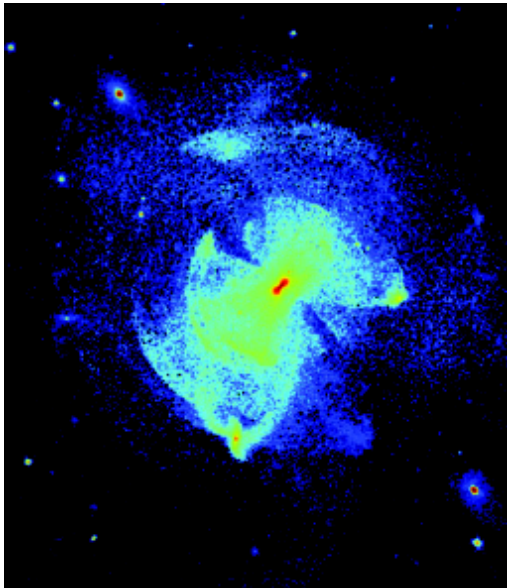


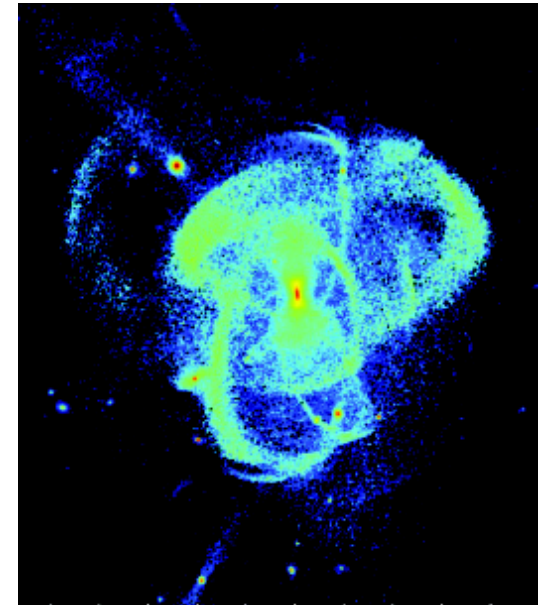
The stellar halo of isolated central galaxies in the Hyper Suprime-Cam imaging Survey



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Galaxy evolution workshop 2019

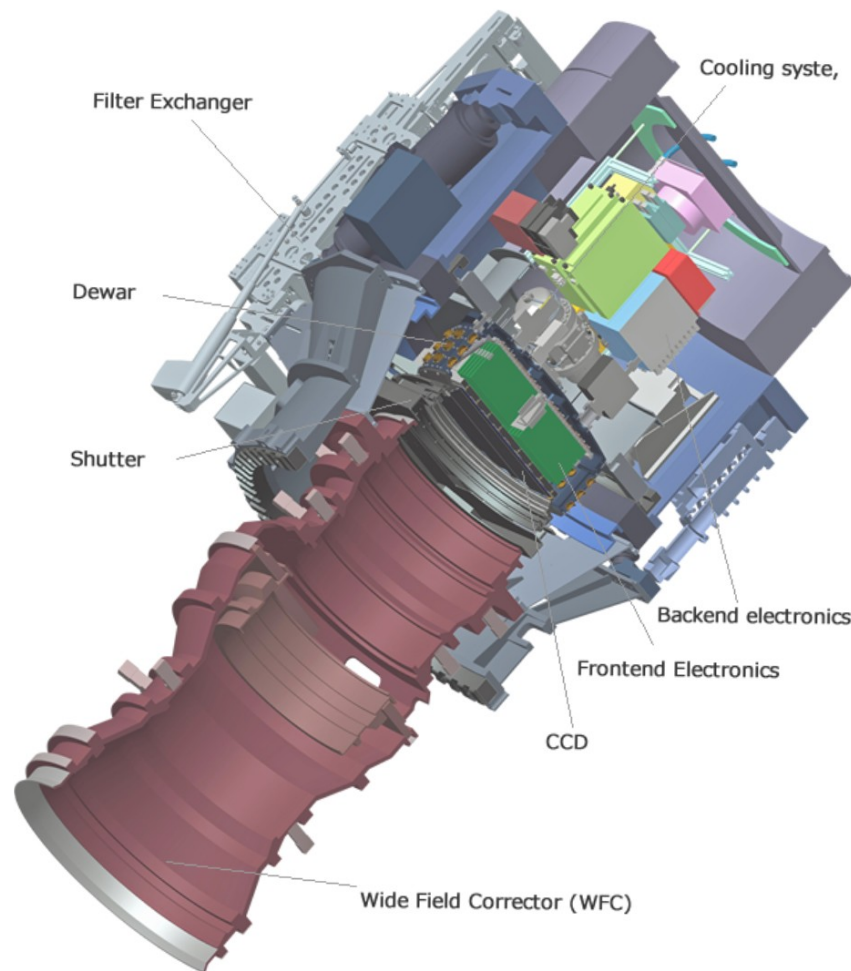
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Hyper Suprime-Cam

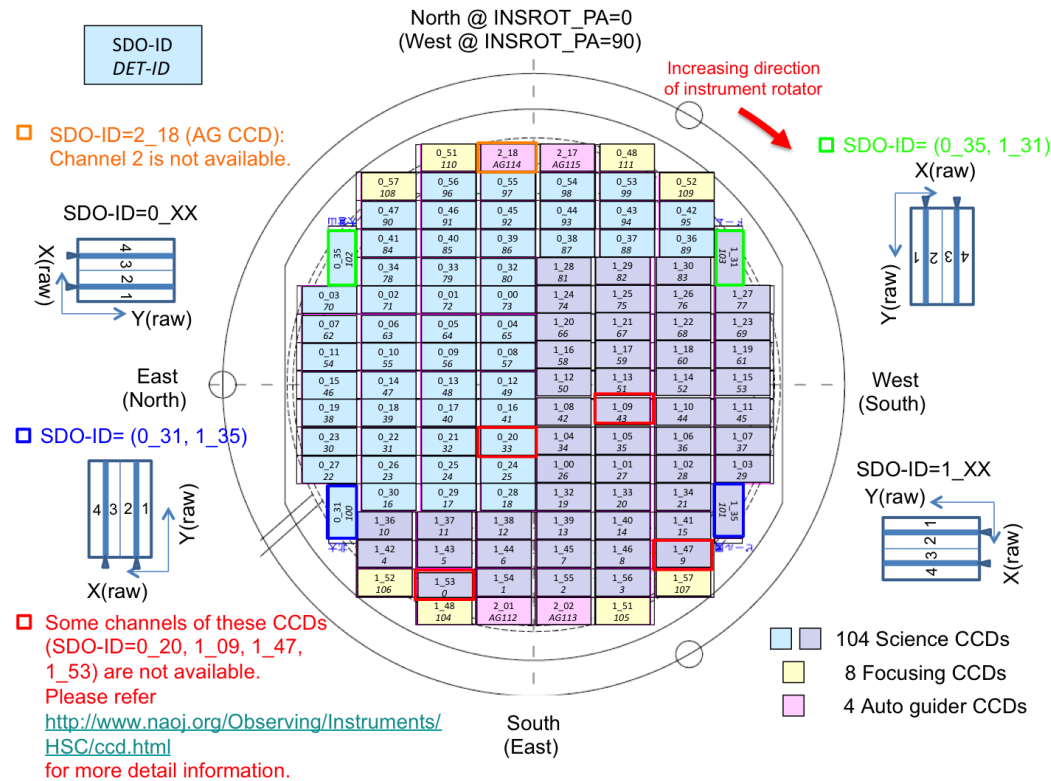


- HSC is a gigantic digital still camera for 8.2 m Subaru telescope built by NAOJ in collaboration with international academic and industrial partners.

