How do galaxy stellar haloes form?

A comparison between state-of-the-art simulations and observations of the Local Group

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How do galaxies form? In the currently favored cosmological model, the outskirts of galaxies (their halo) is built over time through the successive absorption of numerous dwarf galaxies. Even though most of the accreted matter is in the form of the elusive dark matter, baryons (i.e. visible matter, including stars and gas) preserve the imprint of the past and on-going process of hierarchical formation. It is therefore expected that galaxies like our own Milky Way, or its cosmic sister the Andromeda galaxy, are surrounded by very low surface brightness stellar structures that extend out to more than 100 kpc from their host and result from the destruction of numerous dwarf galaxies. This is indeed what we were able to show with the PAndAS survey, a series of deep photometric observations of the surroundings of the Andromeda galaxy (Ibata et al. 2007; Martin et al. 2013; Ibata et al. 2014). Stellar structures are visible out to the edge of the survey, ~150 kpc from the center of Andromeda, in good qualitative agreement with simulations of the process of hierarchical formation of galaxies of this size. It is now time to move to a robust quantitative assessment of the similarities and/or discrepancies between these exquisite observations and the predictions from simulations.

The goal of this PhD thesis, at the boundary between modeling and observations, is to "observe" state-of-the-art cosmological simulations to produce artificial PAndAS surveys that accurately fold in observational uncertainties. The student will have access to the most detailed simulations of the stellar halo formation of large spiral galaxies, the Aquarius simulations (Cooper et al.), through our ongoing collaboration with the ICC in Durham. The student will degrade these simulations by folding in the PAndAS observational constraints (sky projection, survey's geometry, contamination by foreground Milky Way stars, varying depth of the observations,…) and then quantitatively test their similarities/discrepancies with the observations of the M31 stellar halo and its constituents. A particular focus will be placed on the comparison of the size of the observed and simulated stellar halos, their morphology, their structured nature, and their metallicity. In summary, it will be possible to test the validity of state-of-the-art simulations of hierarchical galaxy formation with exquisite observations of the surroundings of the Andromeda galaxy in as unbiased a way as possible to test the currently favored cosmological model.

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