Probability of the most massive cluster under non-Gaussian initial conditions

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Work done with Laura Cayon and Joe Silk

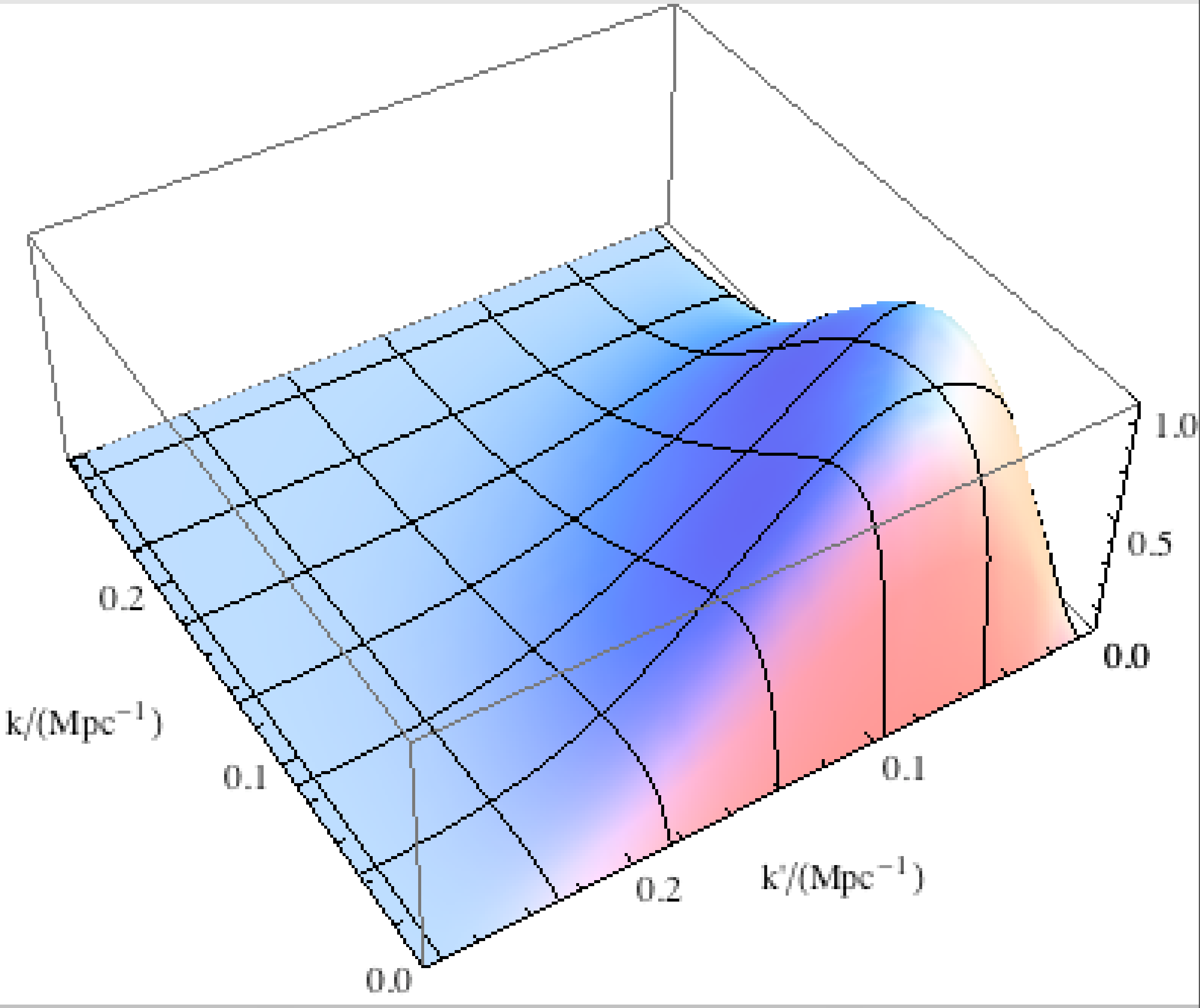
- Mullis et al. (2005) discovered a very massive cluster (XMM2235) at z approx 1.4 using XMM-Newton data.
- Jee et al. (2009) used weak lensing to constrain the mass to be $M_{324} = (6.4 \pm 1.2) \times 10^{14}$
- Probability of measuring a larger mass in a 11 deg^2 survey between z=1.4 and 2.2 is about 3 sigma.