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Hyper Suprime-Cam



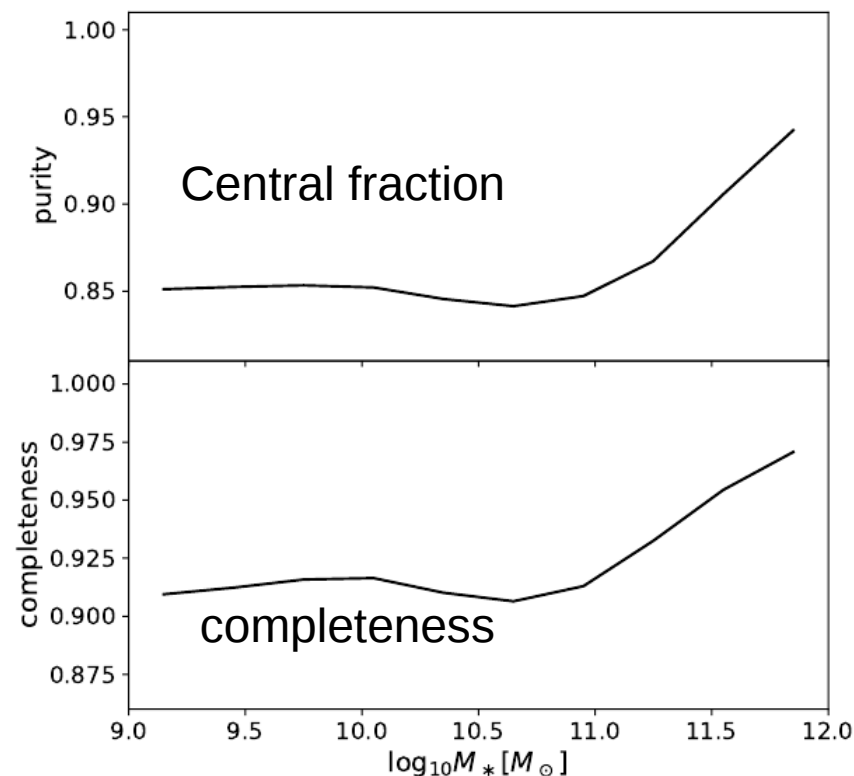
- HSC is a gigantic digital still camera for 8.2 m Subaru telescope built by NAOJ in collaboration with international academic and industrial partners.
- 104 science CCDs, 1.5 deg FOV in diameter, pixel size of ~ 0.168 arcsec.
- The HSC pipeline is an enhanced version of the LSST.

Use coadd image products

- sky background and instrumental features removed by the pipeline

Isolated central galaxies

- Parent sample: SDSS DR7 spectroscopic Main galaxies
- Brightest within **the halo virial radius** in projection.
- Brightest within **three times the virial velocity** along the line-of-sight.
- Not within the virial radius of another larger object.
- Virial radius and velocity obtained through abundance matching.
- Using **photoz probability distribution** to compensate fiber collisions.
- **Redshift range: 0.05-0.16**

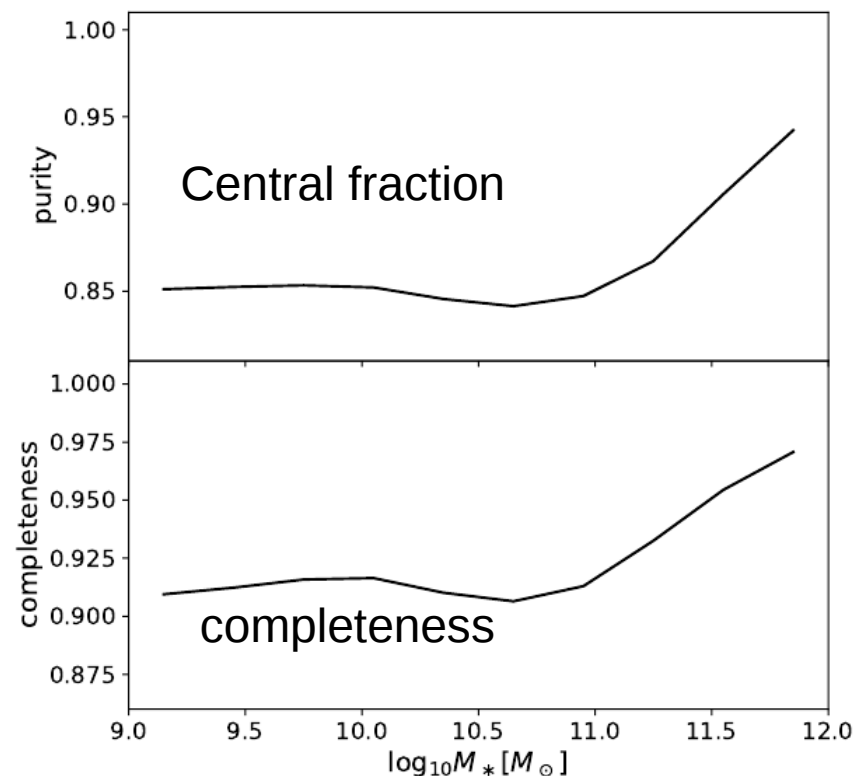


Based on a mock galaxy catalog of semi-analytical galaxy formation model (Guo et al., 2011)

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Galaxy images are stacked!

