Title: Approaches to Dark Matter Halo Substructure

Date: Jun 07, 2008 11:00 AM

URL: http://pirsa.org/08060006

Abstract:

Applications of Analytic Models of Halo Substructure

Andrew R. Zentner
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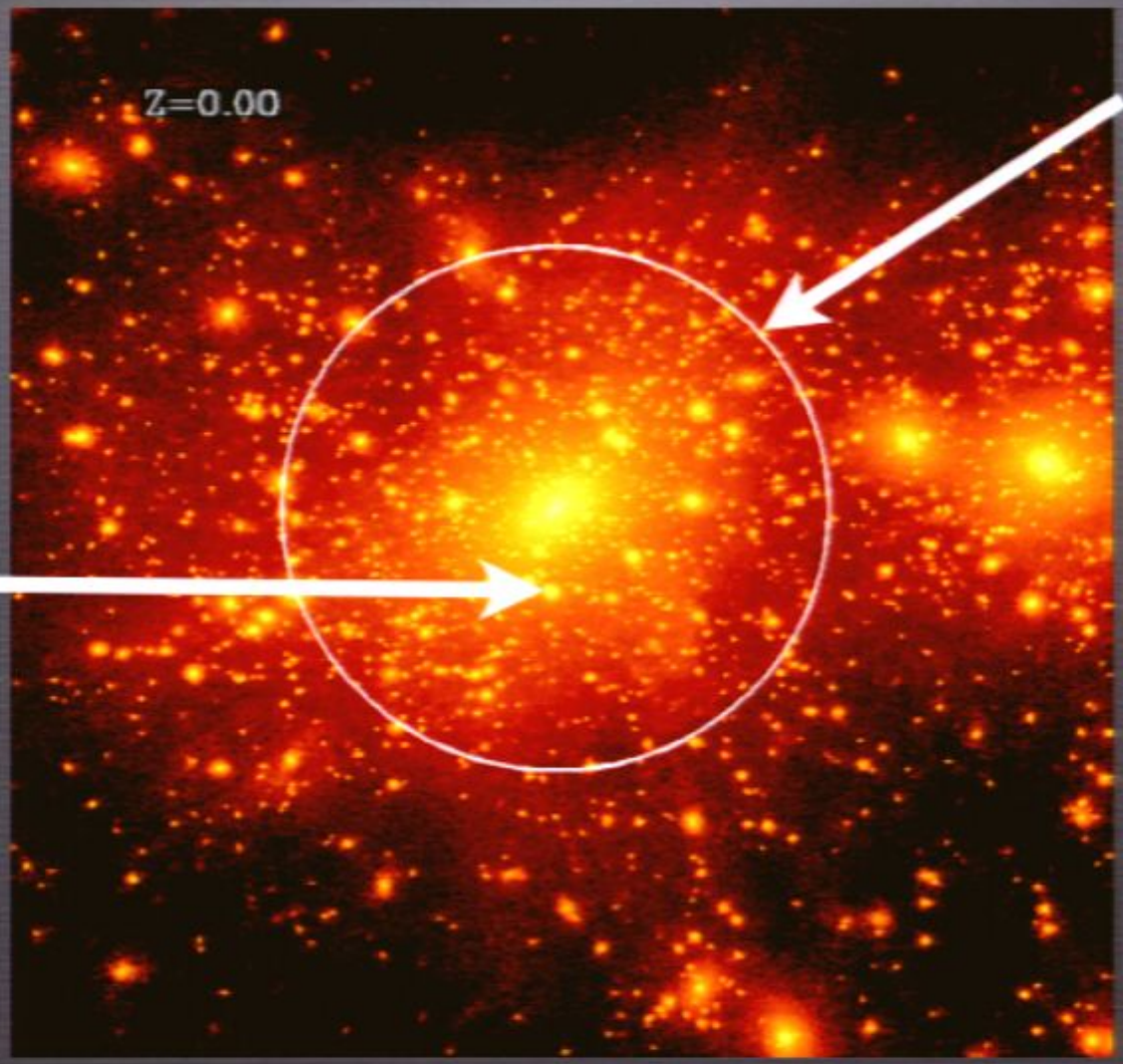
Analytic Modelers


CHANGE
WE CAN BELIEVE IN
OBAMA'08

ΛCDM On Nonlinear Scales



Virial Radius where $\delta\rho/\rho \sim 200$

$M_{VIR} \sim 10^{12} M_{sun}/h$

$R_{VIR} \sim 275$ kpc/h

In this talk, "substructure" means "subhalo"

Analytics: Useful Advantages

- Simple, easy to dissect
- Fast, easy to compute
- No inherent resolution limits
- Can be used to extrapolate from simulations and/or to build up large statistical samples

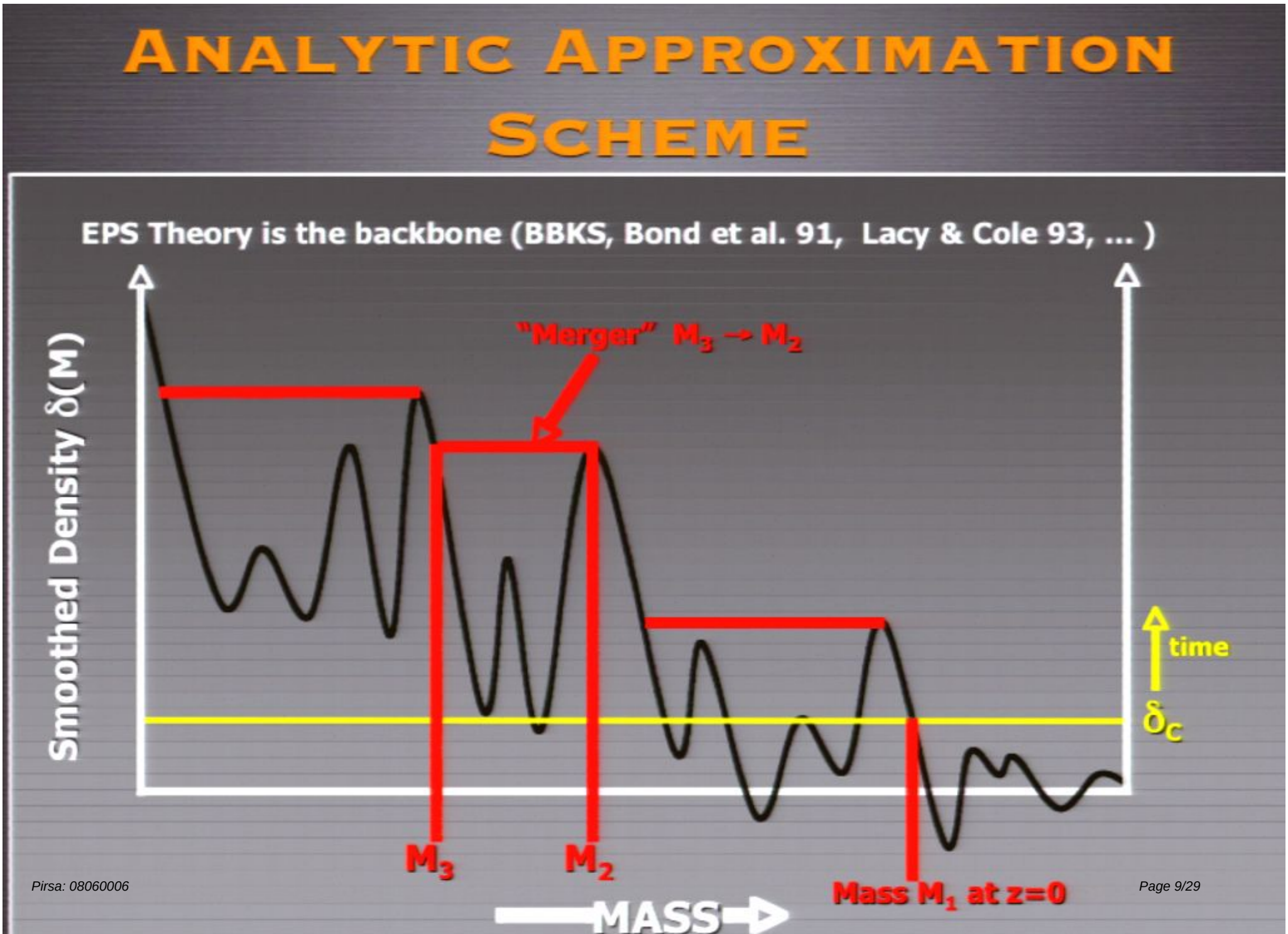
Analytics: Disadvantages

- Approximate
- Moreover! -- Approximate in a way that is not systematically controllable
- Contain a difficult-to-assess and potentially-important systematic error