- Local non-Gaussianity:

$$\Phi(x) = \phi(x) + f_{\rm nl}\left(\phi(x)^2 - \langle\phi(x)^2\rangle\right)$$

- Number counts non-Gaussianity enhancement depends on skewness (Matarrese et al. 2000): $\frac{\mathrm{d}n_{ng}}{\mathrm{d}M} = R(S(f_{\rm nl}), M)\frac{\mathrm{d}n}{\mathrm{d}M}$

- fnl can have a step function like behavior (Riotto and Sloth, 2010)



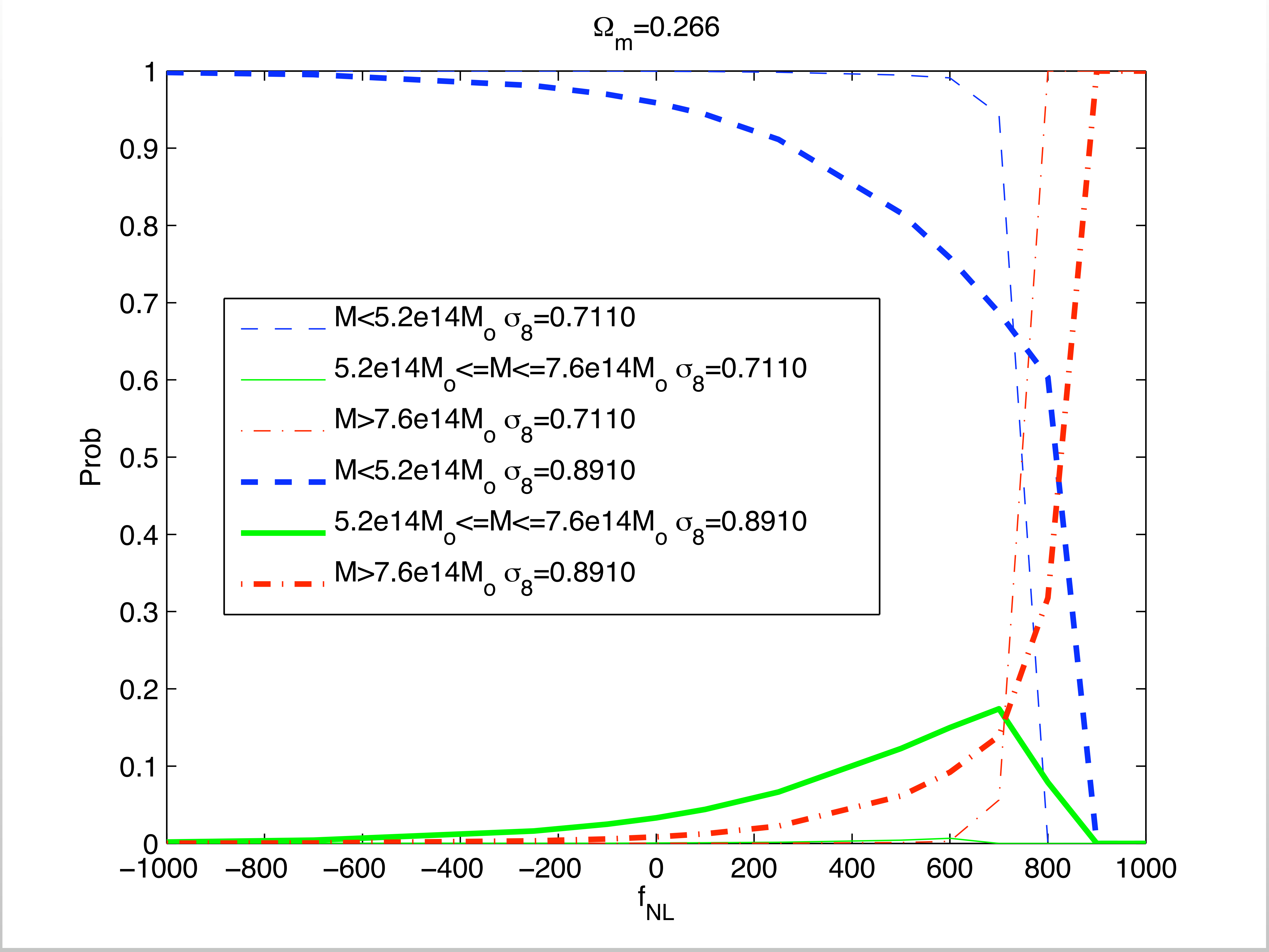
Number counts and Eddington Bias

$$N = f_{\rm sky} \int\int\int {\rm d}z{\rm d}M{\rm d}M_{\rm obs} p(M_{\rm obs}|M) \frac{dV(z)}{dz} \frac{dn_{\rm NG}(M,z,f_{\rm NL})}{dM}$$

