Revealing the spatial distribution of the ultra-diffuse HI reservoir around NGC 891

N. Pingel (ANU, UW-Madison; Nickolas.Pingel@anu.edu.au)

The extent to which diffuse neutral hydrogen (HI) permeates the circumgalatic medium (CGM) of galaxies is a pivotal question in the study of galaxy gas-cycles. Cosmological simulations (e.g., Popping et al. 2009) predict the existence of HI at column density levels $N_{HI} < 10^{18}$ cm^{-2}. However, the detection and characterization of such gas has been elusive (Pingel et al. 2018). Through the analysis of a series of Lyman-alpha absorption sources, Tumlinson et al. 2013 provide a lower limit for observed at ~10^{16} cm^{-2}. However, since absorption measurements only provide pencil-beam measurements, we know nothing about the true angular extent of such gas. Similarly, recent work by Das et al. 2019 with deep (5-sigma detection limit of 8.2×10^{16} cm^{-2}) GBT pointed observations reveal strong evidence for a large amount of diffuse, ultra-low column density gas around HALOGAS sources NGC 891 and NGC 4565. But these pointed observations again lack crucial information on the overall spatial and kinematic distribution of the HI making up this ultra-diffuse HI reservoir. Mapping down to comparable sensitivity levels as Das et al. 2018 with the current single pixel L-band receiver on the GBT requires nearly 1500 hours of observing time (excluding overhead). Thus, multi-beam receivers are are necessary to reduce the required mapping times to within reasonable allocation requests. ***The 40 simultaneous beams of ALPACA would reduce this request to only 100 hours, including observing overhead.***

Such a map would be most sensitive map of the spatial distribution of HI around an external galaxy ever produced by more than an order of magnitude. These highly sensitive data will definitively show whether NGC 891 and similar nearby late-type galaxies are actively accreting HI to fuel continuous star formation, which is the leading explanation as to how galaxies have retained an almost constant HI content even as the star formation rates peak around z~2 (Madau & Dickinson 2014). Such a map would also provide vital constraints on the definition of distinct ‘edge’ of a galaxy. A detection of an ultra-diffuse HI component will inform current photoionization models, which dictate a critical N_{HI} value on the order of 10^{18} cm^{-2} to 10^{17} cm^{-2} wherein the HI radial profile begins to sharply drop off due to ionizing extragalactic background radiation. Kinematic modeling of this extraplanar component would also refine key parameters used in models of turbulent driving in galaxy disks, which depend heavily on estimate of the gas scale height and spatial distribution of the gas velocity dispersion (e.g., Klessen & Hennebelle 2010).