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Measurement of dark matter halo concentrations using a bayesian approach

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ABSTRACT
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1 INTRODUCTION

(Navarro et al. 1997)

2 BASICS OF THE NFW PROFILE

The Navarro-Frenk-White mass profile can be normalized respect to the virial mass and written in function of the normalized radius respect to the virial radius r_{norm} and the concentration c

$$m_{nfw}\left(r_{norm}, c\right) = A\left[\log\left(1 + r_{norm}c\right) - \left(\frac{1}{r_{norm}c} + 1\right)^{-1}\right]$$

Where A is a normalization constant such that $m_{nfw}\left(1, c\right) = 1$

3 BAYESIAN METHOD

In order to obtain a mass profile for each halo in funcion of the radius, the center of each halo must be calculated. However the center of mass will not give an accurate position for the center because some haloes are highly irregular, is more convenient to take the gravitational potential for each particle

$$\phi\left(\boldsymbol{R}_n\right) = -\sum_{j\neq n}\frac{1}{\|\boldsymbol{R}_n - \boldsymbol{R}_j\|}$$

Take $\boldsymbol{R}_0 = \min\left(\phi\left(\boldsymbol{R}_n\right)\right)$ as the center then define new coordinates $\boldsymbol{R}'_n = \boldsymbol{R}_0 - \boldsymbol{R}_n$, this $\boldsymbol{R}_0$ will be in the most relevant region for the dynamics of each halo. Organizing the $\{\boldsymbol{R}'_n\}$ in crescent order, the accumulated mass for each $\boldsymbol{R}'_n$ will be $M_n = nM$.

Then the virial radius is obtained and the particles that are beyond the virial radius are removed. After that both the mass and the radius get normalized respect to the mass and virial radius, we will call these new variables m_n and r_n. The last part of the process consists in fitting the normalized NFW mass profile to the m_n data using the Metropolis-Hastings algorithm to sample the Likelihood $\mathcal{L}\left(c\right) = \exp\left(-\chi^2\left(c\right)\right)$ where

$$\chi^2\left(c\right) = \sum_n\left|m_n - m_{nfw}\left(r_n, c\right)\right|^2$$

And taking the values of c where the Likelihood is maximum. Finally we compare this results with the values obtaned by BDM, since the number of halos obtained by FOF and BDM is different, each BDM halo gets related with the nearest halo in FOF. We compute two concentrations, one where the overdensity limit is $360\rho_{back}$ (like in BDMV) an other where the overdensity limit is $740\rho_{back}$ (like in BDMW).

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Figure 1. FIXME: Mass profile of a halo

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Figure 2. FIXME: Test results

4 MOCK DATA AND SIMULATIONS

5 RESULTS

5.1 Trial Problem with several Generated Halos

To be sure that the results are reasonable, several tests were performed generating halos from the Navarro-Frenk-White profile with known values for ρ_0 and r_s. The center of the generated halos is $\mathbf{0} = (0, 0, 0)$ so we can determine how good estimate is the minimum of the potential at the center of each halo. Two types of tests were run: The first omitting the calculation of the center of each halo and assuming that is $\mathbf{0}$ and second by calculating the center as the minimum of the potential.

5.2 Results from the simulations

5.3 What kind of implications (Low resolution simulations, other fitting algorithms)

6 DISCUSSION

7 CONCLUSIONS

REFERENCES

Navarro J. F., Frenk C. S., White S. D. M., 1997, ApJ, 490, 493