The Cosmic Web in the LADUMA field

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Brief Project Description

The LADUMA (Looking At the Distant Universe with the MeerKAT Array) survey will observe HI in galaxies back to when the Universe was less than one third of its current age using the MeerKAT radio telescope which will enable us to study the HI in galaxies in different environments, well beyond the local universe. This project will focus on identifying large scale structure, namely cosmic web filaments, in the LADUMA field as an interesting environment in which to study galaxy evolution. The project will involve analysing both simulations and real data in order to determine how well the large scale structure can be determined at different redshifts using incomplete spectroscopic catalogues. Further analysis will include an investigation of the properties of galaxies in the identified filaments.

Longer description

Large spectroscopic galaxy surveys (e.g. the Sloan Digital Sky Survey), have uncovered the large scale structure of the universe, known as the 'cosmic web'. Galaxies are preferentially found in higher density regions, such as galaxy clusters or groups, or in the intermediate density filaments which connect groups and clusters. The filaments, clusters and groups surround relatively empty regions known as voids where very few galaxies are located. An important driver of galaxy evolution is the environment, with higher density regions being sites of various processes which affect the colours, star formation rates, morphologies, and neutral hydrogen gas (HI) content of galaxies.

However, the role of the intermediate density filaments, and the dominant processes affecting galaxy evolution within them, is less clear. Recently it has been shown that galaxies inside filaments seem to have on average higher stellar masses than galaxies located outside filaments (e.g. Laigle et al., 2017, Malavasi et al., 2017), as well as redder colours (e.g., Kuutma et al., 2017, Luber et al., 2019). Some studies have shown that galaxies inside filaments seem to have their spins aligned with the filaments in which they are located (Tempel et al., 2013) and this might be connected to gas accretion within filaments.

While the optical properties of galaxies in filaments have been studied by various authors, less is known about the neutral gas content of filaments. Recent studies (e.g. Kleiner et al, (2016), Luber et al. (2019), Blue Bird et al., (2020)) have focused on the HI content of galaxies in filaments in the local universe but deeper HI observations are required to probe this observable at higher redshifts. The LADUMA (Looking At the Distant Universe with the MeerKAT Array) survey will observe HI in galaxies back to when the Universe was less than one third of its current age using the MeerKAT radio telescope which will enable us to study the HI in galaxies in different environments, well beyond the local universe.

The main aim of this project is to identify large scale structure, namely cosmic web filaments, in the LADUMA field. Over the past years, the LADUMA team have put together a database consisting of thousands of optical redshifts of galaxies in the LADUMA field which will be used for the filament identification along with the software package DisSperSE (Sousbie, 2011). The team also has a large photometric redshift catalogue. Specifically a focus of the project will be to

estimate how the completeness of the spectroscopic catalogue affects filament identification at different redshifts and whether the photometric redshifts can be used reliably in the absence of spectroscopy. The student will do this by using cosmological simulations to test the reliability of DisSperSE with different degrees of catalogue completeness and redshift uncertainties.
Time, and results permitting, the student will analyse the properties of galaxies in the identified filaments to make comparisons to the literature.