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Probing Recent Star Formation with NUV in Red Sequence Cluster Galaxies

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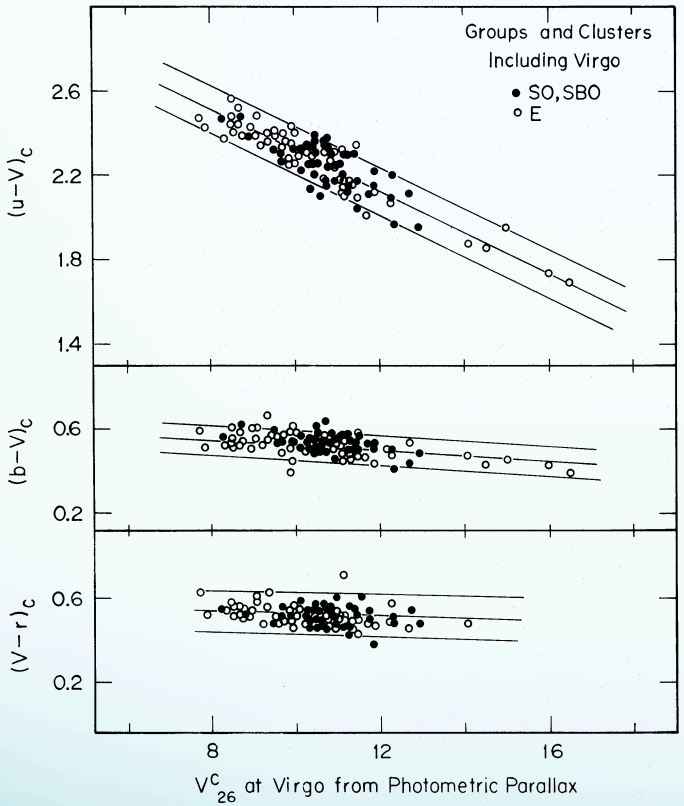
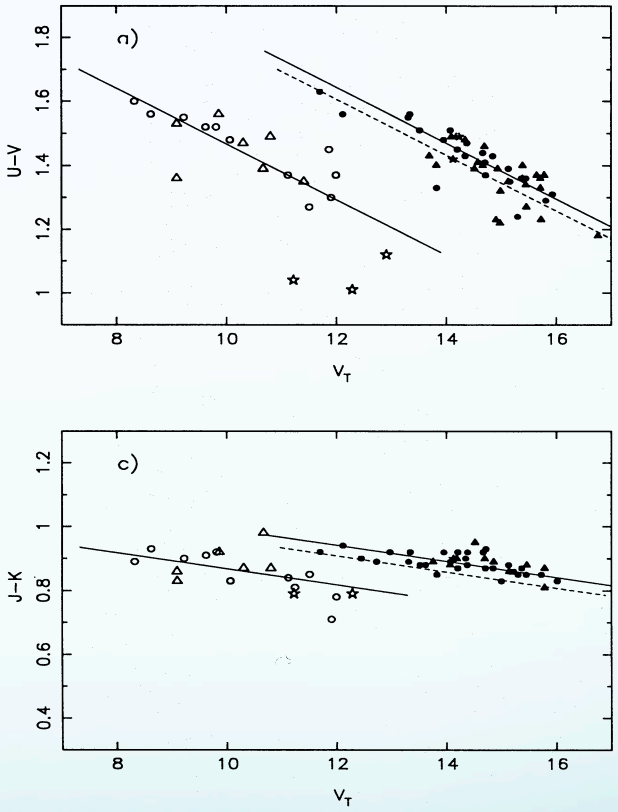
Red Sequence Galaxies

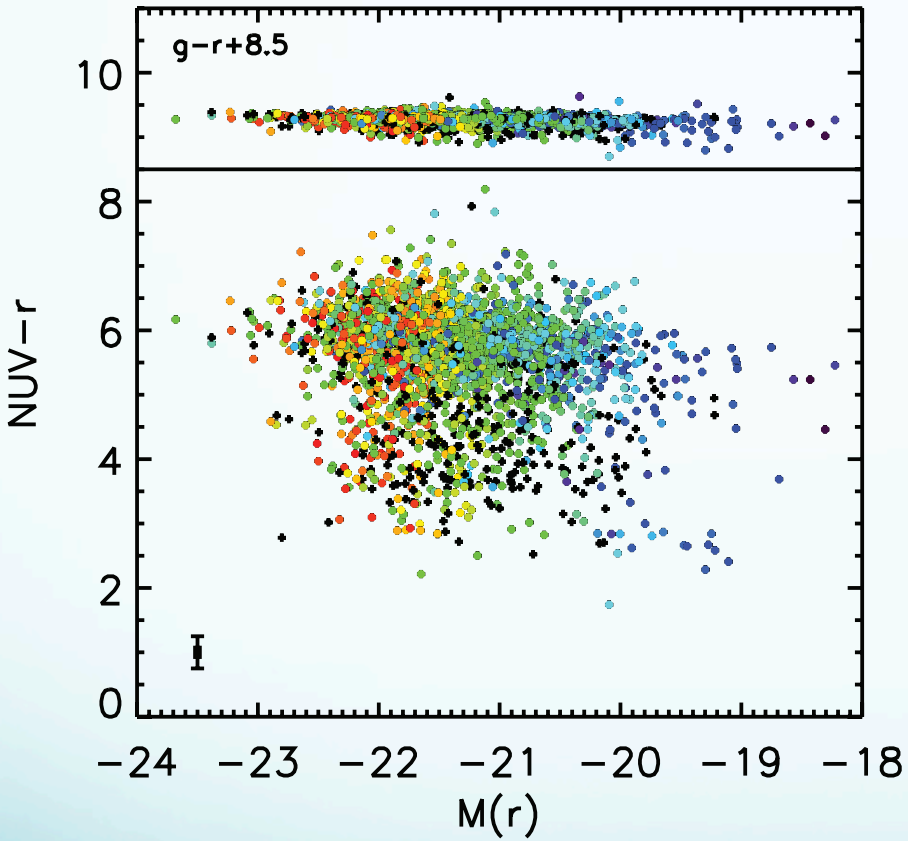


Optical colour magnitude diagrams from Visvanthan and Sandage (1977)

