Imaging the Eridanus Supergroup

Nick Pingel (ANU, UW-Madison; Nickolas.Pingel@anu.edu.au), Ivy Wong, Bi-Qing For, Virginia Kilborn, Anish Roshi, D.J. Pisano

The physical processes that influence the decline of star formation in galaxies over the past eight billion years (e.g., Peng et al 2010) remain unclear. Ram pressure stripping during cluster in-fall will remove the cold gas reservoirs that fuel star formation. On the other hand, galaxies can experience 'pre-processing', which is a general term encompassing the quenching of star formation due to environmental factors (e.g., galaxy group member density, undisturbed vs. actively merging) before entering the virial radius of a galaxy cluster. The questions of how and when galaxies start and stop forming stars and where galaxies are most optimally pre-processed are key evolutionary questions yet to be answered. Hence, direct observational evidence of the HI distribution in and around group galaxies prior to cluster formation (such as a supergroup) is crucial to determine whether the suppression of star formation is occurring due to pre-processing mainly within the galaxy group environment or instead within subcluster in-fall regions during cluster formation. A deep and blind HI survey of an entire supergroup (as opposed to HI observations that target specific group galaxies) is necessary to probe a wide range of cluster environments and processes.

We therefore propose to observe the nearby Eridanus Supergroup, which consists of three subclusters (NGC 1407, NGC 1385 and NGC 1332) at various evolutionary stages that are in the process of merging into a cluster with a mass of approximately $7x10^{13}$ $M_{\odot}$ (Brough et al 2006; Omar & Dwarakanath 2005). Our 50 square degree map (7.07 deg x7.07 deg), when combined with complimentary high-resolution data from the Australian Square Kilometre Array Pathfinder (ASKAP), will provide a complete census of the total gas content and dynamical mass for each subcluster galaxy, thus revealing important kinematic information that can be used to differentiate between ram pressure and other tidal processes. Furthermore, the ASKAP observations presented by Wong et al. 2021 show several dark HI clouds (no stellar counterpart) near NGC 1385 which lack HI relative to Parkes observations. Wide-field observations with ALPACA would provide updated HI mass measurements for diffuse features such as these dark clouds, which may be an extreme class of objects known as dark galaxy candidates. Based on cosmological simulations, such objects form more than 12 Gyr ago and have an uneventful evolution history until cluster in-fall begins. These With ALPACA, we can achieve a HI column density 5-sigma sensitivity level over a 20 km/s line of $5x10^{17}$ cm^{-2} within 30 observing hours, including overhead. This is a marked increase over the currently single pixel receiver, which would take over 500 hours to make the equivalent map.