ANTONIO J. PORRAS

WHAT DRIVES THE MORPHOLOGY OF GALAXIES?

COURSES TIMELINE

- Courses taken:
  - Classical Mechanics (Fisk Undergrad)
  - Math Methods (Vanderbilt)
  - Electrodynamics (Fisk)
  - Quantum Mechanics (Fisk)
- Courses to complete:
  - Stellar Astrophysics (Vanderbilt - present)
  - Classical Mechanics (Fisk Grad - present)
  - Radiative Processes (Vanderbilt - Spring 2018)
  - Large Scale Structure (Vanderbilt - Spring 2018)
- Other courses:
  - Order of Magnitude (Vanderbilt - present)
  - Research credits (Fisk)

OUTLINE

- What the problem is
- Why is it important
- Methods to understanding the problem
- What I have found so far
- What I am working towards
- Broader impact outreach

ANGULAR MOMENTUM IN GALAXIES

- Galaxies acquire angular momentum (AM) from gravitational interactions with neighboring bound structures (Peebles 1969)
- Environment may play a role in galaxy acquisition of AM
- Hierarchical clustering allows to link the relationship between dark matter (DM) halo mass and the cosmological density field (Navarro et al. 1997)

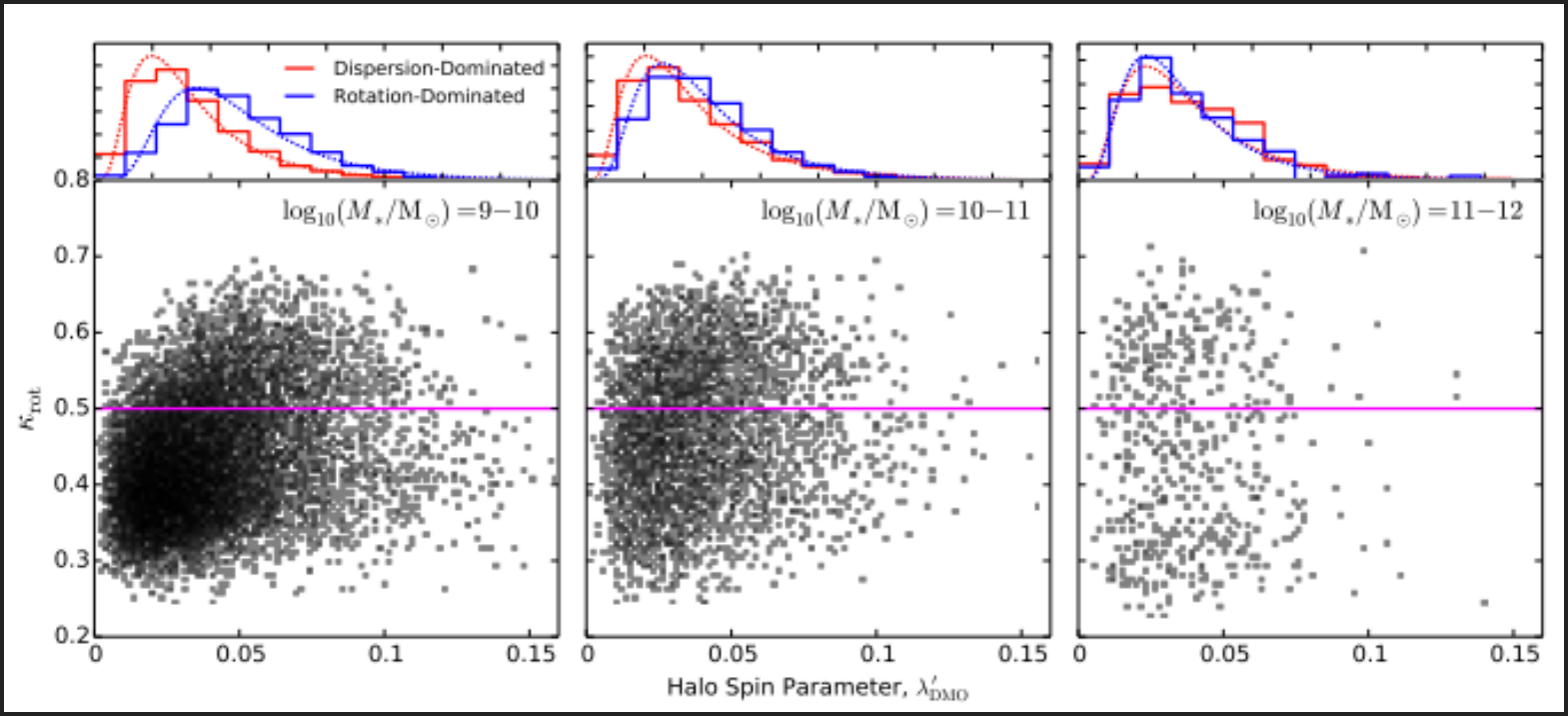
IMPORTANCE OF LINKING AM AND GALAXY FORMATION

