Prospects for Recovering Bars in CALIFA DR3

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Introduction

Disentangling the disk and bar components of nearby spiral galaxies can be difficult with standard image or velocity decomposition techniques. The publicly available software "DiskFit"[1] can extract non-parametric disk and bar components from either photometric images or emission-line velocity fields, making it a unique tool for understanding spiral galaxy structure and dynamics.

We have performed extensive testing of DiskFit's kinematic fitting algorithm using results from the Calar Alto Legacy Integral Field spectroscopy Area survey (CALIFA) DR1[2]. For each system, DiskFit estimates the geometry and velocities (including non-circular flows). Uncertainties on all returned parameters are robustly estimated using a bootstrapping technique.

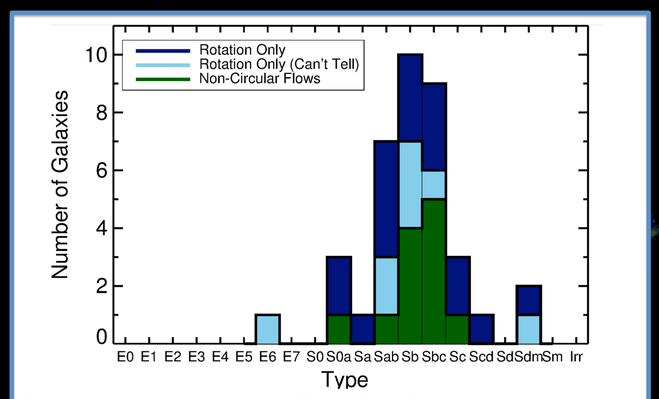
Here, we show an example of the results obtained by DiskFit for a typical CALIFA DR1 galaxy, and explore the inclination and bar-angle limits of DiskFit using simulated galaxies.

Applying DiskFit to CALIFA DR1

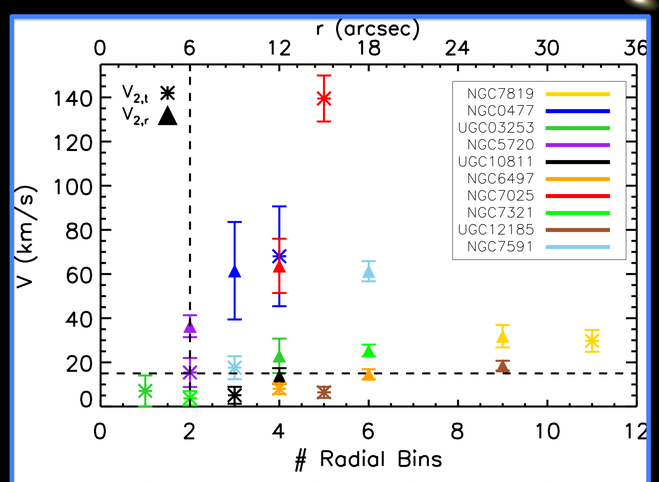
DiskFit was used to successfully model the Hα kinematics of 37 intermediate inclination CALIFA DR1 galaxies (Holmes et al. 2015)

12/37 of these galaxies were found to have statistically significant non-circular flows

DiskFit was found to be sensitive to the radial or tangential components of a bar-like flow with amplitudes >15 kms^{-1} across at least two independent radial bins in the fit, or ~2.25 kpc at the characteristic final sample distance of ~75Mpc

