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SARAO PhD Project

Using Observed Atomic Gas in Galaxies as a Test for Cosmological Simulations of Galaxy Formation

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The main goal of the present project is to critically test the TNG50 cosmological hydrodynamical simulation through the observed atomic gas properties of its galaxies. Recent progress in two independent areas is critical for this goal.

On the one hand, an enormous progress has been made in the field of 3D radiative transfer, thanks to improved techniques and an increase in computer power (e.g., Steinacker et al. 2013). Our team has developed a 3D radiative transfer code (Baes et al. 2011; Camps & Baes 2015) and an advanced postprocessing procedure (Camps et al. 2016) to self-consistently perform radiative transfer for simulated galaxies from cosmological hydrodynamical simulations. Rather than just creating inferred observables, we can self-consistently calculate the UV radiation field at every position of a simulated galaxy. As this is a crucial parameter in the calculation of the HI/H2 fraction, it would allow a far more realistic calculation of the HI properties of simulated galaxies.

On the other hand, new observational HI data is becoming available. Atomic hydrogen is observed in the local Universe by means of its hyperfine transition line at 21 cm, but it is difficult to map this gas at low column densities. Fortunately, radio astronomy is currently being revolutionised by a series of new facilities. In advance of the construction of the Square Kilometer Array (SKA), its pathfinder facilities have started their operation. In particular, the 64-antenna MeerKAT radio interferometer has officially been inaugurated in July 2018, and is now the most powerful radio interferometer in operation. Several large MeerKAT projects have started that will change our HI view of the nearby Universe. These surveys are the perfect observational

benchmarks to which HI properties of cosmological hydrodynamical simulations can be compared. Of particular interest for this proposal is the MIGHTEE PROJECT for which Prof Leeuw and Baes are members.
The general objective of this project is to combine the advancements in radiative transfer modelling and HI observations, in order to critically test the ability of the state-of-the-art TNG50 cosmological hydrodynamical simulation in predicting realistic HI properties of galaxies. The PhD project has two specific objectives.

Specific Objective #1: "Stevens et al. (2019) have shown that the robustness of the HI size-mass relation makes it a valuable tool for theories of galaxy formation and evolution: the success of any model or simulation should be based on its ability to reproduce its scatter, slope and zero point with only a few percent uncertainty." **One specific objective of the project is** to take a select sample of synthetic HI maps for all TNG50 galaxies at z=0, at later at different redshifts out to z=0.5, measure the HI size and HI mass within this diameter as done by Rajohnson et al. for example, construct the TNG50 HI mass-size relation and compare to MIGHTEE result, and predict the redshift evolution for the HI size-mass relation.

Specific Objective #2: The Tully–Fisher relation (TFR) is an empirical relationship between the intrinsic luminosity of a spiral galaxy and its asymptotic rotation velocity or emission line width. **Another specific objective of the project is** to use catalog of multiwavelength fluxes for TNG50 at z=0 (already available in the group) and use SKIRT to calculate HI line profile for each TNG50 galaxy, make sample selection and measure HI profile width consistently for all galaxies, construct TFR at different wavelengths and compare the slope and scatter with observed relations and repeat this exercise at different redshifts to study the redshift evolution.

If you require any further information, please do not hesitate to contact me.

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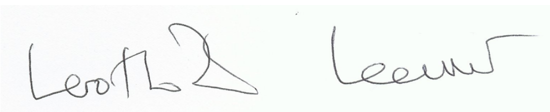

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