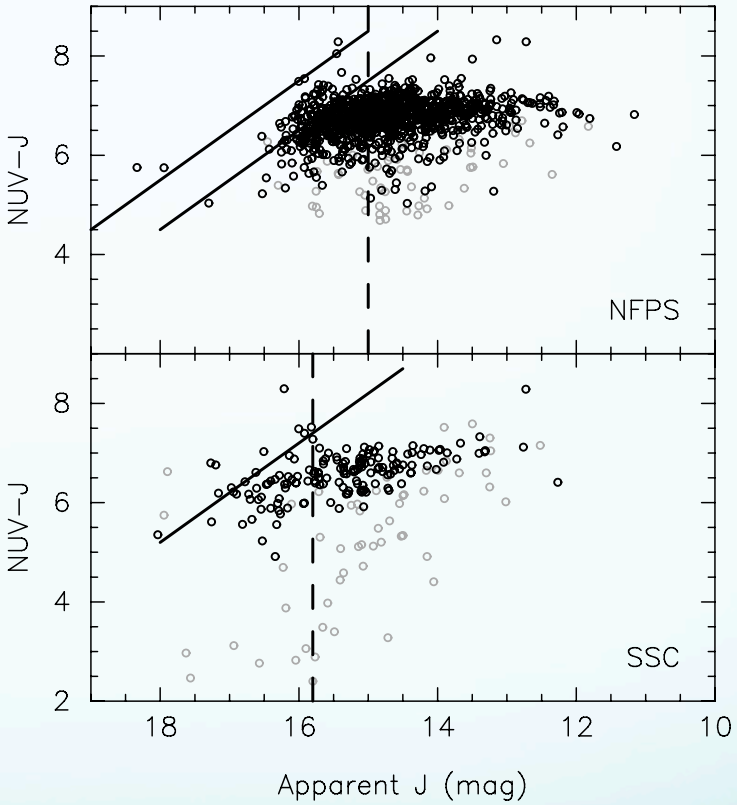


U-V and J-K colour magnitude diagrams from Bower, Lucey and Ellis (1992)

The UV Red Sequence

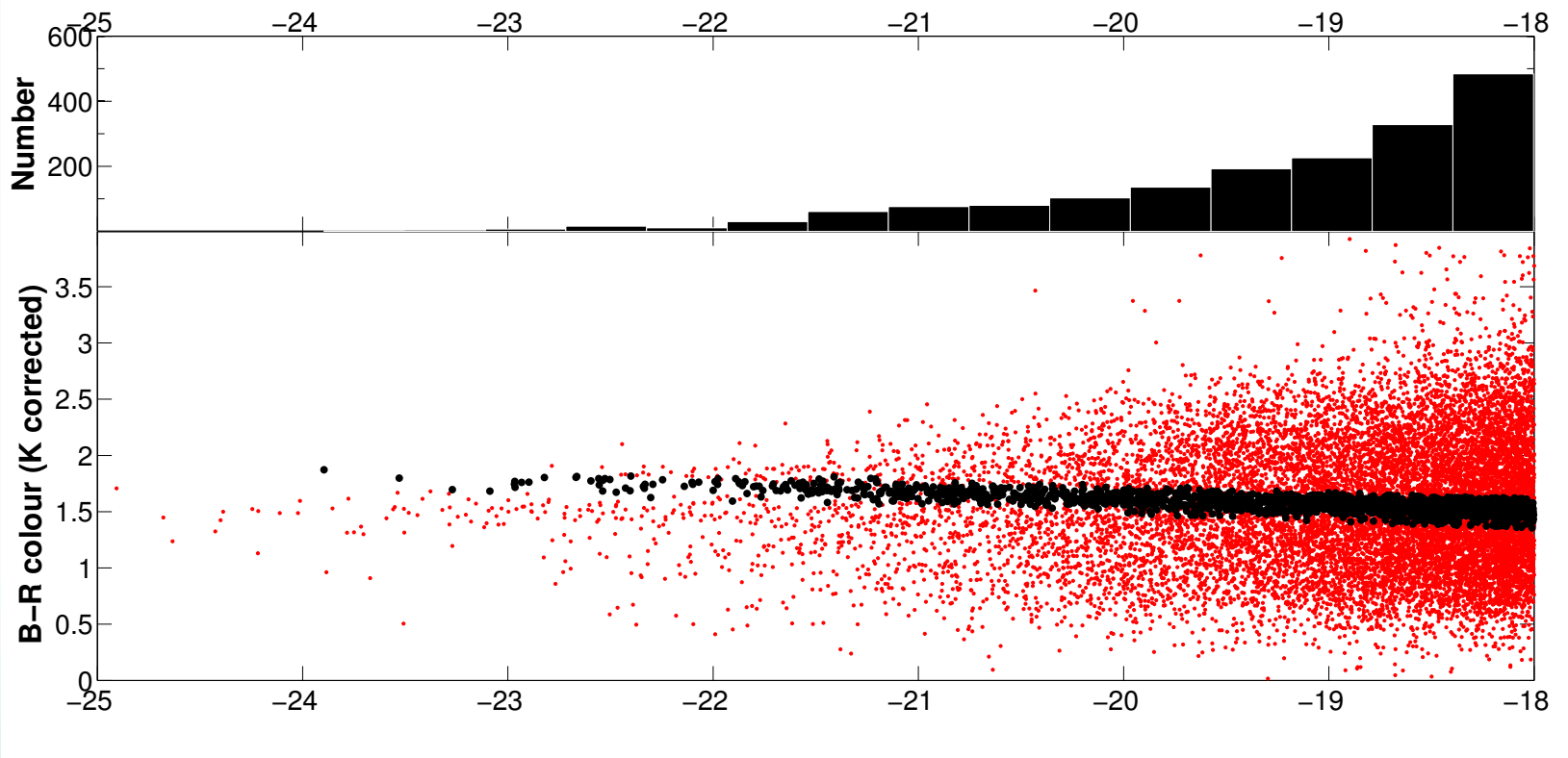


NUV-r and g-r colour magnitude diagrams from Kaviraj et al. (2007)