- Important to understand how galaxies like our Milky Way formed
- Important to understand the distribution of galaxy morphologies in large scale structure
- Important to know how this distribution evolves in time

MOTIVATION

DM HALO DISTRIBUTION FOR GALAXY MORPHOLOGY

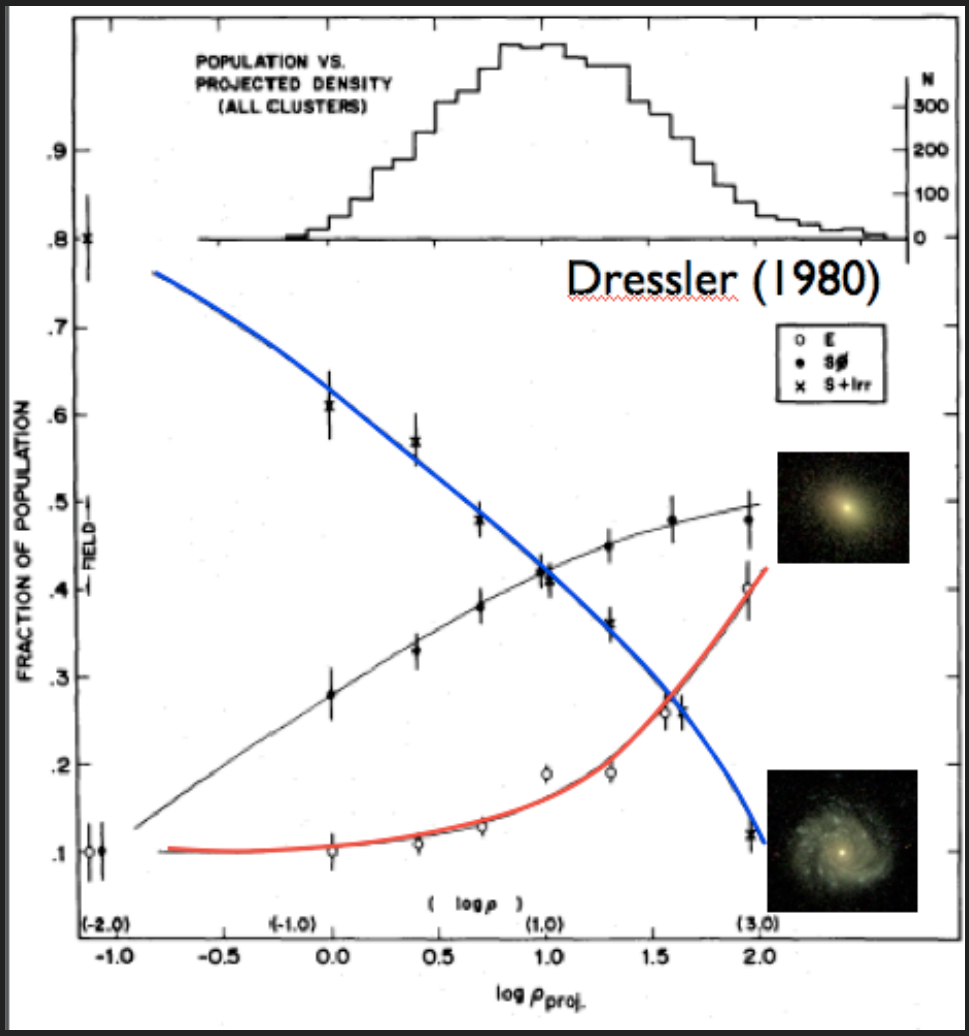
- Low mass dispersion and rotation dominated galaxies in Illustris have different DM halo spin distributions
- As galaxies increase in stellar mass, their DM halo spin distribution becomes similar to one another



