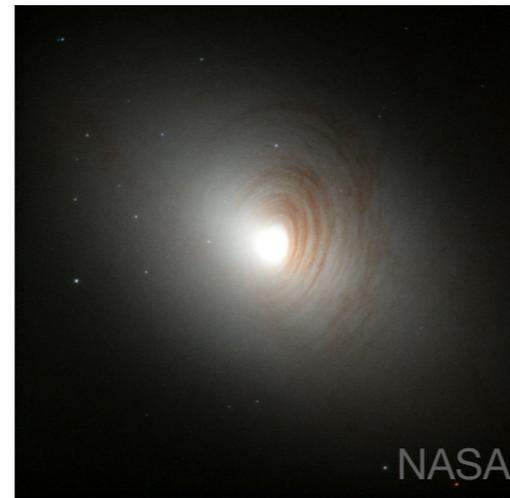
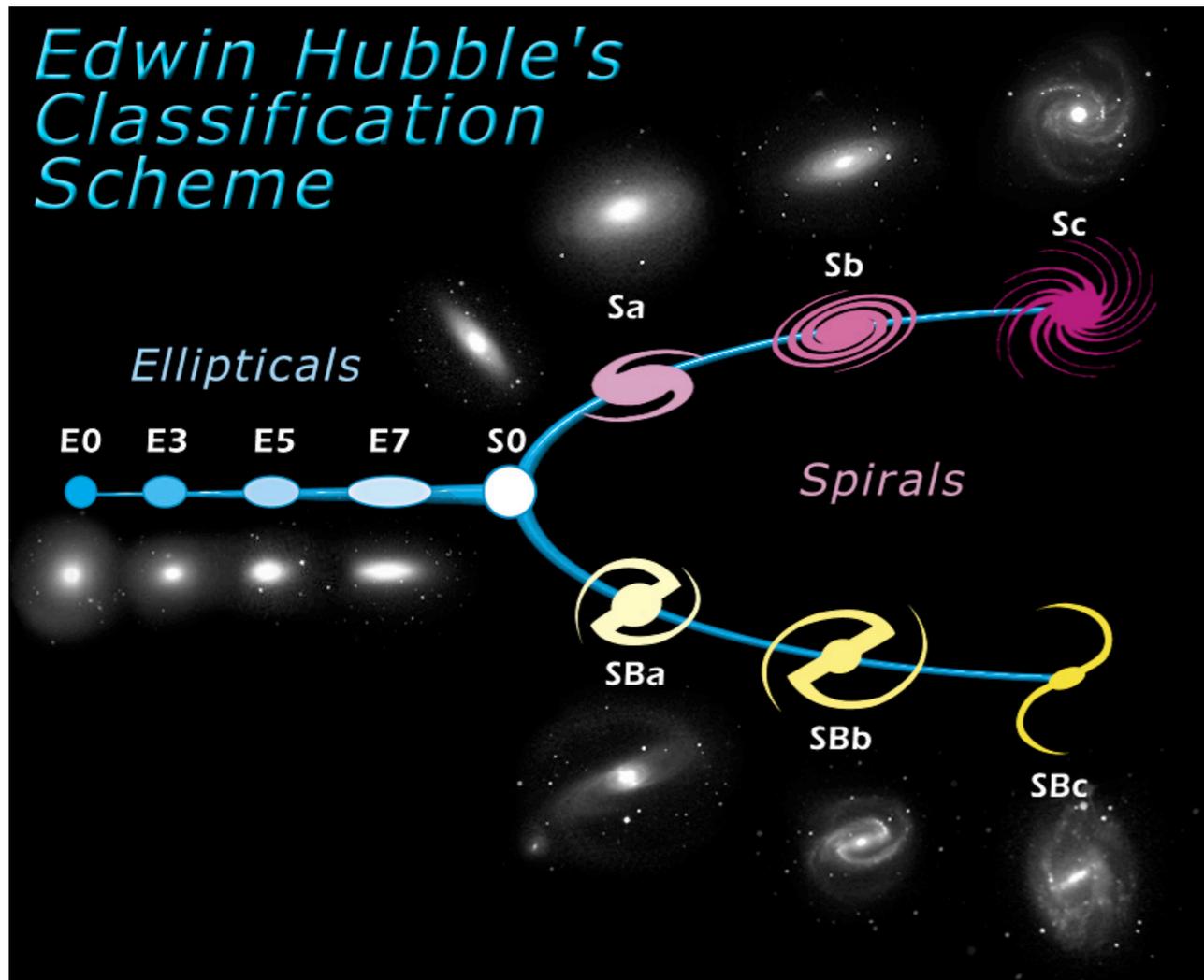


Formation of S0s in extreme environments

- I. Clues from kinematics and stellar populations (Coccatto et al. 2020)
- II. The star-formation histories of bulges, discs, and lenses (Johnston et al. 2021)

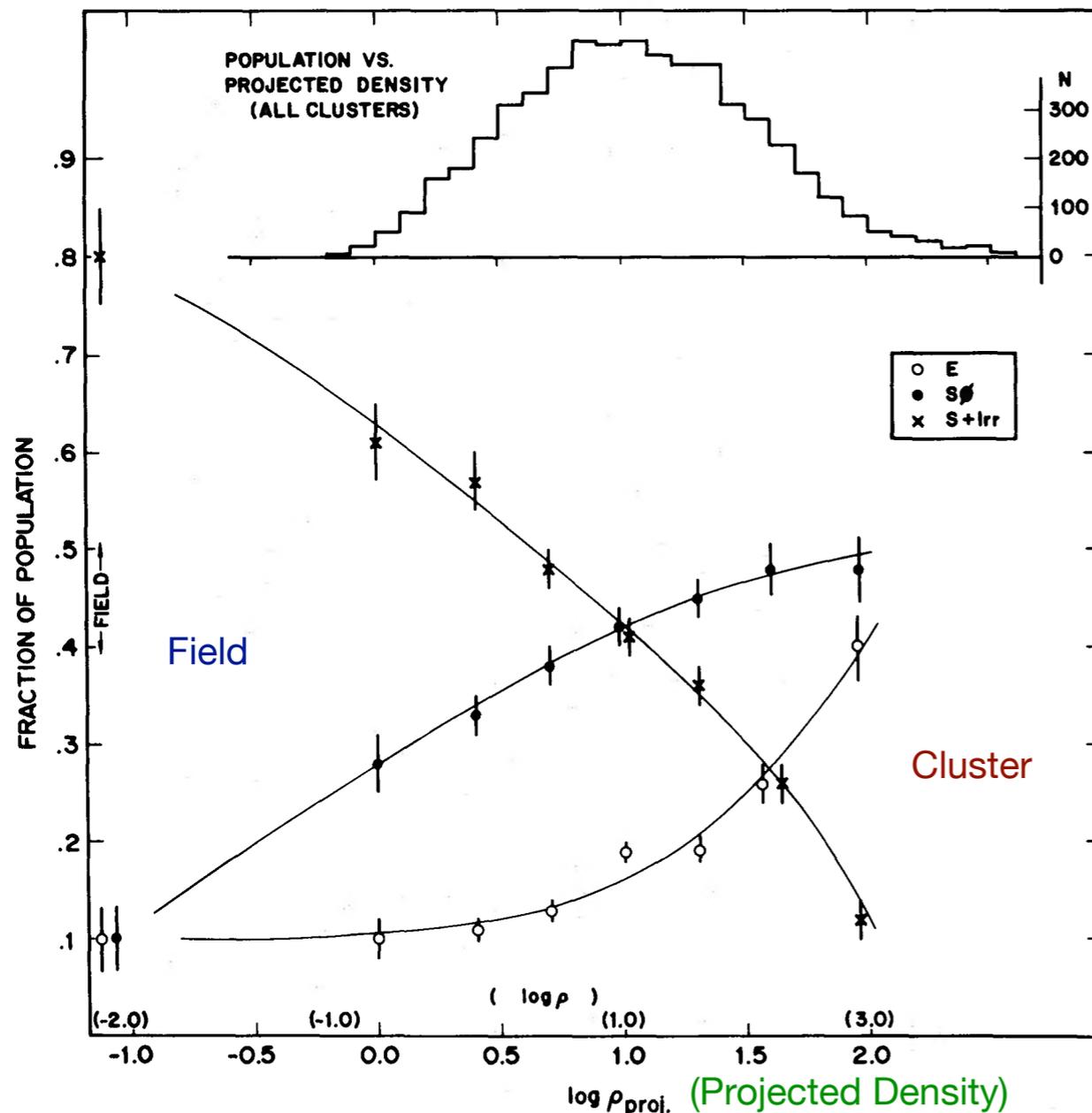
Lenticular Galaxies (S0)