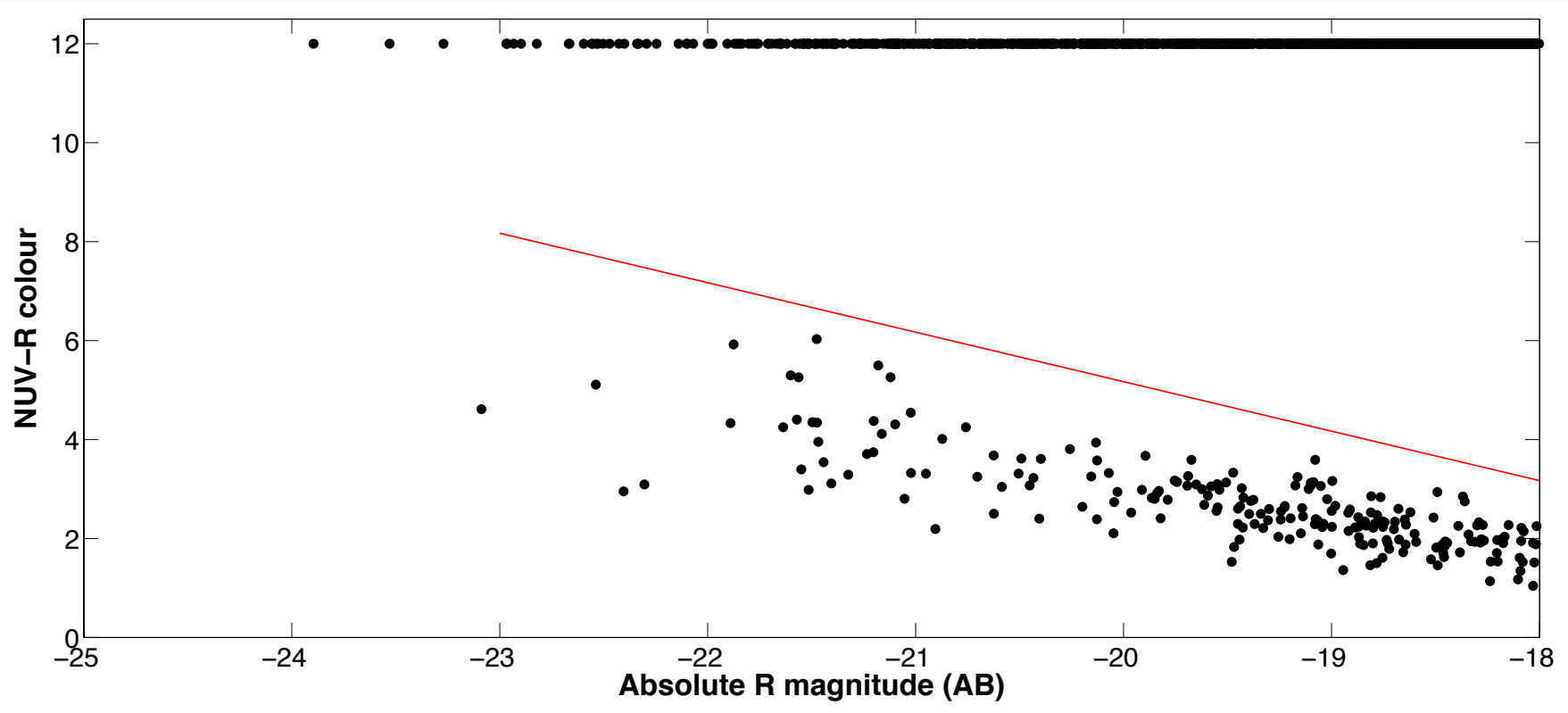
NUV-J colour magnitude diagram form two surveys from Rawle et al. (2008)

Red Sequence Galaxies



Optical K corrected colour magnitude diagram from Abell 2055 from the LARCS dataset (Pimbblet et al. 2002). The red sequence is highlighted in black.

The UV Red Sequence

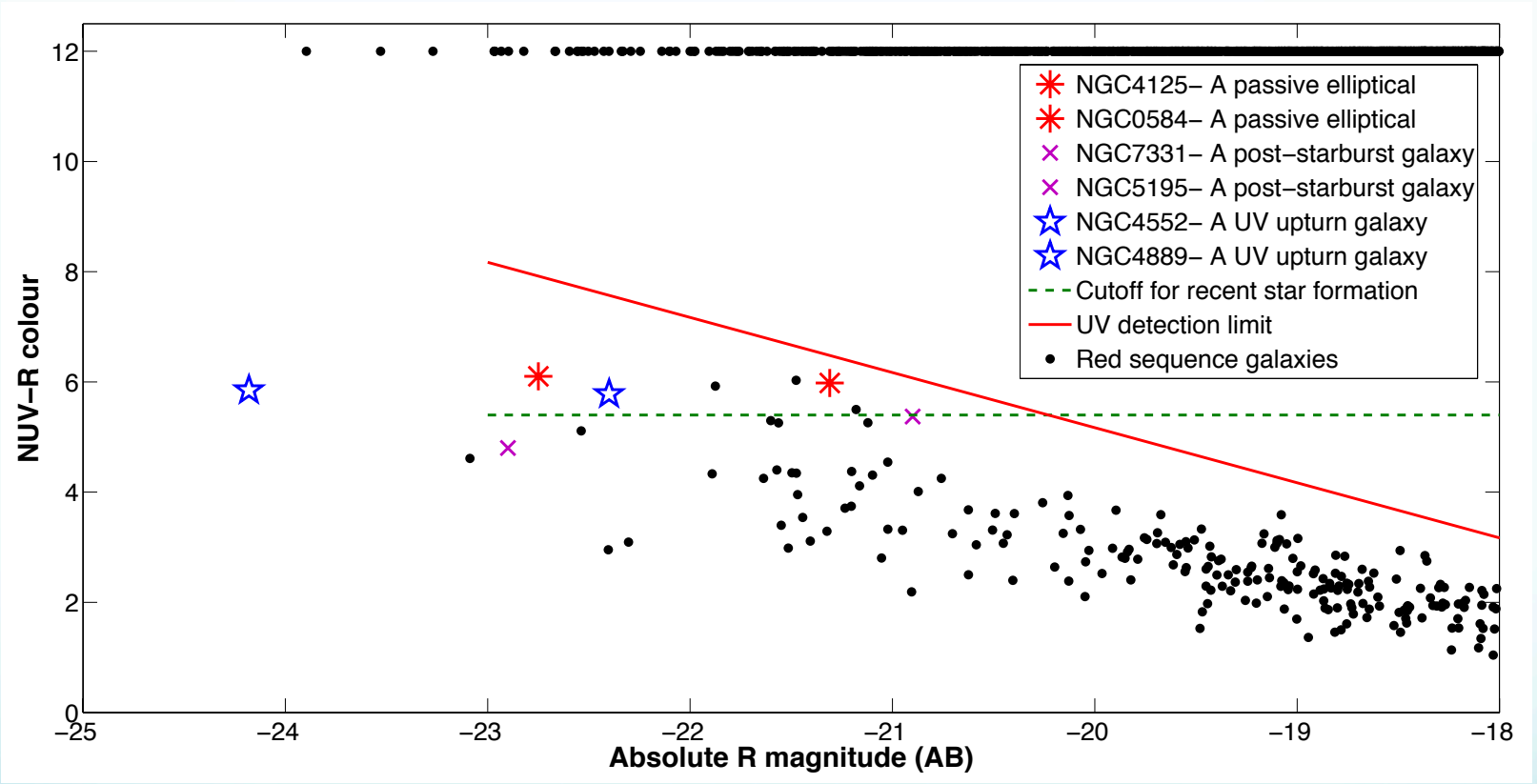


NUV-R colour magnitude diagram for cluster red sequence galaxies. Points at NUV-R=12 are null detections. The red line is the Galex completeness limit.

Why do we see this scatter in NUV-R?

