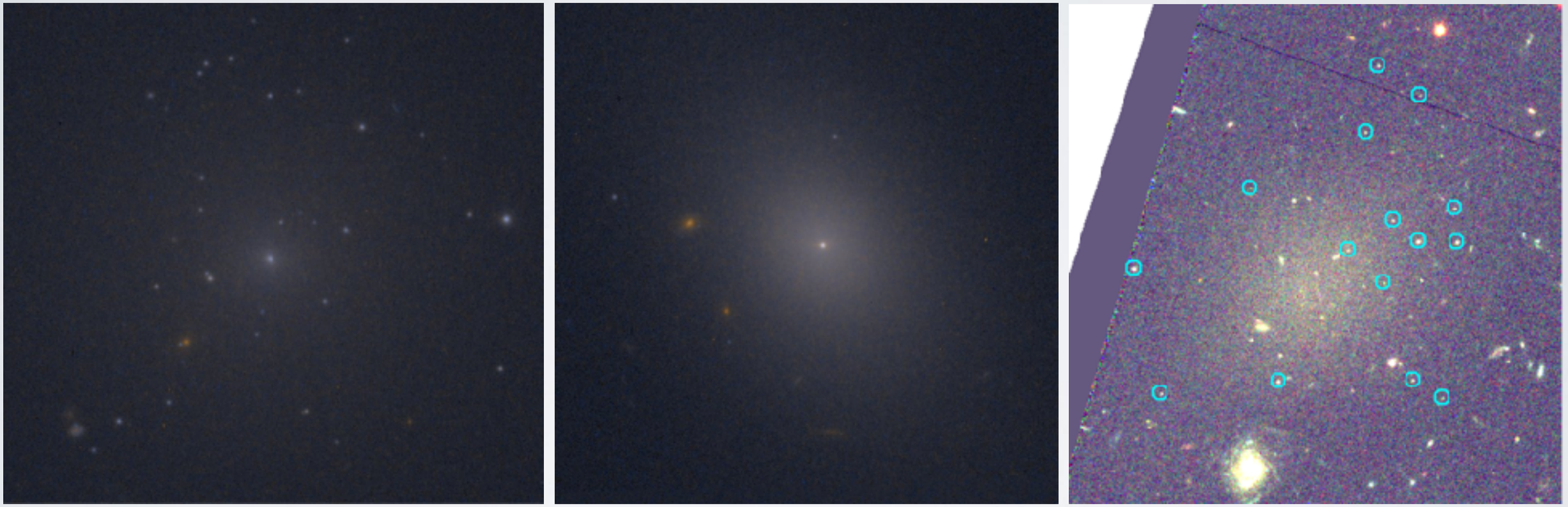
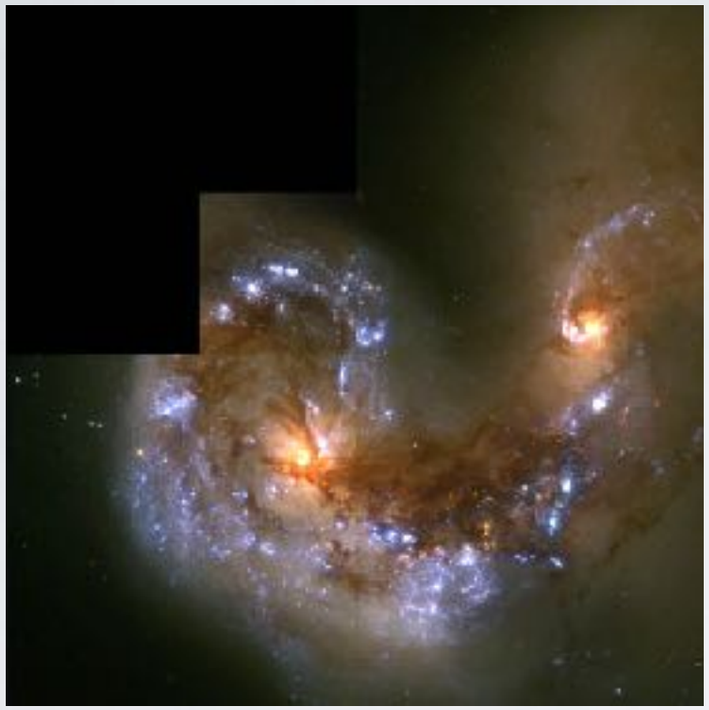
Globular Clusters in Low-Mass Galaxies as Probes of Quenching



