University of Victoria | Graduate Studies

Notice of the Final Oral Examination for the Degree of Master of Science

of

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BSc (Zhejiang University, 2011)

"The Chemical Enrichment of the Intra-group Medium"

Department of Physics and Astronomy

Monday, July 20, 2015
1:30 P.M.
David Strong Building
Room C130

Supervisory Committee:
Dr. Arif Babul, Department of Physics and Astronomy, University of Victoria (Supervisor)
Dr. Christopher Pritchet, Department of Physics and Astronomy, UVic (Member)
Dr. Alexandre Brolo, Department of Chemistry, UVic (Outside Member)

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Dr. Afzal Suleman, Department of Mechanical Engineering, UVic

Chair of Oral Examination:
Dr. Nedjib Djilali, Department of Mechanical Engineering, UVic

Dr. David Capson, Dean, Faculty of Graduate Studies

Abstract

The observable properties of galaxy groups, and especially the thermal and chemical properties of the intragroup medium (IGrM), provide important constraints on the different feedback processes associated with massive galaxy formation and evolution. In this paper, the first in a series of studies aimed at identifying and exploring these constraints, we present a detailed analysis of the global properties of simulated galaxy groups with X-ray temperatures in the range 0.5 - 2 keV over the redshift range $0 \leq z \leq 3$. The groups are drawn from a cosmological smoothed particle hydrodynamics simulation that includes a well-constrained prescription for momentum-driven, galactic outflows powered by stars and supernovae but no explicit treatment of AGN feedback. Our aims are (a) to establish a baseline against which we will compare future models; (b) to identify model successes that are genuinely due to stellar/supernovae-powered outflows; and (c) to pinpoint mismatches that not only signal the need for AGN feedback but also constrain the nature of this feedback.

We find that even without AGN feedback, our simulation successfully reproduces the observed present-day group properties such as the IGrM mass fraction, the various X-ray luminosity-temperature-entropy scaling relations, as well as both the mass-weighted and the emission-weighted IGrM iron and silicon abundance versus IGrM temperature relationships, for all but the most massive groups. We also show that these trends evolve self-similarly for $z < 1$, in agreement with the observations. In contrast to the usual expectations, we do not see any evidence of the IGrM undergoing catastrophic cooling. And yet, the $z = 0$ group stellar mass is a factor of ~ 2 too high. Probing further, we find that the latter is due to the build-up of cold gas in the massive galaxies before they are incorporated inside groups. This not only indicates that another feedback mechanism must activate as soon as the galaxies achieve $M_* \approx$ a few $\times 10^{10}\, M_\odot$ but that this feedback mechanism must be powerful enough to expel a significant fraction of the halo gas component from the galactic halos. “Maintenance-mode" AGN feedback of the kind observed in galaxy clusters will not do. At the same time, we find that stellar/supernovae-powered winds are essential for understanding the metal abundances in the IGrM and these results are expected to be relatively insensitive to the addition of AGN feedback.