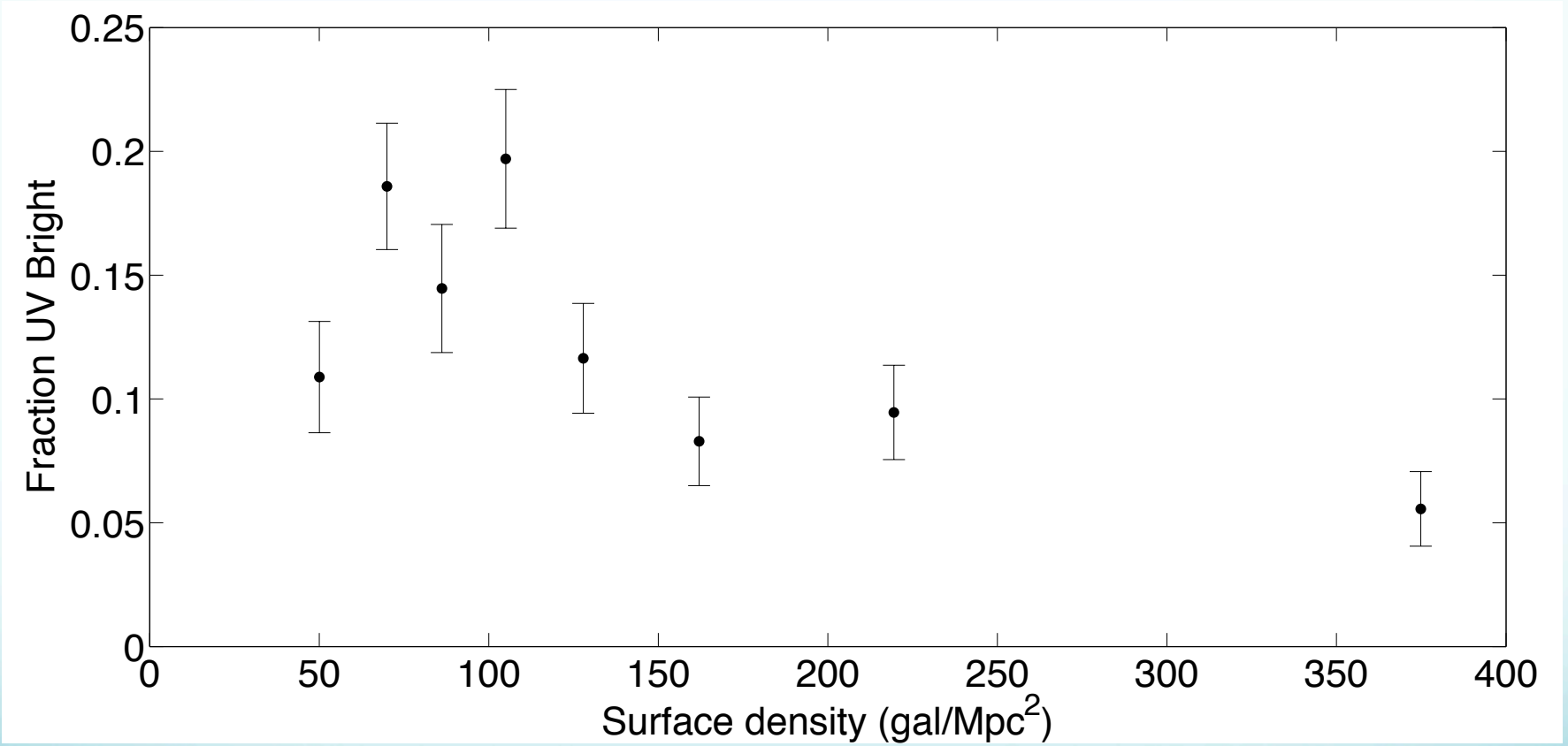
- Low metallicity blue horizontal branch stars
- UV upturn/UV excess- low envelope mass extremely blue horizontal branch stars
- Recent star formation- low level (~1%) new stars within the galaxy

Why do we see this scatter in NUV-R?



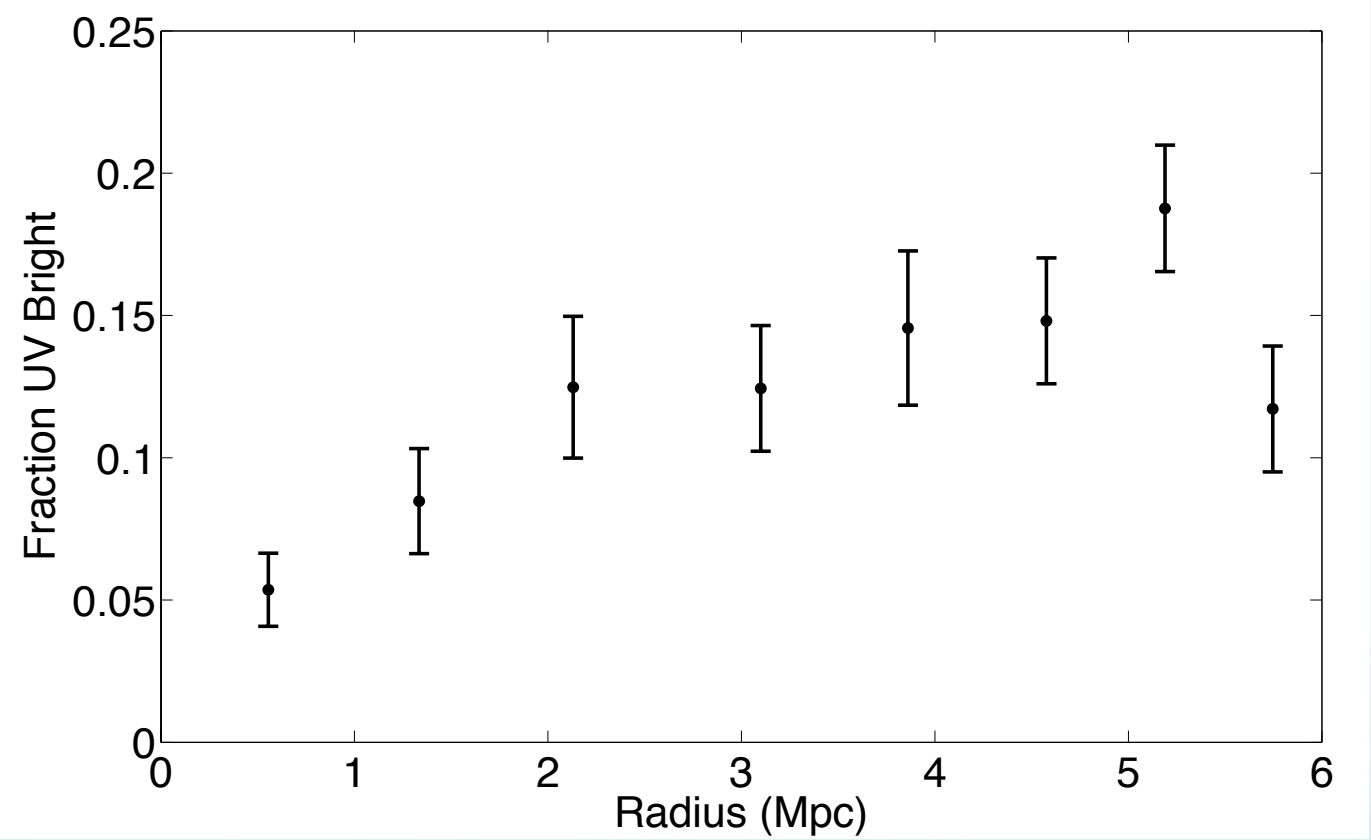
NUV-R colour magnitude diagram, with the recent star formation limit from Kaviraj et al. (2007). Post-starburst, UV upturn, and passive elliptical data derived from spectral templates from Brown et al. (in prep) are also shown.

