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MIGHTEE-HI and CHILES Team Up: new constraints on the evolution of the MHI-M* scaling relation

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Thanks to MeerKAT and other SKA precursors, HI is becoming accessible at higher z, making it possible to explore galaxy scaling relations involving gas mass at z>0. Probing the evolutionary path of such relations allows us to understand how cold hydrogen reservoirs impact star formation and galaxy evolution. Recent works exploiting stacking of the 21 cm line with the MIGHTEE [1] datacubes, on the COSMOS field, have unveiled HI-related scaling relations beyond the Local Universe [2]. Scaling relations built via stacking are typically computed with few data points and need large numbers of objects to build statistical detections. Employing MIGHTEE-HI observations on the COSMOS field in combination with 1000 h of VLA observations provided by the CHILES survey ensures more robust statistics for stacking and yields a robust scaling relation at z∼0.4. Comparing this relation with the scaling relation at z∼0 allows us to gain valuable insights into its evolution Faintness of the 21 cm line prevents direct detection of the HI emission for z≳0.1. Stacking based on optical catalogs enables information to be extracted from co-adding non-detections. Specifically, we combine noise-weighted spectra from the MIGHTEE-HI [3] and CHILES[4] cubes, achieving an increase in the SNR (Signal-to-Noise Ratio) of the stacked spectra. We do this for different stellar mass bins and extract a mean MHI by integrating the profile of the stacked line in each bin. We then obtain the scaling relation by fitting the HI masses extracted from the stacked spectra in each M* bin. When comparing this result with the same relation at z∼0 and z∼1, we find that star-forming galaxies at z≈0.37 are HI-richer with respect to the population at z≈0 and HI-poorer than at higher redshift. Moreover, we find that the slope of the inferred relation is remarkably consistent with the one estimated at lower and higher redshift. This supports the idea that neutral gas exchange mechanisms, responsible for HI depletion and accretion from the surrounding CGM, do not strongly depend on the stellar mass of the galaxy, at least until log(M*)∼10. Moreover, we estimate the growth of MHI with redshift at fixed stellar mass and obtain a power-law index∼2. We also compare this evolutionary rate with the one of molecular gas and of the Main Sequence of star-forming galaxies, paving the way to future work including the contribution of hydro-dynamical simulations.

1. M. Jarvis, R. Taylor, I. Agudo et al., "The MeerKAT International GHz Tiered Extragalactic Exploration (MIGHTEE) Survey", *Proceedings of MeerKAT Science*, May 2016, doi: 10.22323/1.277.0006.

2. F. Sinigaglia, G. Rodighiero, E. Elson et al., "MIGHTEE-HI: Evolution of HI Scaling Relations of Star-forming Galaxies at z<0.5", *The Astrophysical Journal Letters*, **935**, 1, August 2022, pp.L13, doi:10.3847/2041-8213/ac85ae.

3. N. Maddox, B.S. Frank, A.A. Ponomareva et al., "MIGHTEE-HI: The H I emission project of the MeerKAT MIGHTEE survey", *Astronomy&Astrophysics*, **646**, A35, February 2021, doi:10.1051/0004-6361/202039655.

4. R. Dodson, E. Momjian, DJ Pisano et al., "CHILES. VII. Deep Imaging for the CHILES Project, an SKA Prototype", *The Astrophysical Journal*, **163**, 59, February 2022, 12pp., doi:10.3847/1538-3881/ac3e65.