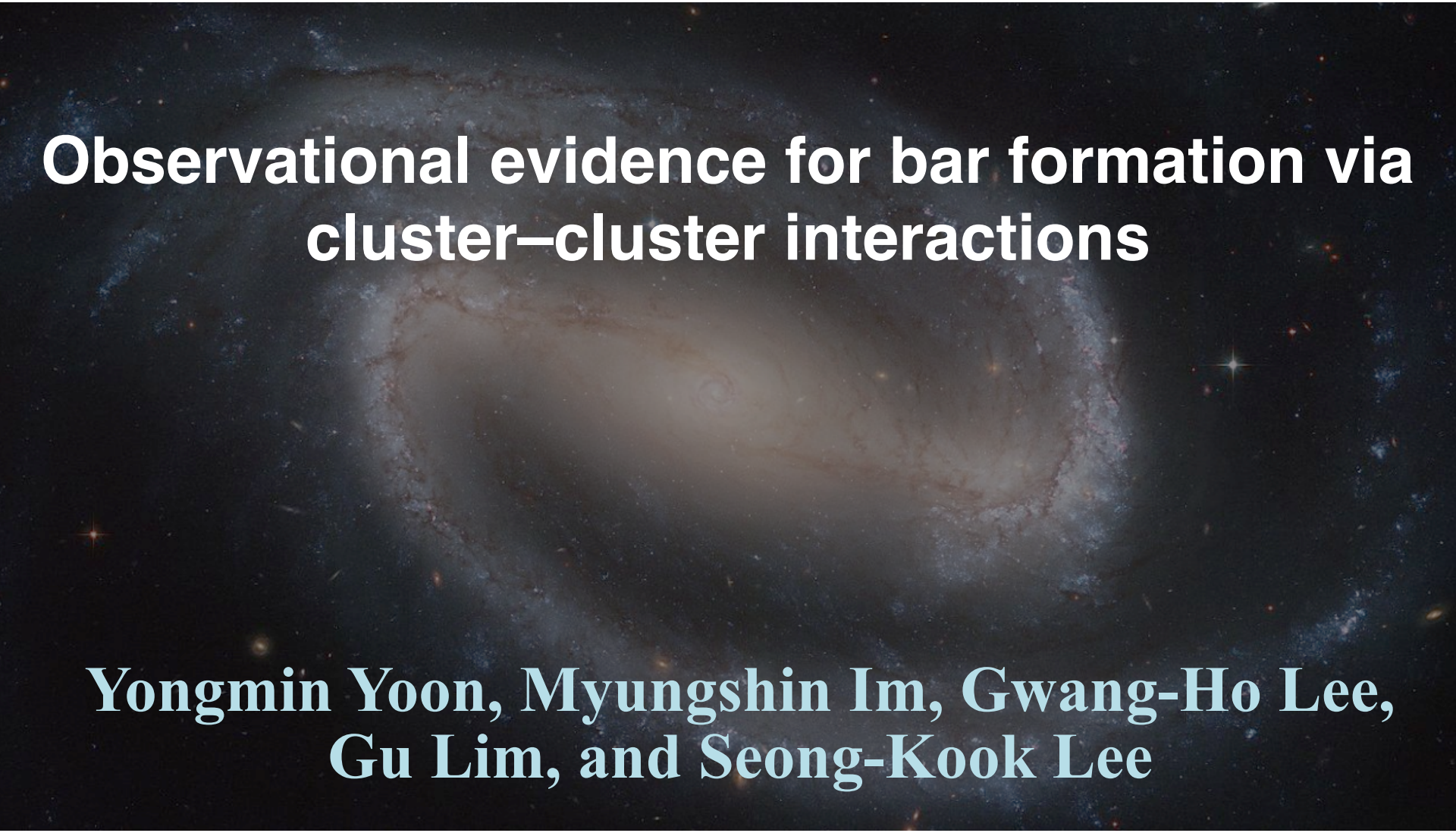


Observational evidence for bar formation via cluster–cluster interactions

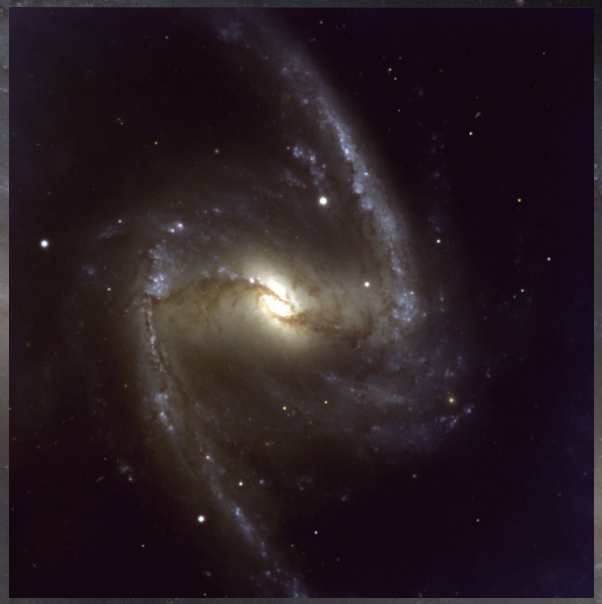
Yongmin Yoon, Myungshin Im, Gwang-Ho Lee,
Gu Lim, and Seong-Kook Lee

CEOU, Seoul National University
Steward Observatory, University of Arizona
