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Baryonic effects in lensing statistics

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Motivation

- Lensing statistics contains useful information about cosmological parameters.
- The next generation cosmological data is very promising (Euclid like survey).
- Precision cosmology is the key goal.
- Universe contains baryons…

Lensing Statistics

$$n(z) \propto z^{\alpha} \exp\left[-\left(\frac{z}{z_0}\right)^{\beta}\right]$$

$$\int_0^{\chi_H} n(\chi) d\chi = 1$$

Smail et. al. 1994

$$g_i(\chi) = 2\frac{c}{H_0}\int n_i(\chi')\frac{\chi(\chi'-\chi)}{\chi'}d\chi'$$

$$\kappa(\vec{\theta}) = \frac{3H_0^2\Omega_m}{4c^2}\int_0^{\chi_H}\frac{g(\chi)}{a(\chi)}\delta(\chi\vec{\theta},\chi)d\chi,$$

$$C_{ij}(\ell) = \frac{9H_0^4\Omega_m^2}{16c^4}\int\frac{g_i(\chi)g_j(\chi)}{a^2\chi^2}P\left(\frac{\ell}{\chi},\chi\right)d\chi$$

Dark matter only (DMO) universe

$$\rho(r|M) = \frac{\rho_s}{(r/r_s)^\alpha (1 + r/r_s)^\beta},$$

alpha = 1, beta = 2 => NFW profile
Navarro et. al. 1997

$$u(x|M) = \frac{\rho(x|M)}{\int_0^c 4\pi x^2 \rho(y|M) dy}.$$

$$P(k) = P_{1h}(j) + P_{2h}(k),$$

$$P_{1h} = \int d\nu f(\nu) \frac{M}{\rho} |u(k|\nu)|^2,$$

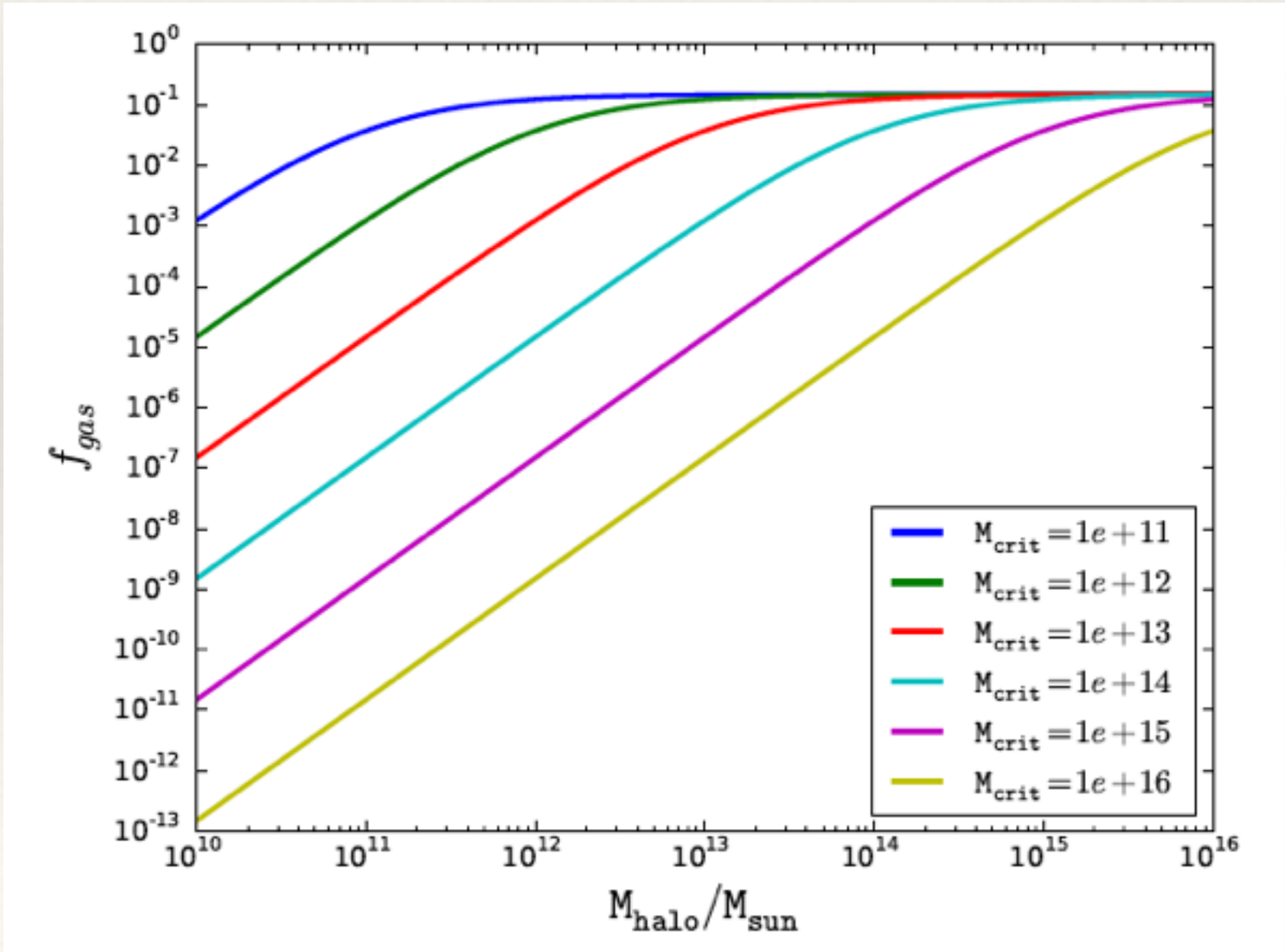
$$P_{2h} = \left(\int d\nu f(\nu) u(k|\nu) b(\nu) \right)^2 P_{lin}(k),$$