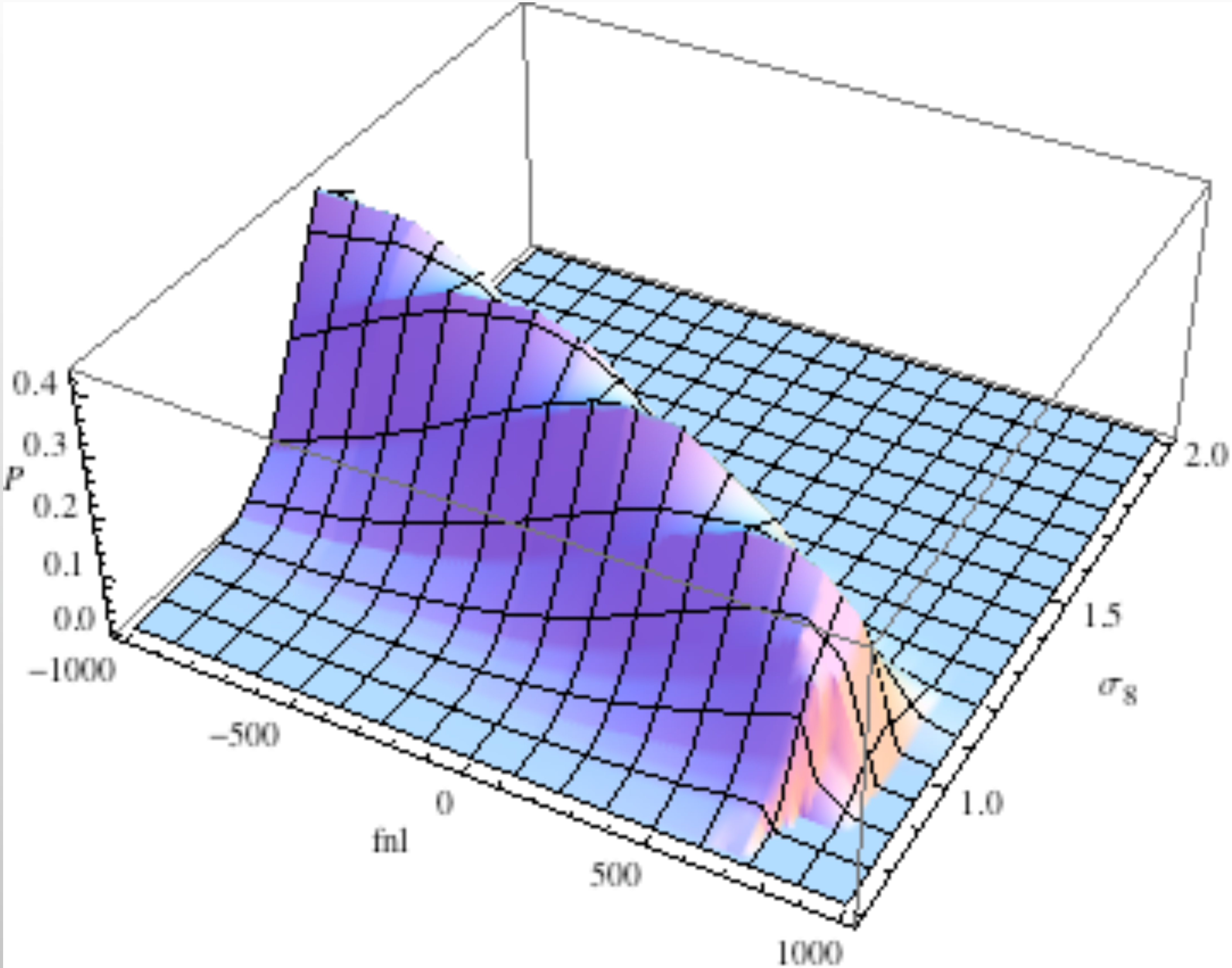
where the measurement error is

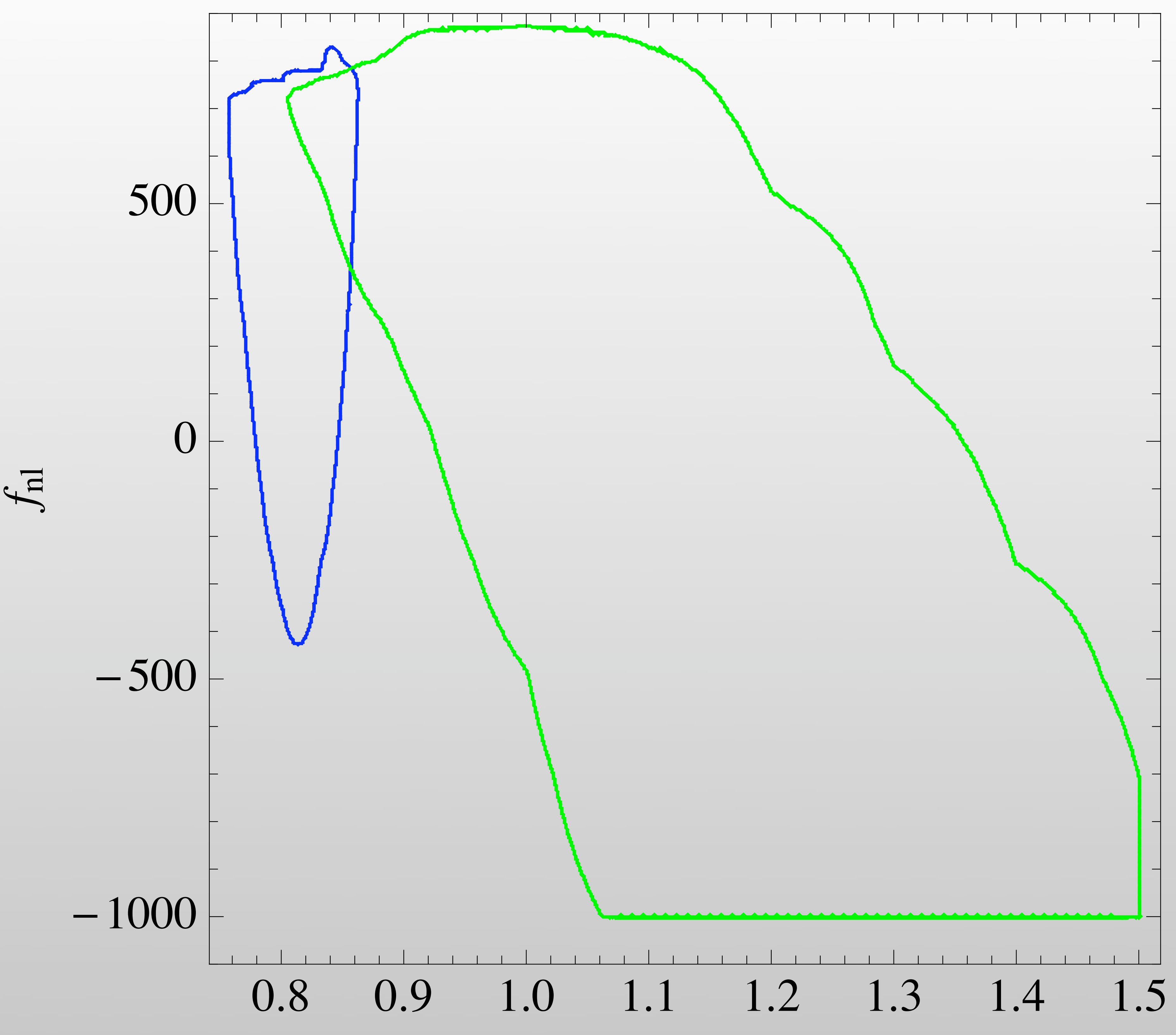
$$p(M_{\rm obs}|M) = {\rm Gaussian}(6.4 \times 10^{14} M_{\circ}, 1.2 \times 10^{14} M_{\circ})$$

The likelihood for the number of clusters can be approximated by a Poisson distribution with a mean of N .

