

Questions answered since 2016 in Computational Structure Formation

Simon D.M. White Report to the MPA Fachbeirat

Virgo - Millennium Database

Documentation

CREDITS/Acknowledgments

- Registration
- News
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- Public Databases
- DGalaxies
- DHaloTrees
- 🗄 Guo2010a
- 🗄 Guo2013a
- 🗄 Henriques2012a
- MField
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- MMSnapshots
- MPAGalaxies
- MPAHaloTrees
- MPAMocks
- Snapshots

Private (MyDB) Databases ____sampling_db (r) ____swhite_db (rw) (context)





Welcome Simon White.

Streaming queries return unlimited number of rows in CSV format and are cancelled after 420 seconds. Browser queries return maximum of 1000 rows in HTML format and are cancelled after 30 seconds.

- The MS halo and galaxy databases have been public since 2006
- >1000 papers have used these predictions
- Most use the galaxies and are by authors unassociated with MPA/Virgo Consortium



Query (stream)

Query (browser)

Help



PDF of the density distribution in the two Millennium Simulations

Medians differ by factor of 2



It depends on what the dark matter is



What is the topology of cosmic voids?

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Single stream regions occupy a small fraction of Lagrangian space, occupying disjoint subregions

→ at high resolution voids contain mass similar to the free-streaming mass and are fully surrounded by caustics.

What is the structure of the smallest halos?



Planck cosmology

Dark matter only

Dynamic range of 30 orders of magnitude in mass

Base Level



Planck cosmology

Dark matter only

Dynamic range of 30 orders of magnitude in mass

Zoom Level 1



Planck cosmology

Dark matter only

Dynamic range of 30 orders of magnitude in mass

Zoom Level 2



Planck cosmology

Dark matter only

Dynamic range of 30 orders of magnitude in mass

Zoom Level 3



Planck cosmology

Dark matter only

Dynamic range of 30 orders of magnitude in mass

Zoom Level 4



Planck cosmology

Dark matter only

Dynamic range of 30 orders of magnitude in mass

Zoom Level 5



Planck cosmology

Dark matter only

Dynamic range of 30 orders of magnitude in mass

Zoom Level 6



Planck cosmology

Dark matter only

Dynamic range of 30 orders of magnitude in mass

Zoom Level 7



Planck cosmology

Dark matter only

Dynamic range of 30 orders of magnitude in mass

Zoom Level 8

The density of this region is only 0.4% of the cosmic mean Wang et al 2019



Density profile shapes

Over 19 orders of magnitude in halo mass and 4 orders of magnitude in halo density, the mean density profiles of halos are fit by NFW to within 20% and by Einasto with $\alpha = 0.15$ to within 7%



Concentrationmass relation

Measured for the first time over the full 20 orders of magnitude populated for a 100 GeV WIMP

There is a turndown at 1000 Earth masses due to the free-streaming limit.

The scatter does not depend strongly on halo mass.

Does halo structure depend on environment?

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At given halo mass, concentration does not depend simply on *local* environment density.

The *range* of local environment density does not depend strongly on halo mass

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Published N-body simulations of WDM are all compromised by a filament fragmentation instability (Wang & White 2008)

Characterization of halo abundances near the freestreaming cutoff requires a new simulation technique.

Combining the phase sheet dynamics of Abel et al (for sheets and filaments) with Nbody dynamics (for dense regions) avoids all spurious structure . (Stücker et al 2019)

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Busch & White 2019



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The Euclidean Distance Transform of the low-density region converges between MS and MSII despite a factor of 125 difference in mass resolution