Master’s Thesis Abstract

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Semi-Cosmological Simulations of Baryons in Growing Halos

In this project, we aim to study the evolution of baryonic gas in a cosmologically growing dark matter halo. We perform the simulations using the astrophysical gas dynamics code PLUTO. We use a dark matter profile that transitions smoothly from the NFW profile within the virial radius to a more realistic profile outside of the virial radius (Diemer and Kravtrov 2014), and we construct the dark matter potential from this density profile. In addition, we introduce a “cosmological potential” which accounts for an evolution that is consistent with Hubble expansion at all times. Unlike cosmological simulations that use comoving coordinates, we use physical coordinates to solve our equations. We use spherical coordinates and apply a reflective inner boundary condition so that the gas thermalizes via an outward-moving virial shock. Cold gas is initialized with a density which is 0.2 (the universal baryon fraction) times the DM density. We study the various mechanisms that govern the formation and evolution of the virial shock and the evolution of the baryon fraction. We also explore the self-similarity of the gas density profiles across cosmological time for different initial conditions. Till now we are studying 1D evolution but intend to generalize the setup to 3D.

We plan to introduce radiative cooling, feedback heating through AGN feedback, and filamentary accretion in the model and analyze their effects on the evolution of baryons. An important question we aim to address is the survival of cosmological filaments in halos of different masses in the presence of radiative cooling. Our setup is a unique framework that provides a bridge between full cosmological galaxy formation simulations and idealized halo simulations, which will provide greater insight into the evolution of the circumgalactic medium with redshift and halo mass.