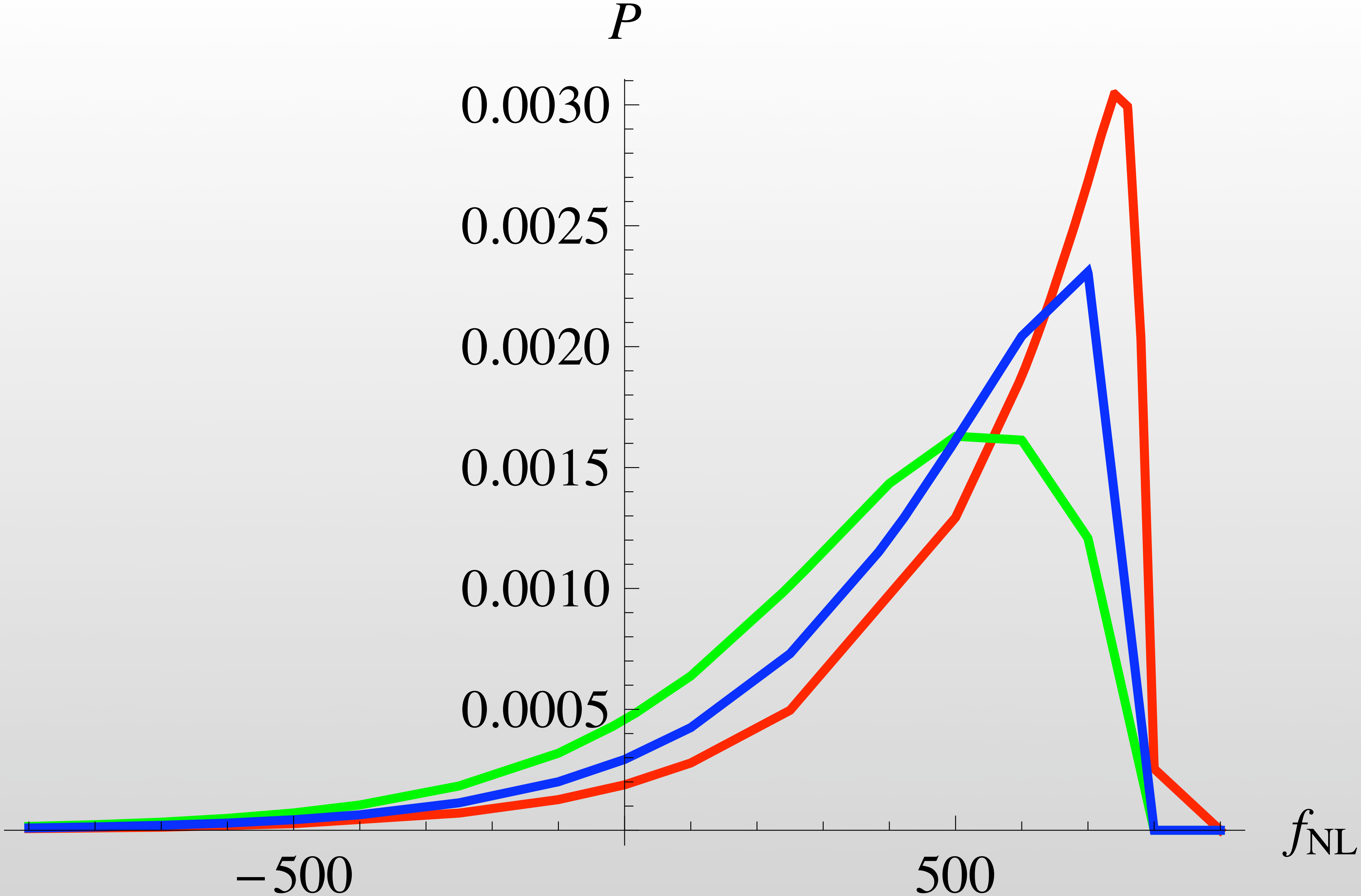


Ωm=0.266
Prob
fNL
M<5.2e14Mo σ8=0.7110
5.2e14Mo<=M<=7.6e14Mo σ8=0.7110
M>7.6e14Mo σ8=0.7110
M<5.2e14Mo σ8=0.8910
5.2e14Mo<=M<=7.6e14Mo σ8=0.8910
M>7.6e14Mo σ8=0.8910
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
−1000
−800
−600
−400
−200
0
200
400
600
800
1000


0.4
0.3
P
0.2
0.1
0.0
−1000
−500
0
fnl
500
1000
1.0
1.5
σ_8
2.0



500
0
−500
−1000
$f_{\rm nl}$
0.8
0.9
1.0
1.1
1.2
1.3
1.4
1.5
σ_8



$$p(f_{NL} > 0|11 \text{ sq. deg.}) = 0.95$$

$$p(f_{NL} > 0|100 \text{ sq. deg.}) = 0.92$$

$$p(f_{NL} > 0|286 \text{ sq. deg.}) = 0.88$$

- For fsky =11 deg. sq. and wave numbers greater than about 0.1 inverse Mpc the XMM2235 cluster's mass is inconsistent with non-Gaussianity at < 5% level.
- Taking into account other cluster surveys and assuming they would be able to detect similar high redshift clusters then the inconsistency of just XMM2235 decreases to about < 12% level.
- But, taking into account other high redshift clusters as recently done by Hoyle et al. and Enqvist et al. also shows tension with Gaussianity.