Where does this happen within a Cluster?



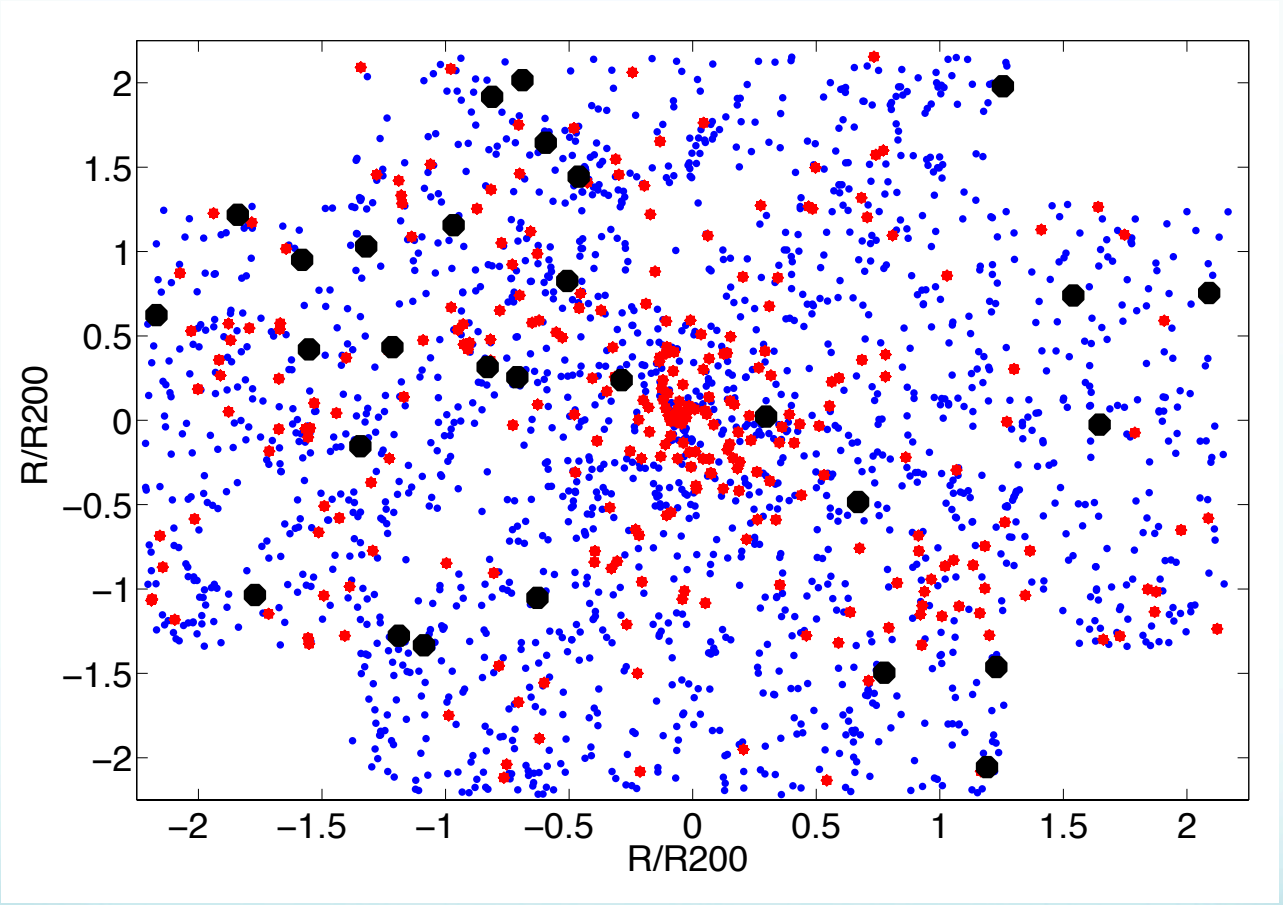
Fraction of UV bright galaxies as a function of surface density. These galaxies prefer lower density environments.

Where does this happen within a Cluster?



Fraction of UV bright galaxies as a function of cluster radius. Similarly, UV bright galaxies prefer higher radii within a cluster.

Where does this happen within a Cluster?

