Feedback from Active Galactic Nuclei in Galaxy Groups and Simulating Groups and the IntraGroup Medium: The Surprisingly Complex and Rich Middle Ground between Clusters and Galaxies

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Abstract

I will summarize a recent review I co-wrote about Feedback from Active Galactic Nuclei in Galaxy Groups and if time allows I will also briefly present one of the companion reviews entitled Simulating Groups and the IntraGroup Medium: The Surprisingly Complex and Rich Middle Ground between Clusters and Galaxies by Oppenheimer et al.

Feedback from Active Galactic Nuclei in Galaxy Groups

The co-evolution between supermassive black holes and their environment is most directly traced by the hot atmospheres of dark matter halos. Cooling of the hot atmosphere supplies the central regions with fresh gas, igniting active galactic nuclei (AGN) with long duty cycles. Outflows from the central engine tightly couple with the surrounding gaseous medium and provide the dominant heating source preventing runaway cooling by carving cavities and driving shocks across the medium. The AGN feedback loop is a key feature of all modern galaxy evolution models. Here we review our knowledge of the AGN feedback process in the specific context of galaxy groups. Galaxy groups are uniquely suited to constrain the mechanisms governing the cooling-heating balance. Unlike in more massive halos, the energy supplied by the central AGN to the hot intragroup medium can exceed the gravitational binding energy of halo gas particles. We report on the state-of-the-art in observations of the feedback phenomenon and in theoretical models of the heating-cooling balance in galaxy groups. We also describe how our knowledge of the AGN feedback process impacts on galaxy evolution models and on large-scale baryon distributions. Finally, we discuss how new instrumentation will answer key open questions on the topic.

https://ui.adsabs.harvard.edu/abs/2021Univ....7..142E/abstract

Simulating Groups and the IntraGroup Medium: The Surprisingly Complex and Rich Middle Ground between Clusters and Galaxies

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Galaxy groups are more than an intermediate scale between clusters and halos hosting individual galaxies, they are crucial laboratories capable of testing a range of astrophysics from how galaxies form and evolve to large scale structure (LSS) statistics for cosmology. Cosmological hydrodynamic simulations of groups on various scales offer an unparalleled testing ground for astrophysical theories. Widely used cosmological simulations with _˜(100 Mpc)ˆ3 volumes contain statistical samples of groups that provide important tests of galaxy evolution influenced by environmental processes. Larger volumes capable of reproducing LSS while following the redistribution of baryons by cooling and feedback are essential tools necessary to constrain cosmological parameters. Higher resolution simulations can currently model satellite interactions, the processing of cool (T_˜10ˆ4 K) multi-phase gas, and non-thermal physics including turbulence, magnetic fields, and cosmic ray transport. We review simulation results regarding the gas and stellar contents of groups, cooling flows and the relation to the central galaxy, the formation and processing of multi-phase gas, satellite interactions with the intragroup medium, and the impact of groups for cosmological parameter estimation. Cosmological simulations provide evolutionarily consistent predictions of these observationally difficult-to-define objects, and have untapped potential to accurately model their gaseous, stellar, and dark matter distributions.
https://ui.adsabs.harvard.edu/abs/2021Univ....7..209O/abstract