

Data Mining of the MultiDark Simulation

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Abstract The MultiDark database (www.multidark.org) provides results from large cosmological simulations performed within the Multimessenger Approach for Dark Matter Detection (MULTIDARK) project. Currently, simulation products of a large $(1\text{Gpc}/h)^3$ and 2048^3 particles simulation are available online. The first data release DR1 contains FOF halo catalogues with various linking lengths, BDM halo catalogues with halo profiles, merger trees, and for selected redshifts the complete particle data of the MultiDark Run 1 (MDR1).

1 The MultiDark Database

The MultiDark database provides data from cosmological simulations in databases which can be queried directly using the Standard Query Language SQL. Since the amount of data which such simulations produce nowadays exceeds the Terabyte range, the full data set is too large to be kept as a local copy for each user. Instead, the user can retrieve only the data subset he or she is interested in. Large observational surveys like the SDSS have already gone in that direction. Having the data directly available via SQL proved to be a very useful concept. With the Millennium Run Database developed within GAVO (German Astrophysical Virtual Observatory), this concept was extended to simulation data as well, allowing to exploit the data much more effectively. In return, this gave rise to many fruitful collaborations and hundreds of articles.

The MultiDark database (www.multidark.org) provides results from cosmological simulations performed within the MultiDark project. At the moment, simulation products of a large $(1\text{Gpc}/h)^3$ dark matter only simulation with a resolution of 2048^3 particles are available. This MultiDark Run 1 (MDR1) simulation is de-

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scribed in details in [1] and uses up-to-date WMAP5 cosmology. A plot of the dark matter density distribution at $z = 0$ is shown in Fig. 1. With this simulation, a mass resolution of $8.721 \times 10^9 M_{\odot}/h$ is reached. In future data releases, further simulations will follow. The Bolshoi simulation [2] is scheduled to be included soon with DR2.

The first data release DR1 provides access via web interface to Friends-of-Friends (FOF) and Bound Density Maximum (BDM) halo catalogues, merger trees, and halo profiles. For selected redshifts, access to the complete particle data is provided. The database can be queried by entering SQL statements directly into a query form on the webpage. Additionally an access through wget is possible, which enables the use of the database with TOPCAT, IDL, R, and custom shell scripts.

After registration with the MultiDark database at www.multidark.org, the user is provided with full access to the whole dataset. Additionally, registered users get 500 MB of private database space for temporary storage of query results. Unregistered users have access to a small sub-volume of the data centered on the most massive halo in the simulation box for testing.

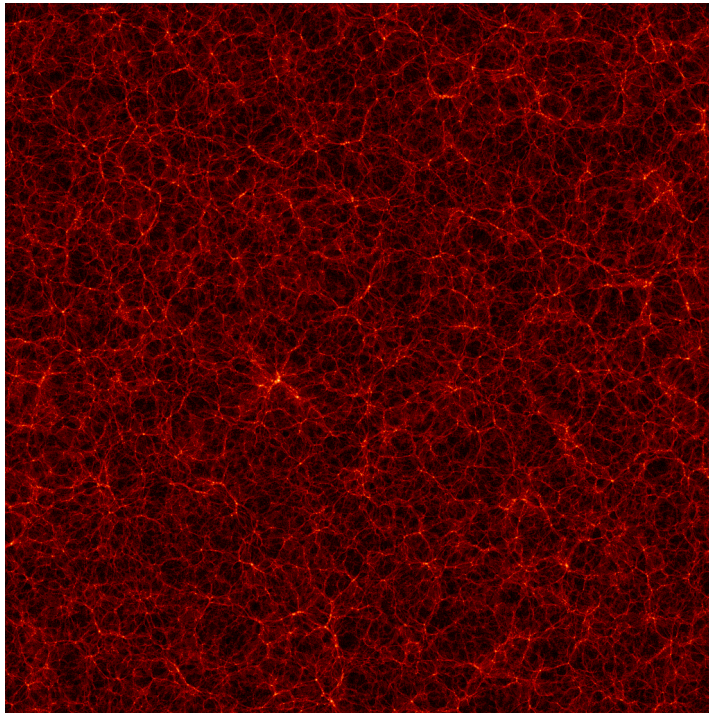


Fig. 1 Slice through the MultiDark simulation at redshift $z = 0$ (snapshot 84), projected along the x-direction to view the y-z density distribution. The slice is $5\text{Mpc}/h$ thick and $1\text{Gpc}/h$ on its side.

The query results are accessible in a fully VO compliant way by selecting VOTable output format. Therefore, the data can be visualised directly in the web browser using VOPlot or is accessible through the analysis and visualisation tool TOPCAT¹.

The MultiDark database webpage provides extensive documentation on the data and the tables available the database. A movie introducing the usage of the database is available together with a short introduction to SQL. Furthermore, the documentation contains many example queries which help the user of the database to get started easily.

References

1. Prada, F., Klypin, A., Cuesta, A., Betancort-Rijo, J., Primack, J.: Halo concentrations in the LCDM Cosmology, arXiv:1104.5130 (2011).
2. Klypin, A., Trujillo-Gomez, S., Primack, J.: Halos and galaxies in the standard cosmological model: results from the Bolshoi simulation. arXiv:1002.3660 Feb, (2010)

¹ <http://www.star.bris.ac.uk/mbt/topcat/>