- **Bulge and Disk**, but no signs of spiral arms
- **Old stellar populations** and very little ongoing star formation

Scenarios for S0 Formation I

Environmental effects of clusters



Dressler (1980)

- S0s are quenched spirals?
- The Morphology-Density Relation showing opposite trends between S0s and Spirals
- A popular explanation is that spiral galaxies falling into clusters lose their gas via ram-pressure stripping or tidal interactions

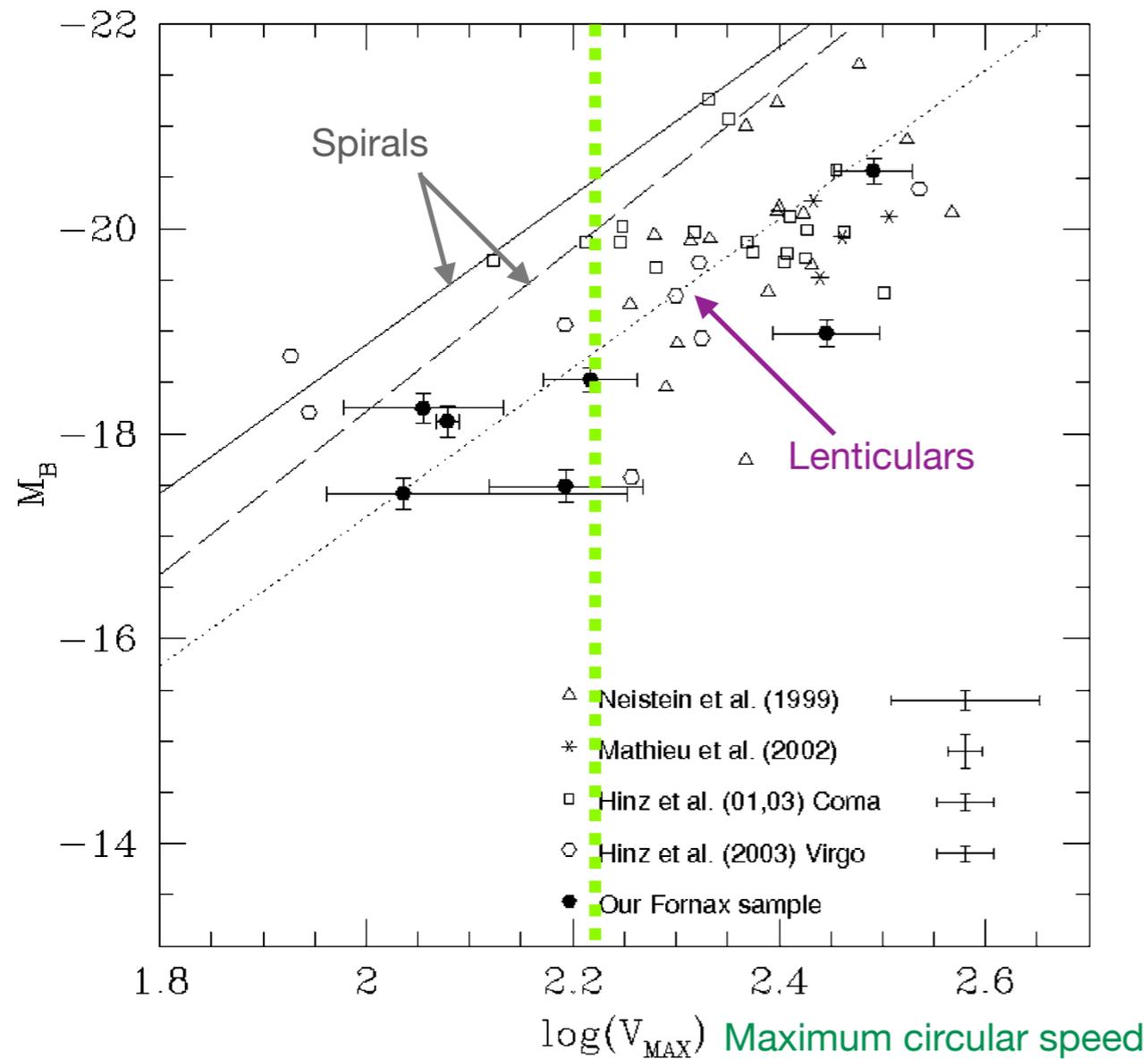
Scenarios for S0 Formation II

Galaxy mergers

- Galaxy mergers can form classical bulge
- Mergers induce a bar in the disc, that can build up a pseudo-bulge
- Discs in S0s are dynamically hotter than those in spirals
- Blue globular cluster population has a wide age range
- The number of field S0s with counter-rotating gas kinematics is higher than in denser environment, implying that this gas could have been accreted from dwarf satellites