Korea Astronomy and Space Science Institute

Introduction

- Bars are commonly found in disk galaxies in the local universe.

NGC 2217



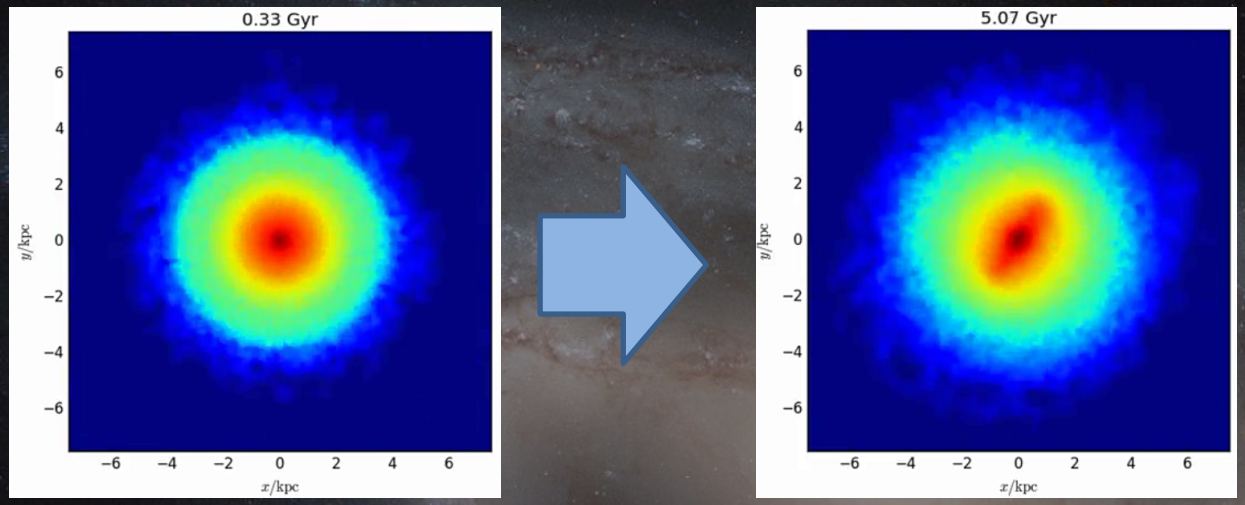
NGC 1365

M95

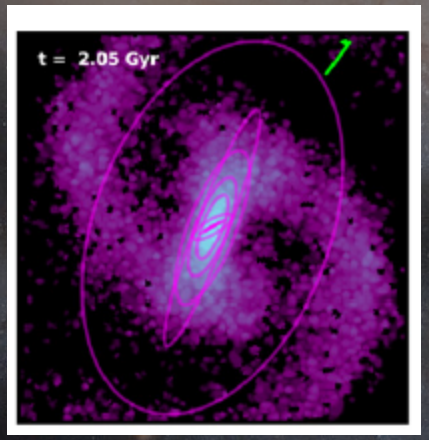
Introduction

- Broadly, there are two main bar formation mechanisms: (1) internal; (2) external.

