THIRTY METER TELESCOPE

Key proposal

Panel: *For office use.*
Category: Resolved Galaxies

Date: May 6, 2016

The Evolution of the Tully-Fisher Relation at $z \geq 1$: Characterizing the Assembly of Rotation-Dominated Disk Galaxies

Abstract of Scientific Justification *(will be made publicly available for accepted proposals)*:
We propose a TMT key program examining the properties of rotation-dominated (RD) disk galaxies over the epoch of peak assembly. TMT will enable a survey probing a larger range in mass and luminosity, down to the sub-L* population. The primary goals of the project include characterizing: (1) the regularity of disks and their stability vs. the stellar and halo mass, (2) the Tully-Fisher Relation and its evolution, (3) the star formation rates and histories vs. radius and as a function of rotation curve amplitude, (4) the presence of bulges and bars, and (5) the abundance gradients. The resulting data will be compared with modern models of the formation of RD-disk galaxies that include feedback. The enormous aperture of TMT and the AO-assisted Integral Field Spectroscopy of NFIRAOS+IRIS (and MOAO+IRMOS) will reveal kinematics in the outer 3 scale-lengths that is comparable to that existing for nearby galaxies and allow us to characterize the detailed evolution of the RD-disk galaxies for the first time.

Investigators

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The main science goals of our program are:

- 1) Obtain accurate rotation curves to 3 disk scale lengths via Hα in order to sample the turnover of disk rotation curves and measure Vmax.
- (2) Quantify the stability and degree of disorder of disks (V/σ) over a broad range of halo masses (Vmax) over the epoch of peak assembly.
- (3) Construct an unbiased Tully-Fisher relation using rest frame bandpasses and stellar mass in order to characterize its evolution and the various sources of scatter (downsizing assembly).
- (4) Use the Hα equivalent width and mid-IR photometry from JWST to measure the star formation rate vs. stellar mass (e.g., Bundy et al. 2009; Pacifici et al. 2015) vs. Vmax.
- (5) Measure Hβ, [OIII] and MgII + Fe for a subset of the sample to characterize the abundance gradients of disks.
- (6) Measure Lick indices of bulges to constrain their age and metallicity compared with the disks (e.g., Thomas, Maraston & Bender 2003).
- (7) Measure the stellar kinematics (e.g., Newman et al. 2015).
- (8) Test and compare with the predictions of disk galaxies formation models.

Choice of Instrument(s) and observing mode:

- AO-IFS is essential for probing the 2d kinematics of disk galaxies.
- The AO capabilities of NFIRAOS associated with IRIS will enable integral-field spectroscopy at near-infrared wavelengths allowing the Hα line to be used for both sampling disk kinematics and for measuring accurate star formation rates.
- We plan parallel H and K band imaging centered on each IFU target position with IRIS.
- MOAO+IRMOS when available for selecting RD disk galaxies in field which would have a high enough density on the sky !