Rodriguez-Gomez et al. 2016

MORPHOLOGY DENSITY RELATION

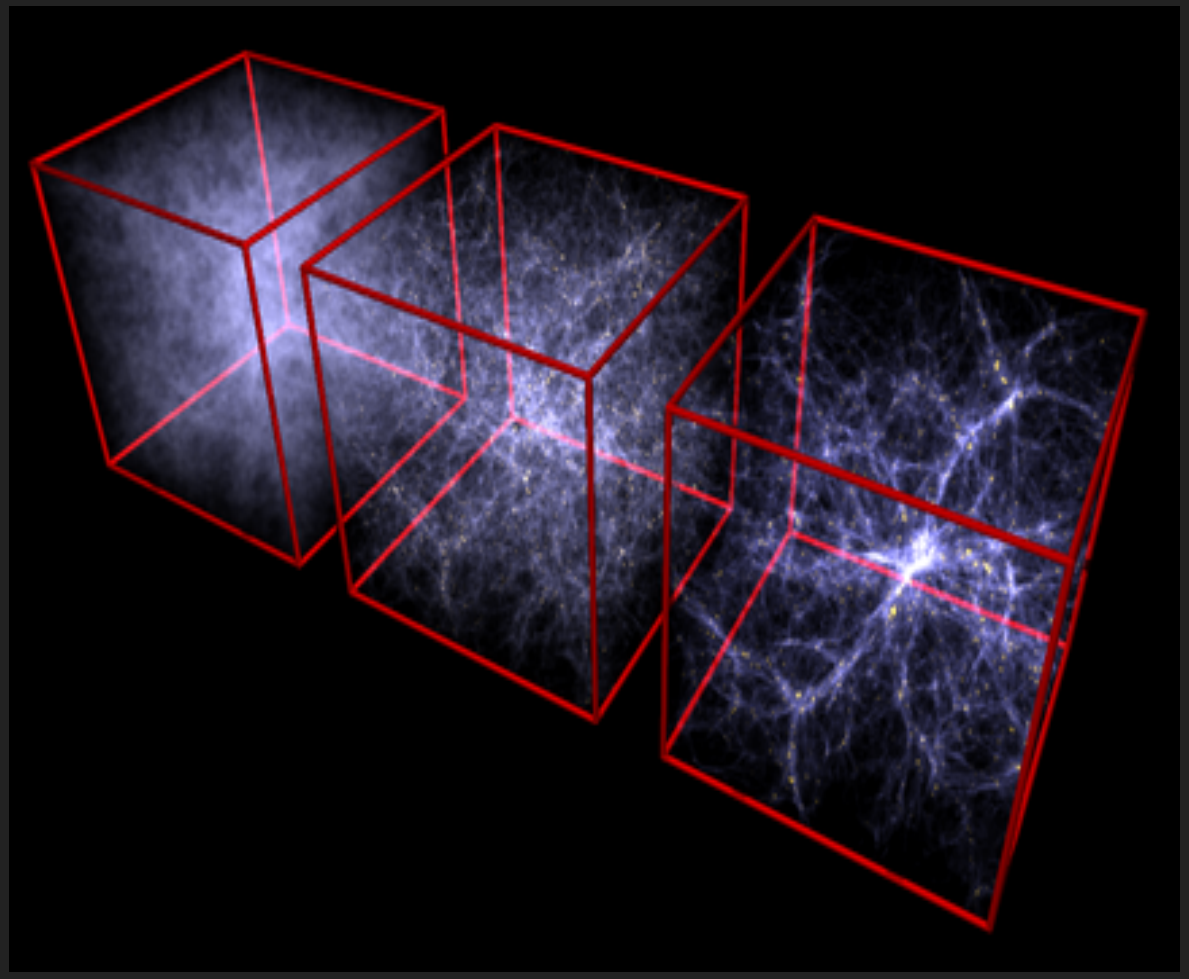
- Most spiral galaxies live in low density regions
- Most elliptical galaxies live in high density regions
- This comes from observations
- Goal: comparing semi-analytic and observed morphology density relation



Dressler 1980

METHODS

MODELING OUR UNIVERSE

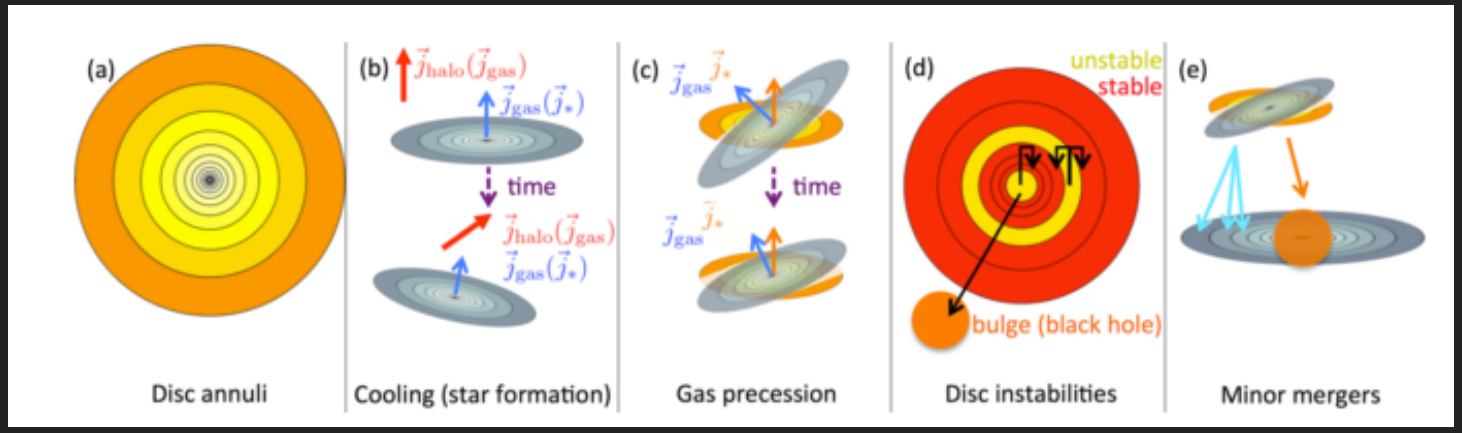


- Cosmology
  - Baryonic matter: 5 %
  - Dark matter: 25%
  - Dark Energy: 70%
- Particle mass
- Simulation box size
- Spatial resolution