Kwak et al. (2017)



Spontaneous disk instability



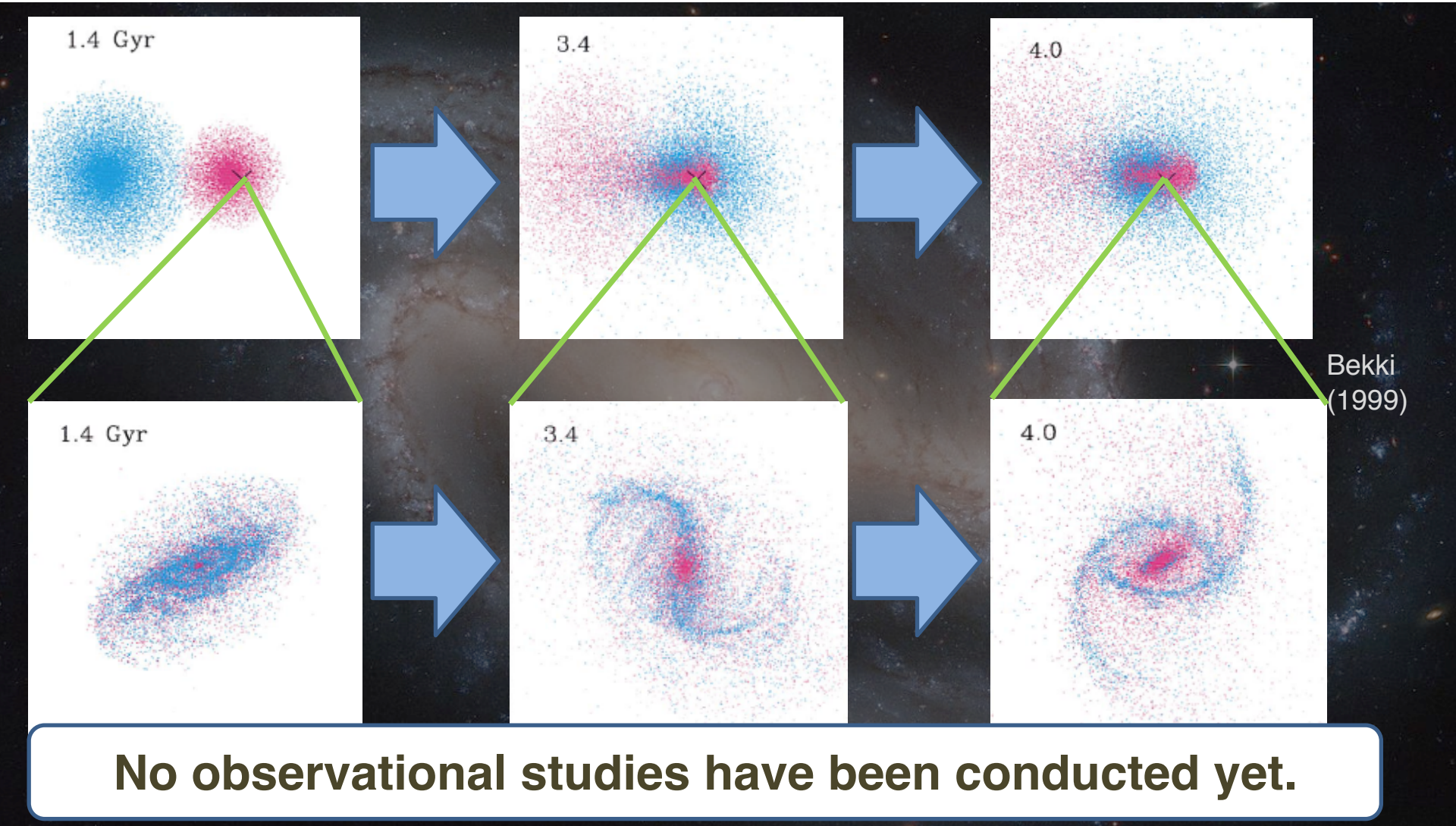
Tidal force from interactions

Lang et al. (2014)