Eric Peng (Peking University/KIAA)
Yiqing Liu (Oxford), Sungsoon Lim (PKU), Alessia Longobardi (KIAA/PKU),
and the NGVS Team

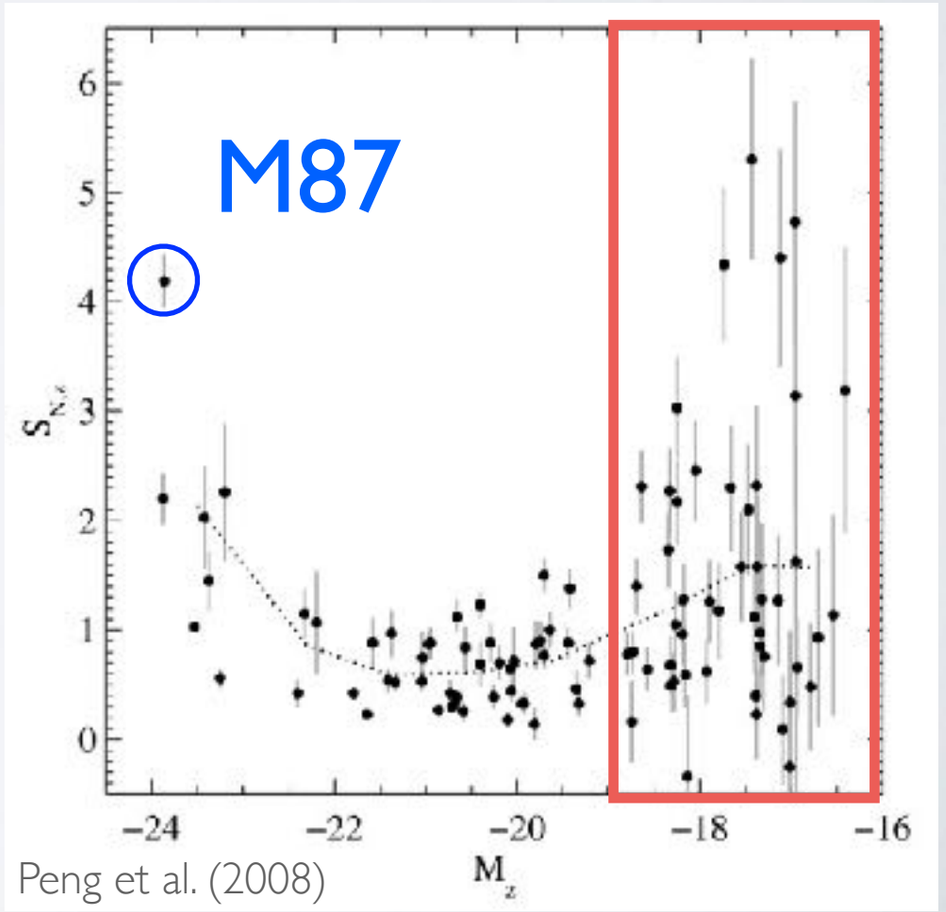
History: The specific frequency “problem”



Efficient star cluster formation?

