

Testing Cold Dark Matter with ultra-diffuse galaxies and MeerKAT

Abstract

Despite the central role of dark matter (DM) in our cosmological model and the wealth of evidence for its existence, the question of its composition remains unanswered. In this proposal, we propose to observe a class of galaxies that will provide new clues on the nature of DM.

Ultra-diffuse galaxies (UDGs) are extreme systems with sizes as extended as large spirals galaxies but with stellar masses ~ 1000 times lower. Recently, it has been suggested that two gas-rich UDGs with relatively high-resolution HI data present a challenge for the Cold Dark Matter (CDM) model: mass modelling of the UDGs' rotation curves suggests that their DM haloes are strikingly different from any other galaxy. Specifically, the density of the haloes is much lower than expected for CDM. Given that the density of the haloes varies with different types of DM (e.g. cold, self-interacting, fuzzy), UDGs can provide novel and unprecedented constraints on the nature of DM. However, only two UDGs have data good enough to perform rotation curve decomposition, hampering our understanding of their DM properties.

We propose to remedy this situation by exploiting the unrivalled MeerKAT sensitivity to observe five gas-rich UDGs at high spatial resolution. Our deep observations will trace the rotation curves of the UDGs with 8-12 beams across their discs and reaching radial extents of ~ 15 -30 kpc, providing robust inference on their DM properties. The data will answer unequivocally whether gas-rich UDGs are truly in tension with CDM, and will provide unmatched constraints on alternative DM theories.