Introduction

- Not very well recognized mechanism

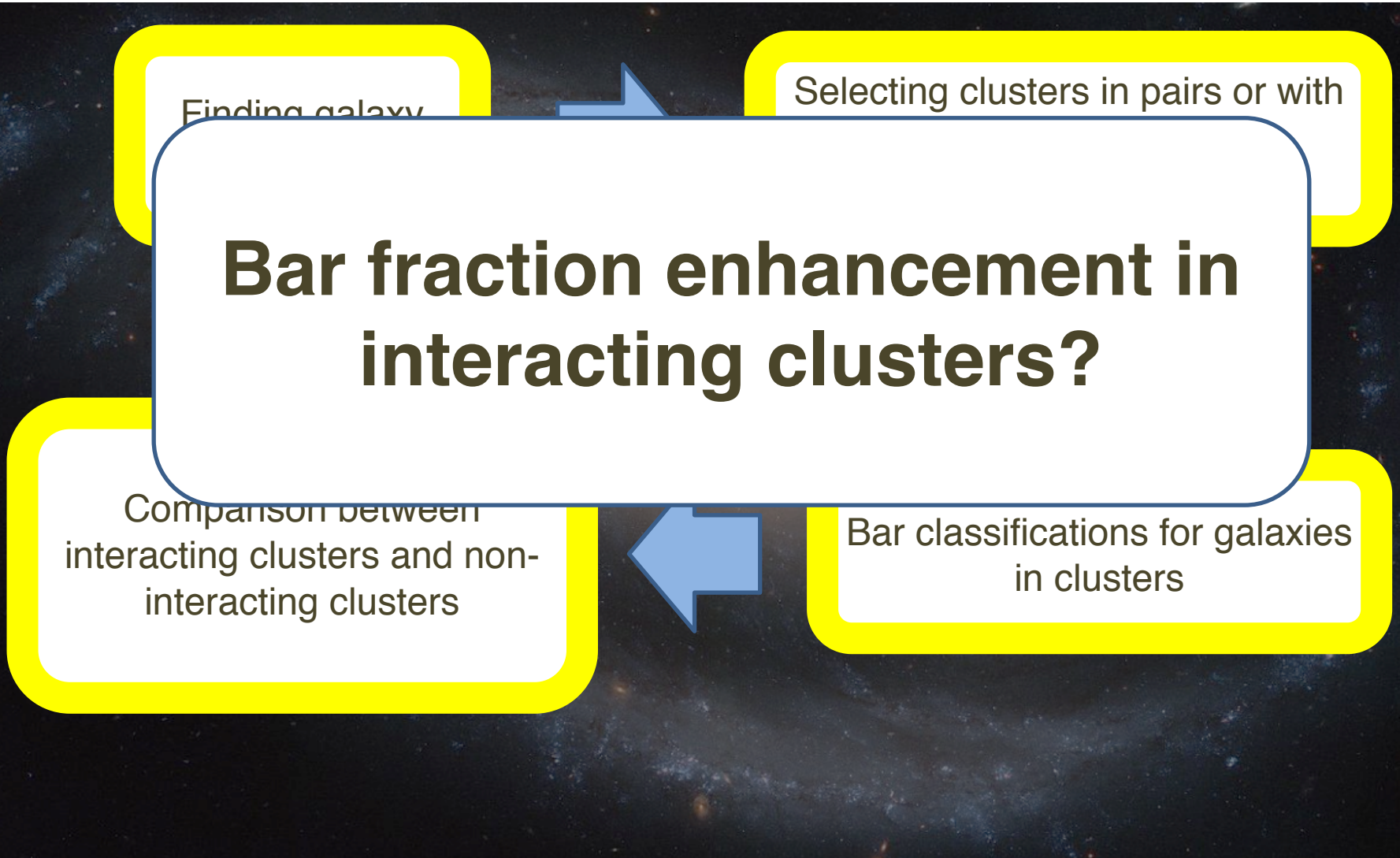
  : Bar formation by cluster-cluster interaction



No observational studies have been conducted yet.

Introduction

- In this study...