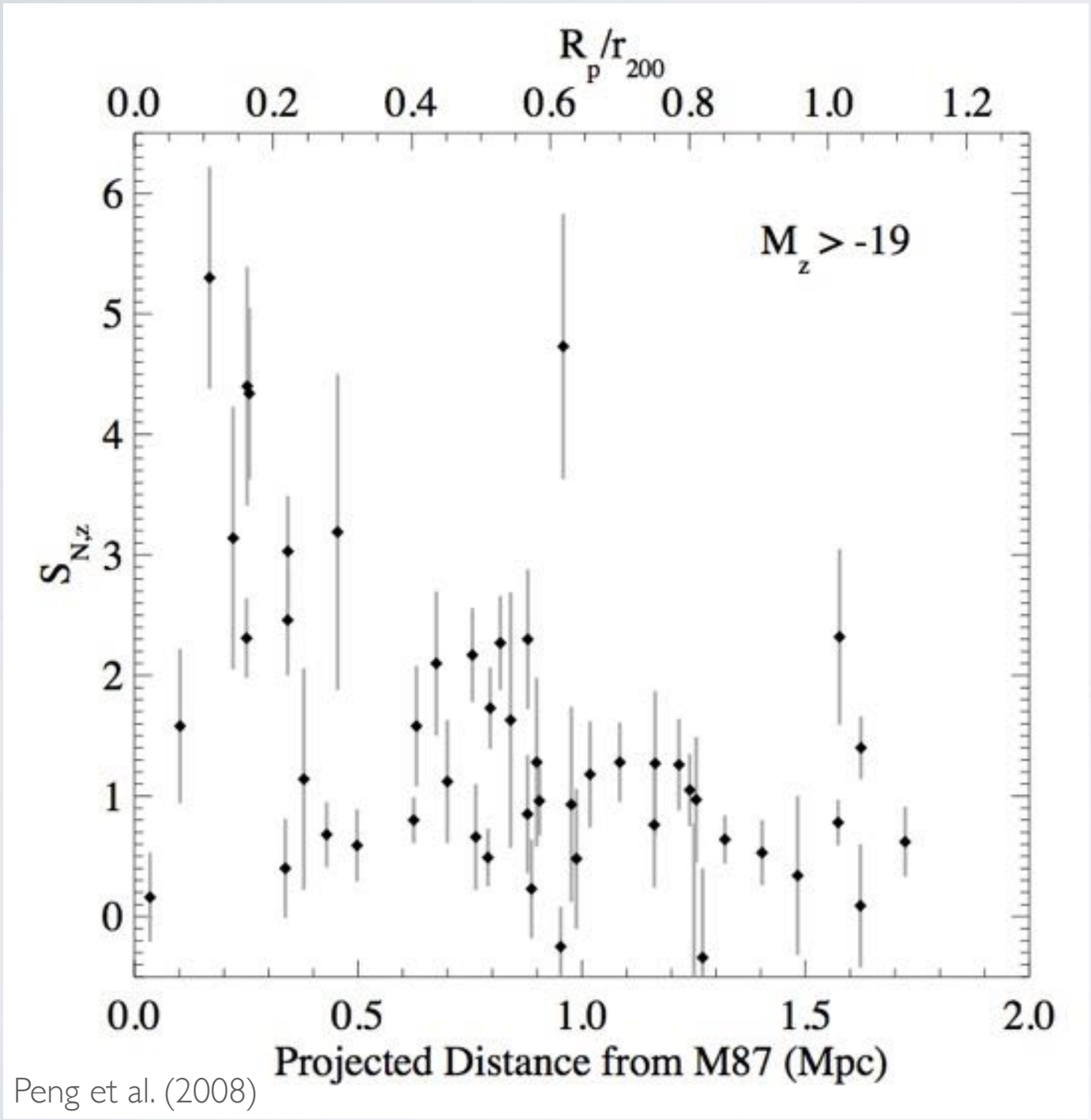
Efficient formation of GCs in late-time major mergers is not the solution

The answer must lie with low-mass galaxies



Peng et al. (2008)

