Using satellites to investigate the growth of galaxy groups and the quenching of (central) star formation

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Distribution of satellites around SFing and quiescent galaxies
ZFOURGE: The FOURSTAR Galaxy Evolution Survey

**Fig. 5:** Redshift distribution in a single pointing. A single 2-orbit G141 grism pointing was included in the ERS observations in GOODS-South. We successfully measured redshifts for 245 galaxies in this field, 76 of which are at $z > 1$. The two highlighted redshift spikes demonstrate that we can unambiguously measure the environment of galaxies and determine group memberships. The two groups are remarkably compact: in each of the groups the galaxies are likely part of a single halo and many merge. 3D-HST will observe 122 pointings, yielding $\sim 10^4$ redshifts and several hundred galaxy groups at $1 < z < 3.5$.

**Fig. 6:** 3D-HST will cover most of the Faber MCT area. To overcome field-to-field variations (e.g., Moster et al. 2010) and to obtain sufficiently large samples we propose to cover a total area of 580 arcmin$^2$, spread over 4 fields: COSMOS, UKIDSS/UDS, GOODS-South, and AEGIS. The red circle indicates the virial radius of an $M \sim M^*$ galaxy at $z = 2$. The WF C3 pointings and ACS parallels will coincide with those of the Faber MCT imaging program in these fields. Adding the existing grism data in GOODS-North, 3D-HST will provide spectra and redshifts in all 5 MCT fields, covering 75% of the total area, thus greatly enhancing the scientific returns from the 912-orbit MCT program.

**Instrument**
Magellan/FOURSTAR
$J_1,J_2,J_3,H_S,H_I,K_S$
11’x11’

**Survey**
3 legacy fields
$J_{123}$~25.5 Hls~25.0 Ks~24.8
($5\sigma$, AB, total)
Distribution of satellites around SFing and quiescent galaxies

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Quiescent galaxies have more satellites. Why?

• A comparison to N-body simulations suggest that a \( \sim 2x \) difference in the number of satellites suggests a \( \sim 2x \) difference in halo mass.

• So massive quiescent galaxies occupy more massive halos than SFing galaxies, but the difference is smaller at low masses.

• Is this telling us something about quenching?
Simple quenching model: hard halo mass threshold

Populate halos according to the stellar-to-halo mass relation, add in some scatter, and randomly quench some galaxies according to the halo mass

![Graph showing the relationship between quenching probability and halo mass]
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But this model produces the wrong quenched fractions as a function of mass
Simple quenching model: hard halo mass threshold

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This model also produces too large of a halo mass difference at intermediate stellar masses
Simple quenching model: soft halo mass threshold

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The data require soft halo mass threshold for quenching: something other than environment quenches central galaxies
Stellar mass function of satellites as a function of central mass
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Stellar mass distribution in groups unchanged since $z \sim 1$: the satellite population grows in tandem with the central galaxy.
Summary

At high masses, quiescent galaxies have more satellites

implication: weak relationship between environment and central quenching

Stellar mass distribution in within groups unchanged since z~1: growth of centrals and satellites closely tied