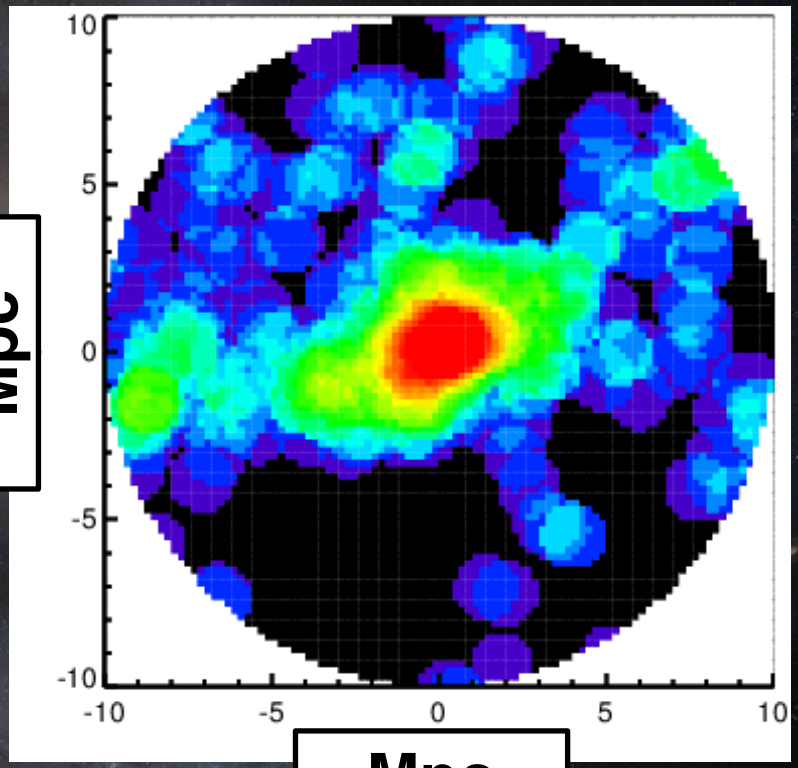
Analysis

- Finding overdense regions

Galaxies in overdense region (2 **σ**)

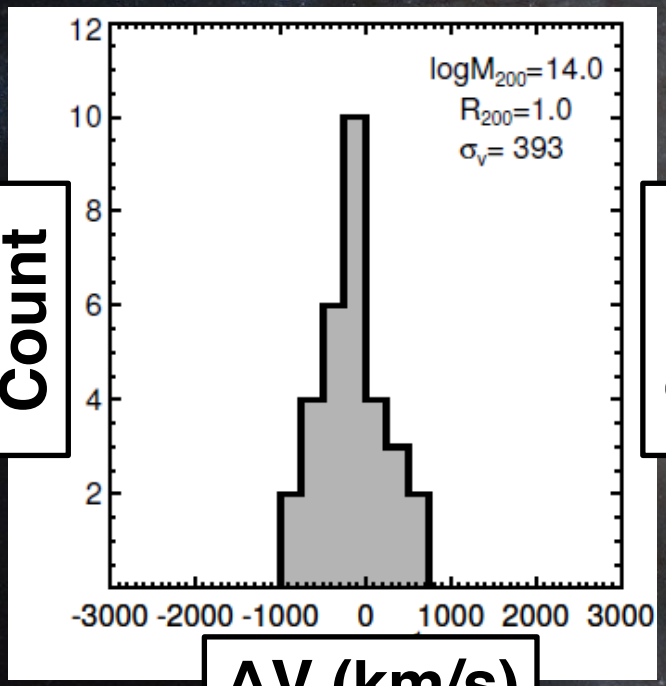
Friends-of-Friends (FoF) algorithm

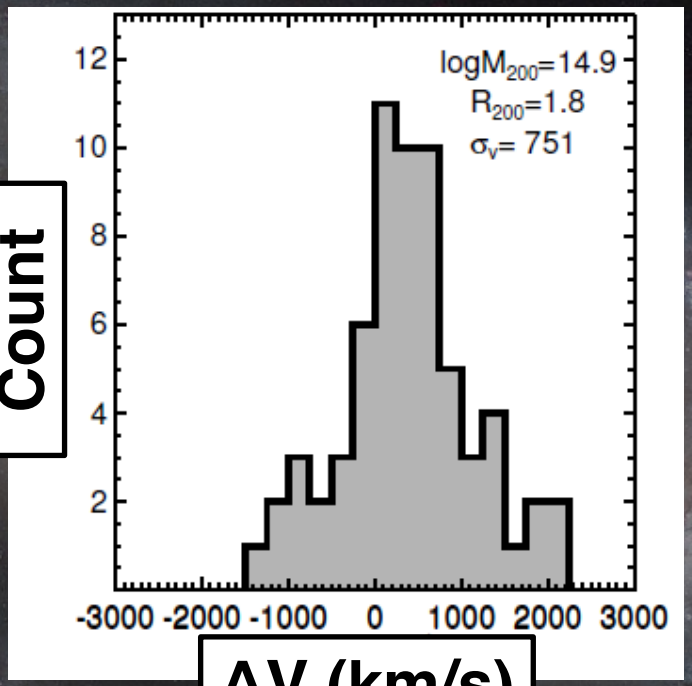
Overdense region



Analysis

- Measuring dynamical masses
- 105 clusters with $\log(M_{200}/M_{sun}) > 13.85$ are found in $0.015<z<0.060$.