Scenarios for S0 Formation III

Passive evolution of spirals



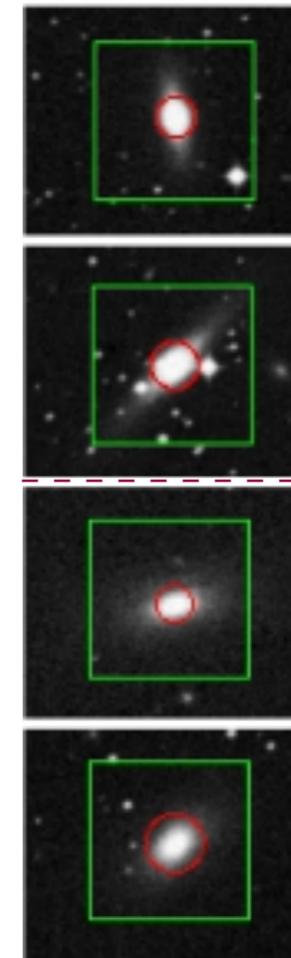
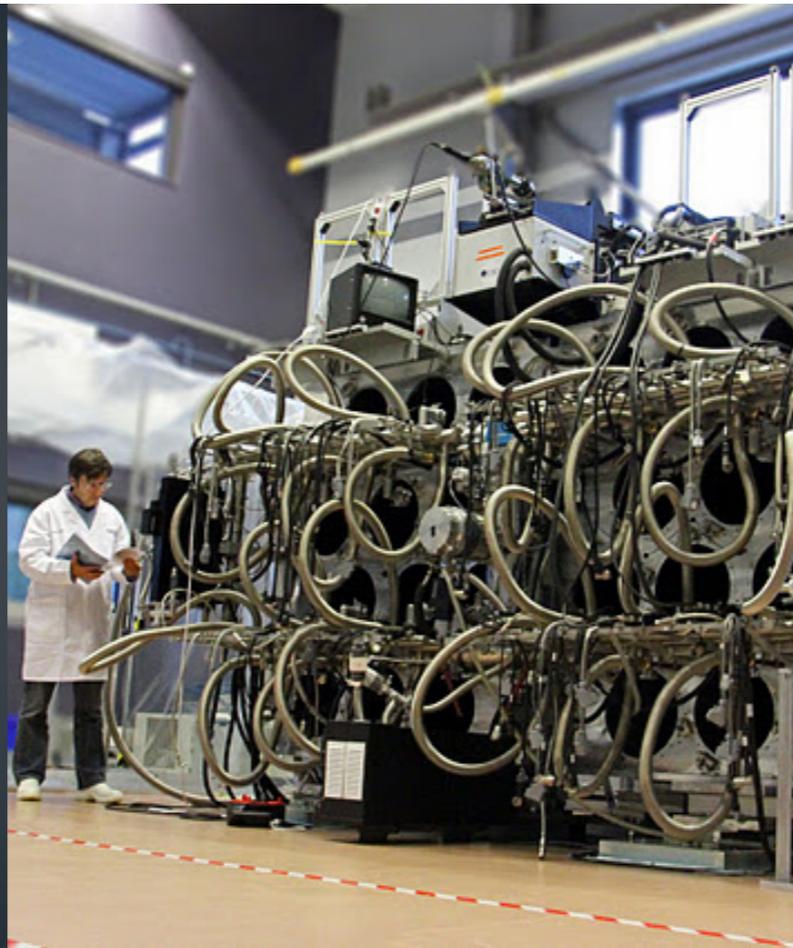
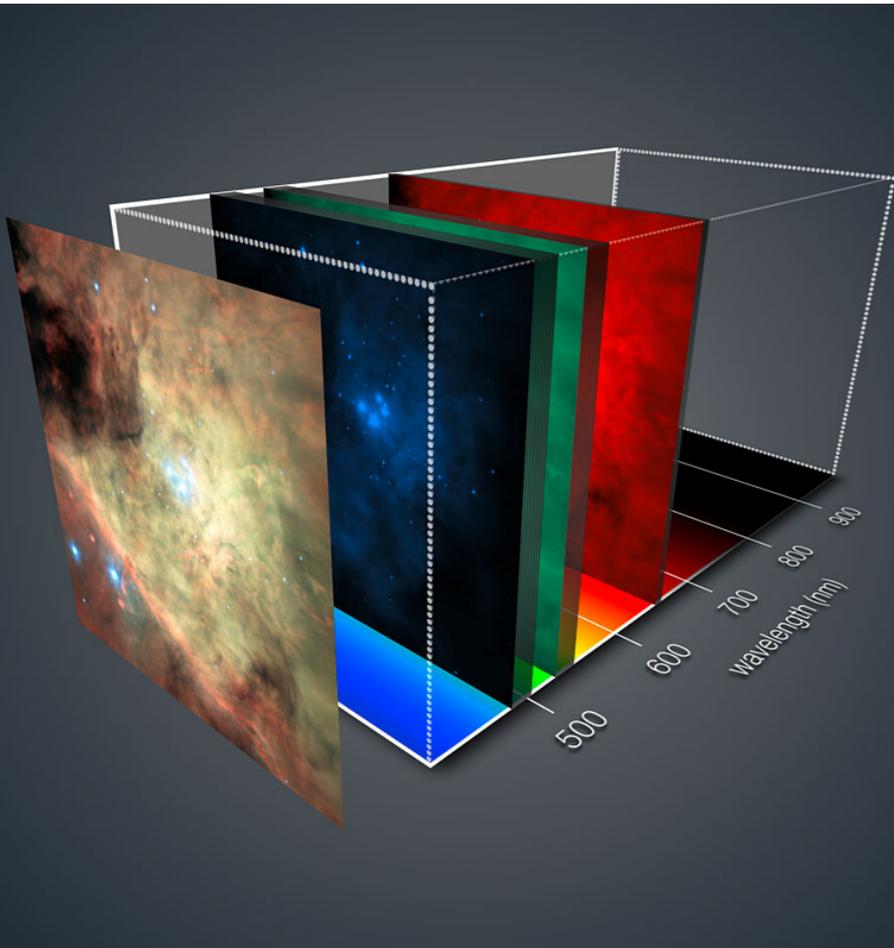
- Faded field spiral galaxies that exhausted their gas reservoirs and lost their spiral structures through disc instabilities
- Similar Tully-Fisher relation with Spirals, but fainter luminosities (due to old stars)
- The luminosities of bulges in S0s are brighter than expected from a simple cessation of star formation in the disc
- Younger stellar populations are found in the bulge regions of Fornax and Virgo S0s, triggered by residual disc gas that was channeled into the centre of the galaxy

MUSE Wide Field-of-View IFU Spectroscopy

A MUSE study of 12 S0s in radically different environments (cluster vs. field)

Spatially-resolved studies of kinematics and stellar populations of the S0 galaxies

VLT/MUSE IFU FoV $1' \times 1'$
(Gemini/GMOS IFU FoV $5'' \times 7''$)

