; Matzner & McKee 2000; Enoch et al. 2008; Dib et al. 2011). Significant variations in

PROPERTIES OF FRACTAL CLOUD COMPLEXES
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2. SIMULATED FRACTAL CLOUDS

To generate fractal clouds, we have used the same procedure as described in Sanchez et al. (2005). Within a sphere of radius R_f werandomly place the centers of N spheres of radius Rf /L with L > 1. In each sphere we again place the centers of N smaller spheres

with radius R_f /L^2, and so on, up to a given level H of hierarchy. At the end of this procedure there are N^H points distributed in the

space with a fra N / log L.

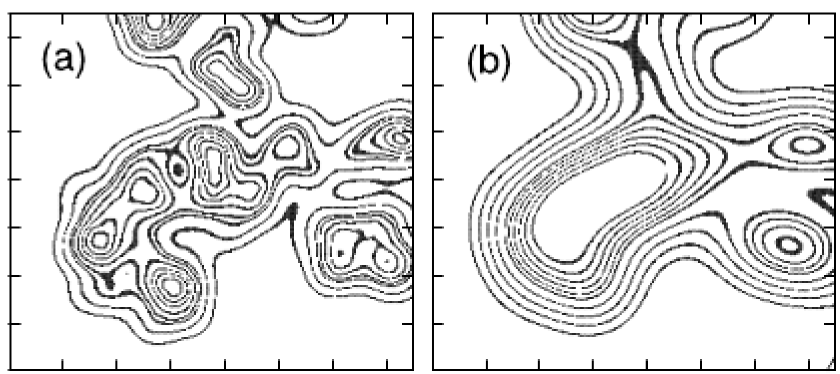
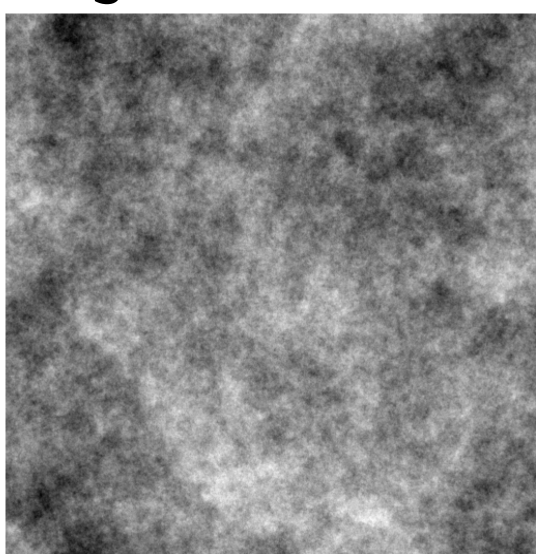


Fig. 2.—Slice along the $z = 0$ plane, showing density contours of part of a fractal with $D_f = 2.6$, calculated by using eq. (1) with (*a*) $\sigma = \sigma_{opt}$ and (*b*) $\sigma = 2\sigma_{opt}$.

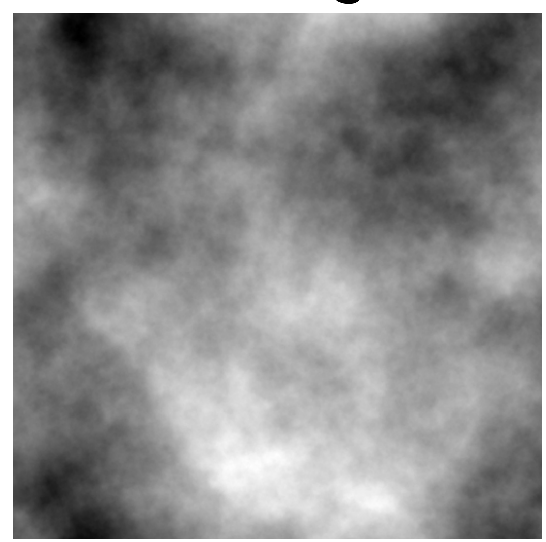
Fractal Brownian motion (fBm) clouds

Fractal Brownian motion clouds (Stutzki et al. 1998) are generated by first filling a three-dimensional lattice in wave-number space (k , k , k) with noise distributed as a Gauss-ian with a dispersion of unity. The noise cube is multipliedby $k^{-5/3}$ for $k =(k_x^2+k_y^2+k_z^2)$. The inverse three-dimensional fast Fouriery transform of the resulting truncated noise cube gives a fractal (Voss 1988) with a Gaussian distribution of intensity I (x, y, z). To simulate a turbulent fractal, we exponentiate this intensity distribution

$I(x, y, z) =\exp [\alpha I_0 (x, y, z)/I_{0,max}$ for maximum original intensity $I_{0,max}$ This gives another fractal, now with a lognormal density distribution.



H=0.2



H=0.8