Title

Testing the limits: dark matter models, disc stability, and ISM properties in gas-rich ultra-diffuse galaxies

Abstract

Dark matter (DM) plays a pivotal role in our cosmological model, but the question of what it is made of remains unanswered. We propose to observe a galaxy sample that will provide key insights into that puzzling question.

Ultra-diffuse galaxies (UDGs) are extreme systems with sizes as extended as large spiral galaxies but with stellar masses about 1000 times lower. Recently, kinematic studies reported that some gas-rich UDGs are outliers of the baryonic Tully-Fisher relation (a fundamental scaling law of galaxies) and that their inferred DM distributions challenge the Cold Dark Matter (CDM) model. Since the density of the haloes varies with the type of DM (e.g. cold, self-interacting, fuzzy), UDGs can provide unprecedented constraints on the nature of DM. However, the above results have significant uncertainties since they are based on only two UDGs with high-resolution HI data.

Harnessing the unmatched MeerKAT sensitivity, we will observe a representative sample of eleven gas-rich UDGs at high resolution. Our observations, benchmarked with a pilot study, will trace the rotation curves of the UDGs with 10-20 beams across their discs and reaching radial extents of ~15-30 kpc, providing robust inference on their DM halo properties. The data will reveal whether UDGs are in tension with CDM and provide new constraints to support or falsify alternative DM theories. Besides, our program will tackle other topical subjects of broad interest, such as the origin of UDGs, the limits of disc stability, and the processes driving the ISM at extreme and unexplored regimes.