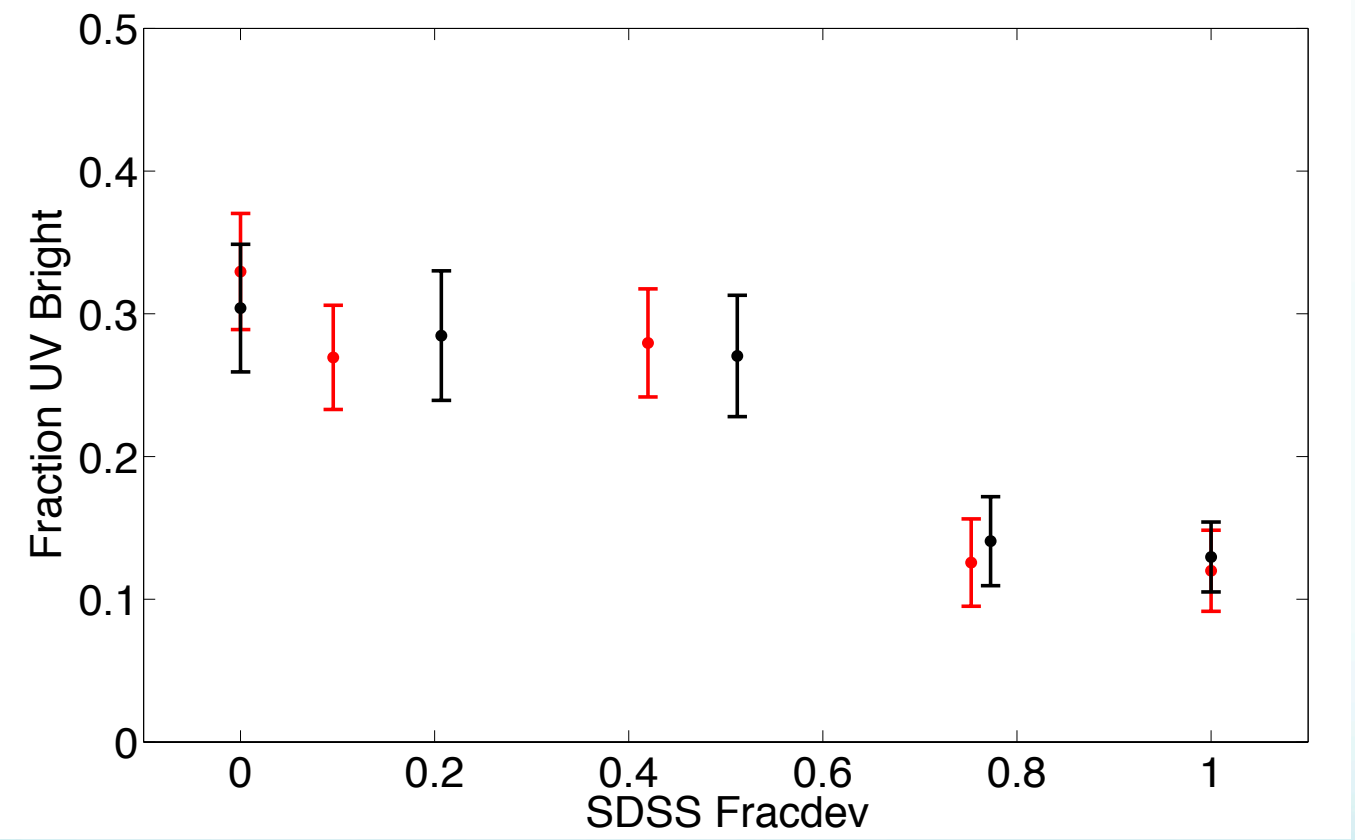


Spatial distribution of the UV bright galaxies on the sky (black points), with the passive red sequence (red) and other galaxies (blue).

What do these galaxies look like?

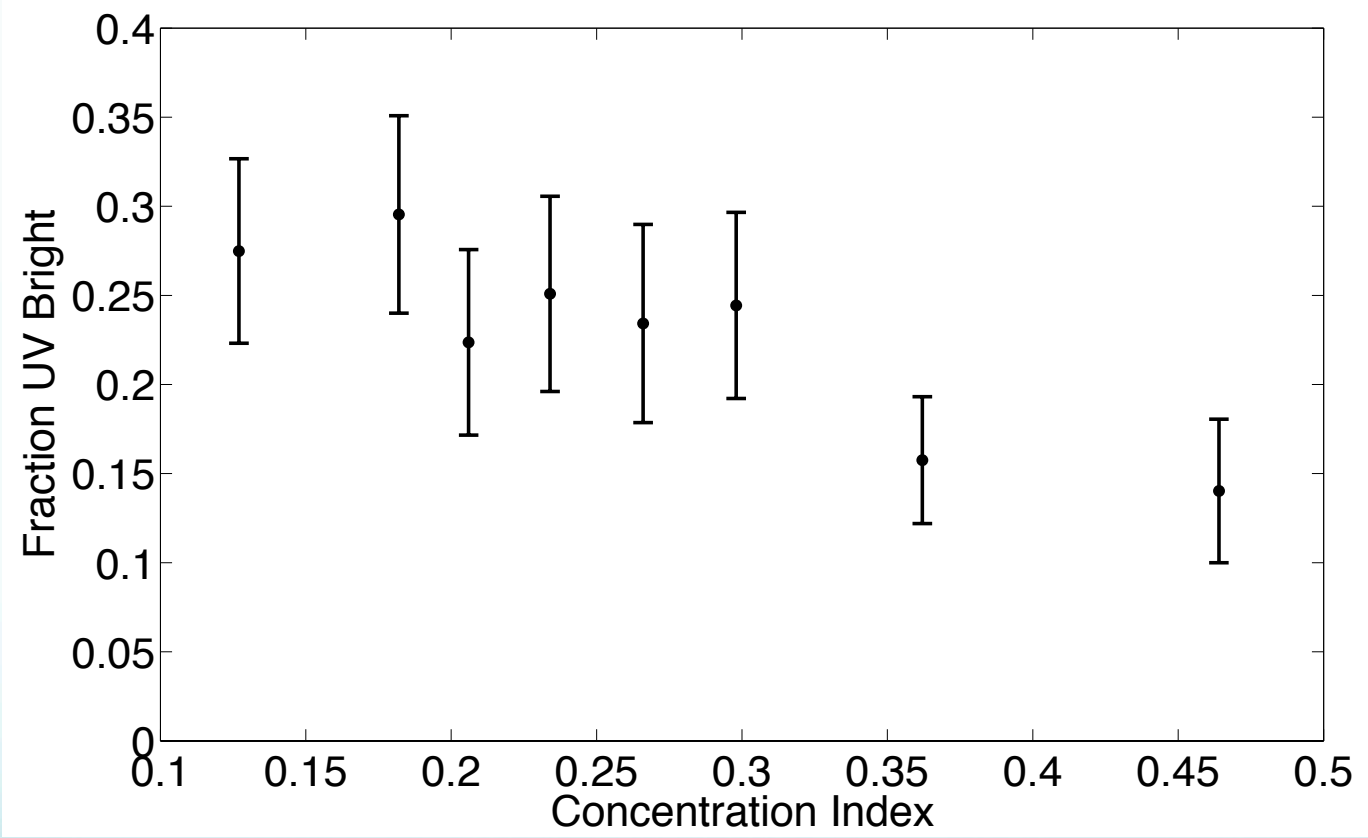
(above) SDSS Colour images of galaxies from Abell 2055. The top row show galaxies with passive NUV-R, while the bottom row display UV strong cluster candidates.

What do these galaxies look like?