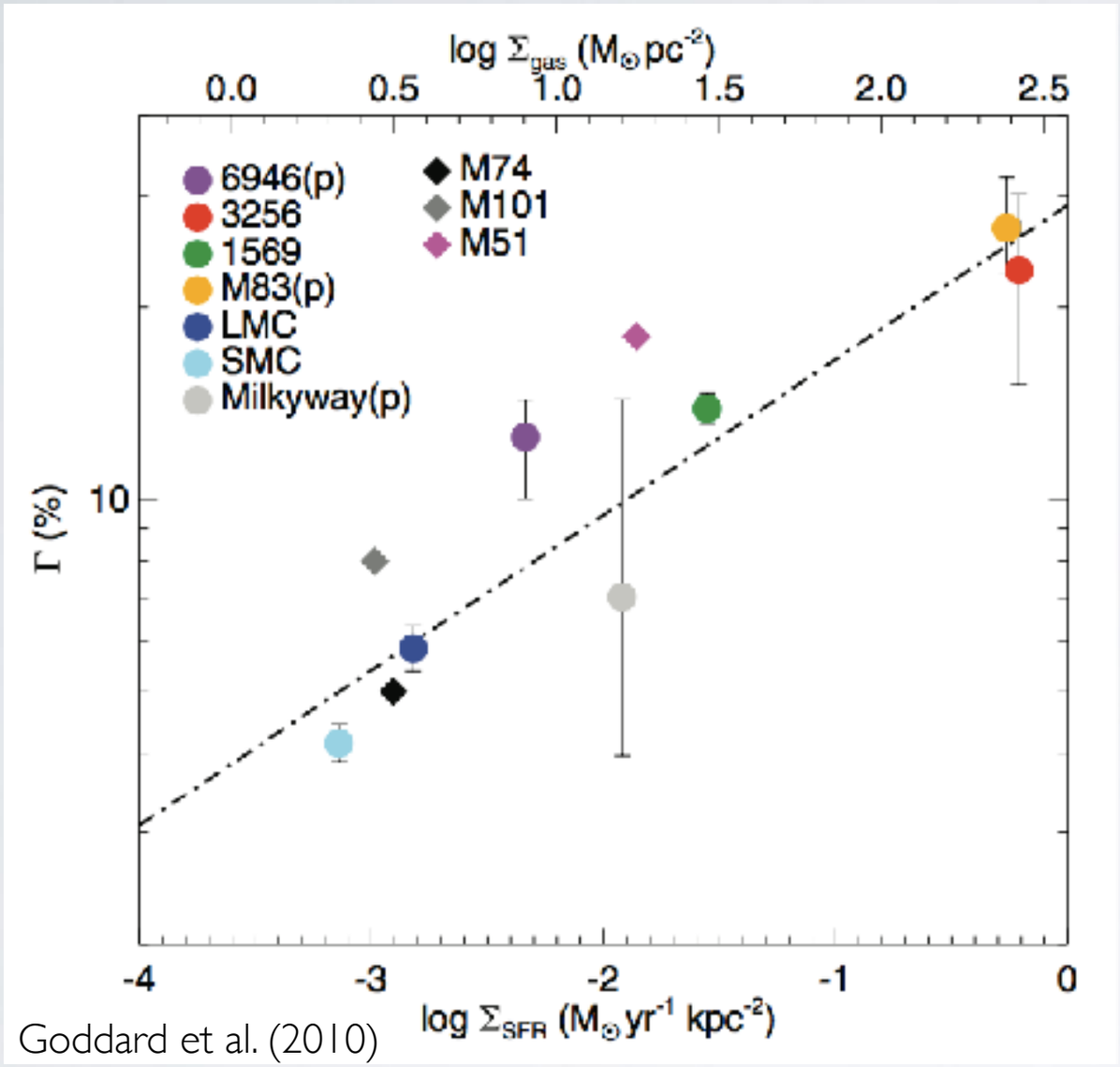
Connecting low-mass galaxies and massive halos