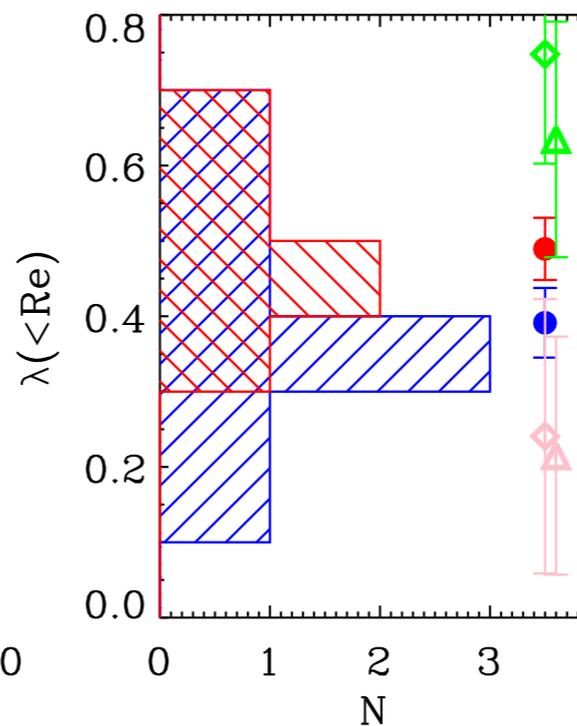
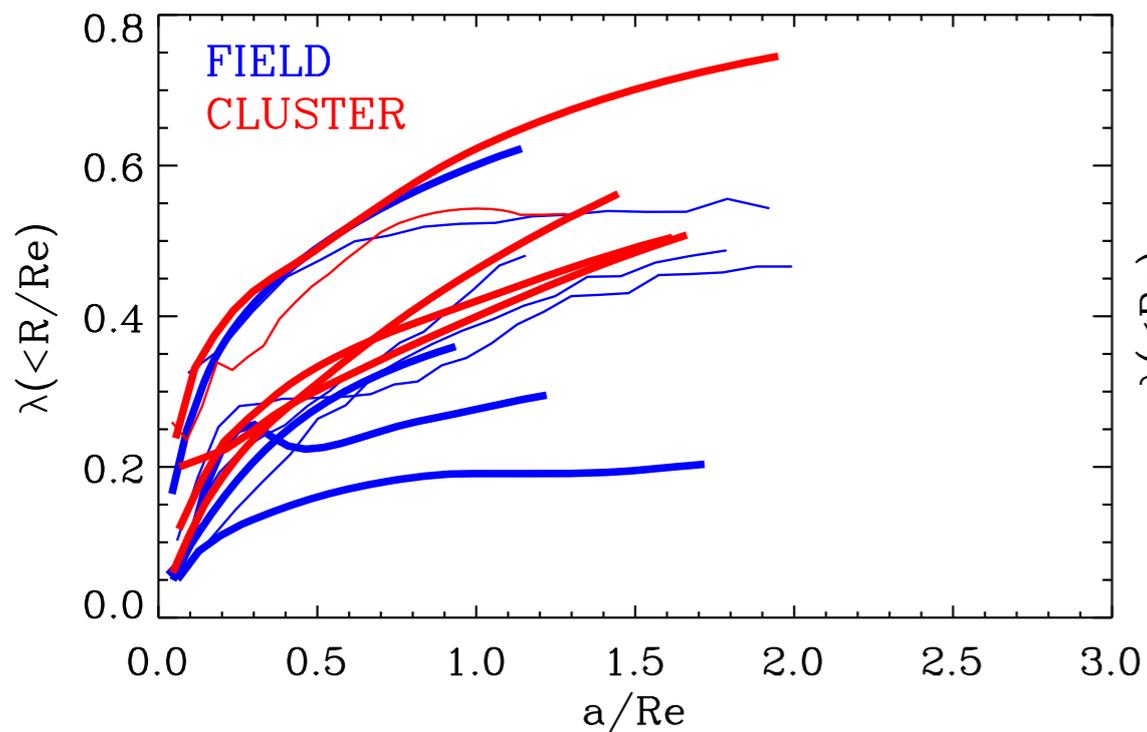
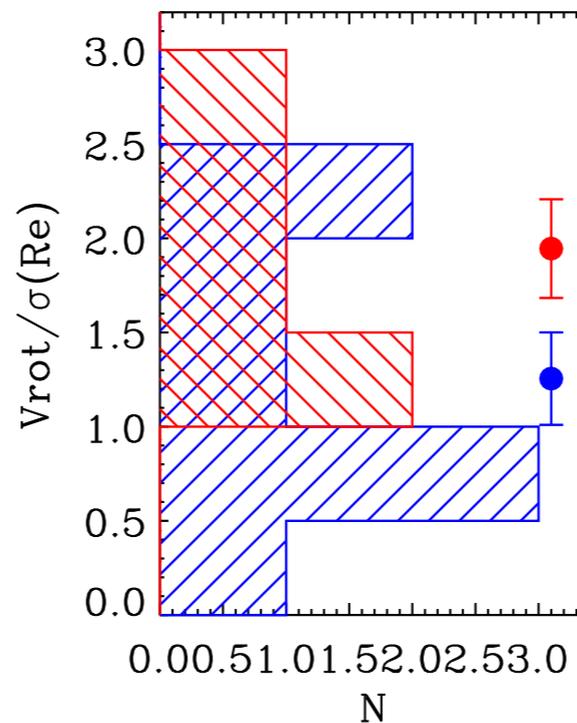
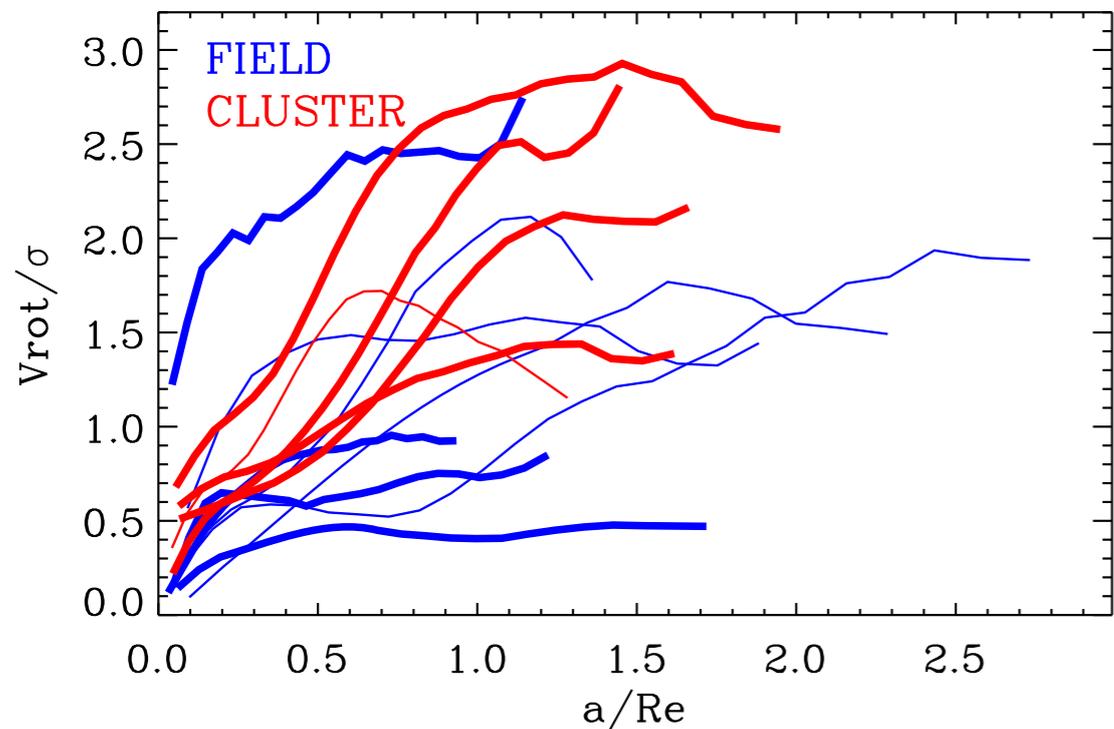