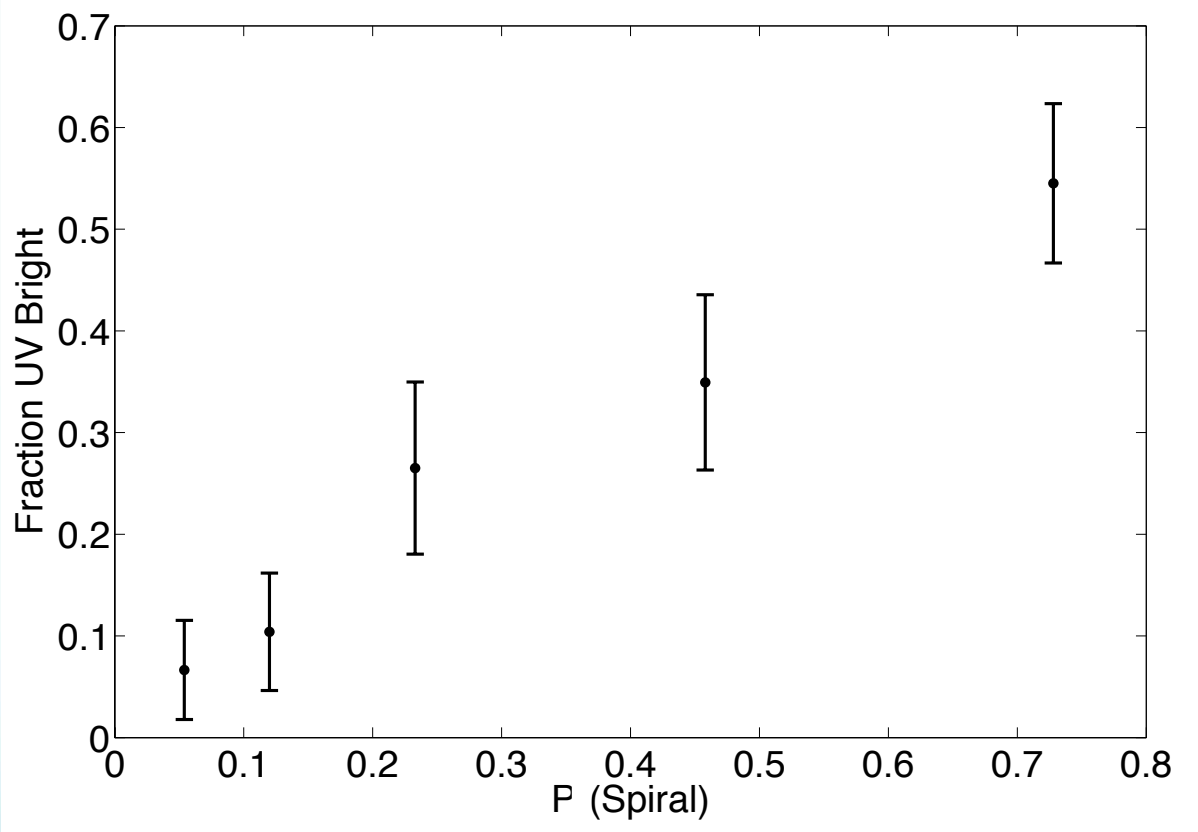
Fraction of UV bright galaxies as a function of their SDSS fracdev in r (red) and i (black) bands. Galaxies that prefer a bulge light profile are less likely to have recent star formation.

What do these galaxies look like?



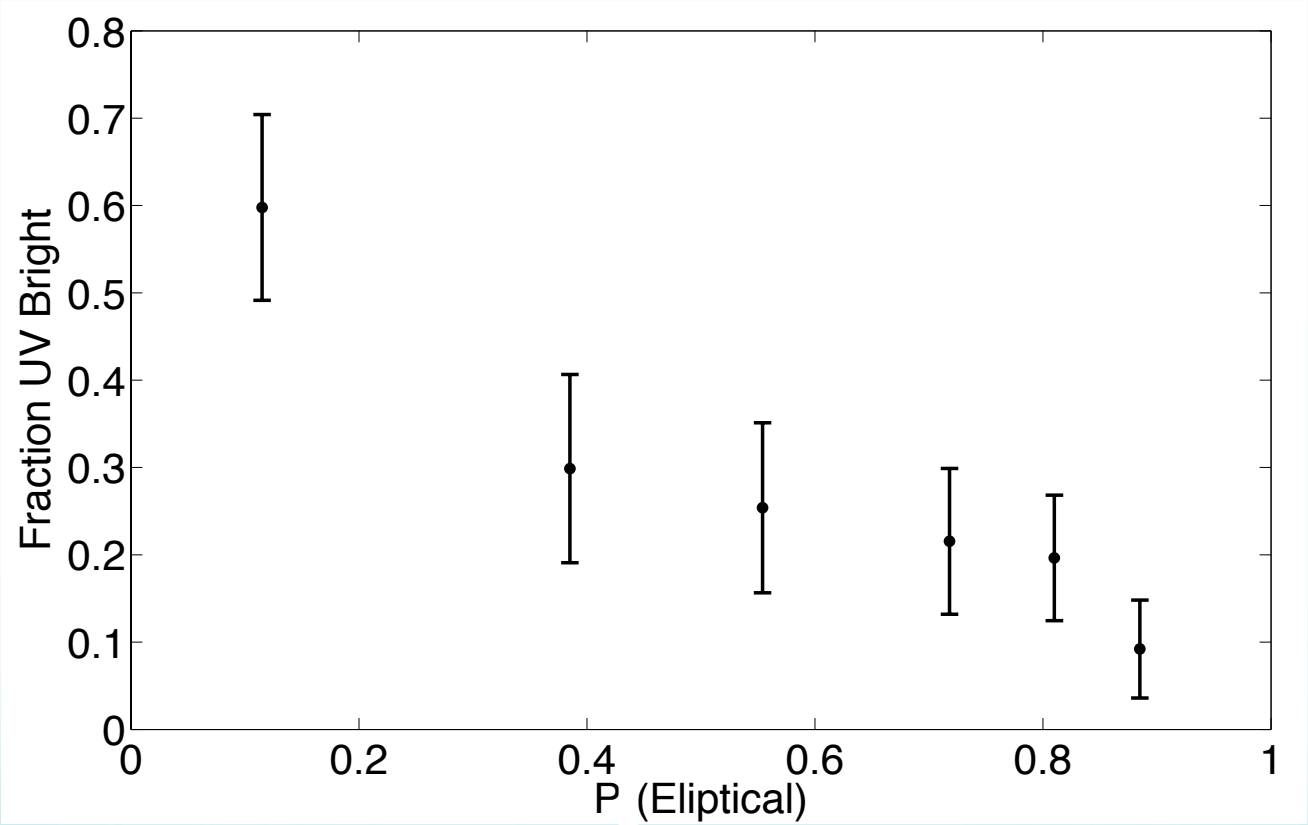
Fraction of UV bright galaxies as a function of concentration. Galaxies that are more centrally concentrated are less likely to be UV bright.

What do these galaxies look like in Galaxy Zoo?