$$R_{200} = \frac{\sqrt{3}\sigma_v}{10H(z)}$$

$$M_{200} = 3\frac{\sigma_v^2 R_{200}}{G}$$

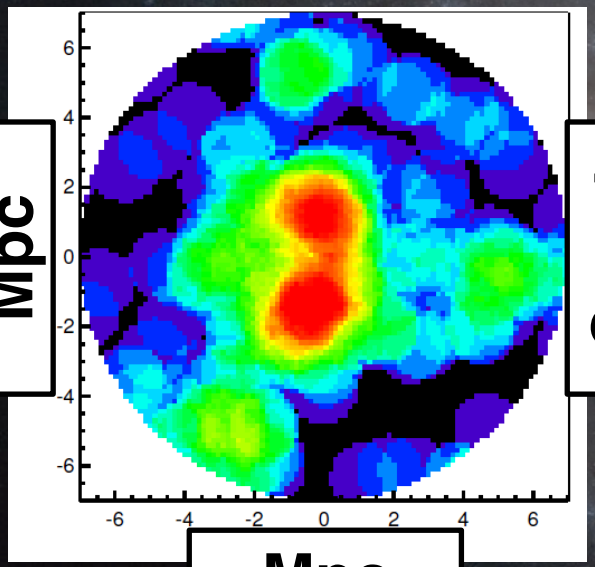
Demarco et al. (2010)
Kim et al. (2016)

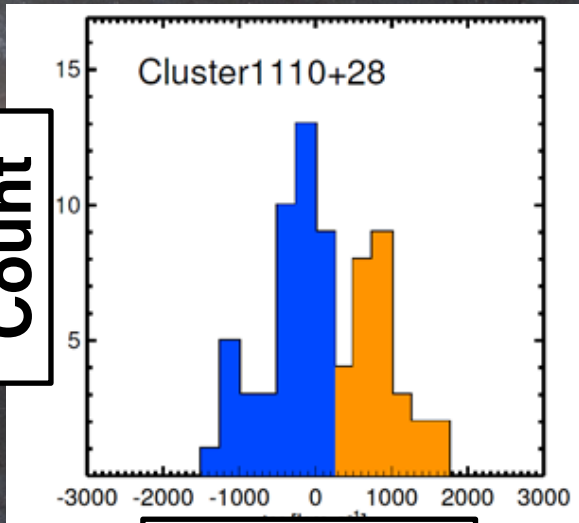
Analysis

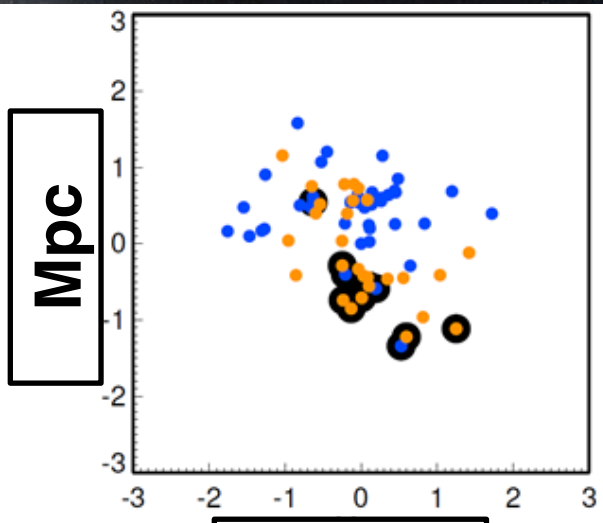
- Among the 105 clusters, 16 clusters are in pairs or with substructures → Interacting clusters