Peng et al. (2008)

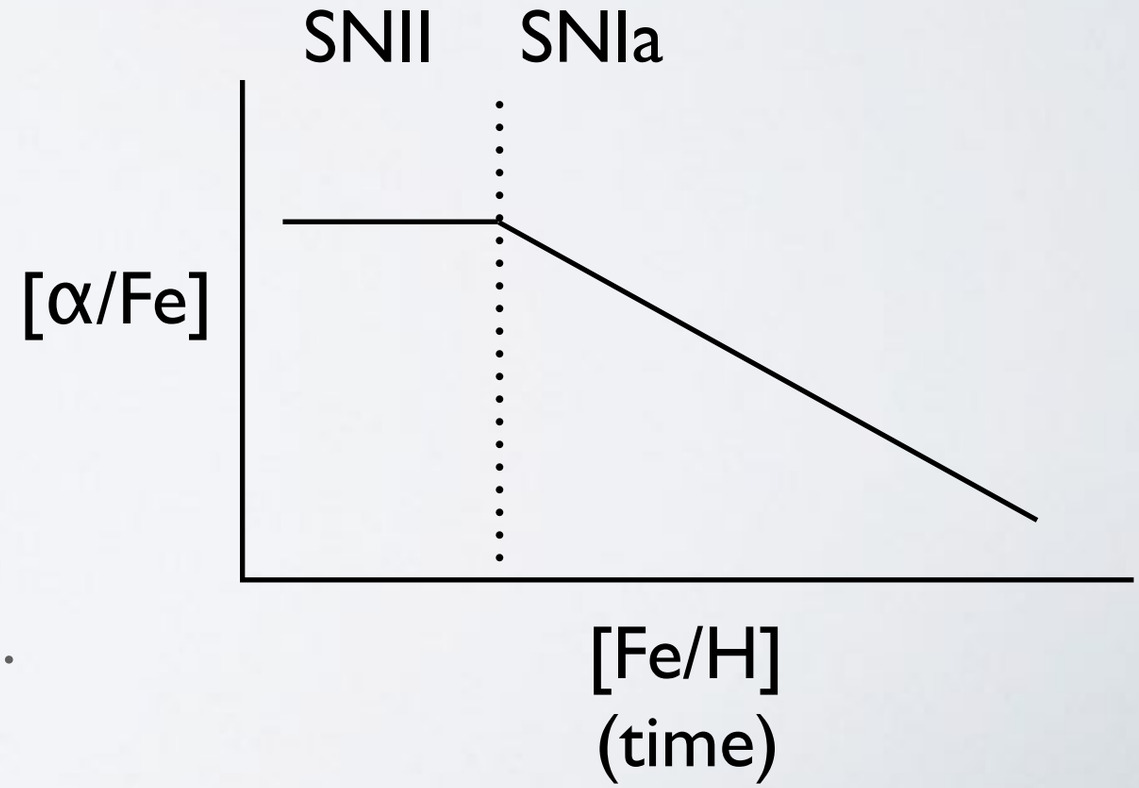
- M87 has the highest S_N in local Universe, with 2/3 of GCs metal-poor.
- Only objects with comparable S_N are early-type dwarf galaxies
- S_N of dEs are correlated with environment

Massive star clusters form when star formation rate density is high



Goddard et al. (2010)