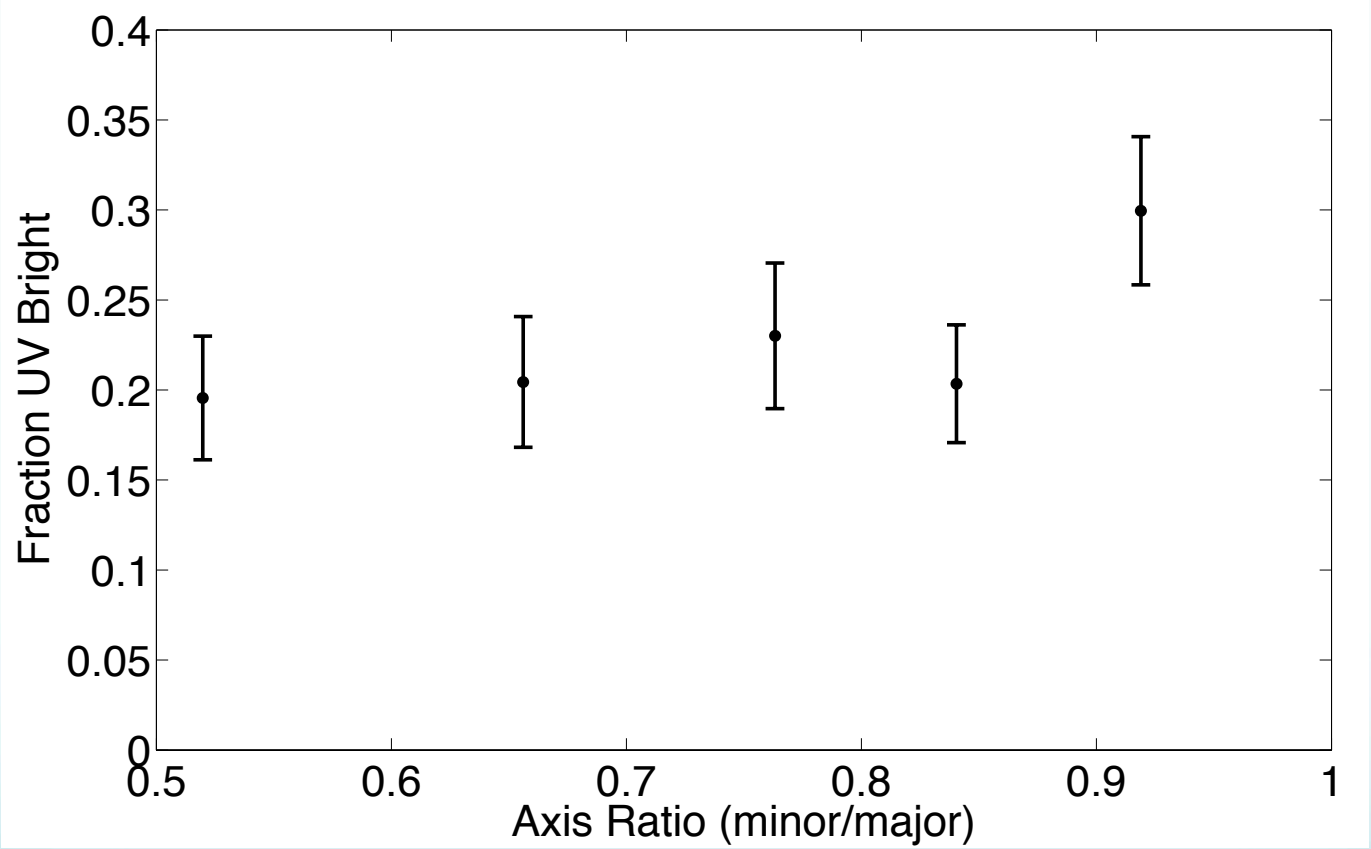
Fraction of UV bright galaxies for binned percentage of votes as "spiral". Red sequence galaxies that are voted to be spirals are often UV bright.

What do these galaxies look like in Galaxy Zoo?



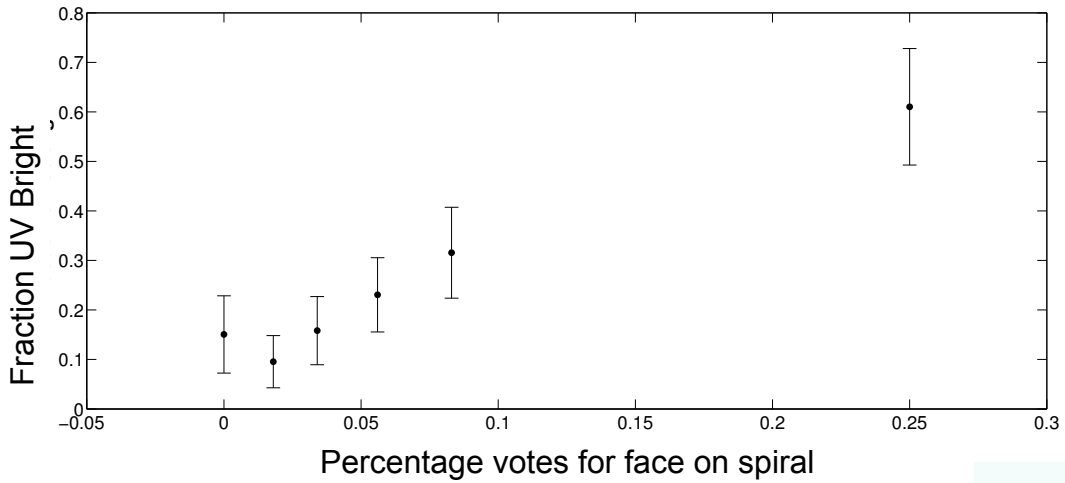
Conversely, the galaxies that are voted “Elliptical” are less likely to have very blue UV colours.

Are they just Edge on Spirals?



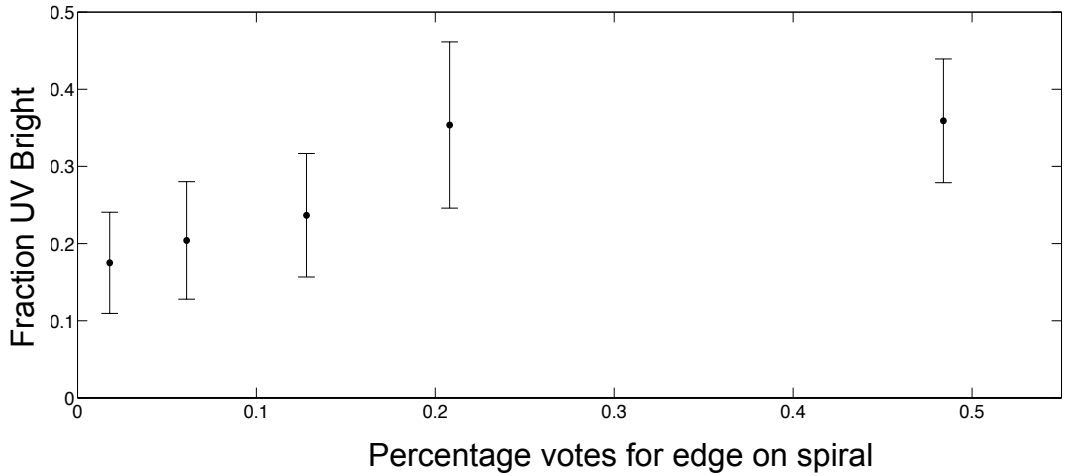
The fraction of these blue UV galaxies doesn't increase with smaller axial ratios- these galaxies are probably predominantly elongated.

Are They Just Edge on Spirals?



Both face on spirals (left) and edge on spirals (bottom) have increased UV strong fractions with increased spiral probability.

These galaxies appear to be spirals- both edge on and face on.



What are these galaxies?

- High mass, Low SSFR Spirals
- Requires masses and SFR measurements – Ongoing work.
- Merger Remnants?
- Galaxies do not have tidal or merger features- maybe minor mergers.
- Infalling stripped disks?
- Can be stripped at the large distances shown, and wouldn't disrupt the disk.

Summary

- The UV colour magnitude relation shows high scatter, traditionally explained by recent star formation.
- The UV bright, red sequence galaxies we see are are disky galaxies, at high cluster radius.
- This “recent star formation” may actually be late-types entering a cluster