Millennium simulation box. Springel V., Hernquist L., 2003

SEMI-ANALYTIC MODEL DARK SAGE

- Evolves angular momentum structure in disk
- Allows for individual stellar and gas plane
- Treats Tommre's instabilities by allowing material exchange between annuli

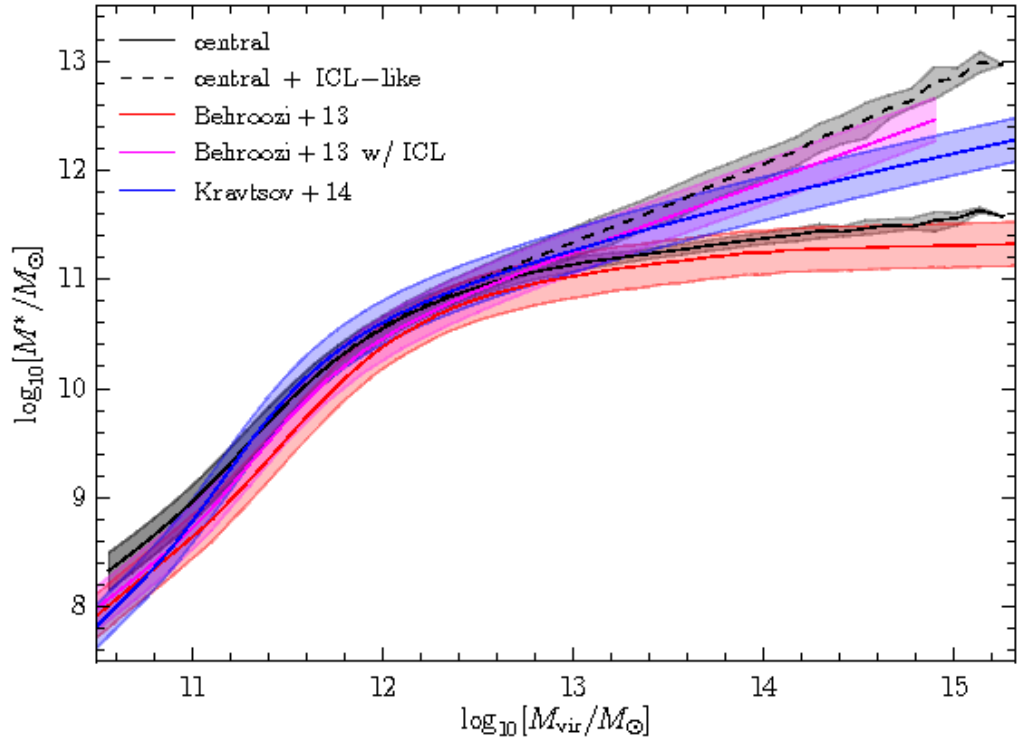


DARK SAGE semi-analytic model. Stevens et al. 2016

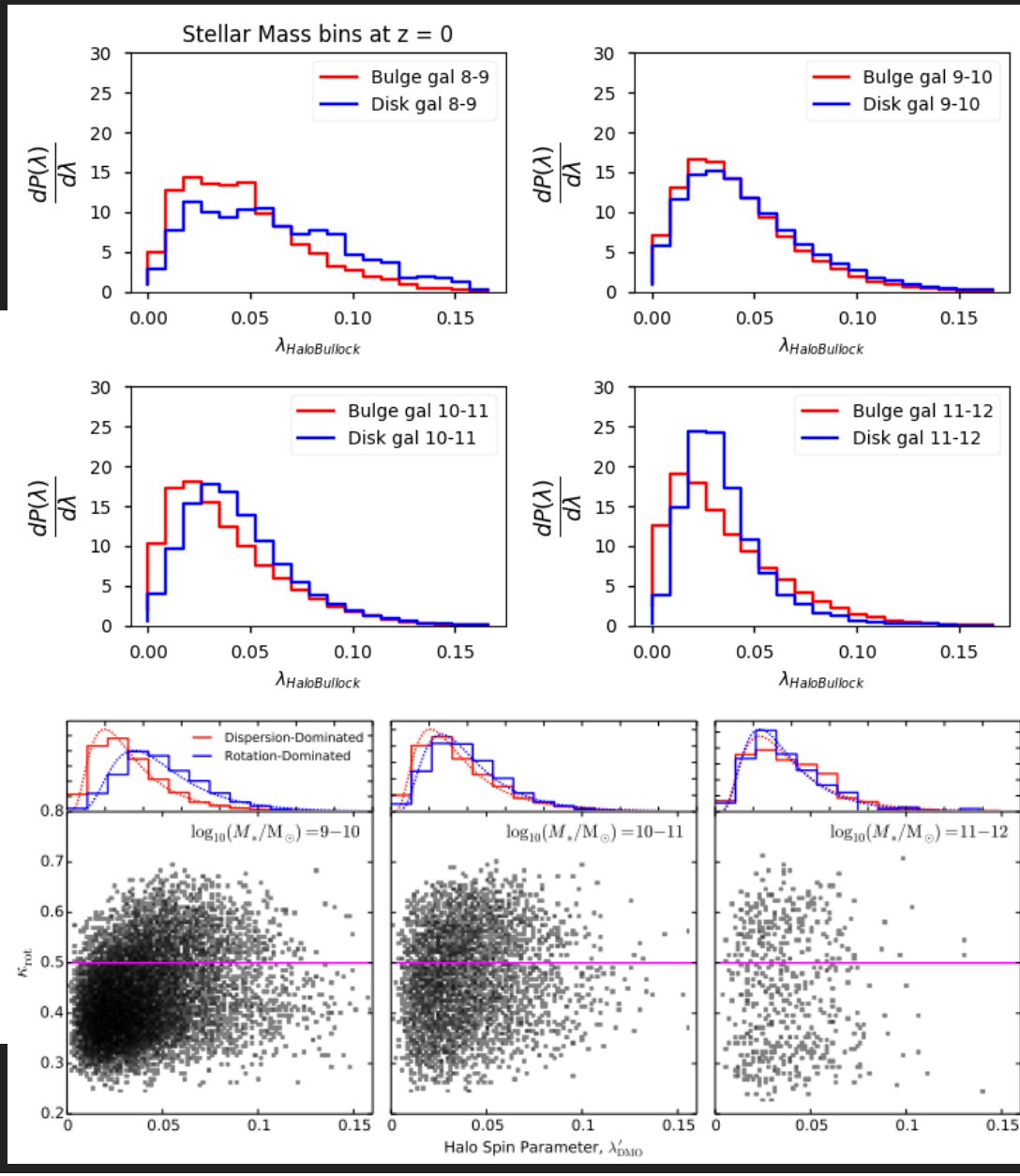
RESULTS THIS FAR

HALO SPIN IN GALAXY MORPHOLOGY

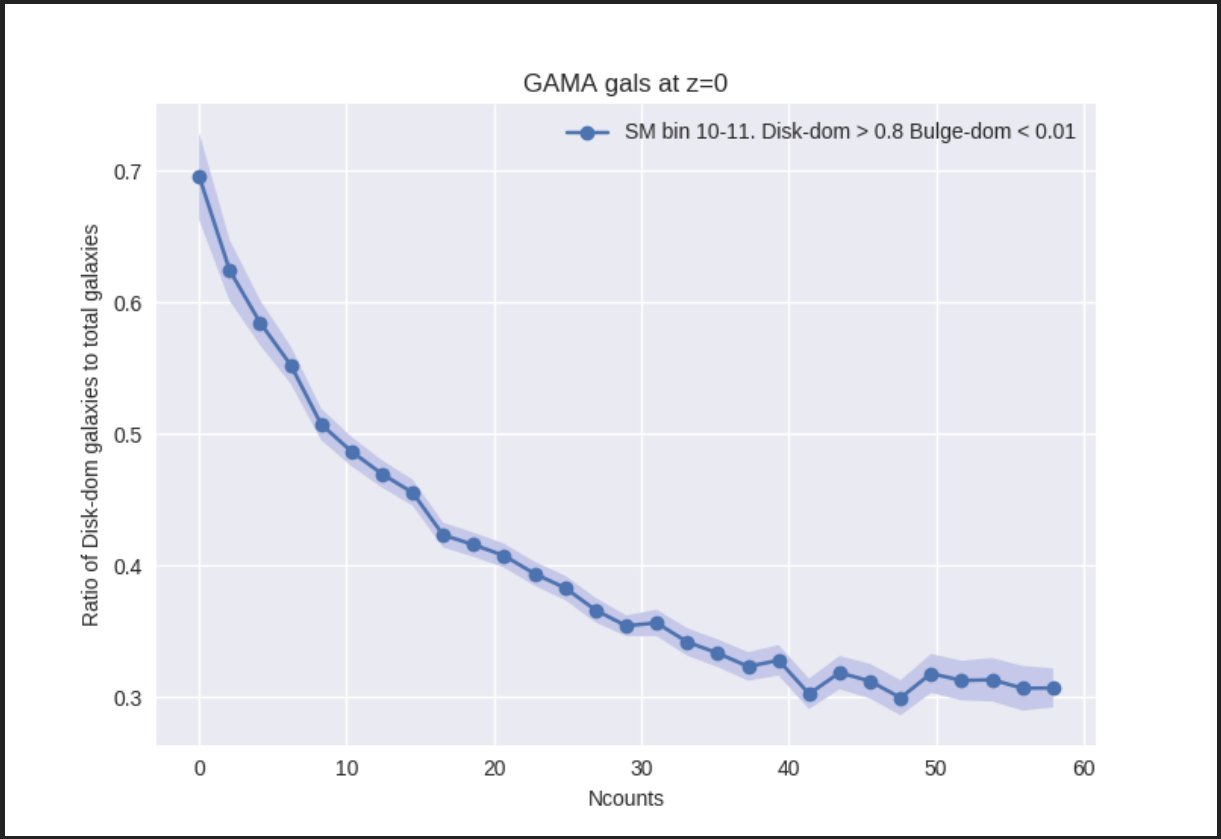
- Dark Sage disk and bulge dominated galaxies at low