Pair

Substructure







Analysis

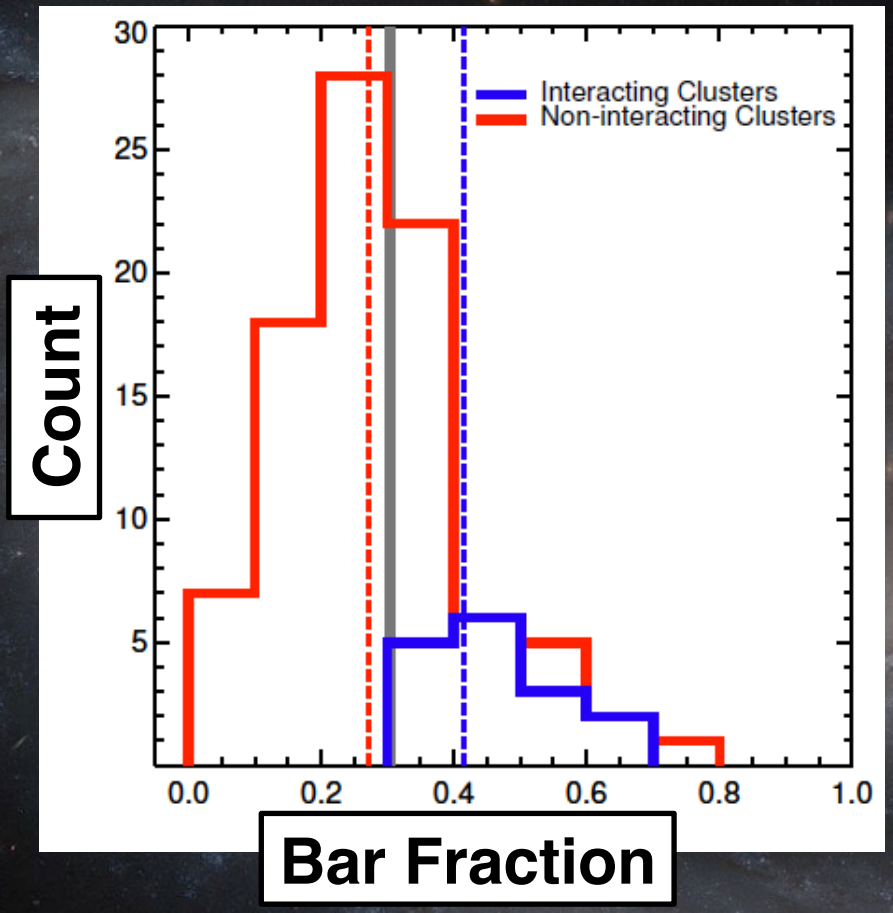
- Classifying bars for cluster member galaxies using the Ellipse task & visual inspection

Barred galaxies

Non-barred galaxies

Results

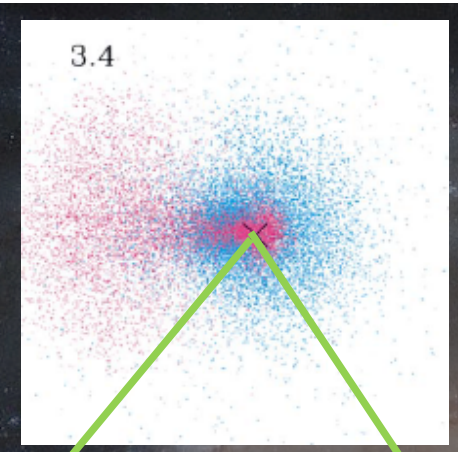
- Bar fraction is enhanced (~1.5 times) in interacting clusters.

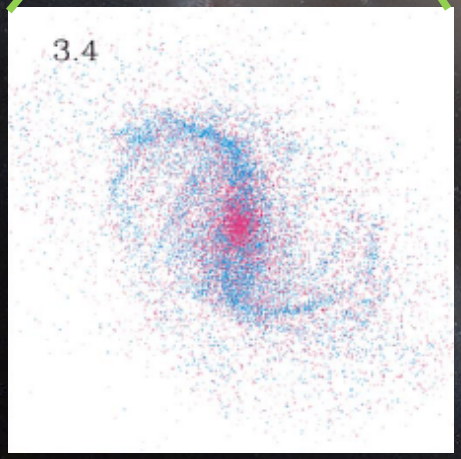


KS test: 99.999% (4.5σ)

Conclusion

- **Our results stand as the first observational evidence for a bar formation mechanism, cluster-cluster interaction.**





Bekki (1999)