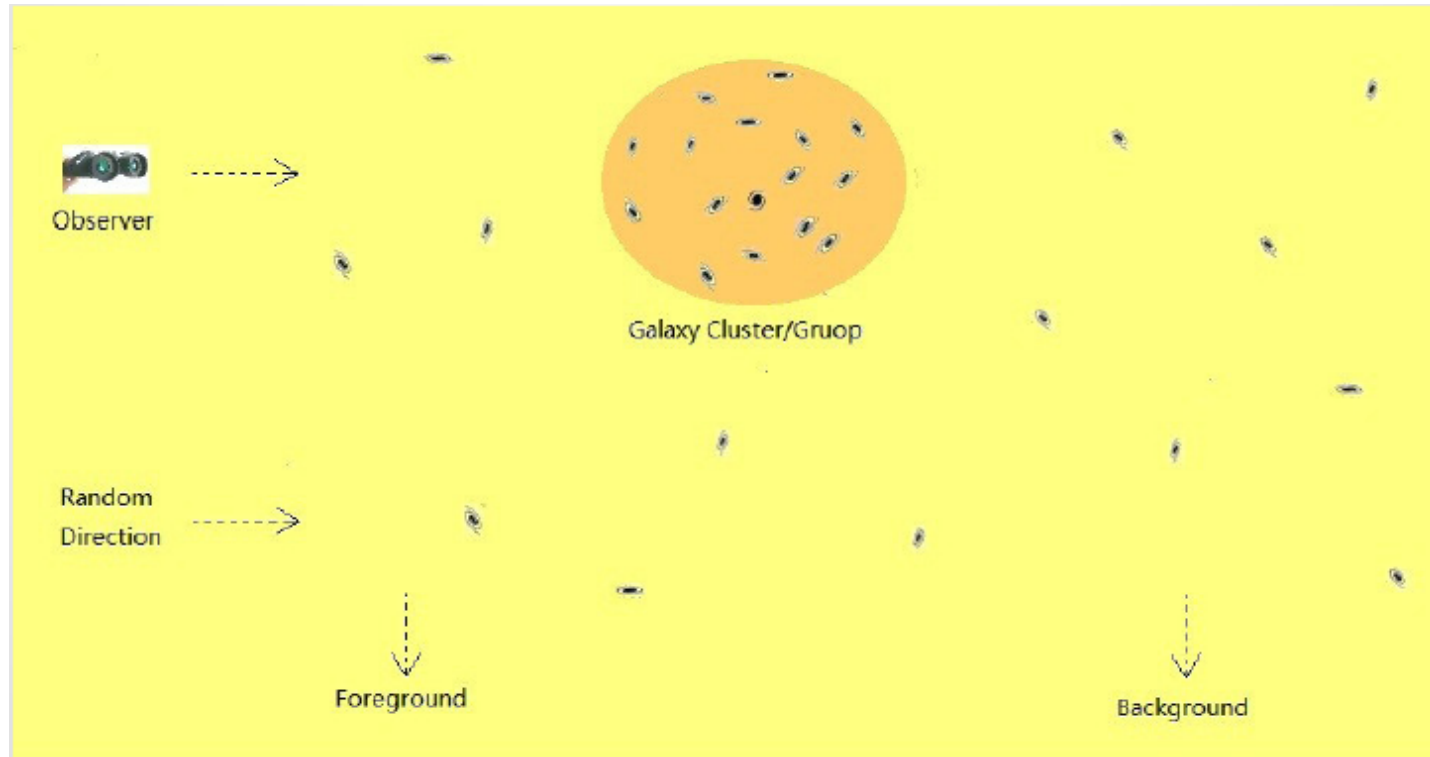


Based on a mock galaxy catalog of semi-analytical galaxy formation model (Guo et al., 2011)

Methodology

- Image cutouts
- Cosmic dimming correction
- **Source masking** by creating g,r and i band stacked images at first and run SExtractor with different detection thresholds
- Image resampling to the same WCS: pixel size~0.8 kpc
- Clipping and stacking
- Random sample **correction for residual background**