Becker et al. 2015

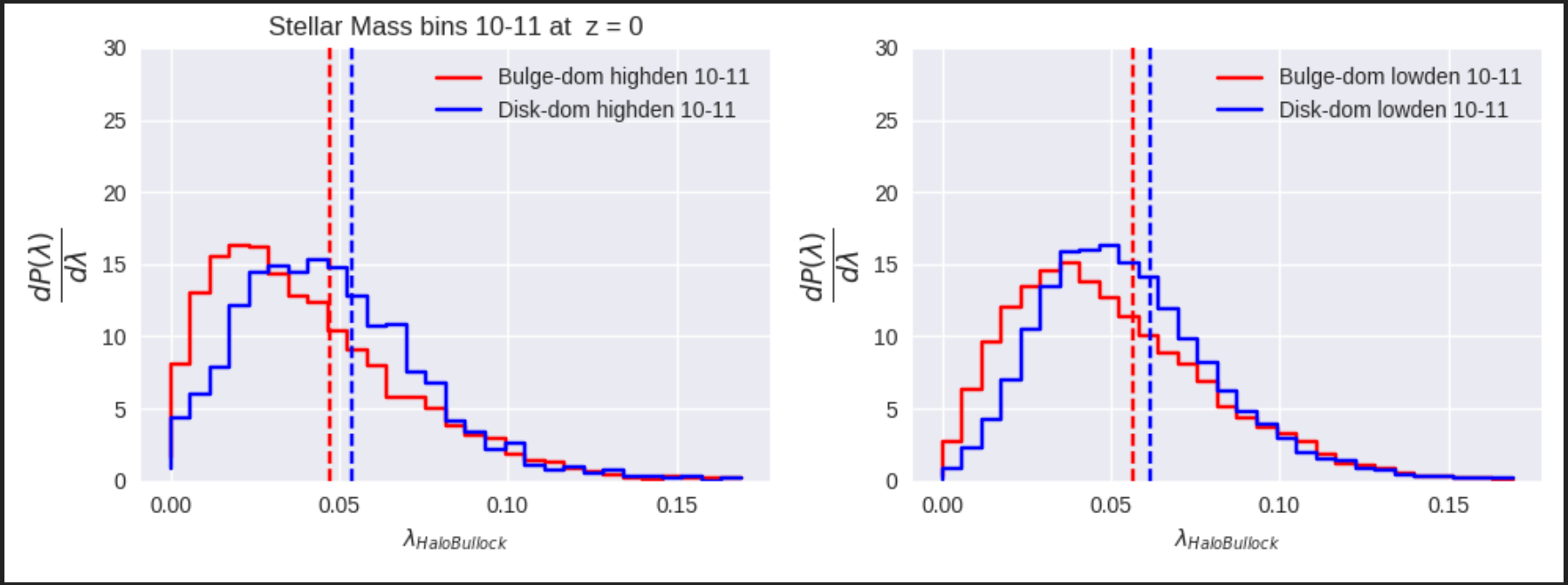


MEASURING ENVIRONMENT FOR DARK SAGE GALAXIES



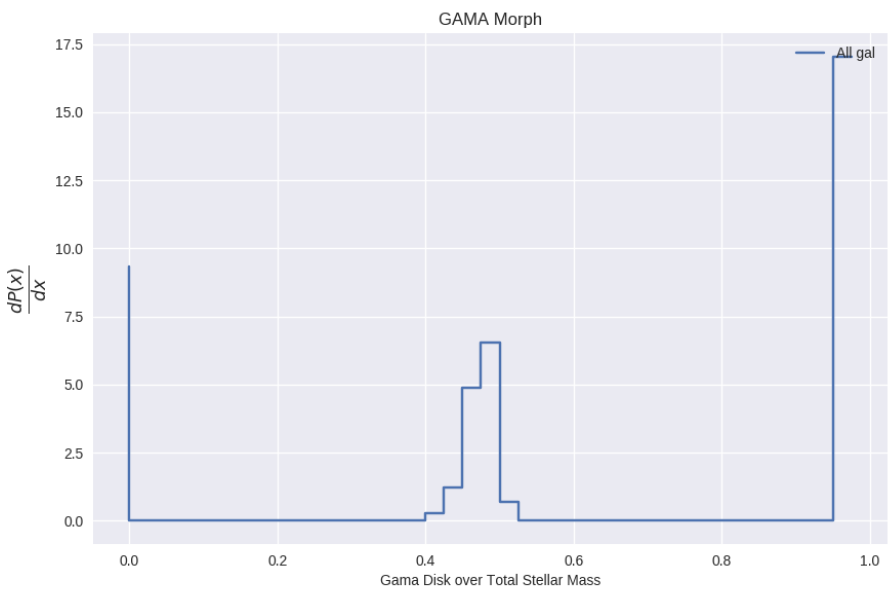
- Counted how many galaxies there are in a sphere of radius 8Mpc
- For every galaxy in the sample, we looked at the nearest neighbor

HALO SPIN FOR DISK AND BULGE DOMINATED GALAXIES



- Bulge(red) and disk (blue) dominated galaxies at stellar mass bin of 10-11
- High density environment (left) and low density environment (right)
- Dashed line is the mean for every distribution