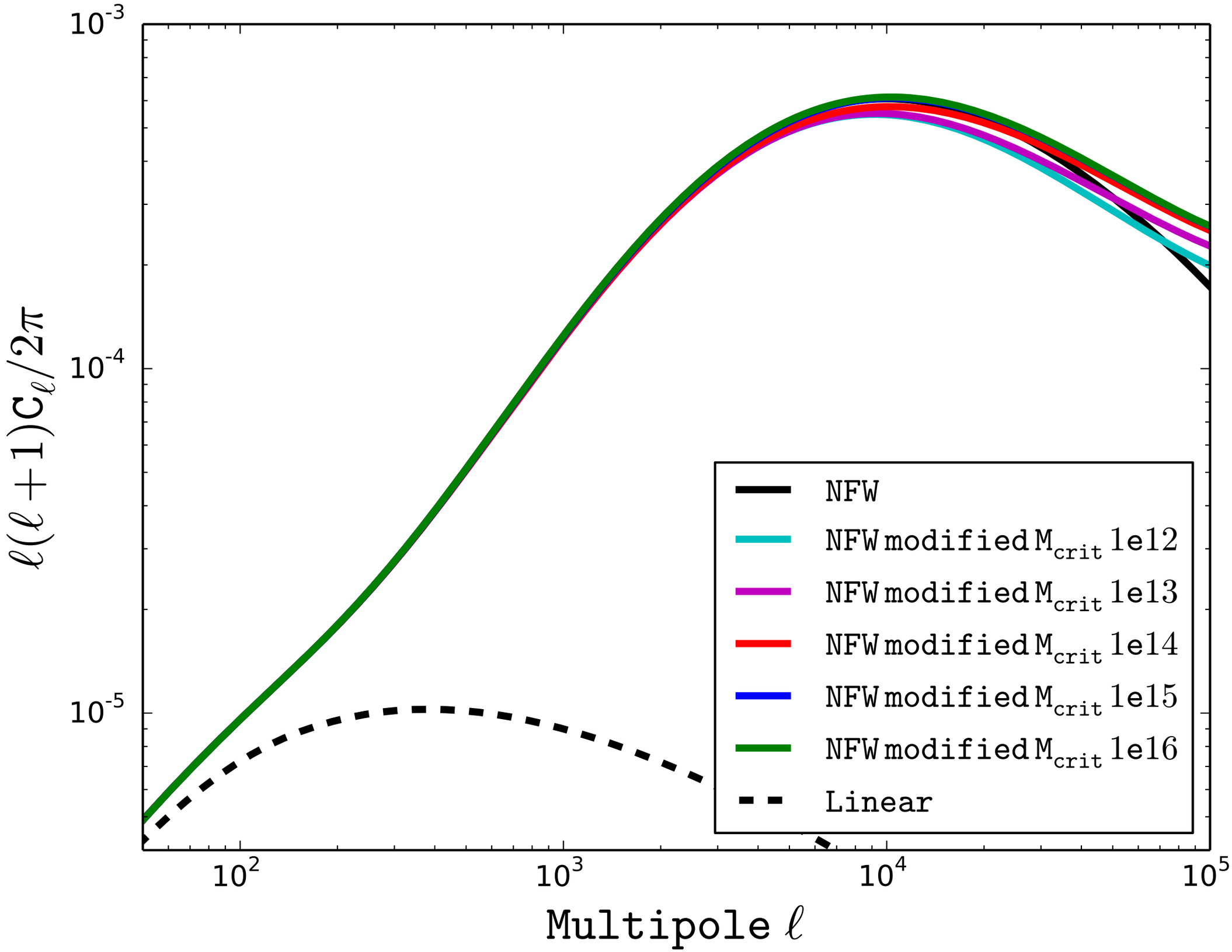
An analytic model for baryons

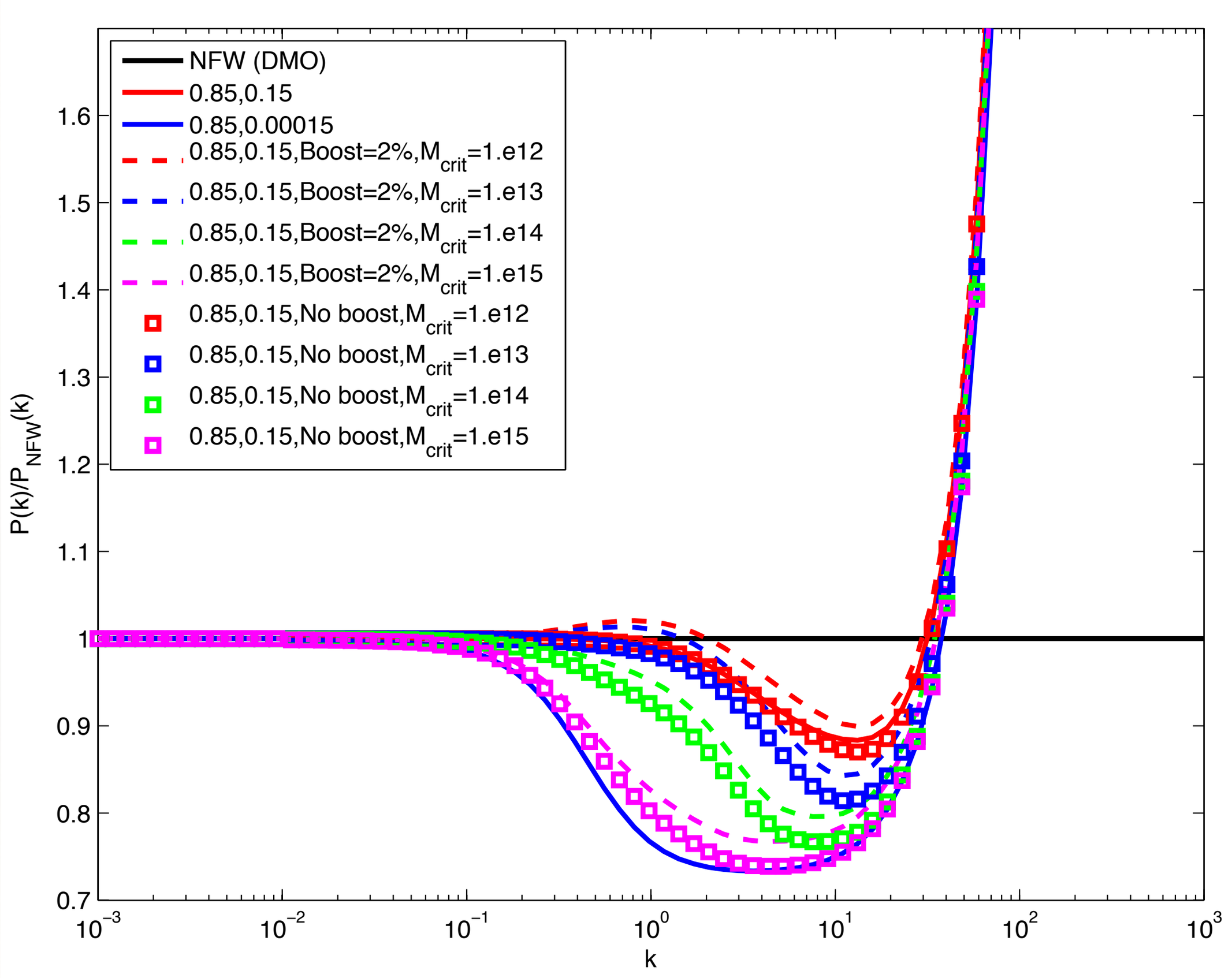
$$\rho^{mNFW}(r) = \rho_{ac}^{NFW}(r) + \rho_{m*}(r) + \rho_{gas}(r),$$