Analytic Techniques

Photo: A. Kravtsov

Analytic Approximation Scheme



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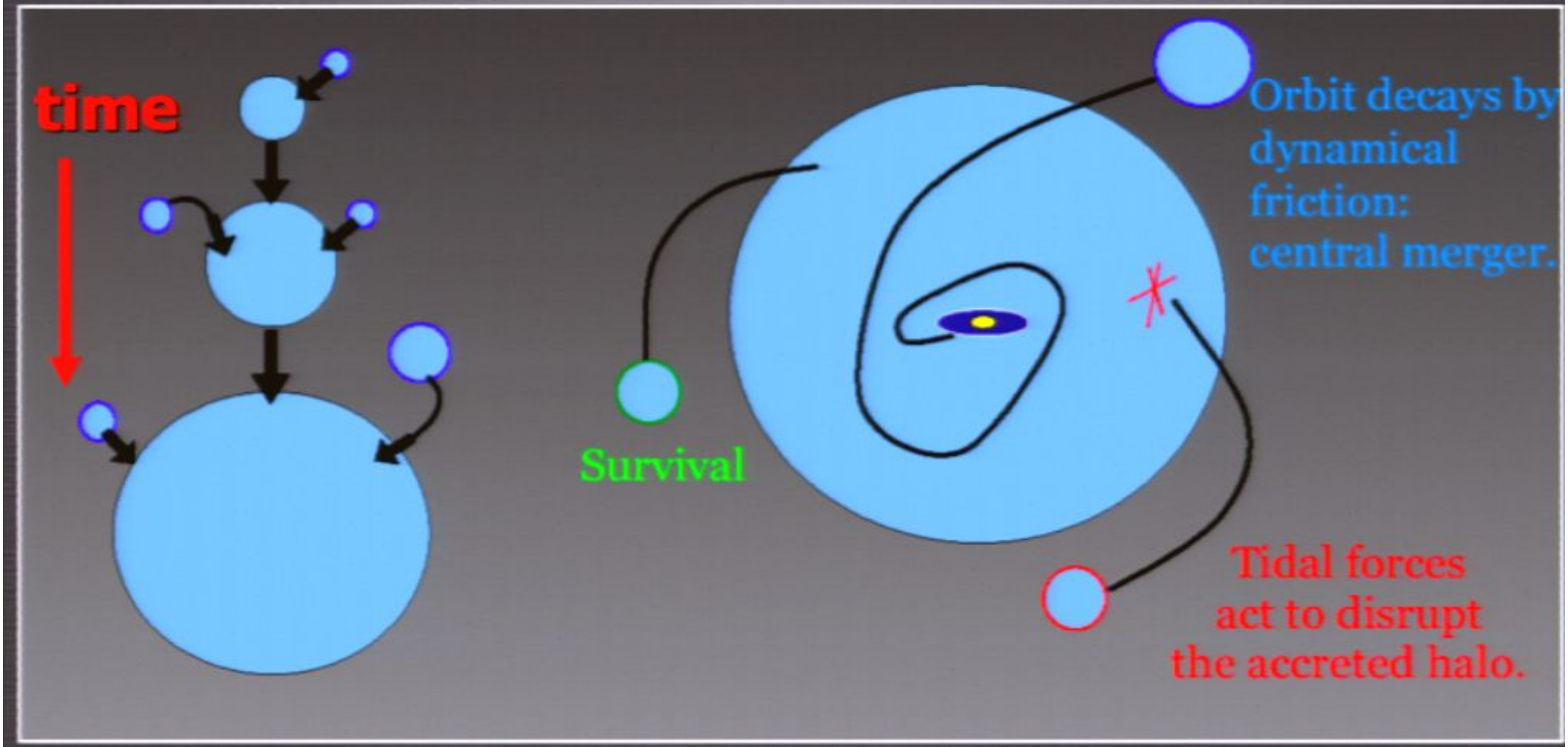
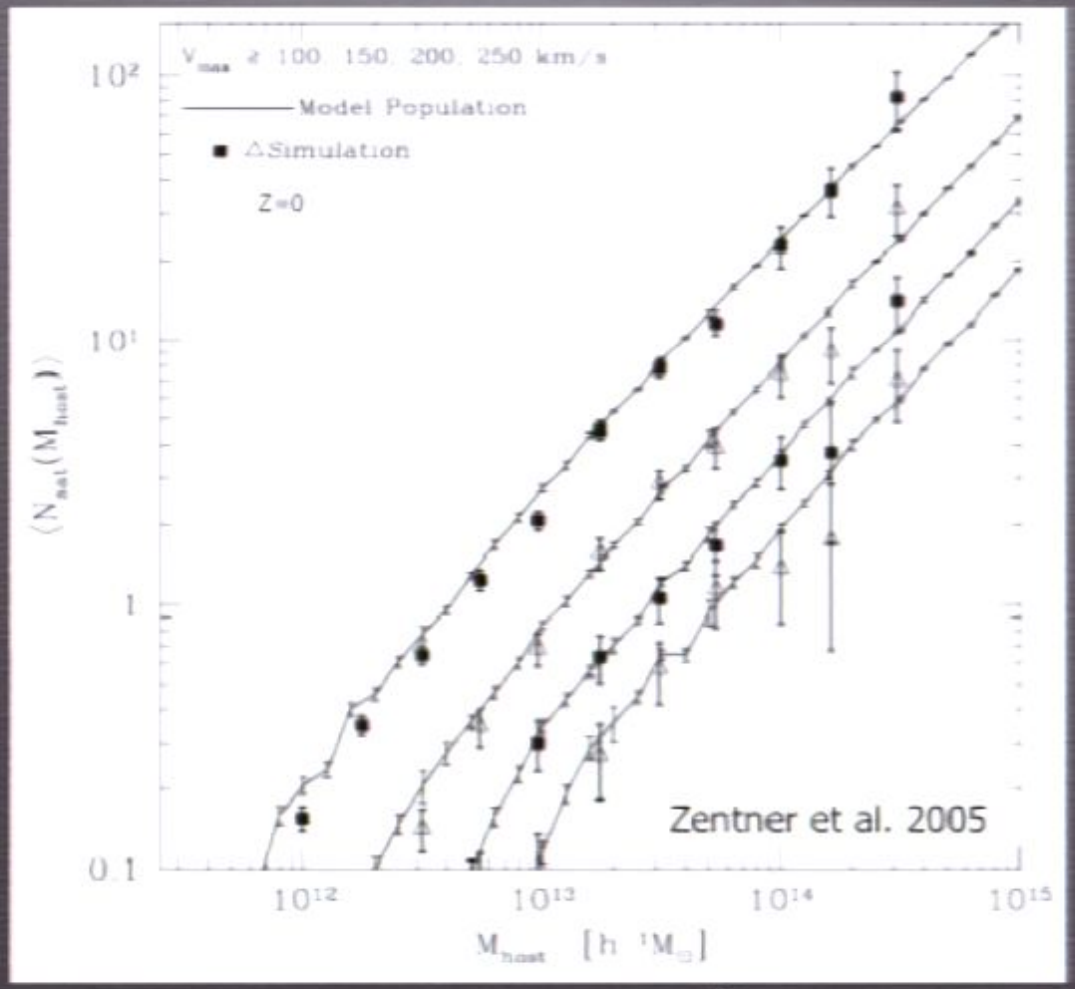


Gnedin & Ostriker 1999; Gnedin, Ostriker, & Hernquist 2000; Taffoni et al. 2002; Taylor &

