

TITLE : The Importance of Baryonic Effects in Galaxy Groups for Precision Cosmology

AUTHOR : Manuel Rabold

ABSTRACT:

This thesis work is a contribution to the quest of the precise determination of the cosmological parameters which describe our universe, in particular its time evolution and its composition. Future sky surveys like Euclid or the Large Synoptic Survey Telescope will measure the relevant cosmological spectra with unprecedented precision. These spectra, which are statistical quantifications of the clumping of matter on different scales, depend directly on the cosmological parameters. A higher observational precision on the spectra, means therefore smaller uncertainties onto the values of the parameters.

The information from these precise measurements can be fully exploited only, if on the theoretical side, the spectra are calculated with the same high accuracy. The work of this study is situated here. Through the utilization of computer simulations, the evolution of the large scale structure in the universe can be computed, for a given set of cosmological parameters. The spectra can then be extracted from the simulation results and compared with the observational counterpart.

It is therefore of crucial importance that any uncertainties arising from numerical effects in the simulations are precisely quantified. Beyond this it is useful for the physical understanding, to quantify the influence of different physical processes, which are included in the simulations.

The focus of this work lies on the matter distribution within galaxy groups sized mass accumulations, since they give the strongest contribution to the aforementioned spectra. Sixteen halos of this size have been simulated with various layers of included physics. The starting point are pure dark matter only simulations. Then in a second step the baryonic component is included as a non-radiative fluid. In subsequent steps the ability to cool and form stars was added to the baryon component, as well as an established model of stellar feedback. Beyond these an experimental implementation of Active Galactic Nucleus feedback was tested. This physical process is of particular importance, as it is expected to resolve existing mismatches between theory and observation in the baryon content of galaxy groups and clusters.

The thesis also contains a report, on how the numerical parameters affect the mass distributions within the galaxy group halos, as compared to impacts from physical causes.