The effects of environment on galaxies' neutral atomic gas reservoirs

Motivation/background

A galaxy's evolution is driven by a combination of "nature" (e.g., the initial mass and spin of the dark matter halo in which it collapses, together with the composition of its baryons) and "nurture" (e.g., the environment in which it finds itself, as characterized by the number and distribution of its neighbors). With the growth of large-scale structure over cosmic time, the properties of galaxy environments have changed, and therefore the effects of environment on galaxies' gas content are expected to have changed as well. Thanks to the superb capabilities of South Africa's MeerKAT array, the Looking At the Distant Universe with the MeerKAT Array (LADUMA) survey is now making it possible to examine how environment has influenced galaxies' neutral atomic (HI) gas content over the last nine billion years. LADUMA observations probe HI in emission out to a redshift $z_{HI} \sim 1.45$, through a combination of individual detections and statistical detections of "stacked" samples, and thereby enable more illuminating studies of the "nature" and "nurture" factors governing galaxy evolution than have been possible before.

Aims/goals

This project will combine MeerKAT HI observations with optical spectroscopy from SALT and other facilities to enable the statistical detection of HI from "stacked" samples of galaxies, which will be drawn from different environments out to a redshift $z_{HI} \sim 1.45$. Using these datasets, the visiting student will address one or more of several questions: (a) whether key scaling relations at $z \sim 0$ evolve as functions of redshift and/or environmental density; (b) whether the "cold" mode of gas accretion expected to become more significant at higher redshift leaves imprints on the HI properties of galaxies in lower and/or higher density environments; and (c) whether HI is more prevalent in the circumgalactic media of distant galaxies than in those of their $z \sim 0$ analogs. The visiting student will also have opportunities to contribute to LADUMA at a technical level, e.g., by assessing and refining strategies for HI source-finding that can provide a lower-z anchor for the interpretation of higher-z stacking studies.

Activities

During a one-month stay at Rutgers, the visiting student will have regular interactions with the project host (Baker), the other members of the host's research group, two other faculty members who are members of the LADUMA team (Gawiser, Hughes), and the diverse set of students, postdocs, and faculty (studying galaxy evolution from both observational and theoretical perspectives) who comprise the Rutgers astrophysics group. Because Rutgers is within a 1.5-hour train ride of multiple astronomy departments, the visiting student will also have opportunities to interact with a broader cross-section of the U.S. astronomical community.

Expected outcomes

The visit will contribute to the development of at least one paper (to be led by the visiting student) on the effects of environment on galaxies' HI content; this paper will make a unique contribution to the literature in this field by virtue of the uniquely high HI redshift to which its analysis will extend. Significant technical contributions to LADUMA's data analysis workflow will be recognized by automatic coauthorship on all relevant papers that rely on those contributions.