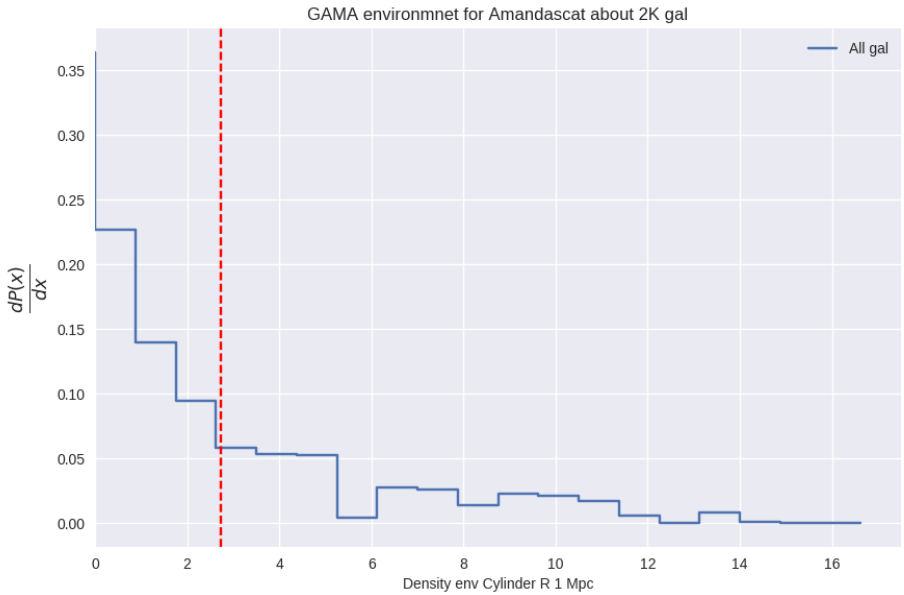
GAMA SURVEY GALAXIES



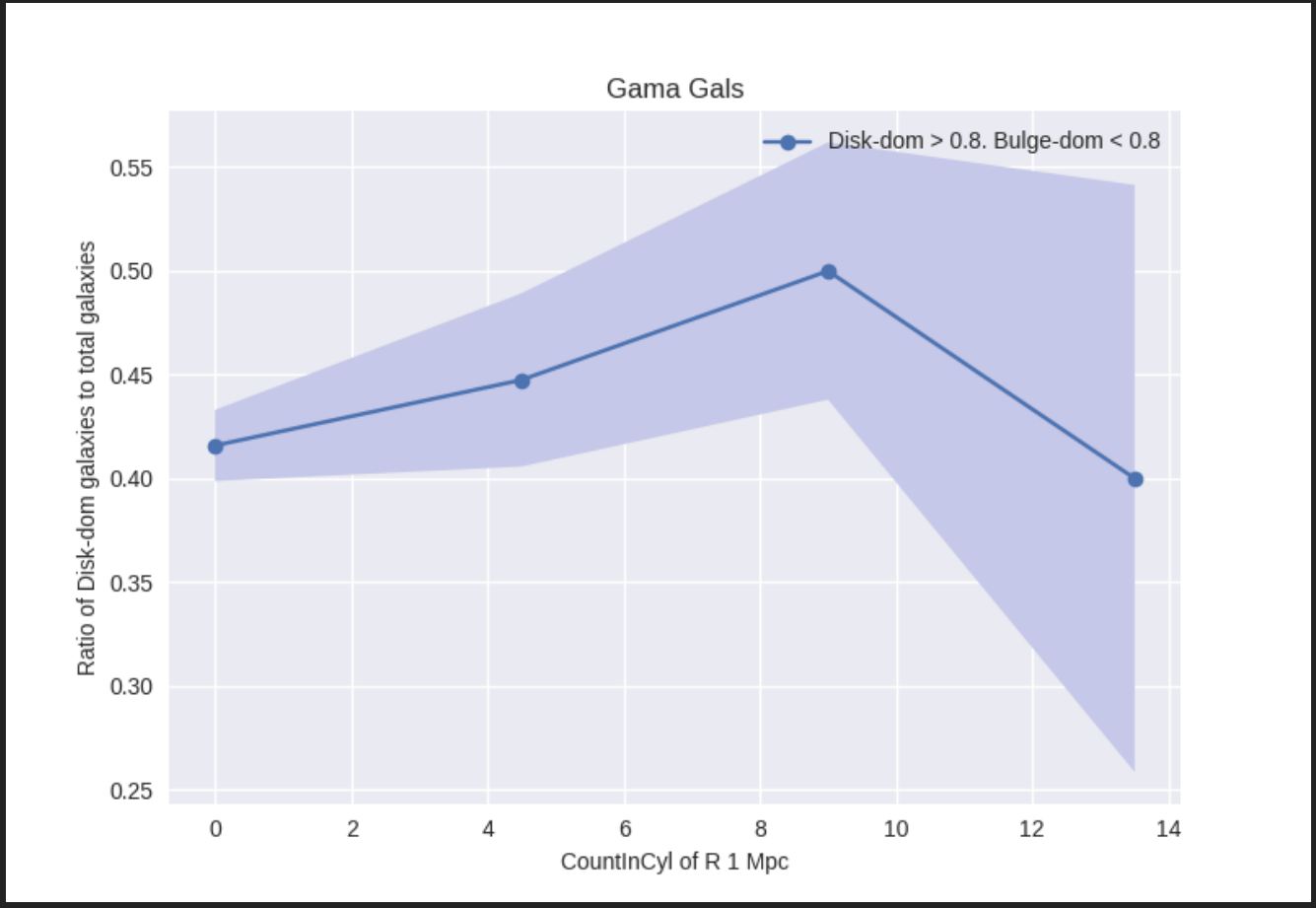
- Morphology distribution for 2000 GAMA survey galaxies

- Distribution of those galaxies' environment.

- Environment is measured using a cylinder with R 1Mpc and height of 20Mpc to account for redshift distortion

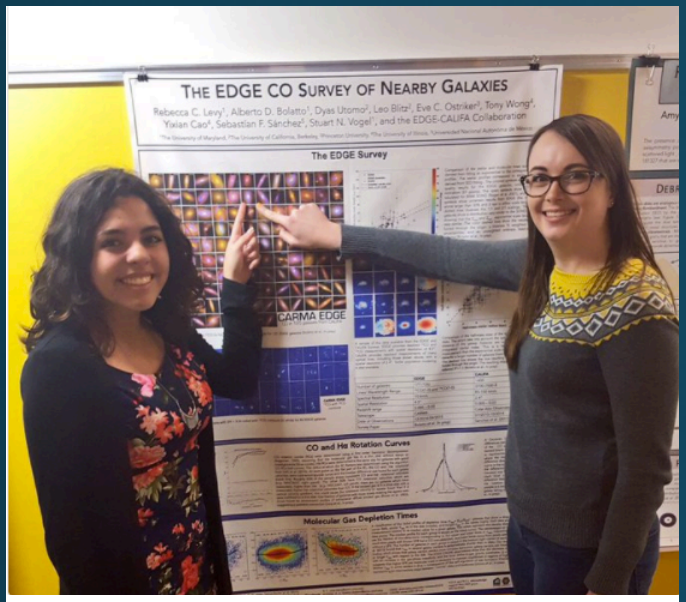


MEASURING ENVIRONMENT FOR GAMA GALAXIES



- Counted how many galaxies there are in a cylinder of radius 1Mpc, height 20Mpc
- The shaded region is the poisson error assuming Poisson distribution

COSTA RICA – U.S. BRIDGE PROJECT



GRADMAP
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Meet our winter workshop students!

Natalia Ramirez
University of Costa Rica
Physics Major
Second Year

- Provide computational and research training to nontraditional students interested in astronomy
- Inform students about graduate school in the United States
- Expand their international network
- Website: http://costarica-us-bridge.weebly.com/

Questions?