Subhalo Populations: Halo Occupation Distribution

Mean Halo Occupation $\langle N_{SUB}(M_{HOST}) \rangle$

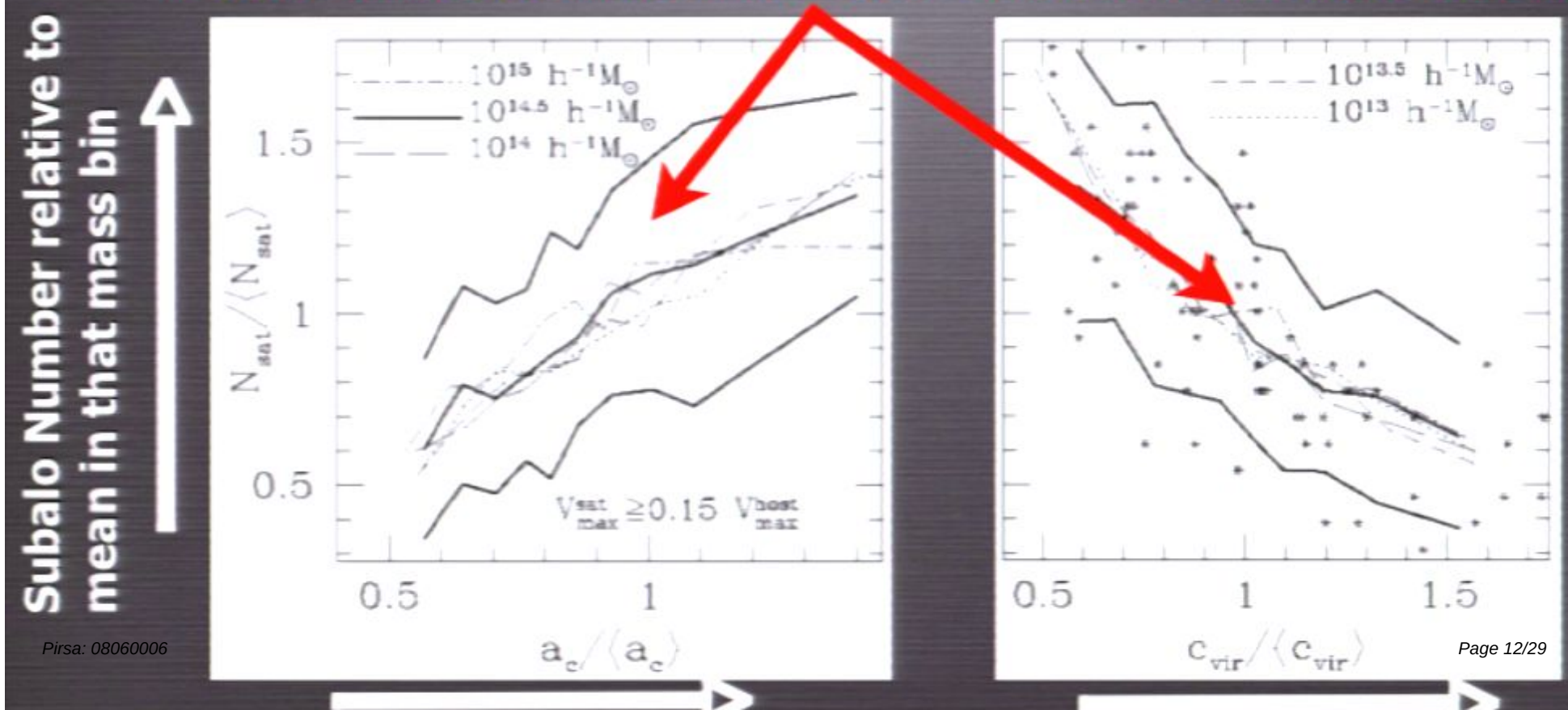


Correlations Between Host and Subhalo Properties

Subhalo/mass accretion history controls the competition in

***Accretion* vs. destruction**

Early-Forming Halos: Less Substructure



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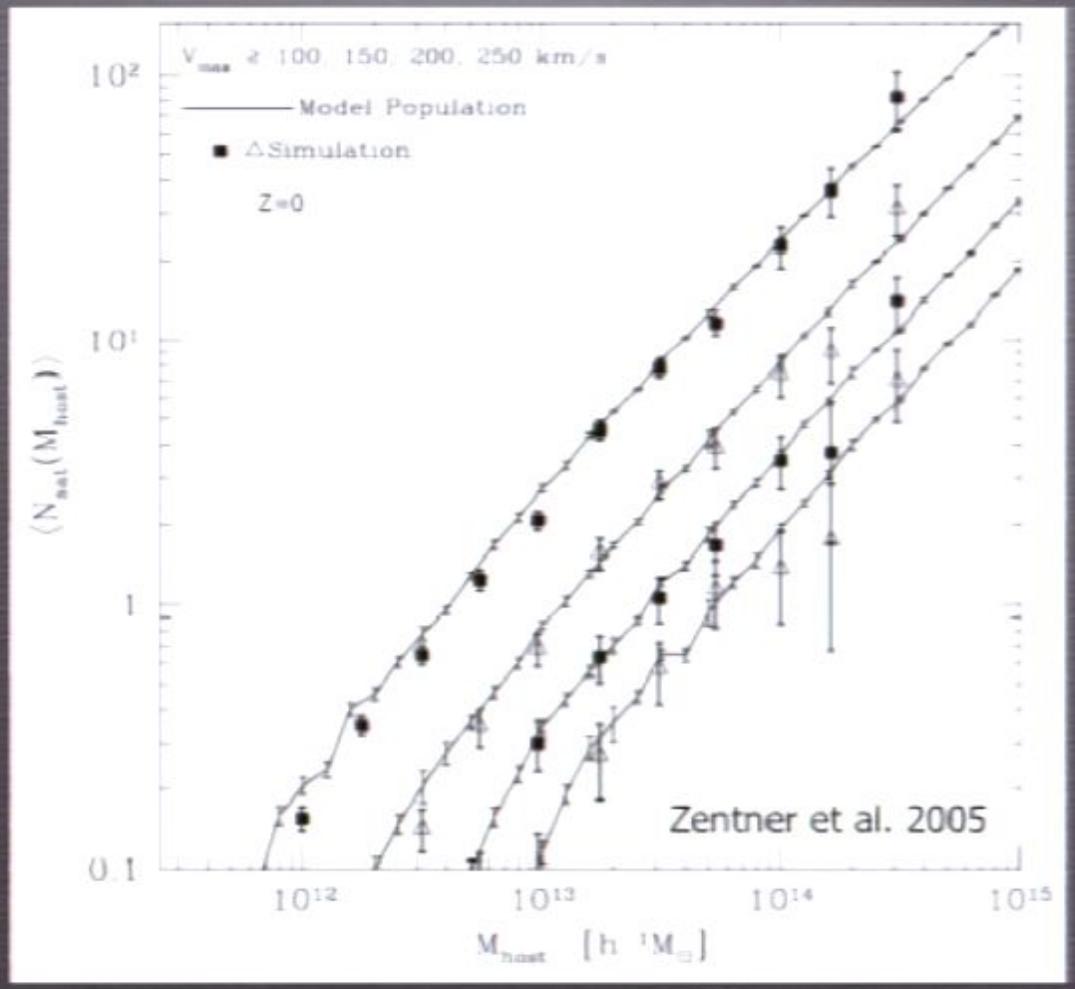

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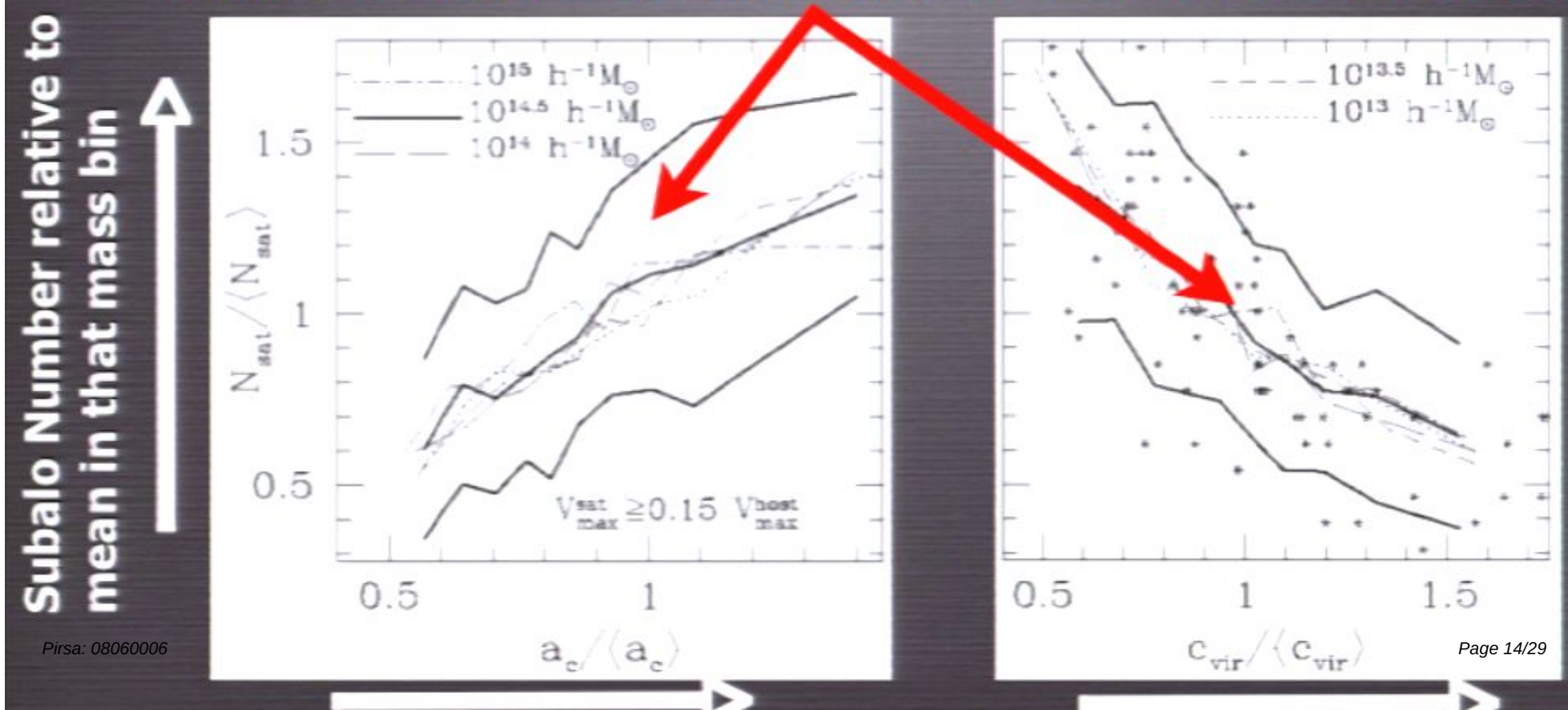
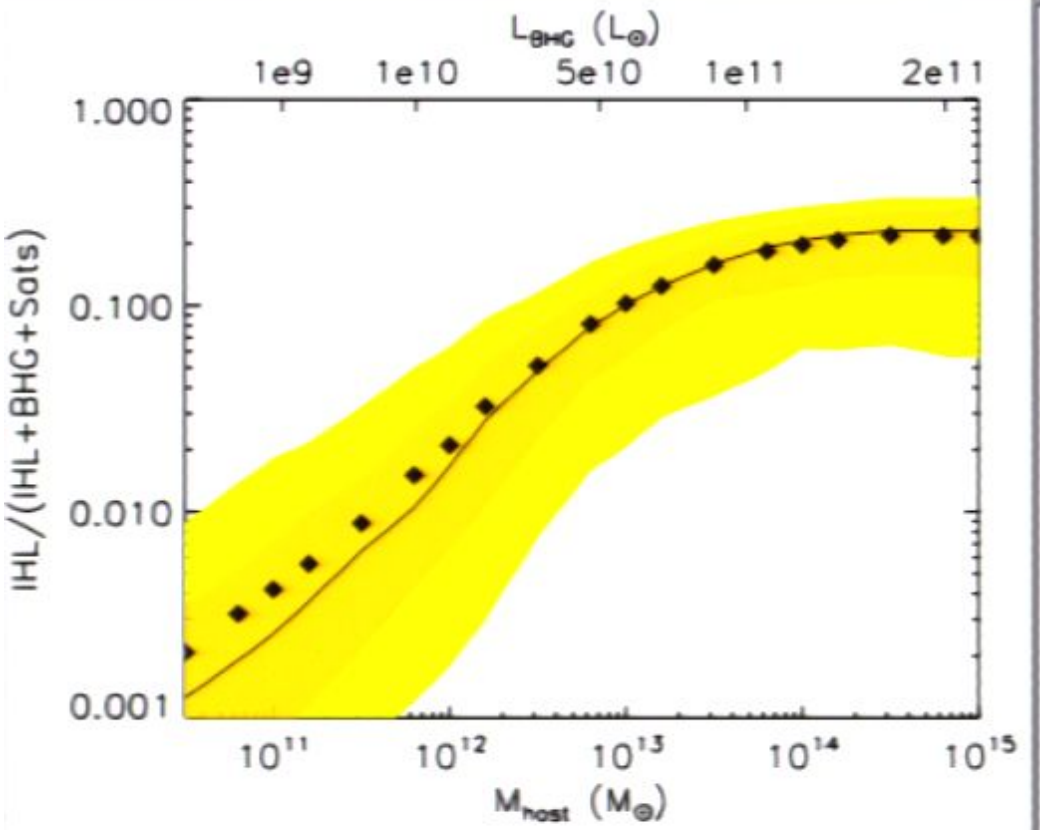
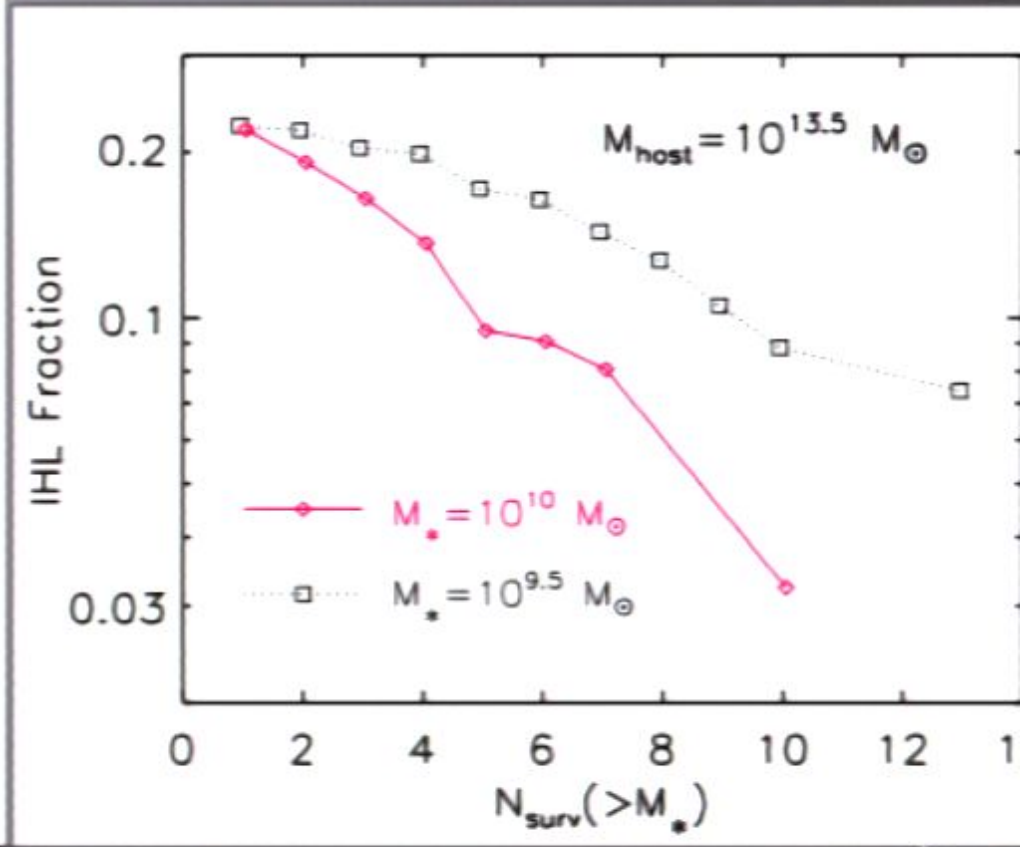