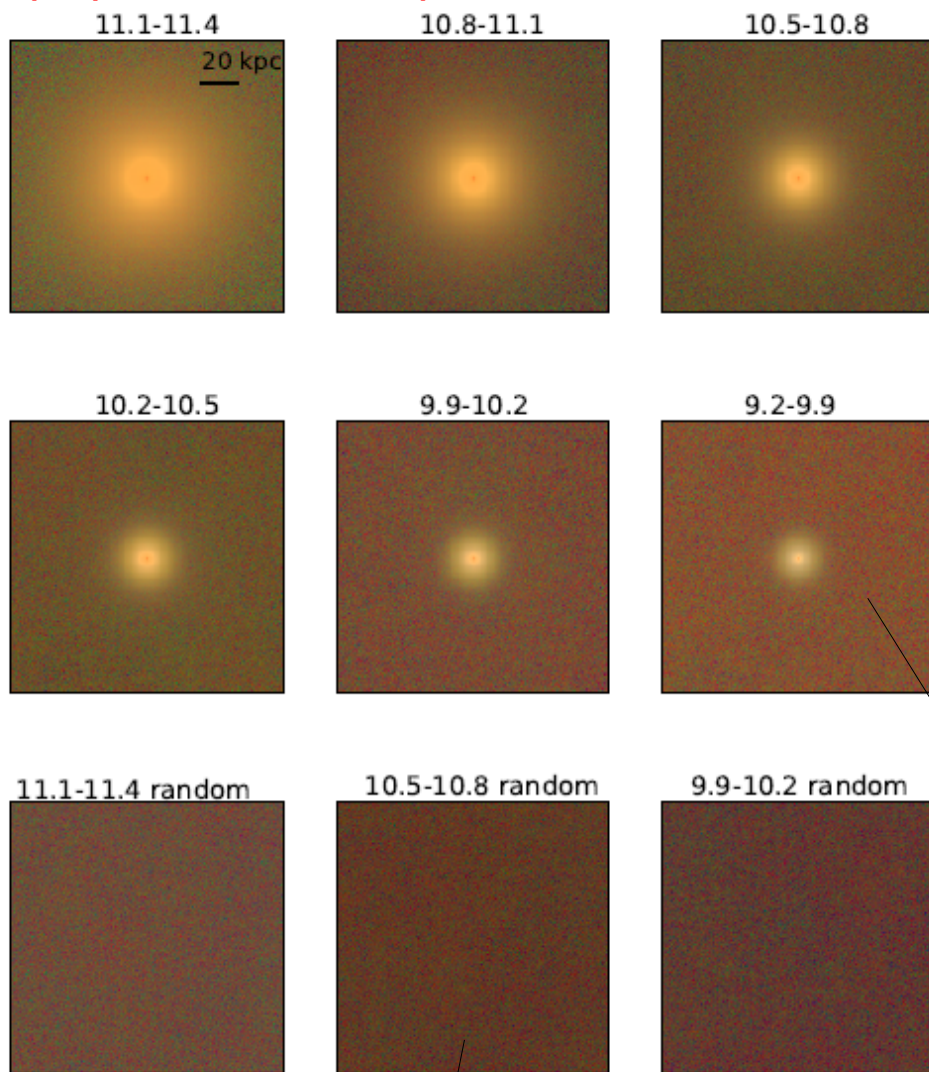
Random stacks



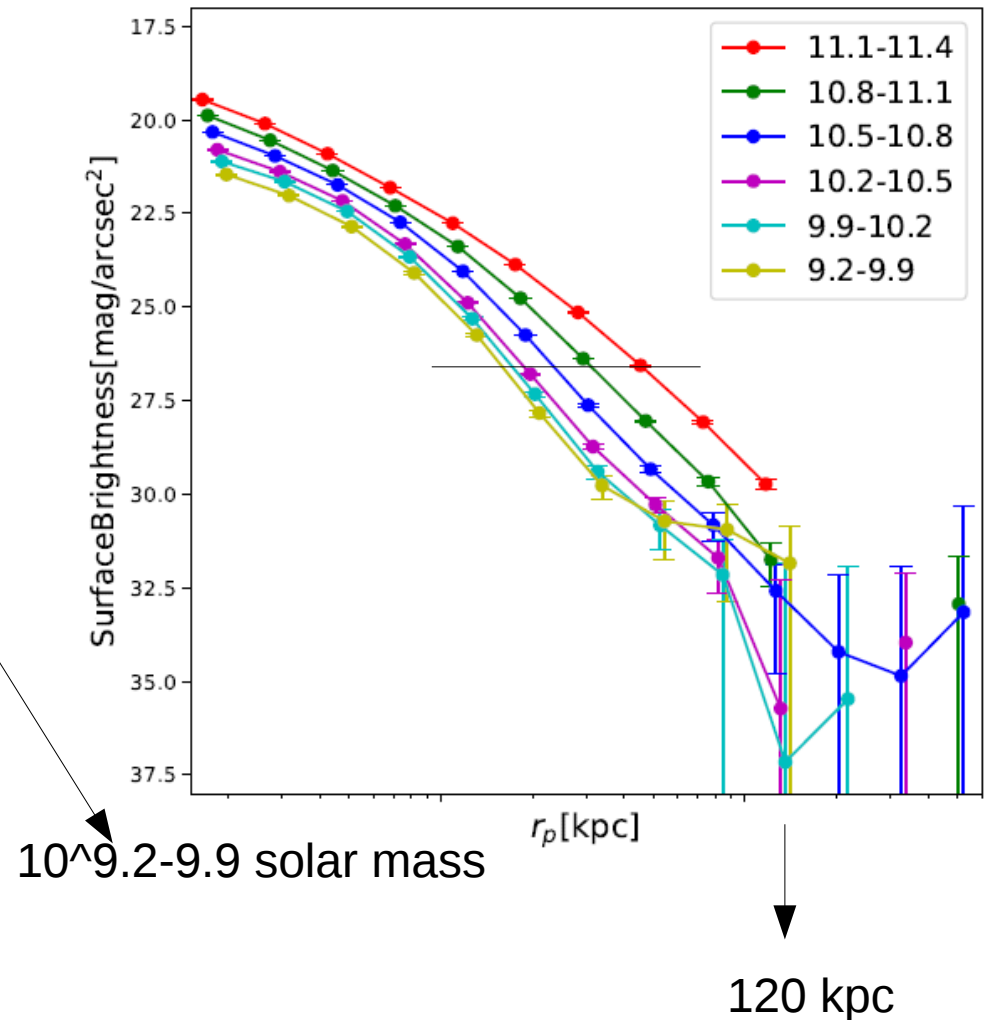
- Random stacks cannot account for incomplete masking of satellite galaxies!

Surface Brightness

HSC g,r,i-bands mapped to RGB
(Lupton et al. 2004)



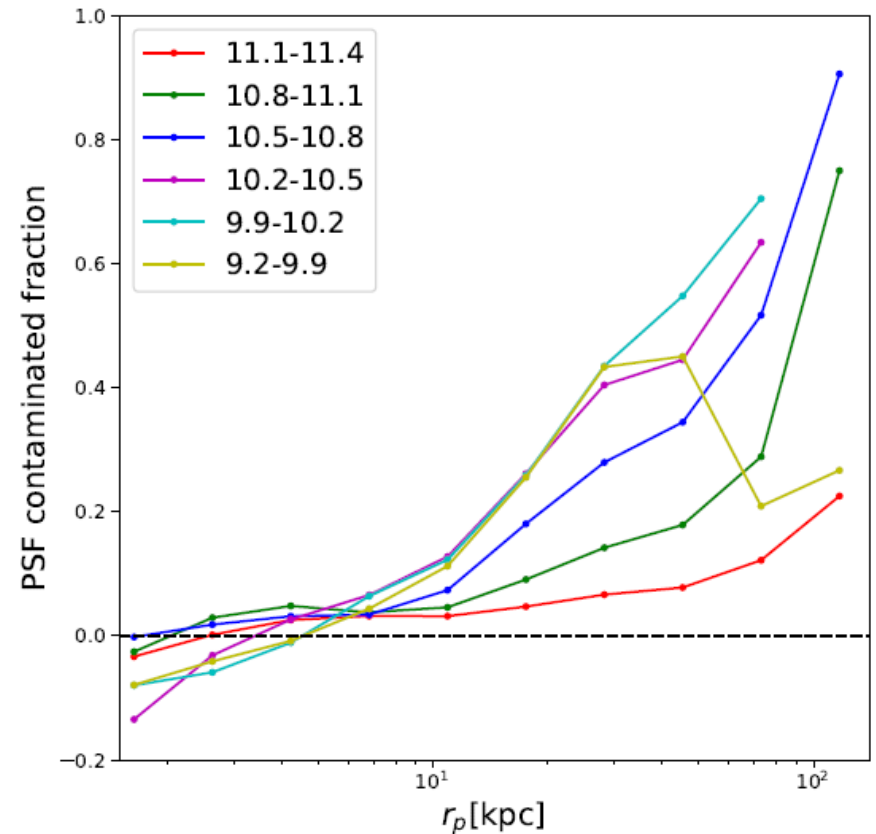
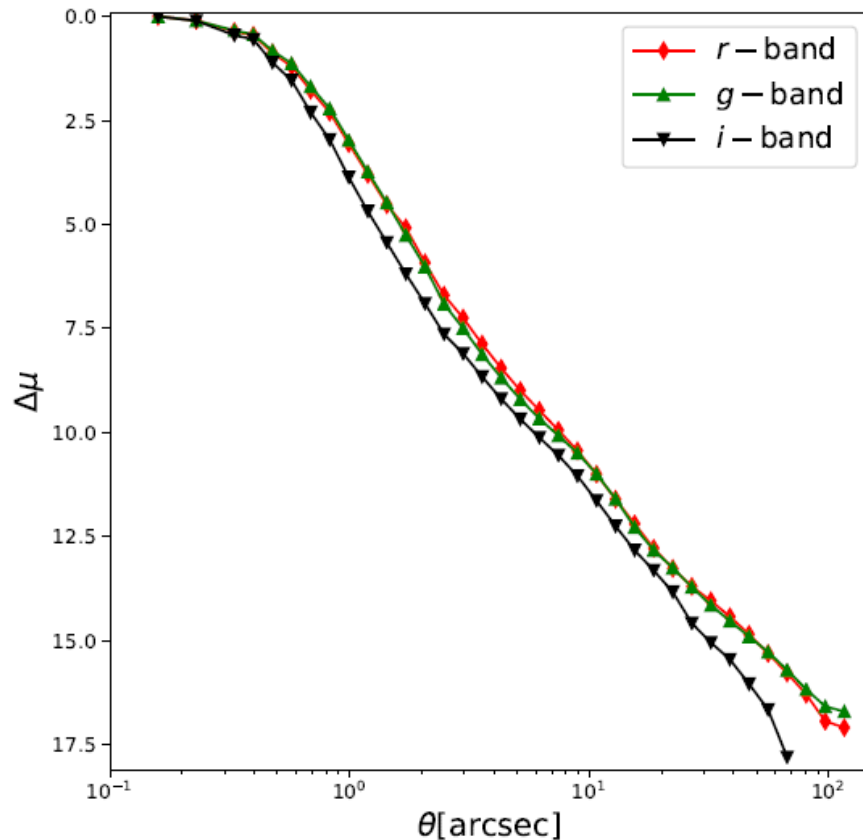
HSC r-band



Random stacks are ideally flat.