6 Cluster S0s

6 Field S0s

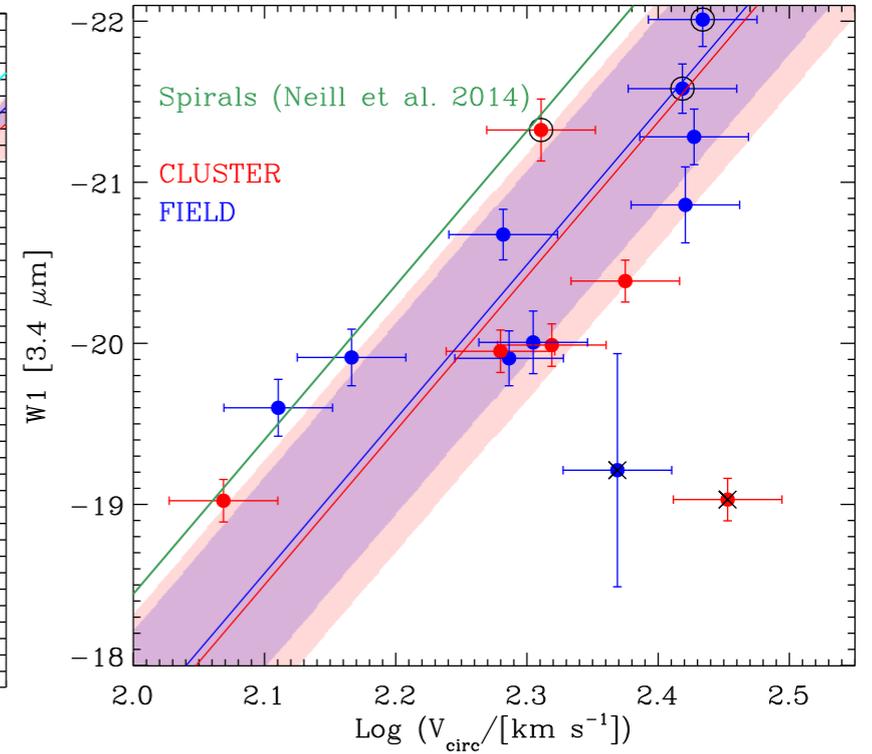
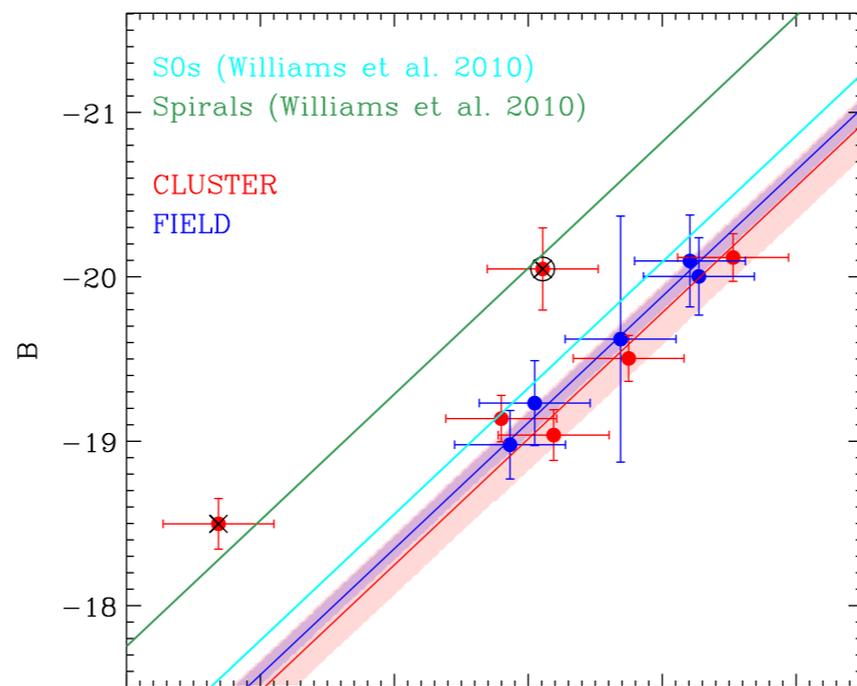
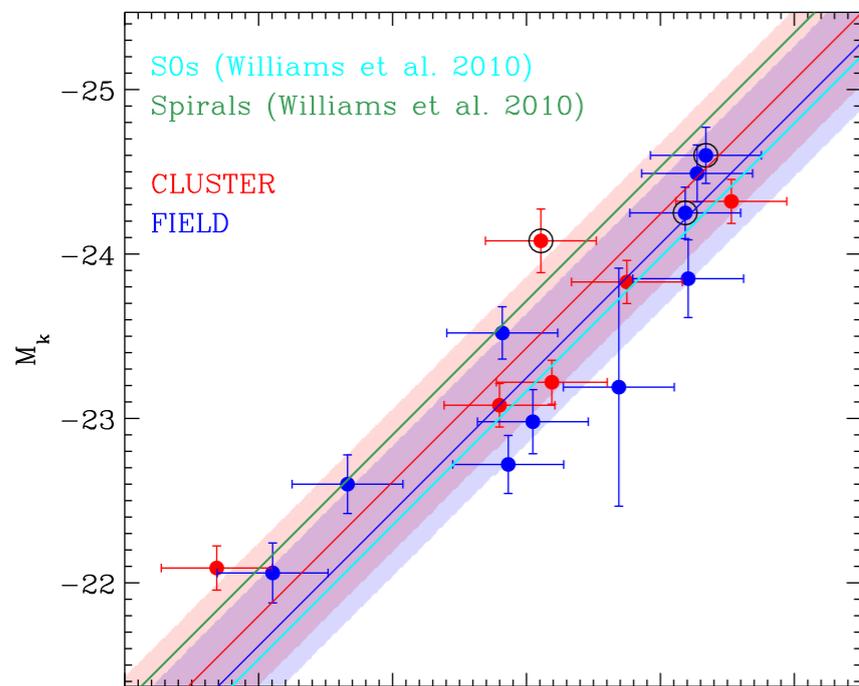