Globular clusters preferentially form in starbursts



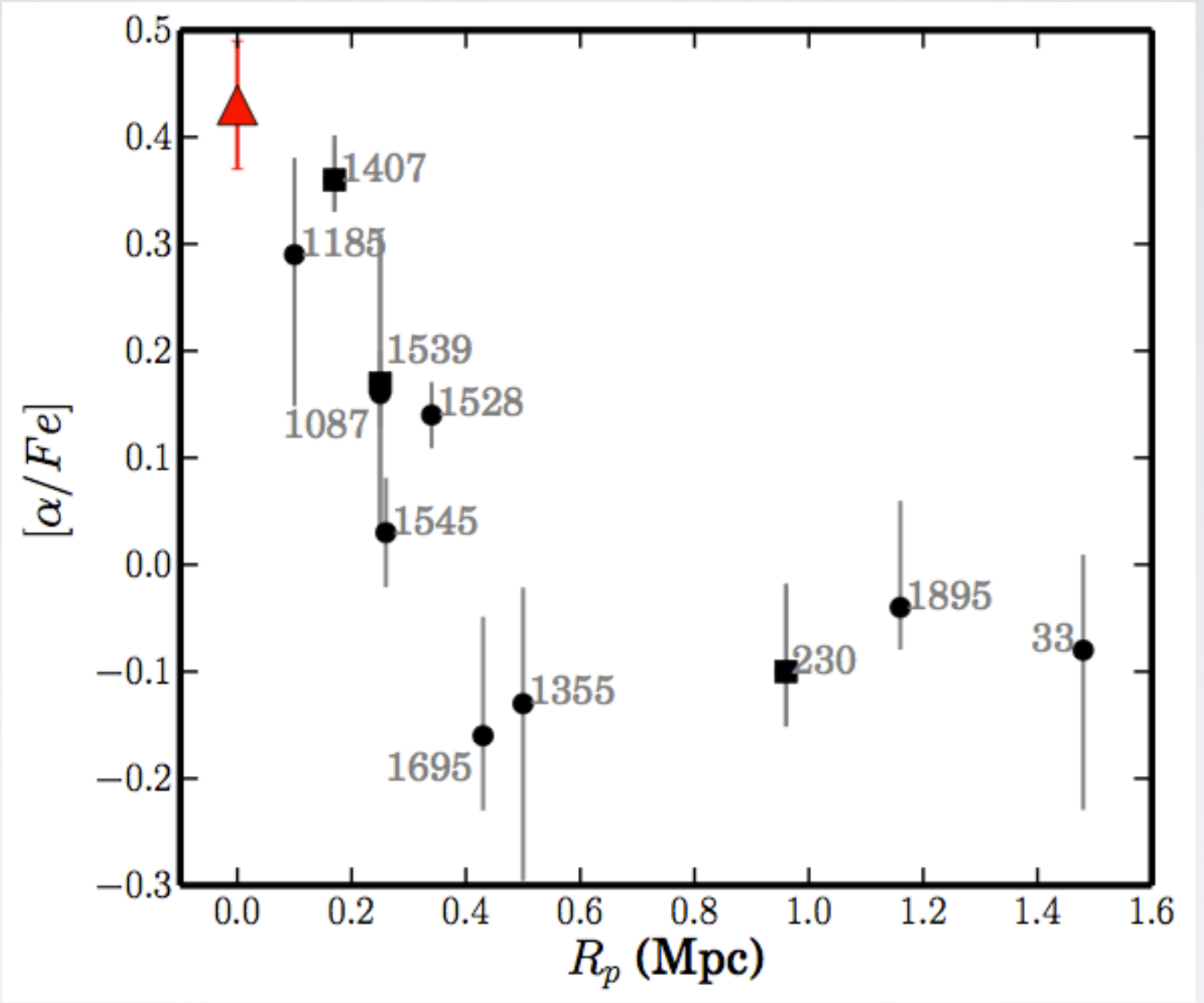
If GCs are formed in high intensity bursts, then dwarfs with high S_N should have high [alpha/Fe].