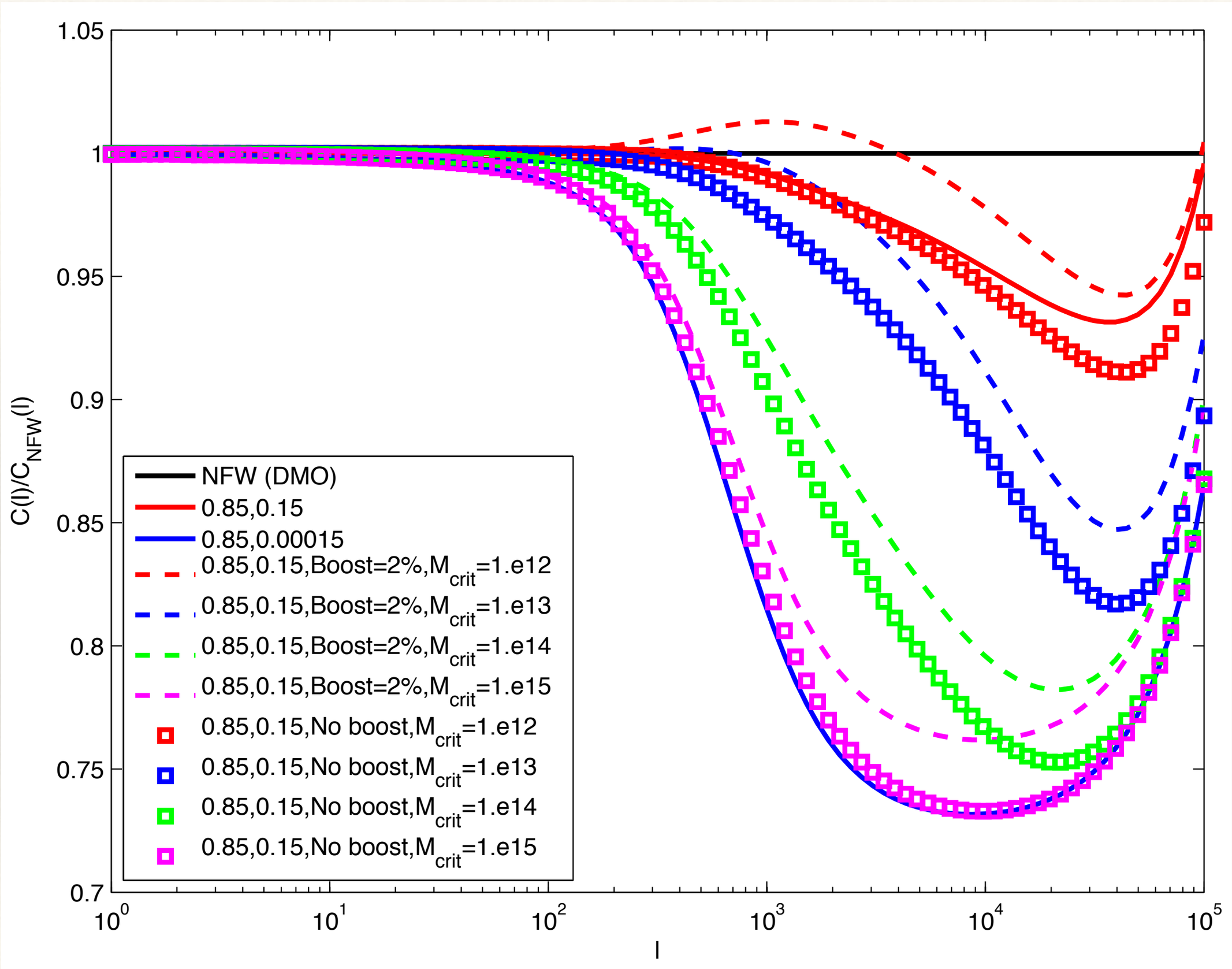
$$f_{\rm gas} = \frac{0.15}{1 + \left(\frac{M_{\rm crit}}{M_{\rm halo}}\right)^{\beta}}$$