V_{rot}/σ profiles and lambda profiles



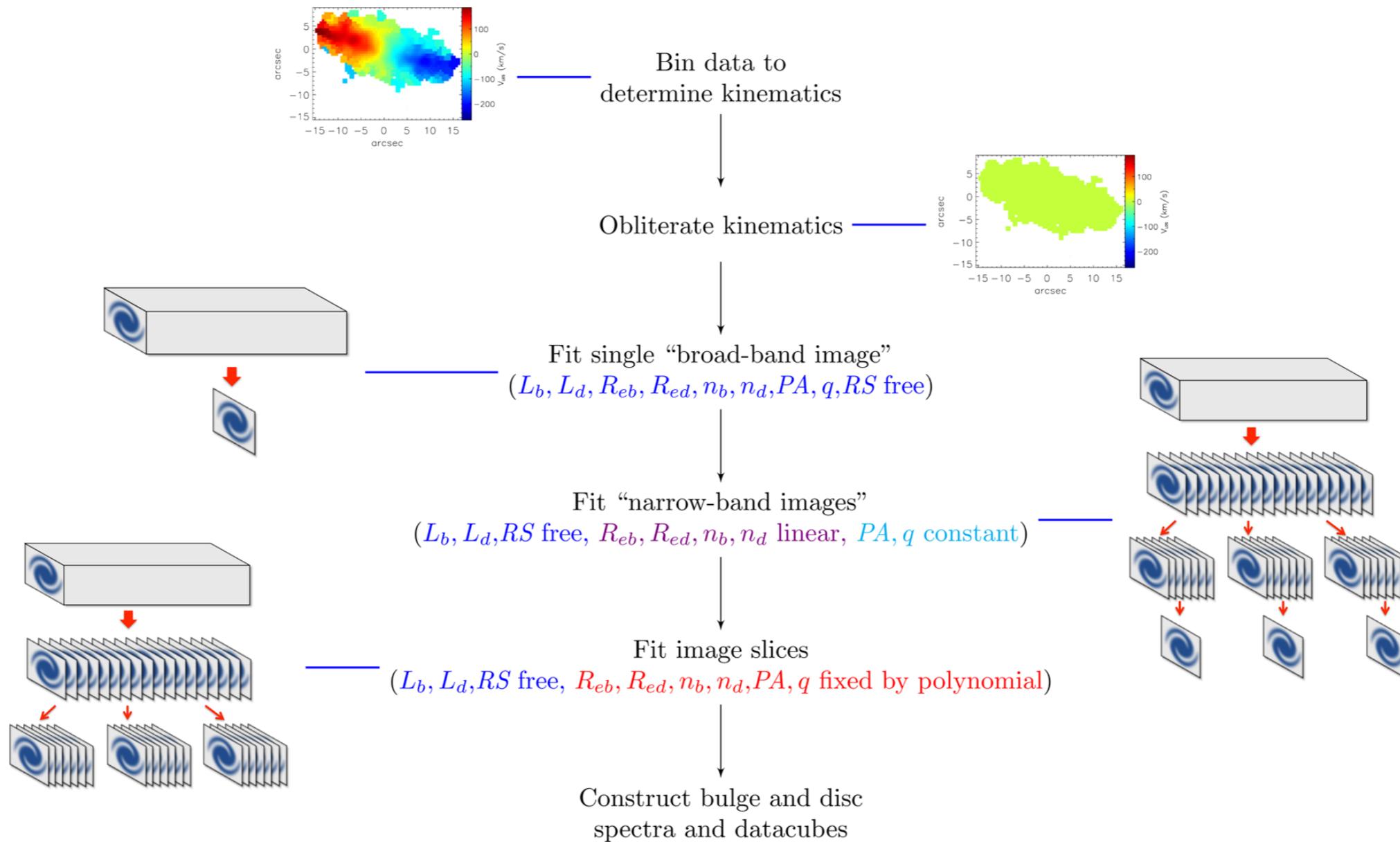
- Lenticulars in the cluster are more rotationally supported, suggesting that they are formed through processes that involve the rapid consumption or removal of gas
- S0s in the field are more pressure supported, suggesting that minor mergers