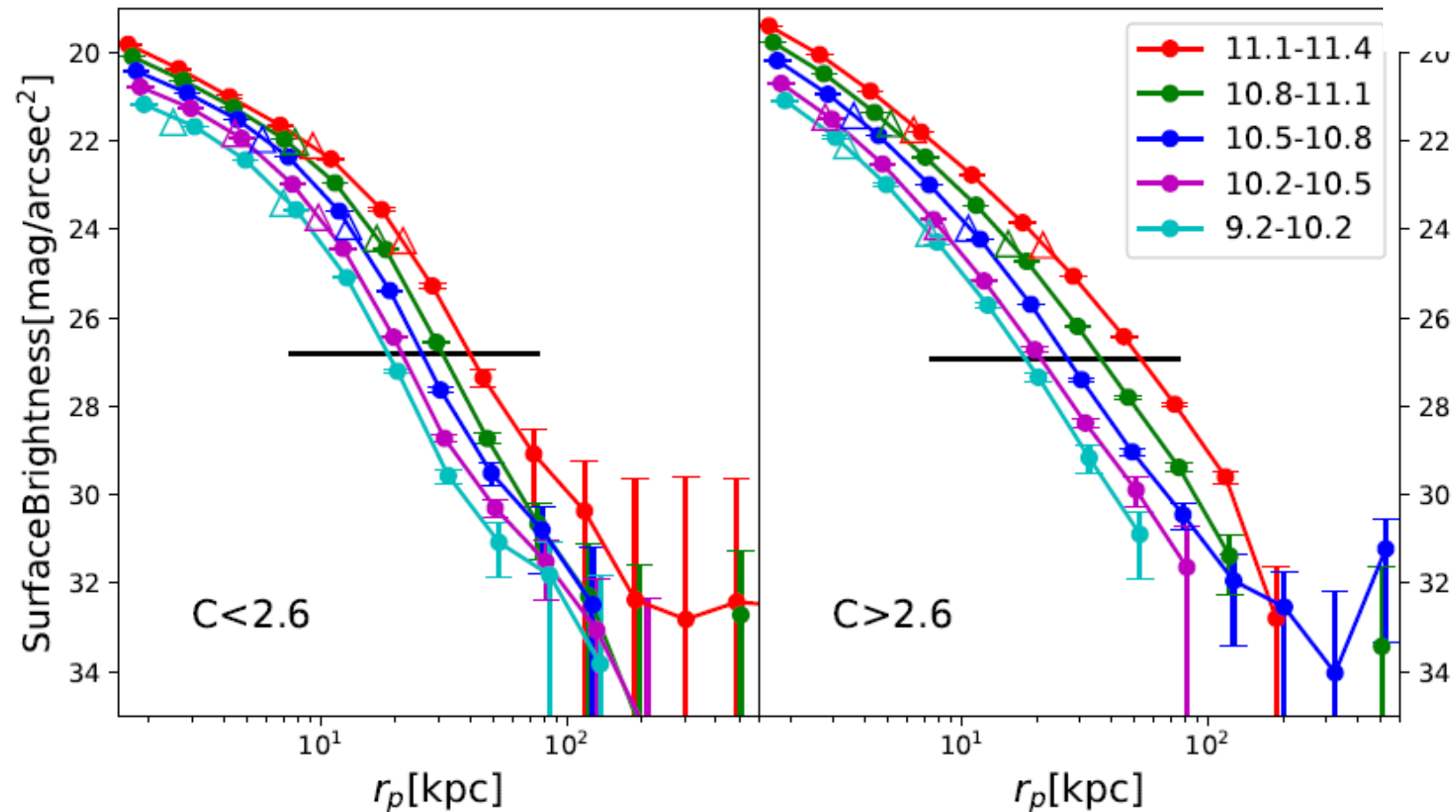
PSF effect

Extended PSF wings



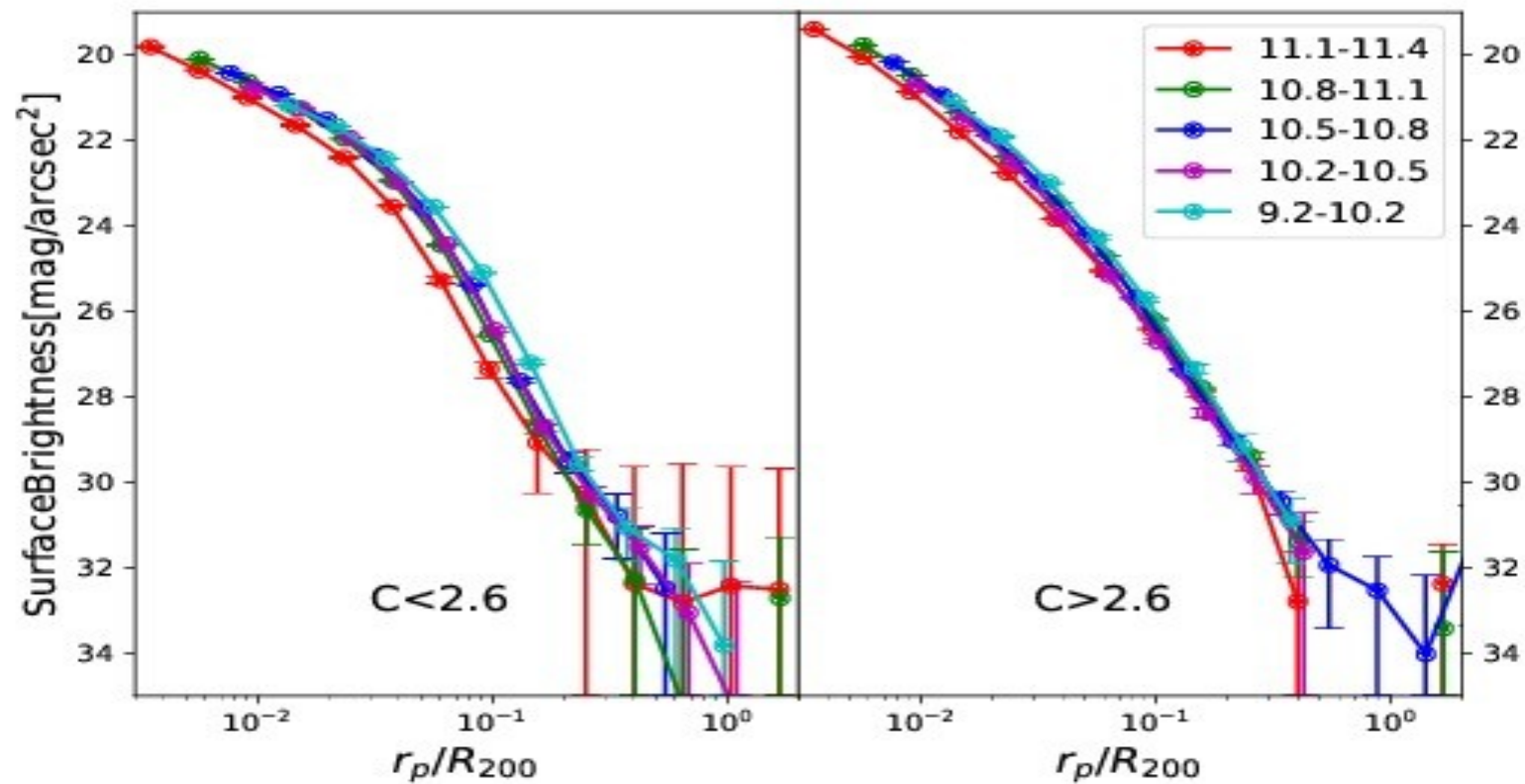
We can go down to **30 mag/arcsec²**, out of which the PSF-free stellar halo contributes **31 mag/arcsec² (3-sigma significance)**.