Diffuse Intra-Cluster Light





Total mass of System

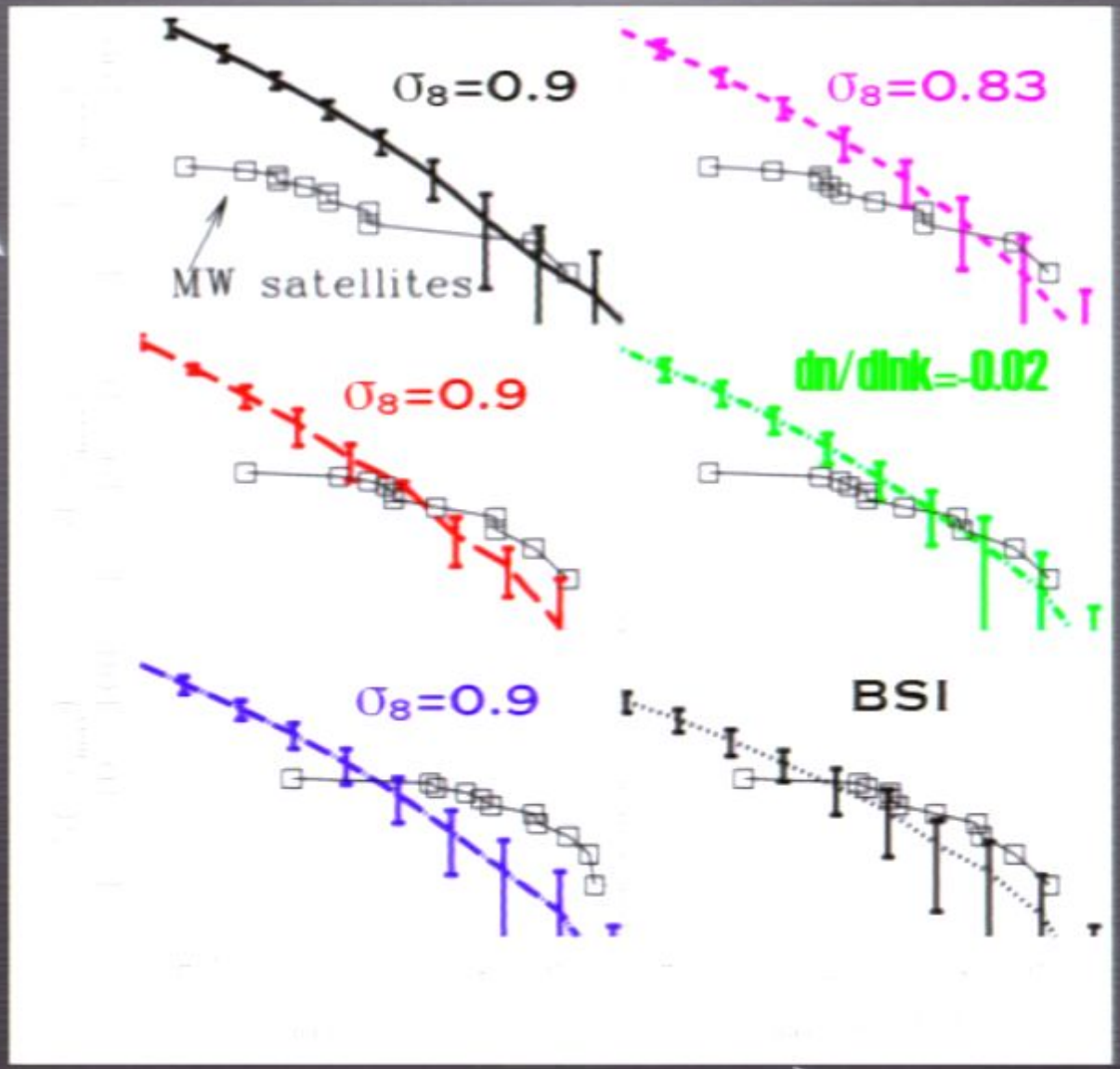
Number of luminous Satellite

- **Predict abundance and scatter in intra-halo light at fixed total mass, origin of scatter**

Substructure in the Milky Way & Other Galaxies

- **Rather than a substructure "problem", this is a proving ground, to test**
  - Structure formation on small scales
  - The nature of the dark matter

The Milky Way Satellites



Number of satellites, $N(>V_{MAX})$

Maximum Circular Velocity

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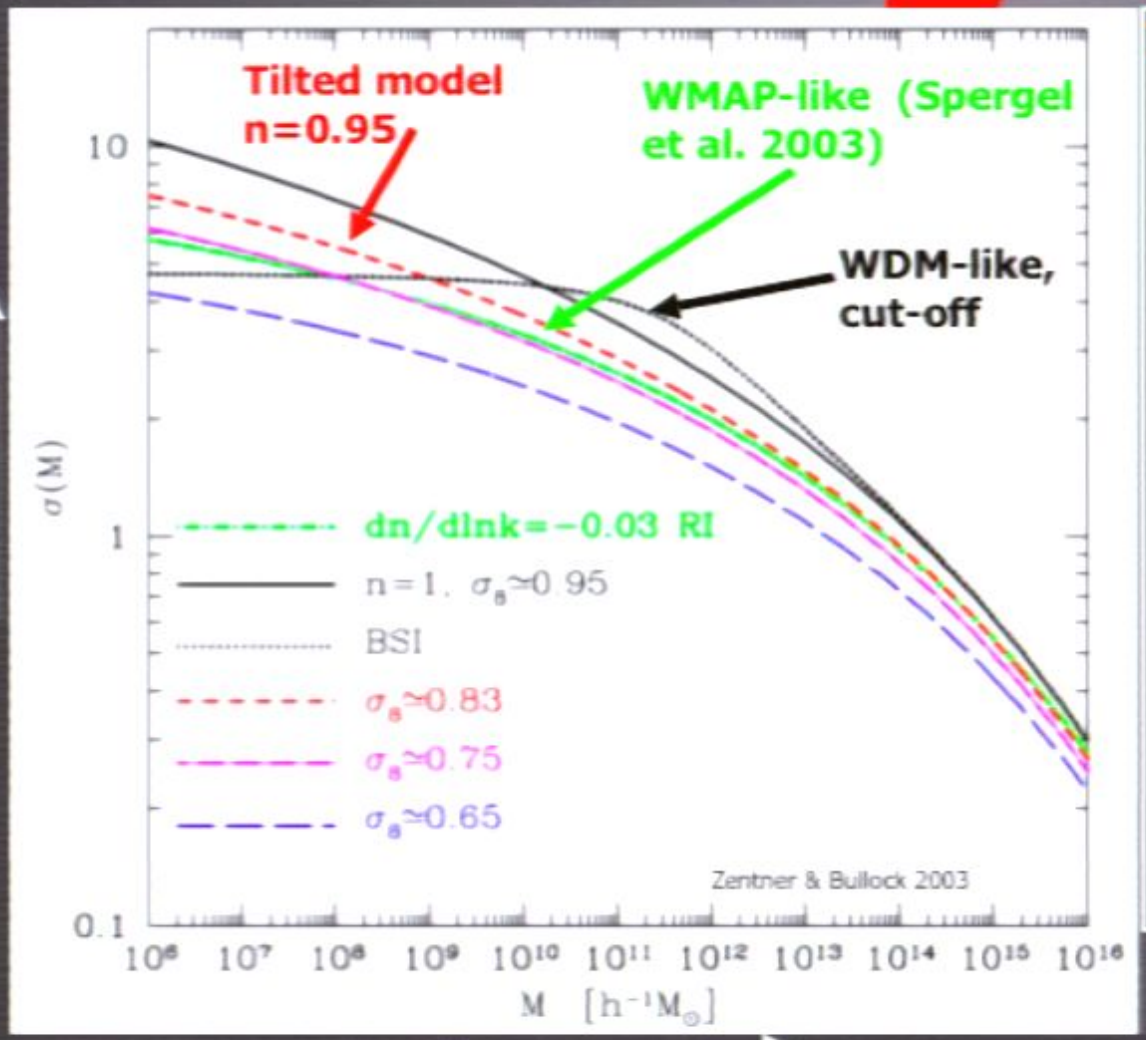