Tully-Fisher Relation

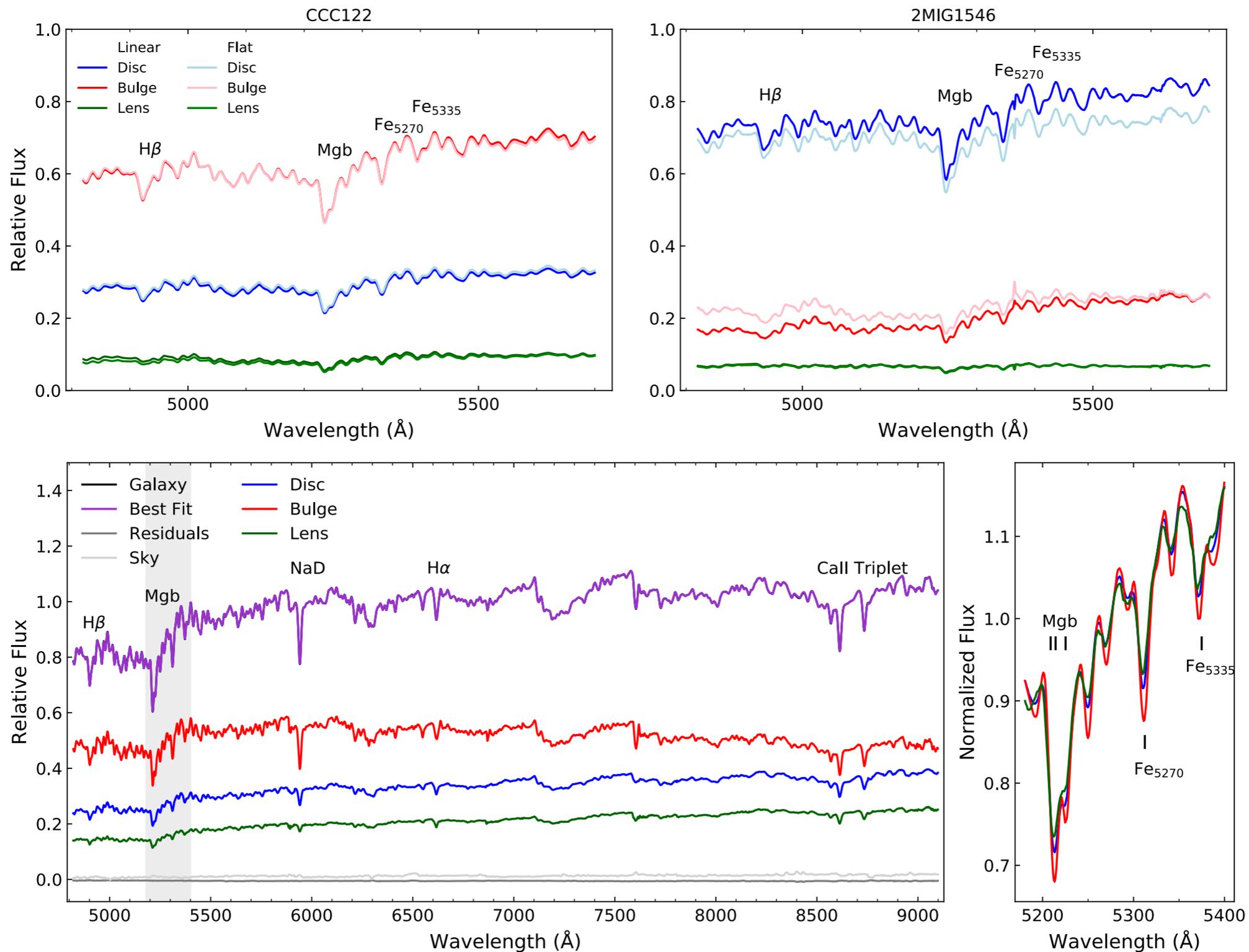


Bulge-disc decomposition of IFU data cubes (BUDDI)

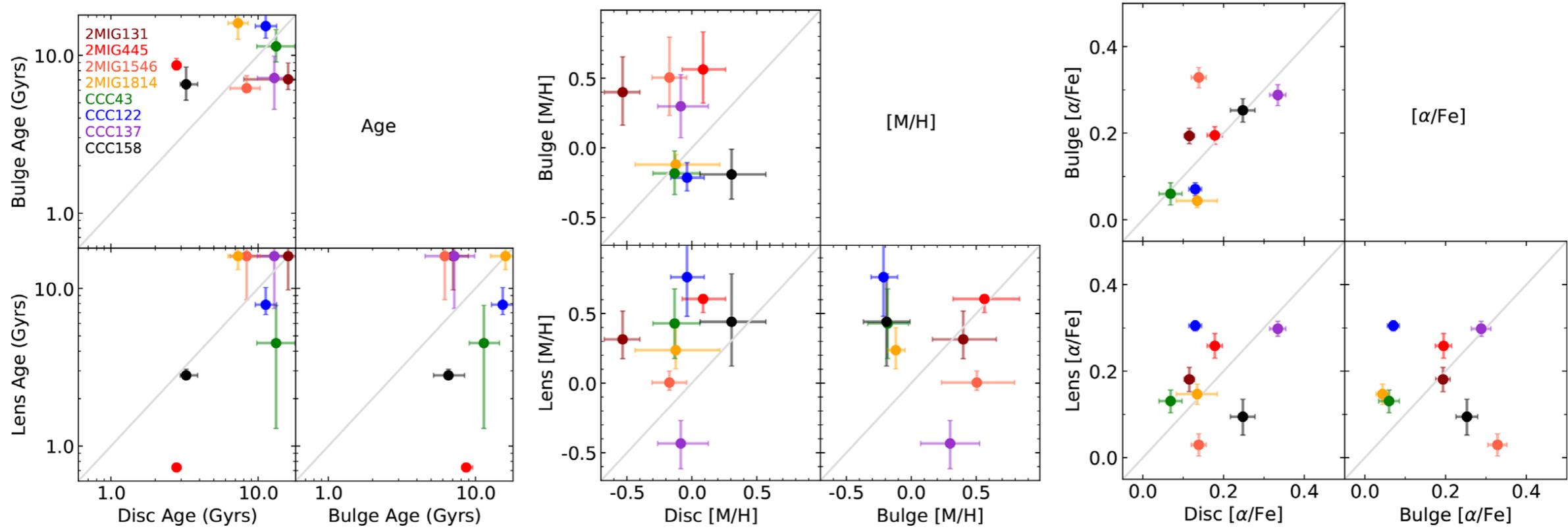
Johnston et al. (2017)