Low and high concentration

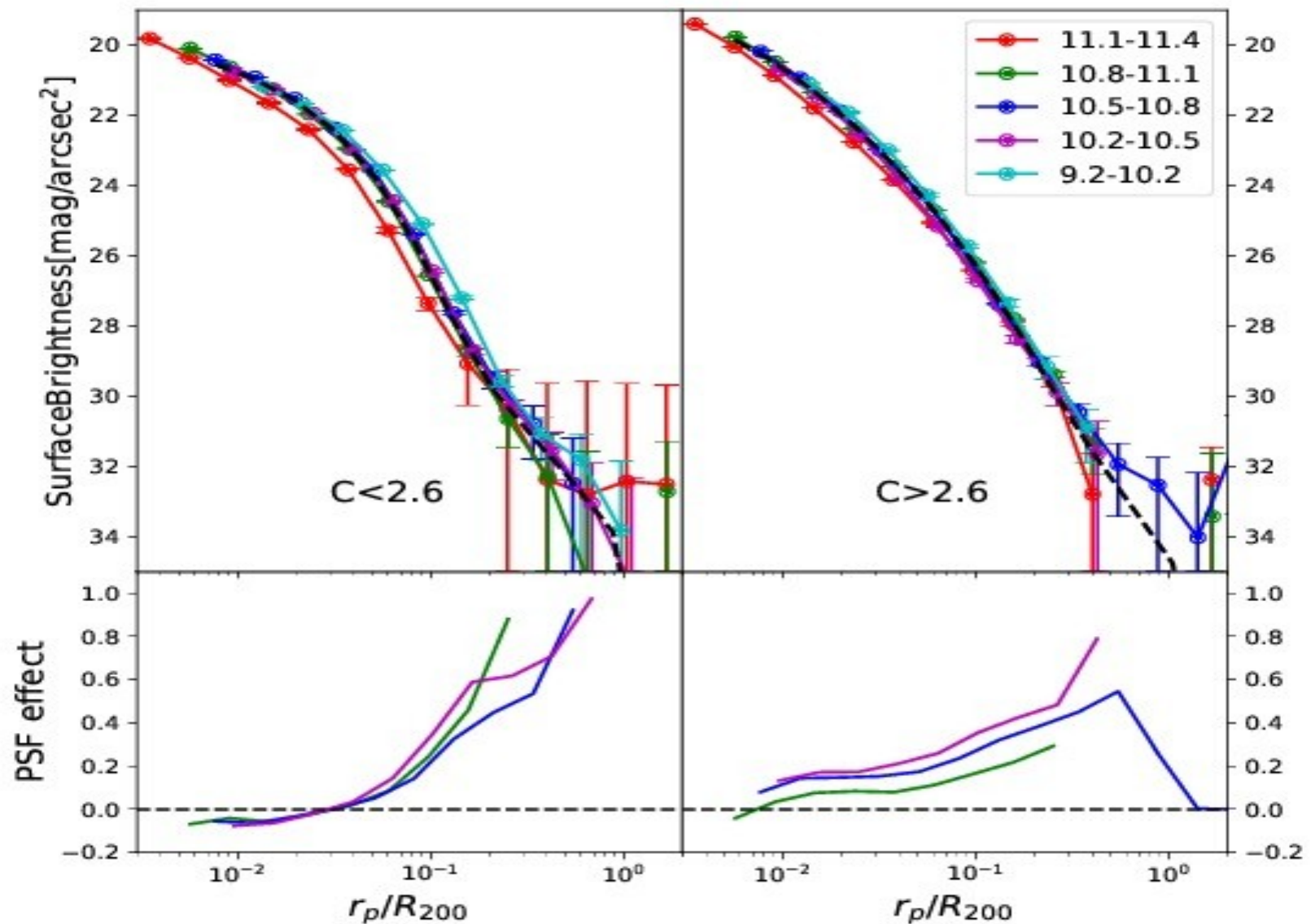


- Low and high concentration galaxies show distinct features in their outer stellar halos.

Universality of the stellar halo

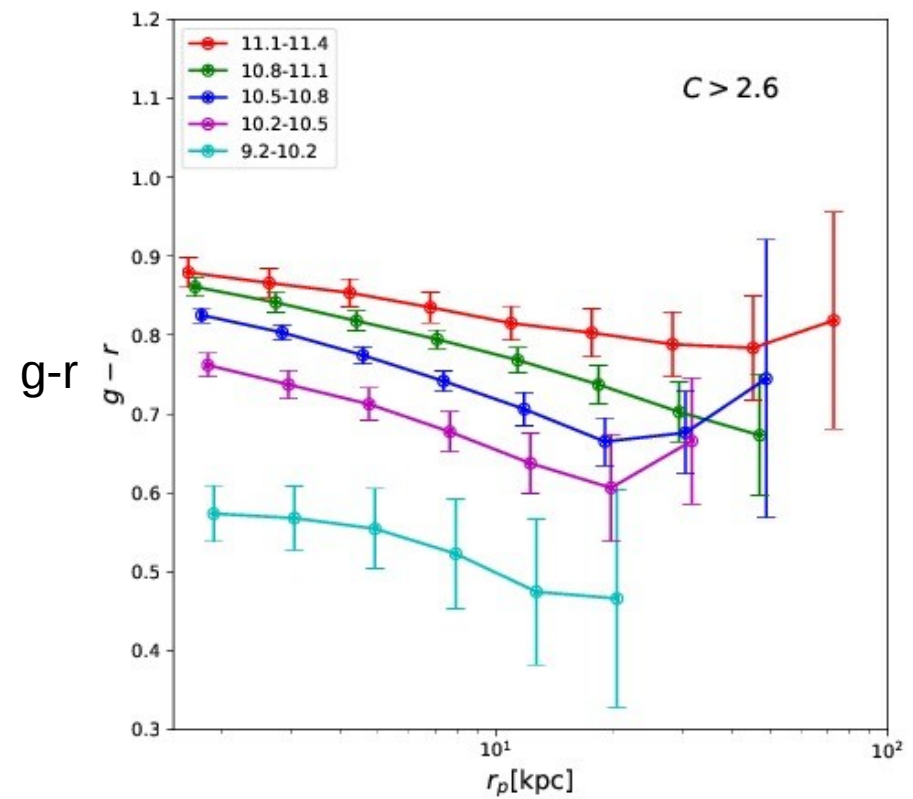
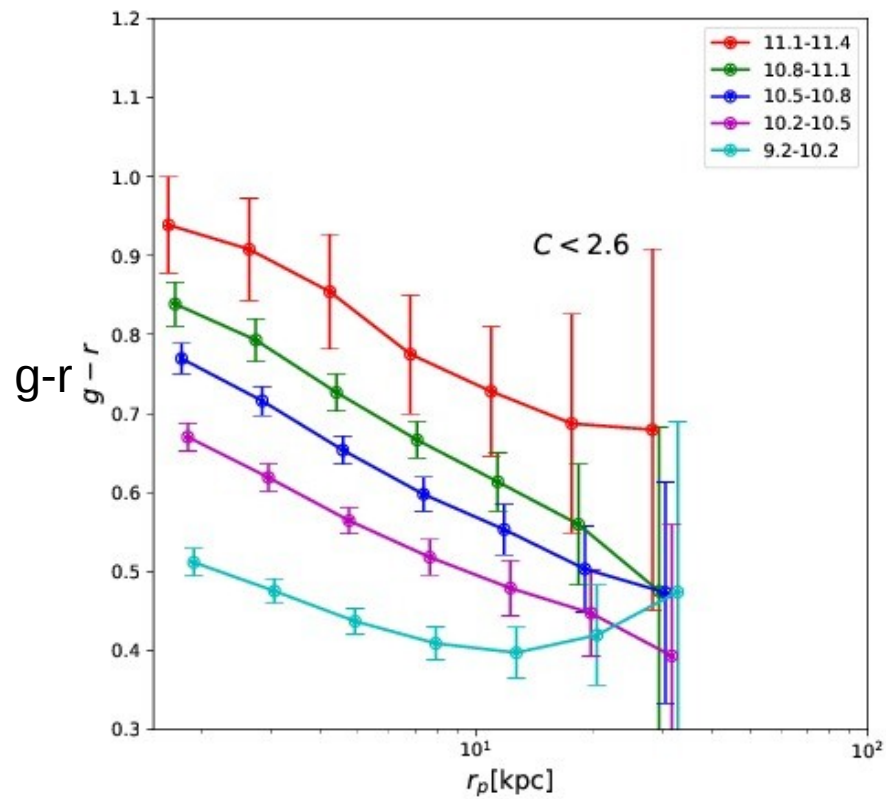