The Timescales of Star Formation in Virgo Dwarf Galaxies

Y. Liu, EP, et al. (2016)

Yiqing Liu

(Oxford)

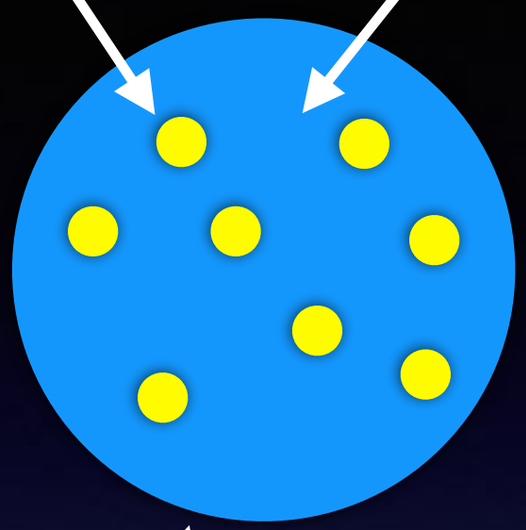


Low-mass galaxies in denser environments have shorter star formation timescales

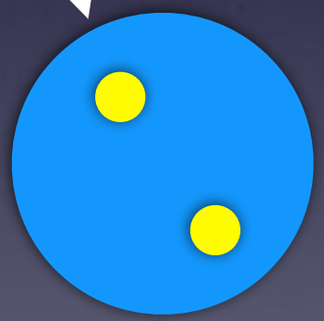
Liu, Y., EP, et al. 2016a

