Disruption Timescales of Satellite Halos in a Dense, Clustered Environment (Preliminary result)

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NEXT GENERATION VIRGO CLUSTER SURVEY (NGVS)

- Multipassband (ugriz) optical survey with MegaCam at the CFHT
- cover ~104 degree$^2$ ($R_{\text{vir}}$ of M87 and M49)
- spatial resolution : 0.6'' (~48pc)
- surface brightness : ~ 29 mag/arcsec$^2$
- detection limit : ~25.9 mag
  : ~5 mag fainter than VCC
  (Binggeli et al. 1985)

Ferrarese et al. 2012
ABUNDANCE MATCHING

stellar mass function (virgo cluster)

sub-halo mass function

Key assumptions - one galaxy per one dark matter clump
  - galaxy luminosity tightly correlated with halo mass
SUB-HALO MASS FUNCTION

**Model 0**: constructed by sub-halo catalog (sub-halo : AHF or Rockstar) - lower limit

**Model 1**: constructed by halo merger tree (field halo : FoF) - upper limit

**Model 2**: halo merger tree + pruning algorithm (sub-halo disruption) - realistic
PRUNING MERGER TREES

B is disrupted. 

B is survived.

: B is spiraled into A’s center by dynamical friction. 
\( t_{\text{dis}} < \Delta t \)

: B is considered to be a distinct object. 
\( t_{\text{dis}} < \Delta t \)

Disruption timescale by dynamical friction 
(Colpi et al. 1999)

\[
t_{\text{dis}} = \frac{k}{f_m} \frac{M_h / M_s}{\ln(M_h / M_s)} \epsilon^\alpha \frac{P_{\text{vir}}}{2\pi},
\]
AIM & METHOD

We perform cosmological high-resolution zoom simulations targeting a Virgo cluster-like halo (using Gadget 2).
- particle mass = $3.32 \times 10^6$ $M_\odot/h$
- particle number for a Virgo cluster-like halo = $\sim 40$ M

Then, we measure disruption timescale of sub-halos ($t_{\text{dis}}$) by tracing their core structures, and suggest the more realistic pruning criteria.
AIM & METHOD

cores identified by FoF (l=0.02)

field halos identified by FoF (l=0.2)
FoF HALO MERGER TREES

We first construct **halo merger tree with FoF field halo catalog.**
- problem: Many of FoF field halos are **unvirialized**, especially in clustered region.
  \[ \text{virial ratio} = \frac{-2\mathbf{K}}{\mathbf{P}}, \quad \text{unvirialized halo: virial ratio} < -2 \]

**Spatial distribution of halo mergers**

We choose only mergers with **virialized halos.**

\[ M_s/M_h : \text{mass ratio of satellite and host halos} \]
FoF HALO MERGER TREES

Predicted disruption timescale by dynamical friction (Colpi et al. 1999)

$t_{\text{dis}} = \frac{k}{f_m \ln(M_h/M_s)} \epsilon^\alpha \frac{P_{\text{vir}}}{2\pi}$

- Measured disruption timescale is slightly shorter than predicted timescale by dynamical friction of Colpi et al. (1999).
- Disruption timescale is not a function of orbital eccentricity.
- What is the other effects that shorten the disruption timescale? : major mergers, triaxial shape

$T_{\text{dis}}/P_{\text{vir}}$ : disruption timescale normalized by dynamical time
We construct halo merger tree with AHF (Amiga Halo Finder; Knollmann & Knebe, 2009) field halo catalog.

- AHF -> remove unbound particles
AHF HALO MERGER TREES

scaled disruption time Vs. Ms/Mh

Low $M_s/M_h$ mergers: Dynamical friction is not the major effect to disrupt. Lower $M_s/M_h$ mergers tend to be more quickly disrupted.

High $M_s/M_h$ mergers: Dynamical friction is the major effect to disrupt. Overall timescale is slightly shorter than that of Colpi et al. (1999).
Which effects **shorten the disruption timescale of satellites?**

1) **dynamical friction** for high-mass satellites
2) **major merging events** for low-mass satellites.

-> quantifying the effects  
-> making the more realistic pruning criteria  
-> constructing sub-halo mass function for a virgo cluster  
-> assigning each galaxy mass
HALO PROPERTIES & ACCRETION HISTORY

Halo shape changes during major mergers.