Universality of the stellar halo



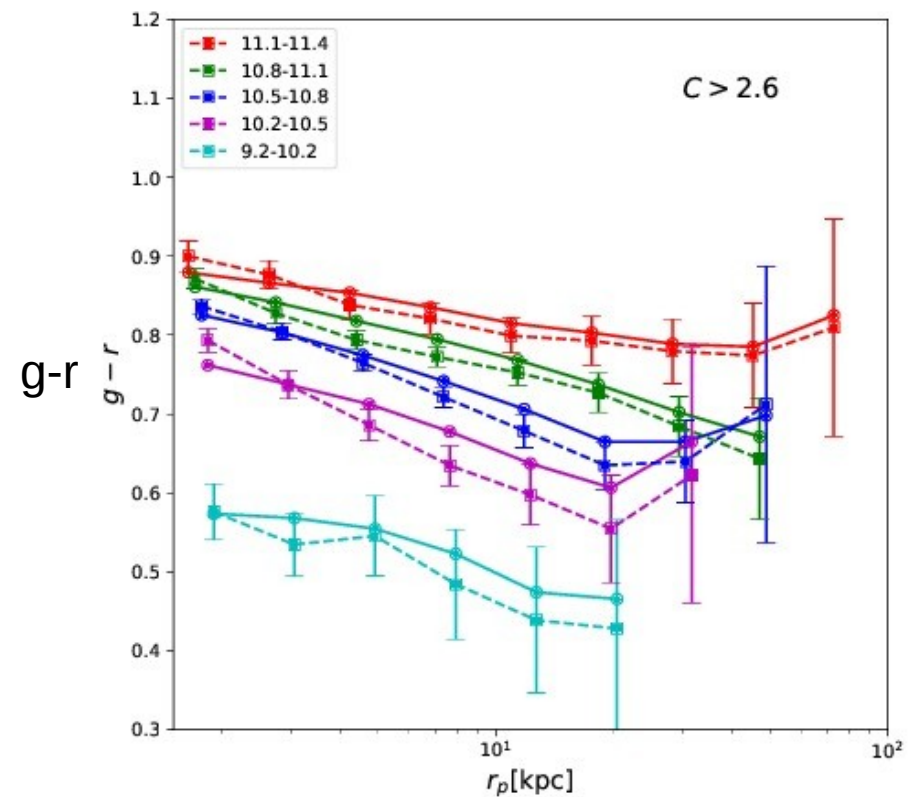
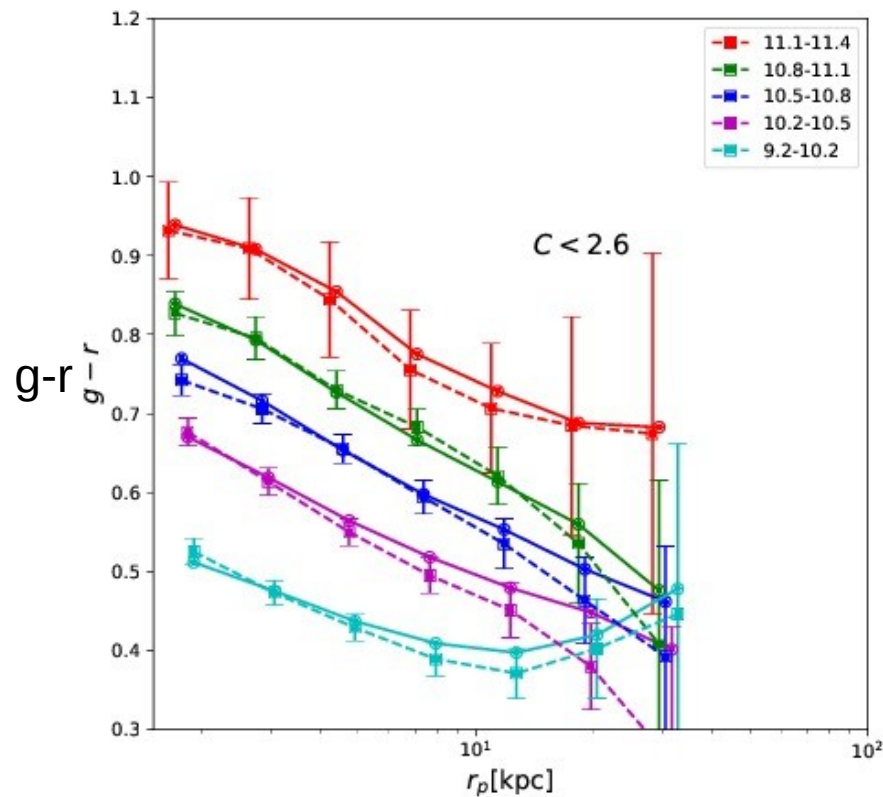
Color profiles

