UCT MSc or PhD Project

Making the Deepest Images of the Circumgalactic Medium

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Background:

Galaxies form by building up most of their mass, comprised of dark matter, through mergers and accretion of smaller lumps of mass assembling in a hierarchical fashion. While this process is well-understood for the assembly of their dark matter halos, it is clear that galaxies cannot obtain enough of their gas and stars via the same process. In particular, since gas is the fuel for star formation, we need to understand gas accretion in galaxies. Theory suggests that galaxies accrete their gas through two types of accretion: hot and cold. Hot accretion involves gas falling into the dark matter halo, being shock-heated to the virial temperature of the halo, and then slowly cooling onto the disk of the galaxy in a quasi-spherical manner. This mode of accretion is predicted to be dominant for higher mass galaxies in the present day. On the other hand, cold mode accretion involves gas remaining at relatively cooler temperatures as it enters the dark matter halo and falling directly onto the disk of a galaxy along filamentary structures. This process should be the dominant accretion process in the early universe and for low mass galaxies in lower density environments. While there is some observational evidence that cold mode accretion is occurring, we lack details of how this process works. To gain further insight into the mechanics of gas accretion, we require sensitive maps of the surroundings of galaxies, the circumgalactic medium (CGM).

Project Aims:

The MHONGOOSE survey is using MeerKAT to make extremely deep maps of the extended HI emission around 30 nearby galaxies revealing previously unknown HI features around these galaxies an order of magnitude fainter than previous surveys could detect. Complementing MHONGOOSE is a similar HI survey done with the Australia Telescope Compact Array (ATCA): IMAGINE. IMAGINE has surveyed 28 galaxies with a sensitivity comparable to MHONGOOSE, but at coarser resolution. Both samples of galaxies have also been observed with either the Green Bank Telescope or Parkes to provide sensitive single-dish data capable of detecting the most diffuse gas in the CGM. Six galaxies are in common between the two surveys, allowing for both comparison and combination of the data.

For a MSc project, the student will

1. Make a systematic comparison of the measure HI properties of the six galaxies in common between the IMAGINE and MHONGOOSE surveys. This would include comparing the HI fluxes and linewidths of the galaxies detected in the surveys as well as identifying unique features seen in only a single survey.
2. Explore how to best combine the data from MeerKAT and the ATCA in order to produce the deepest images of a single galaxy to search for evidence of cold-mode accretion in the CGM.

For a PhD project, the student will

1. Combine the data from both MHONGOOSE and IMAGINE surveys, including the single-dish surveys to make the deepest available images of the CGM of six galaxies in order to search for evidence for cold-mode accretion.
2. Using the known properties of the six galaxies with the measured HI properties, the student will compare the results with predictions from galaxy formation models to constrain the nature of gas accretion in the local universe.