$f_{DM\,(AC)} = f_{DM}$ + Boost




10^{-3}
10^{-4}
10^{-5}
$\ell(\ell+1)C_\ell/2\pi$
10^2
10^3
10^4
10^5
Multipole ℓ
NFW
NFW modified M_{crit} 1e12
NFW modified M_{crit} 1e13
NFW modified M_{crit} 1e14
NFW modified M_{crit} 1e15
NFW modified M_{crit} 1e16
Linear


NFW (DMO)
0.85,0.15
0.85,0.00015
0.85,0.15,Boost=2%,M_crit=1.e12
0.85,0.15,Boost=2%,M_crit=1.e13
0.85,0.15,Boost=2%,M_crit=1.e14
0.85,0.15,Boost=2%,M_crit=1.e15
0.85,0.15,No boost,M_crit=1.e12
0.85,0.15,No boost,M_crit=1.e13
0.85,0.15,No boost,M_crit=1.e14
0.85,0.15,No boost,M_crit=1.e15
P(k)/P_NFW(k)
k
1.6
1.5
1.4
1.3
1.2
1.1
1
0.9
0.8
0.7
10^-3
10^-2
10^-1
10^0
10^1
10^2
10^3


1.05
1
0.95
0.9
0.85
0.8
0.75
0.7
$C(l)/C_{NFW}(l)$
10^0
10^1
10^2
10^3
10^4
10^5
l
NFW (DMO)
0.85,0.15
0.85,0.00015
0.85,0.15,Boost=2%,M_{crit}=1.e12
0.85,0.15,Boost=2%,M_{crit}=1.e13
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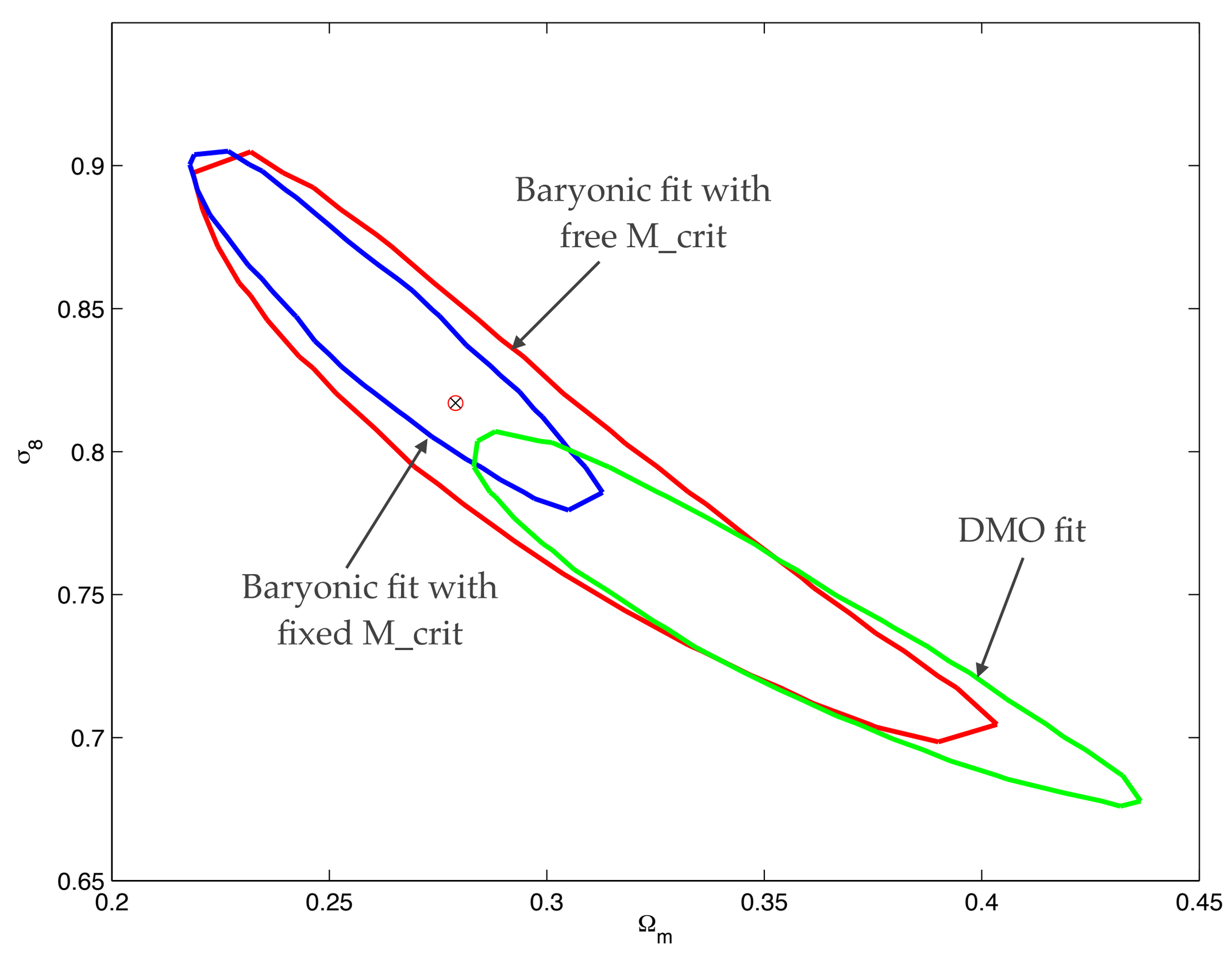
0.85,0.15,No boost,M_{crit}=1.e15


Baryonic fit with
free M_crit
Baryonic fit with
fixed M_crit
DMO fit
0.9
0.85
0.8
0.75
0.7
0.65
σ_8
0.2
0.25
0.3
0.35
0.4
0.45
Ω_m

ongoing…

- Adiabatic contraction,
- Tomography,
- Covariance matrix - Gaussian and non-Gaussian,
- Fisher analysis and MCMC.

Thank you for your attention…