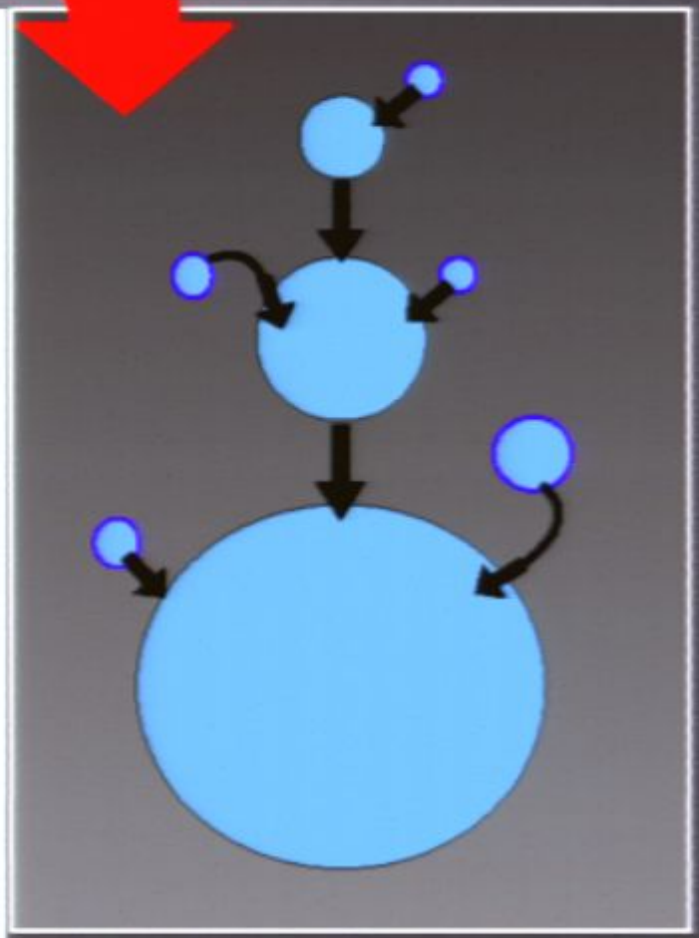

rms density fluctuation

Mass scale ∝ (length scale)$^{1/3}$

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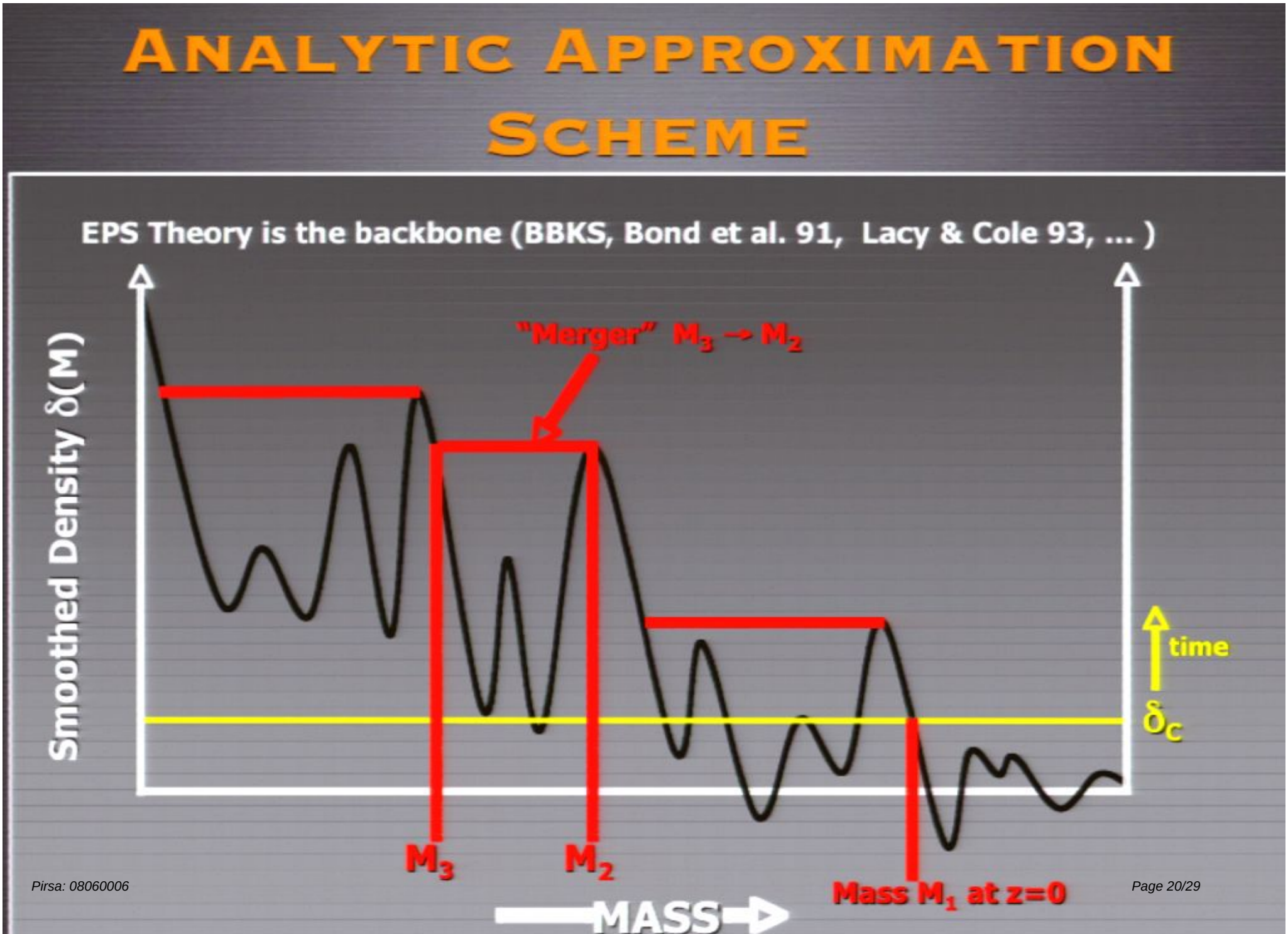

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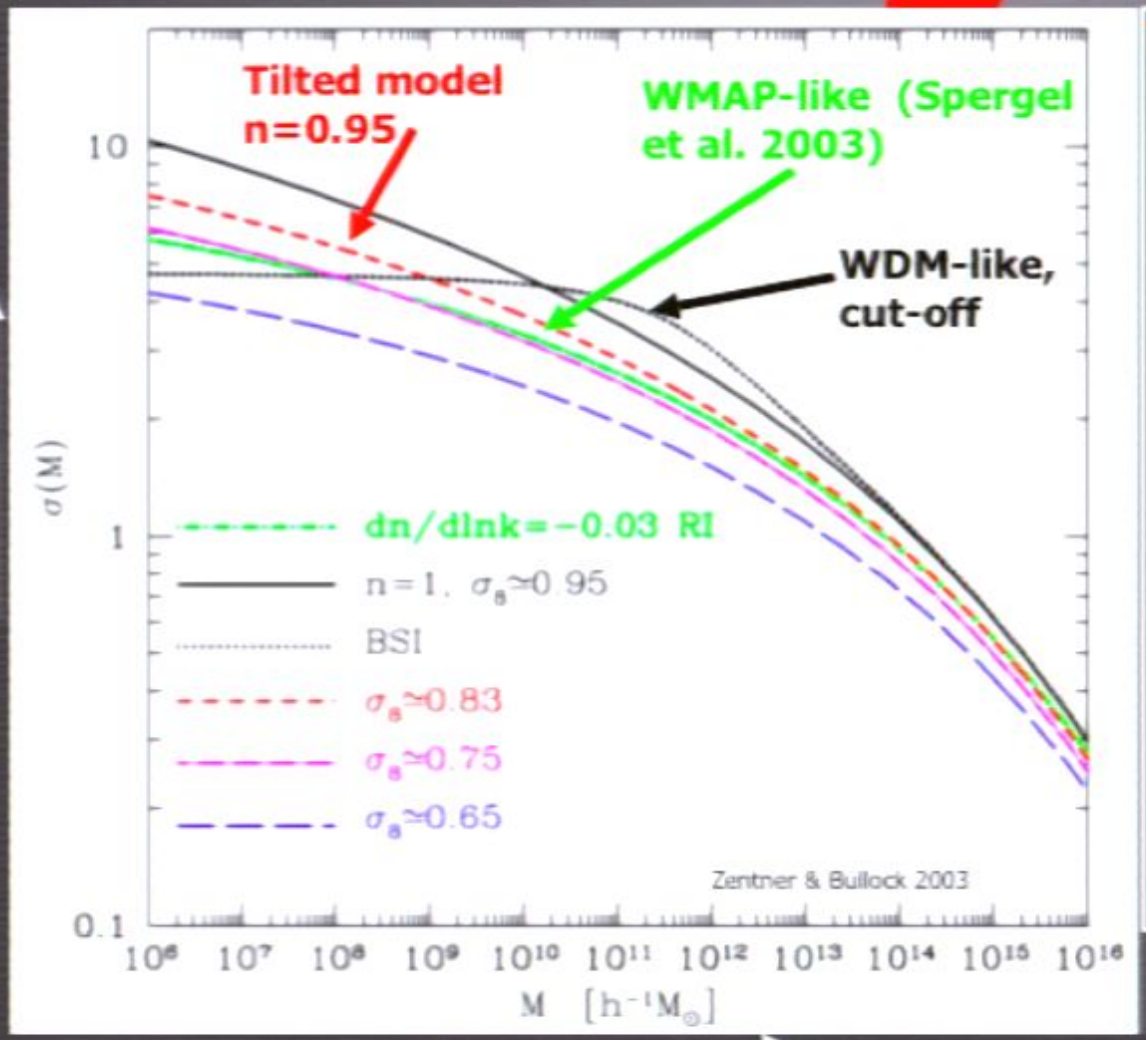