Low and high concentration galaxies with $0.05 < z < 1$



Color profiles

Low and high concentration galaxies with $0.05 < z < 1$

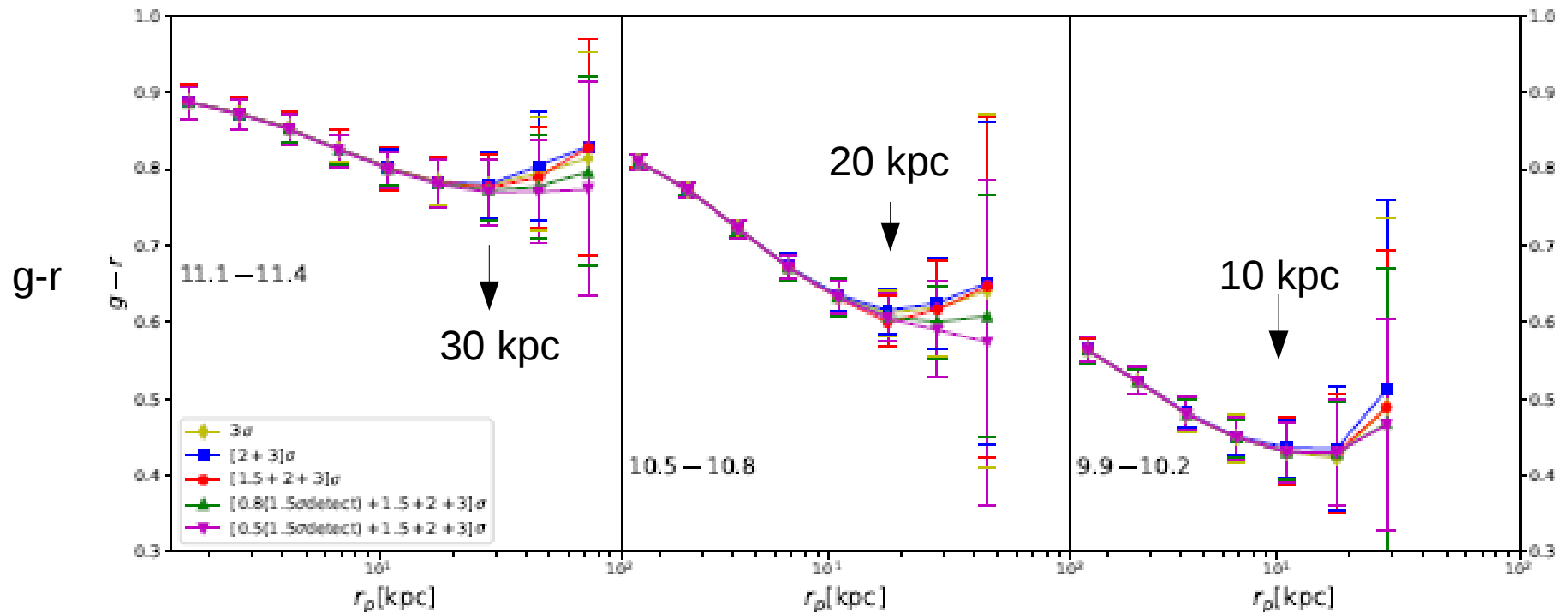


Dashed – PSF-free color profiles

The extended PSF wings slightly flattens the color profiles.

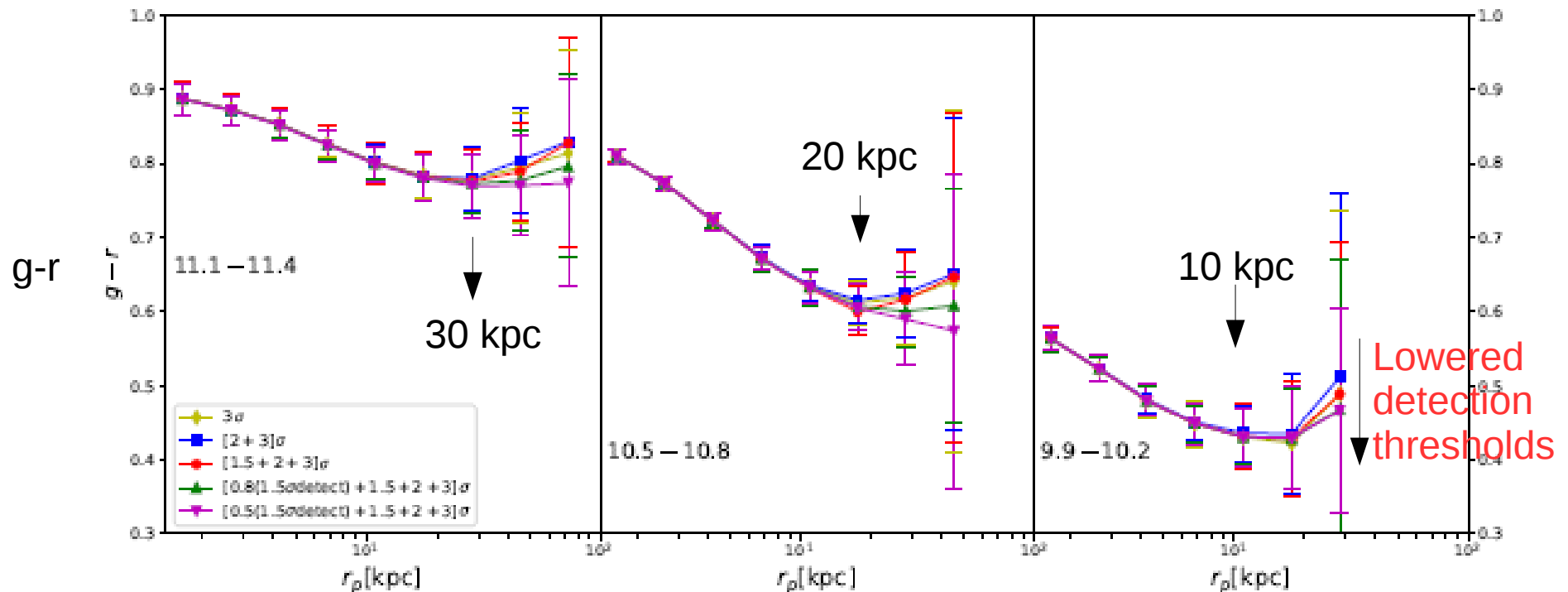
Systematics in color profiles

Galaxies with $0.05 < z < 1$ - to minimize K-corrections



Systematics in color profiles

Galaxies with $0.05 < z < 1$ - to minimize K-corrections



- Positive color gradients are sensitive to how satellite galaxies are masked!

Summary

- The surface brightness profiles centered on isolated central galaxies can be robustly measured up to **120~kpc**, and down to 30mag/arcsec^2 (**31mag/arcsec^2** for the PSF-free stellar halo with 3-sigma significance).
- Our measurements cover a wide stellar mass range for galaxies (**$9.2 < \log M^*/M_{\text{sun}} < 11.4$**).
- Stellar halos are **close to universal after scaling** the projected radius by the halo virial radius.
- The **extended PSF wings** significantly contaminate the outer stellar halo for smaller and late-type galaxies!
- The **red halo effect is less severe** for HSC, which uses thicker CCDs. PSF only tends to slightly flatten the color profiles.
- **The latest data release of HSC is at least 20 times smaller than SDSS, but we can push to similar scales + magnitudes and smaller galaxies than previous studies!**
- This study can be further extended with data from the future LSST survey.

Thank you!