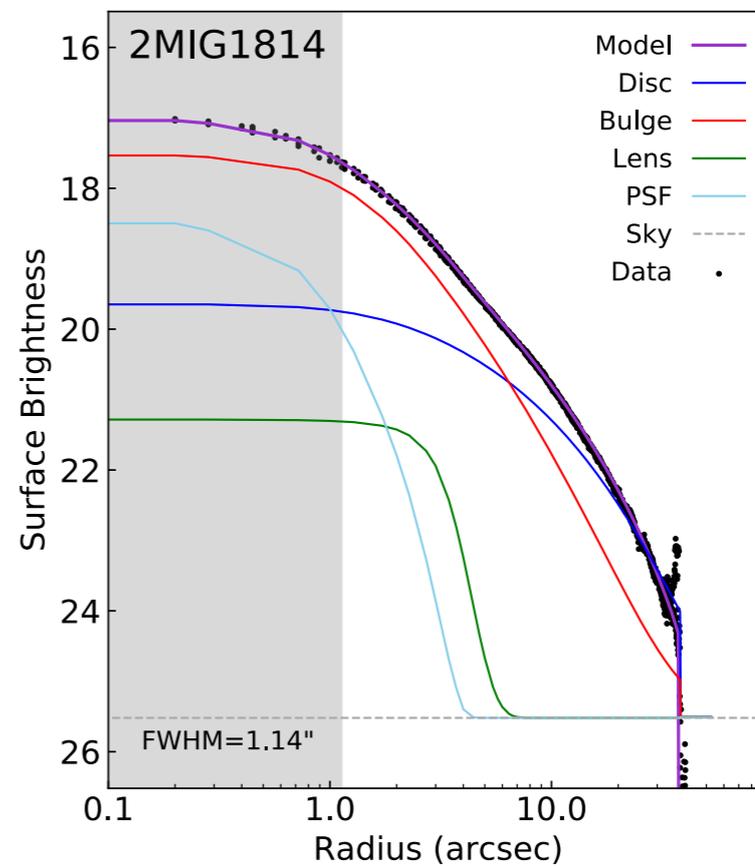
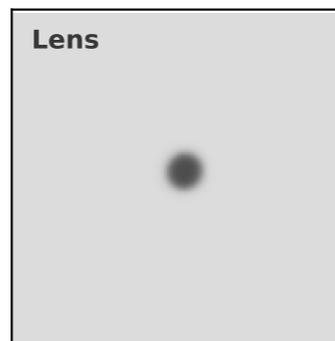
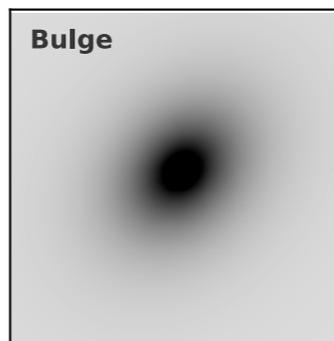
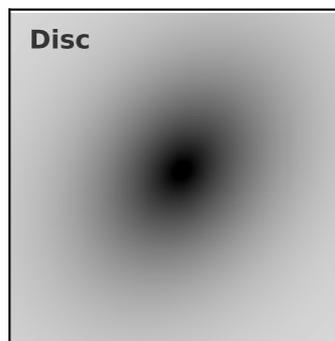
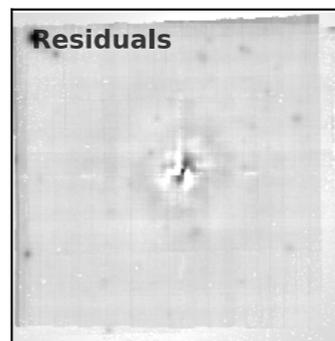
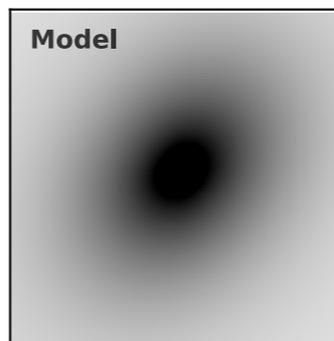
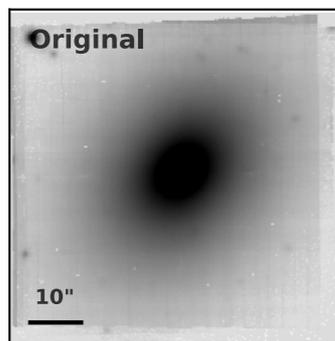
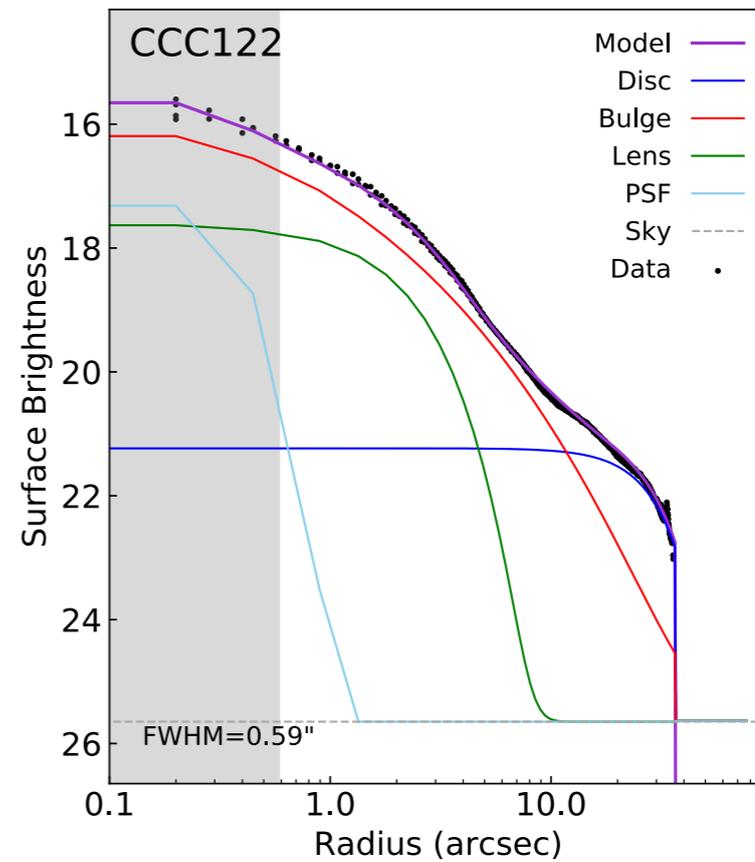
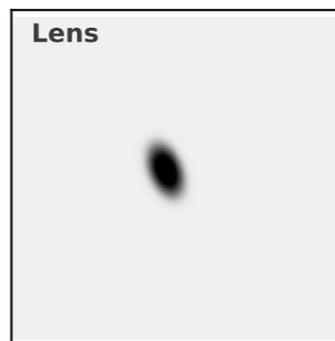
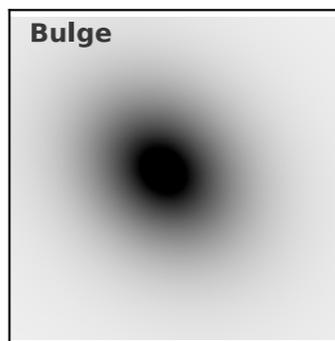
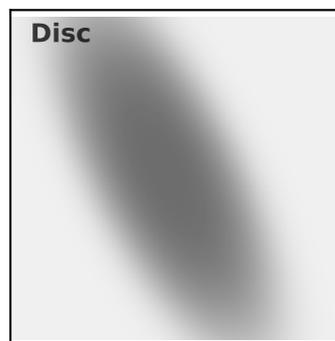
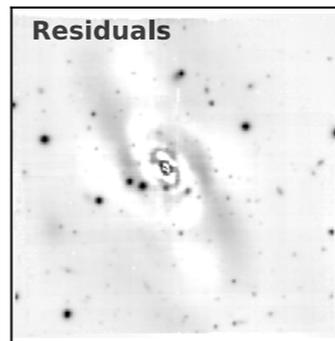
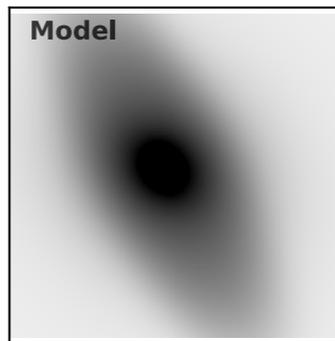
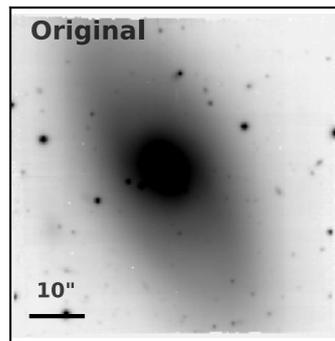


Bulge-disc decomposition of IFU data cubes



Stellar Populations





Summary

- The kinematics of S0 galaxies in field and cluster are different
- Overall, the field S0s may indicate that these galaxies have been affected more by minor mergers than the cluster galaxies
- Alpha-enhancement of the bulges and discs are correlated, while this of the lenses are completely unconnected to either component