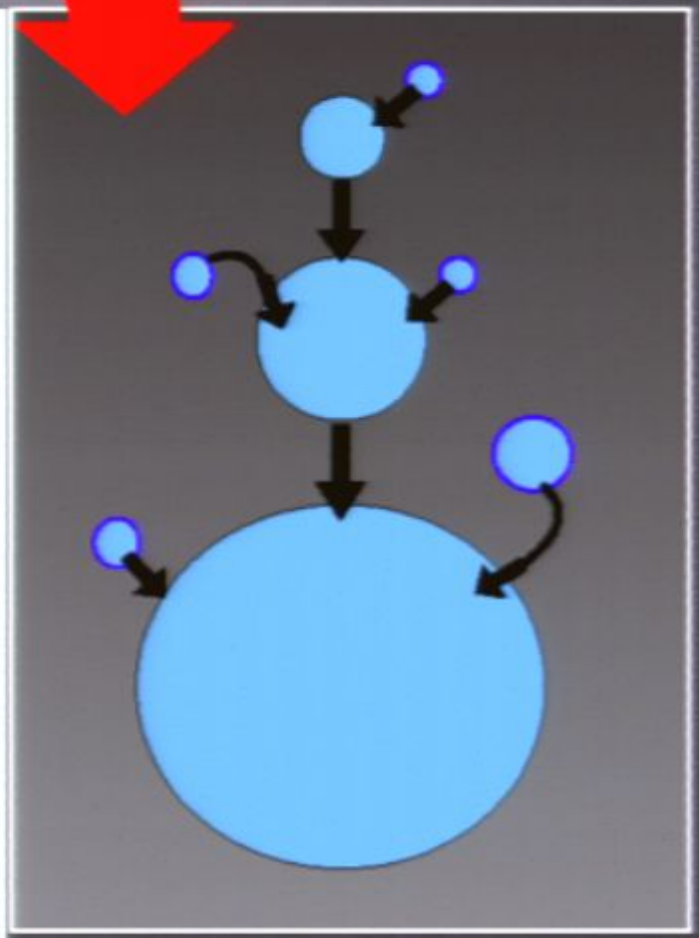

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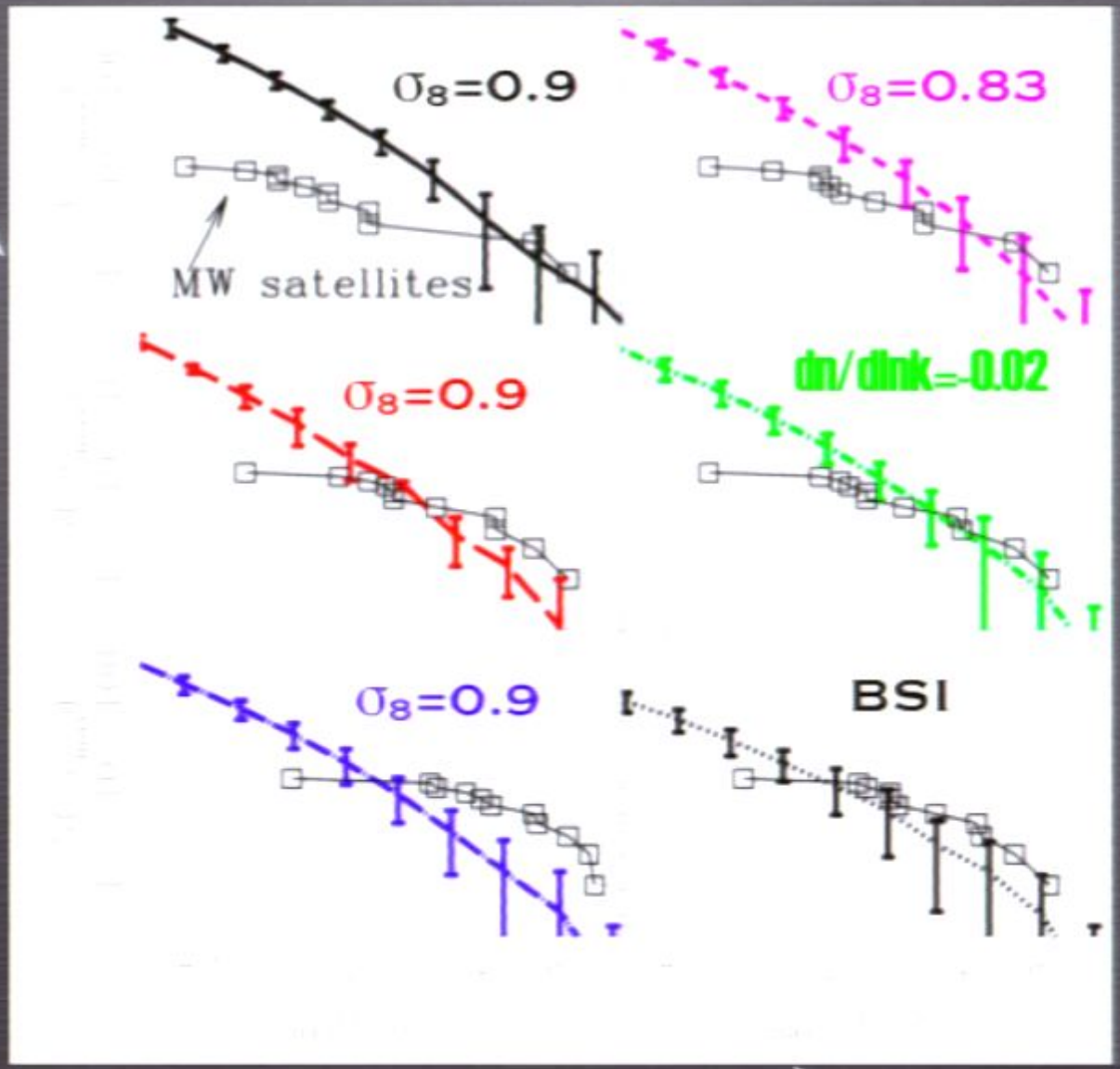

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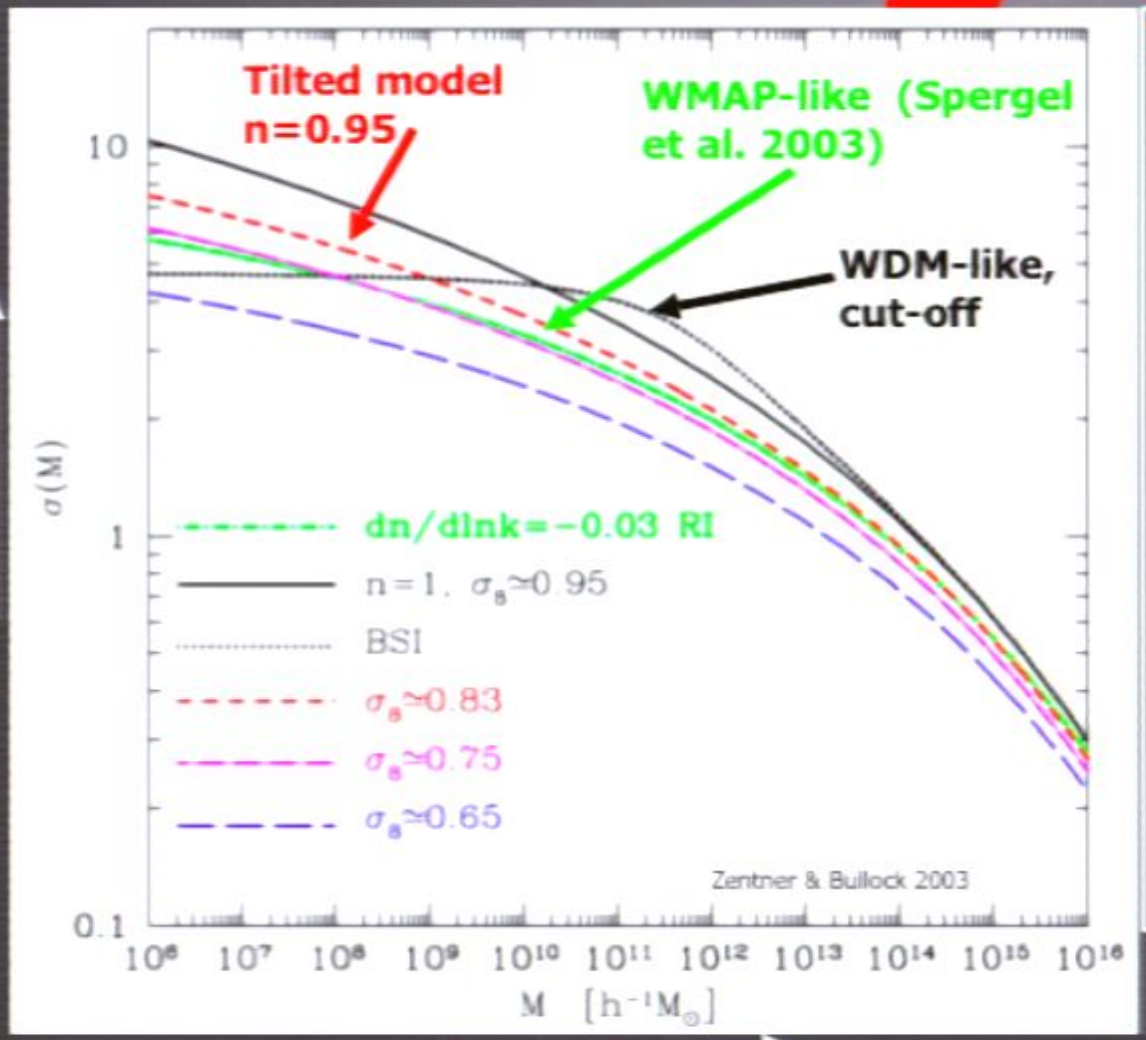