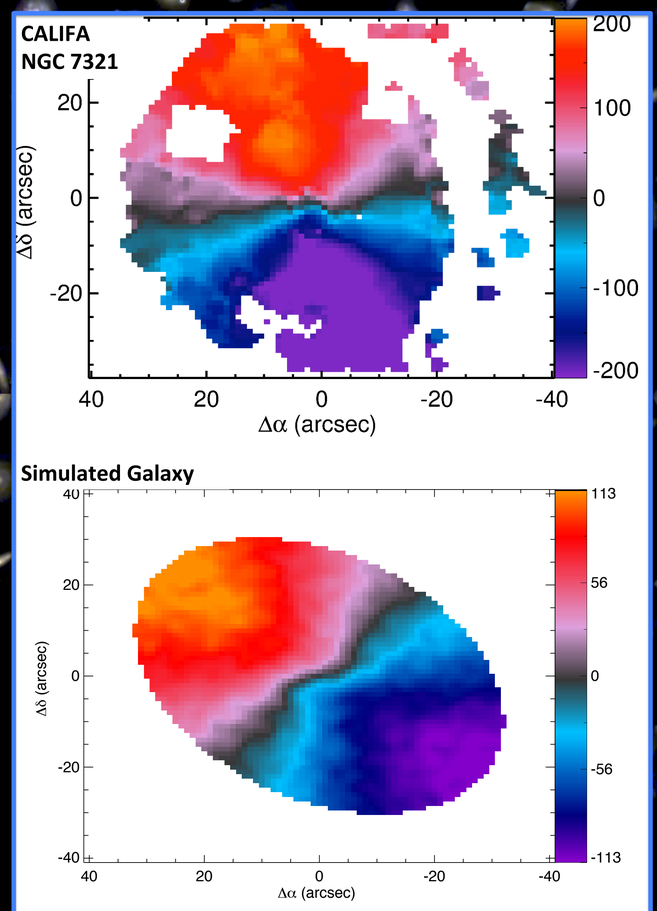


Optimal kinematic model for 37 CALIFA DR1 galaxies as a function of morphological type (Holmes et al. 2015)



Mean value of $V_{2,t}$ and $V_{2,r}$ as a function of the number of independent radial bins (bottom) or arcsec from the centre (top) over which the flow was detected (Holmes et al. 2015).

Simulating CALIFA-like Galaxies



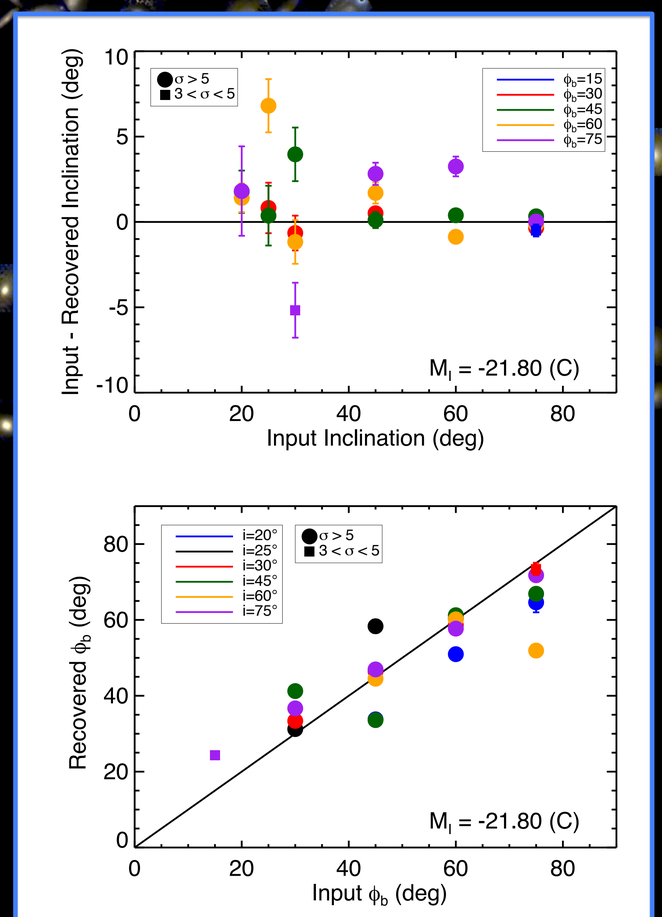
(Top) A typical CALIFA galaxy displaying non-circular flows.
(Middle) A simulated galaxy with CALIFA-like noise.
(Bottom) Rotation curve used to generate simulated galaxy.

To better understand DiskFit's sensitivity to bar-like flows in CALIFA-like galaxies a set of simulated galaxies was created ranging in inclination and bar position angles from 15-75°

DiskFit is mathematically degenerate for ϕ_b=0°, 90°

Simulated galaxies were created spanning the CALIFA DR3 luminosity range using rotation curves from Catinella et al. 2006. Non-circular flows were included using the median properties from the DR1 sample.

Recovering Bars in CALIFA DR3



Comparison of idealized models to DiskFit results by inclination and colour coded by bar-angle from the major axis (top). Comparison of model and DiskFit bar angle colour coded by inclination (bottom).

DiskFit recovers statistically significant non-circular flows for 40° < i < 75° and the bar is oriented ϕ_b=15-60° from the major axis.

DiskFit typically has difficulty recovering disk properties at low inclinations, and bar properties when ϕ_b≈75°

Future Work

In the future, we will further expand on DiskFit's ability to model CALIFA-like galaxies through the use of further simulations, including examining the effects of varying amplitudes of non-circular flows.

Given the preliminary results found here, it is expected that will will be able to model ~300 CALIFA DR3 intermediate-inclination galaxies. This statistically-representative sample will allow us to perform volume corrections and identify bar characteristics by morphological type.

References

[1] DiskFit is publicly available at: http://www.physics.rutgers.edu/~spekkens/diskfit/
[2] Holmes et al. 2015
[3] S. F. Sánchez et al. 2016 (submitted)
[4] Catinella et al. 2006