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FILAMENTS IN WARM DARK MATTER

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Using Warm Dark Matter rather then Cold Dark Matter we are able to solve the overproduction of satellite galaxies orbiting in galactic halos. Moreover, we can show that this model leads to interesting new results in terms of the history and large-scale distribution of low-mass objects as well as the formation of filamentary structures when being compared to the standard CDM scenario.

CDM models have been very successful in reproducing the large scale structure properties of the universe. However, they have lately been facing a state of crisis because of apparent discrepancies between high resolution N-body simulations and observations on galaxy scales. One can divide these problems into two categories: the cuspiness of typical $L_\star$ galaxy halos on the one hand, and the dearth of dark matter satellites in these very same halos on the other.

One suggested solution to these problems is the introduction of Warm Dark Matter (e.g. Bode, Ostriker & Turok 2001, and references therein). We ran a series of such N-body simulations focusing the comparison to the standard CDM model on the formation and merger histories of the two most massive dark matter halos found in those runs (Knebe et al. 2002). The results show that WDM is able to reduce the number of satellites within such halos. In addition to that we find that halos in the mass range $M \in [10^{10}, 10^{11}]h^{-1}$ $M_\odot$ preferentially form along the filamentary structures as well as at lower redshifts. Our interpretation is that in the WDM model the filaments fragment as opposed to the standard hierarchical structure formation scenario in CDM.

To clarify this finding we re-simulated one of the filaments with much higher mass resolution ($m_p = 10^7 h^{-1}$ $M_\odot$). The time evolution of that filament is presented in Fig. 1. Despite the obvious differences at redshift z=5 the filaments look astonishingly similar at z=1. And for WDM we clearly observe individual (low-mass) halos appearing during the course of the filament evolution. To further investigate and quantify the formation history of objects within the filament we performed a standard friends-of-friends (FOF) analysis. Each individual FOF halo was then either tagged 'old' or 'new' depending on its presence at the previous redshift. However, a halo was only marked 'old' when its progenitor was at least 1/3 third of the current halo mass. We are able to show that in WDM a large fraction of objects is formed within the filament whereas in CDM nearly all halos are already in place at redshift $z = 5$. This can be easily understood if the WDM filament itself fragments and hence forms halos in a top-down fashion.

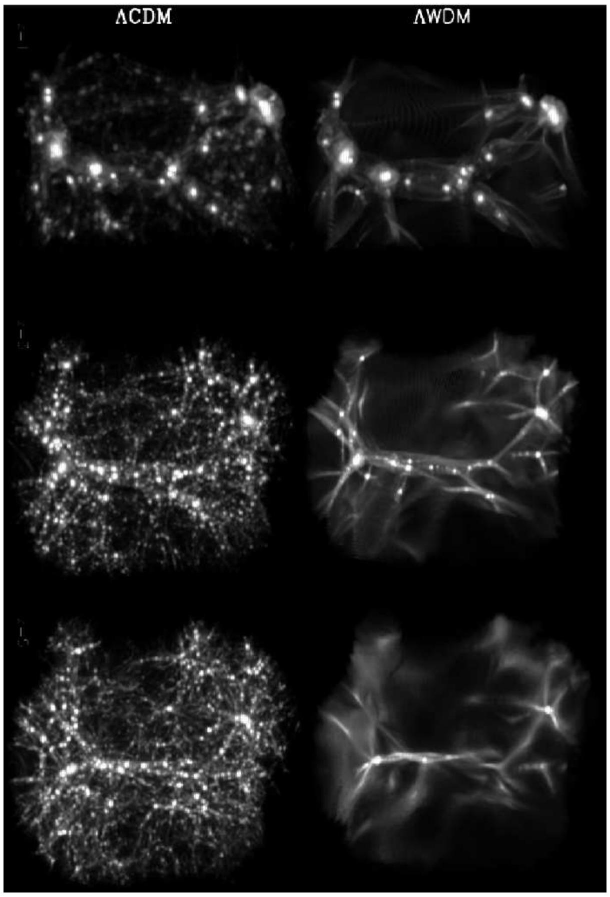

Fig. 1. Evolution of a single filament in CDM and WDM. The redshifts are $z = 1$ (top), $z = 3$ (middle), and $z = 5$ (bottom).

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