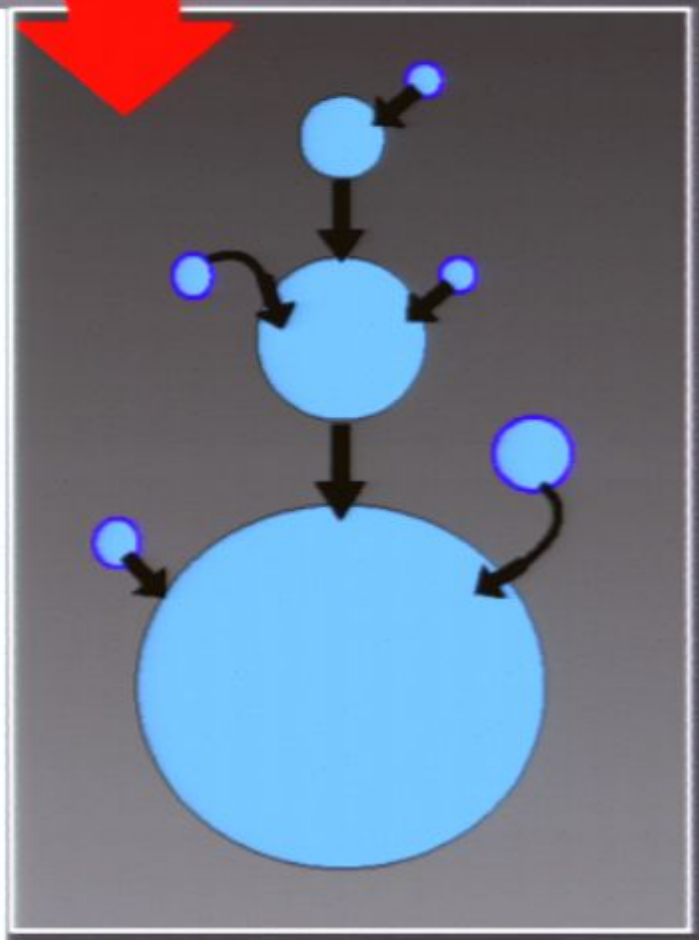

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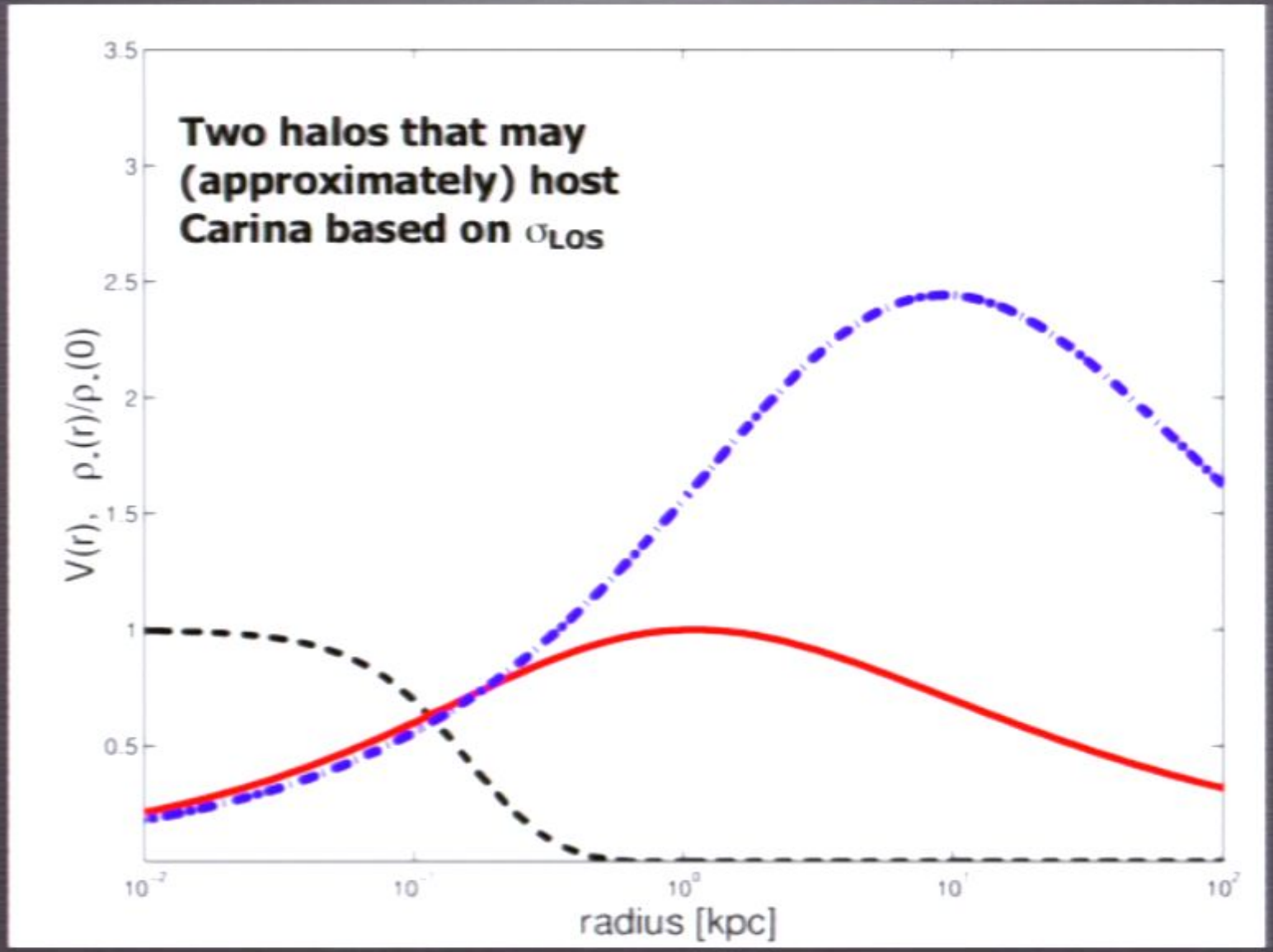
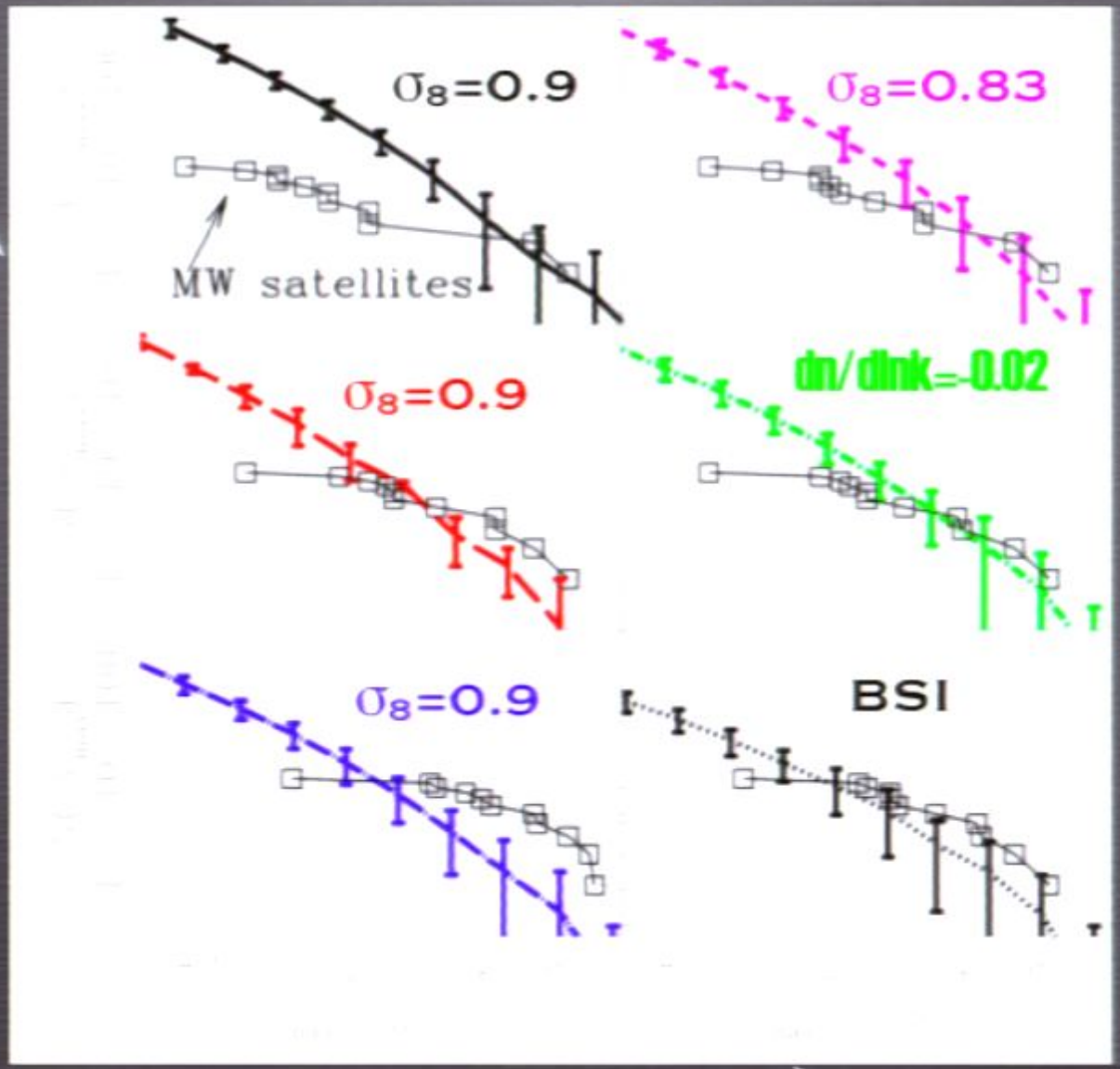


Black: stellar distribution
Colors: halo circular velocity

radial position

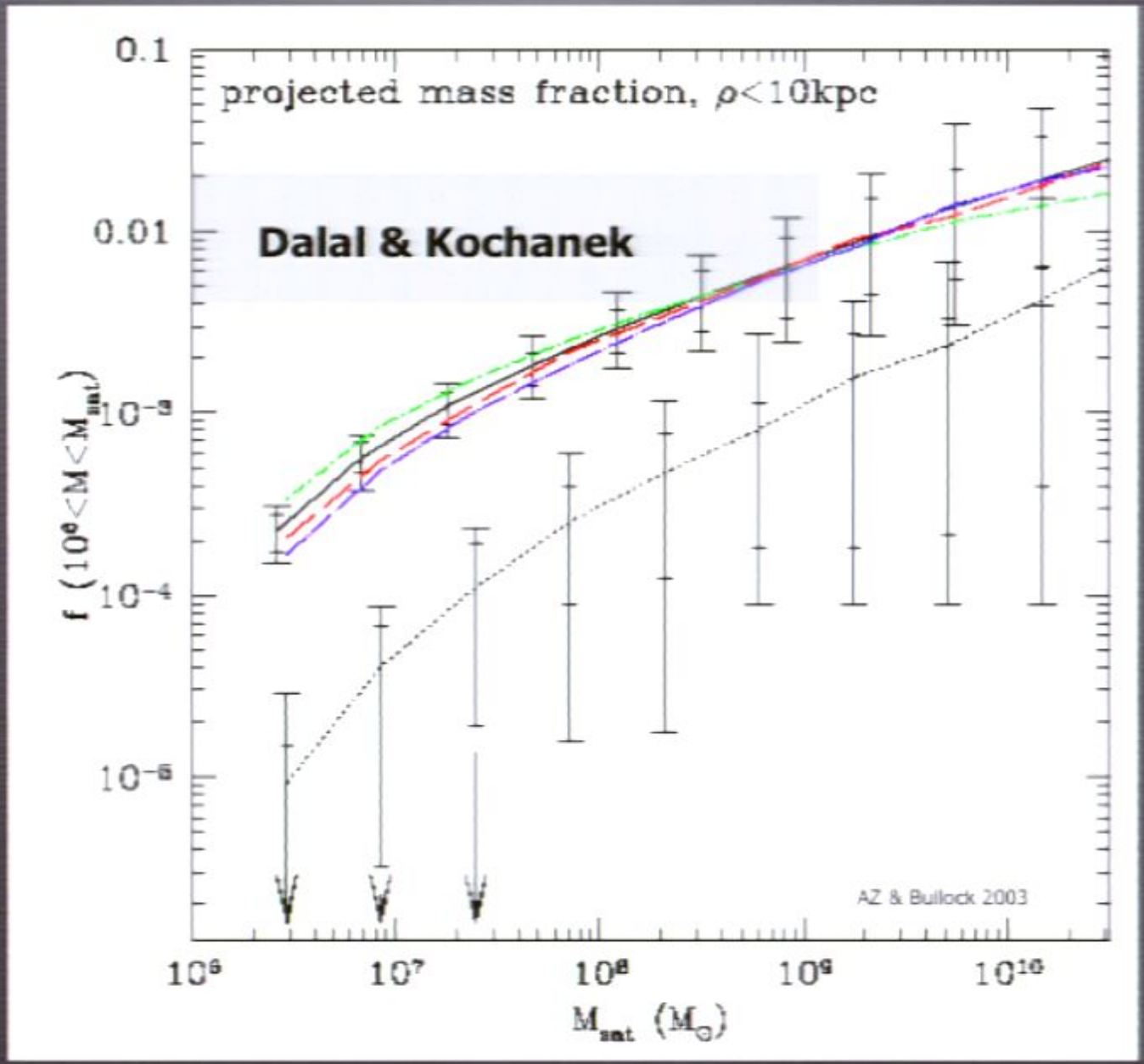
The Milky Way Satellites



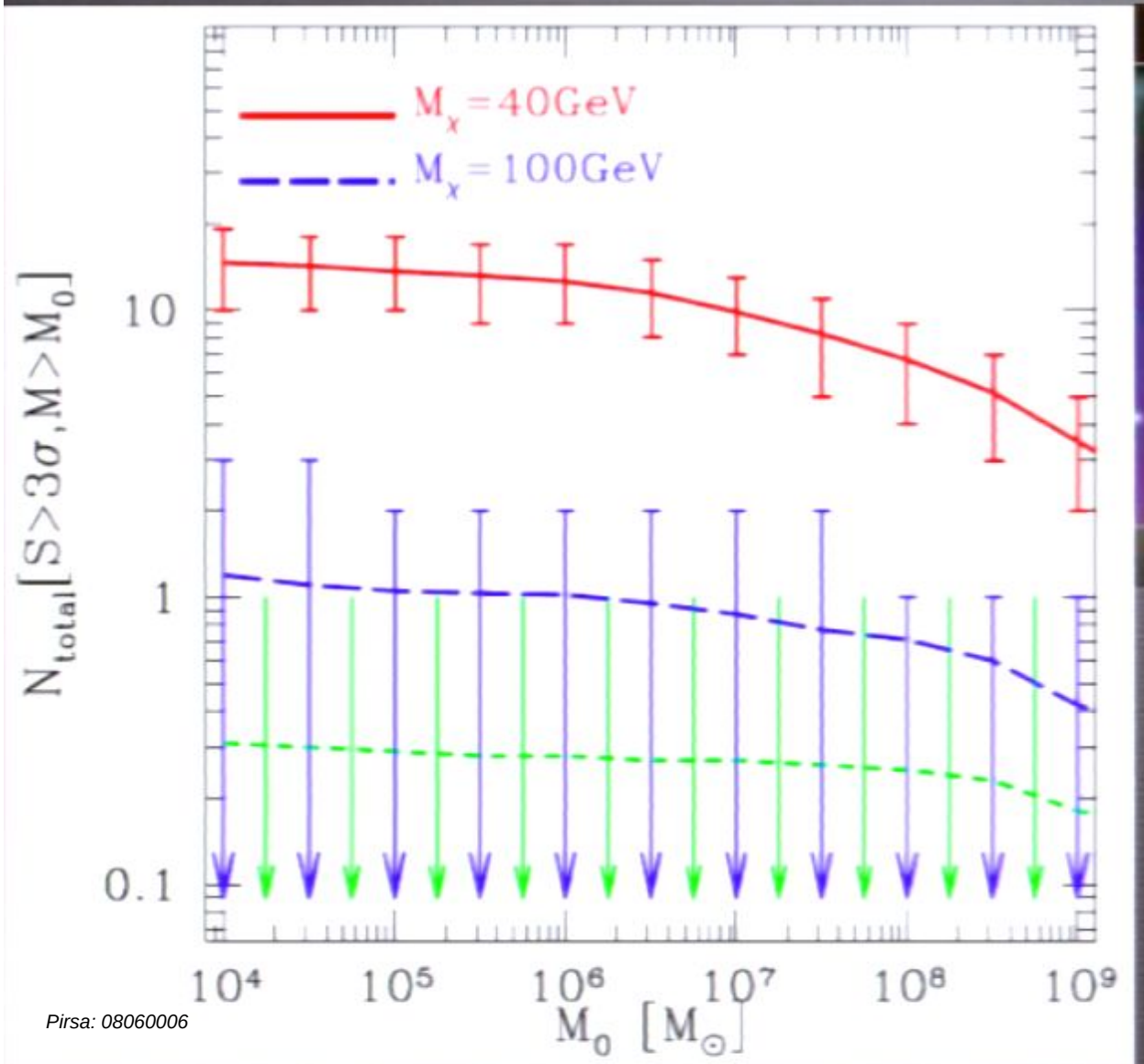
Number of satellites, $N(>V_{MAX})$

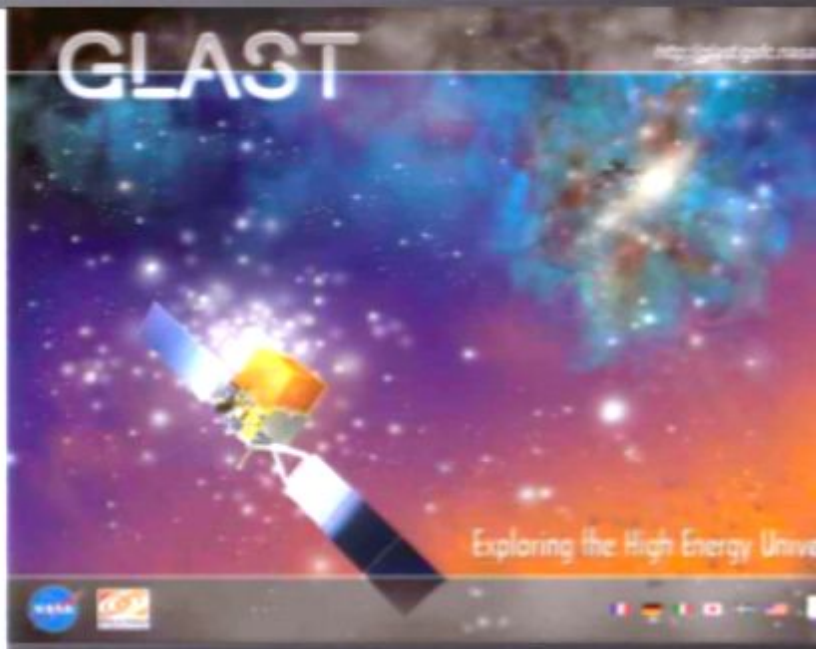
Maximum Circular Velocity

Satellites Elsewhere



Indirect Detection





Number of potential sources depends weakly on minimum mass

Summary

- Analytic models provide a good alternative to simulations when ultra-high "resolution" is needed or when large statistical samples need to be constructed

- It will be necessary to improve our ability to understand halo substructure in order to learn about the dark matter and/or the process of galaxy formation