GC

Gas



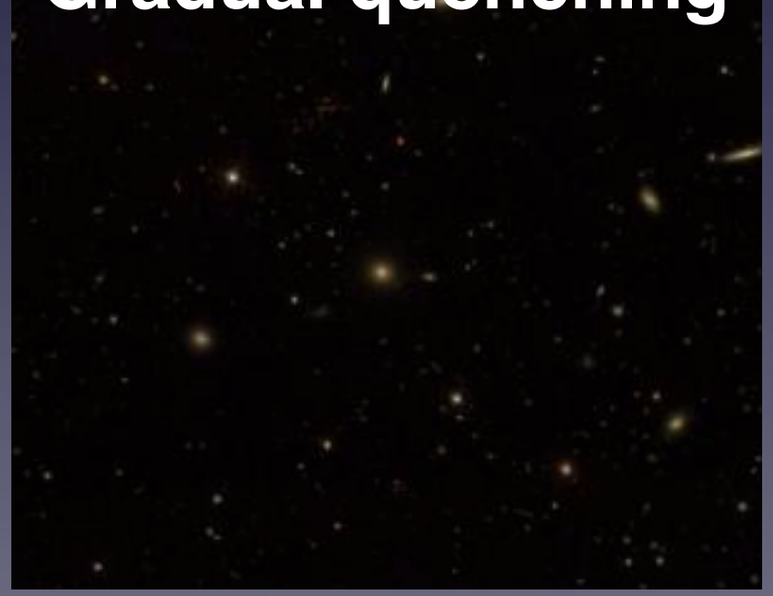
Young galaxies in the Early Universe



Different initial total (gas) masses

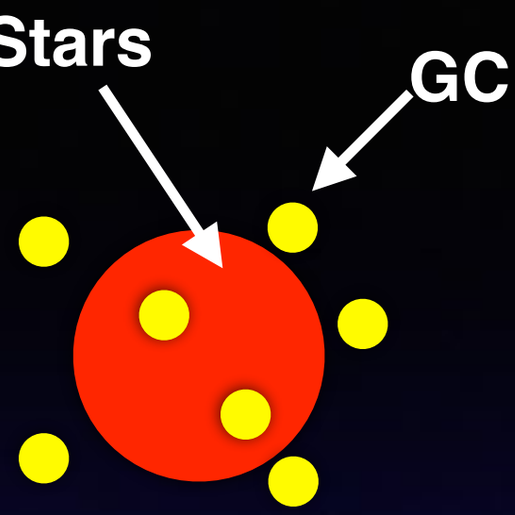
High density
Rapid quenching

Low density
Gradual quenching



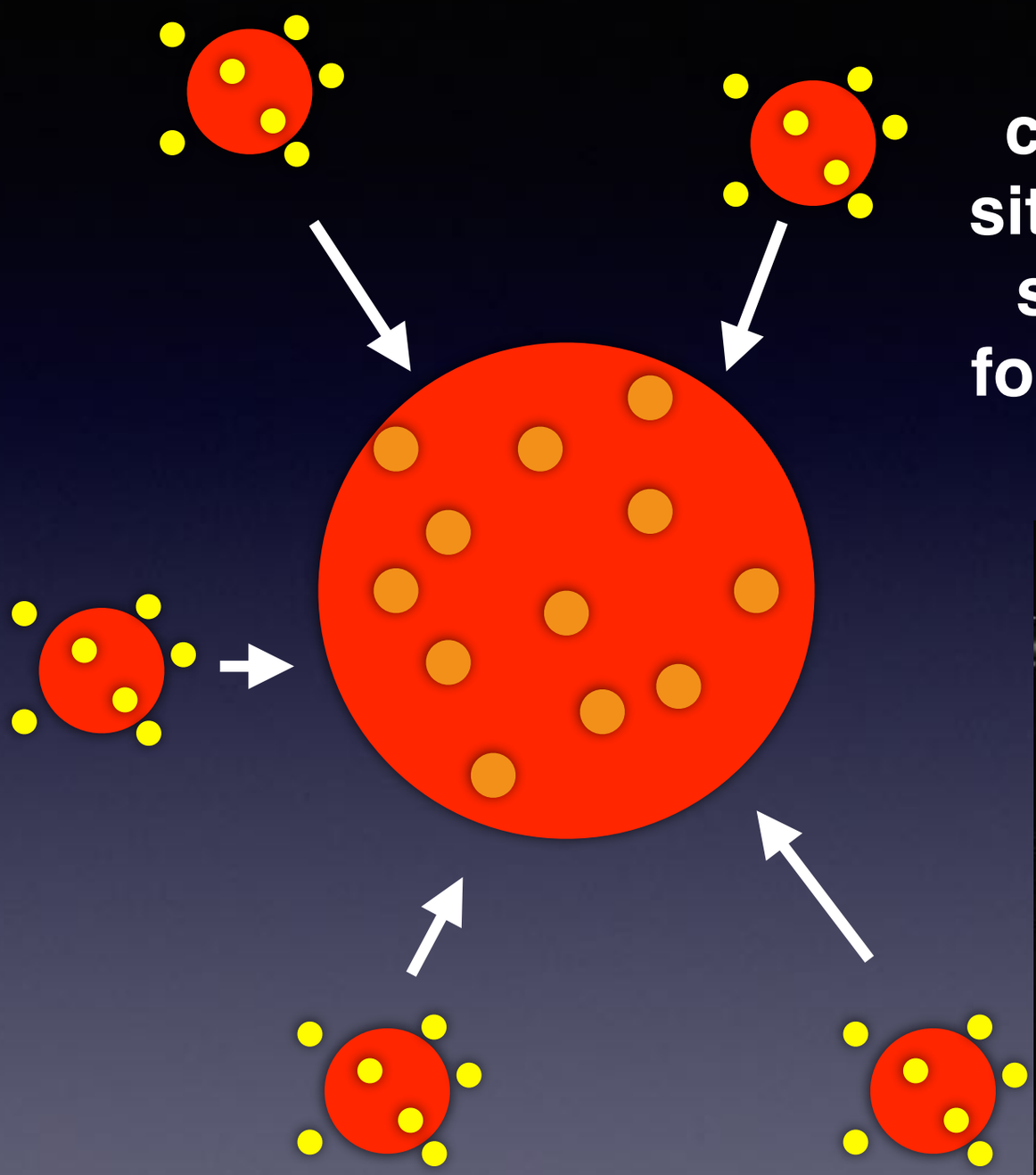
Stars

GC



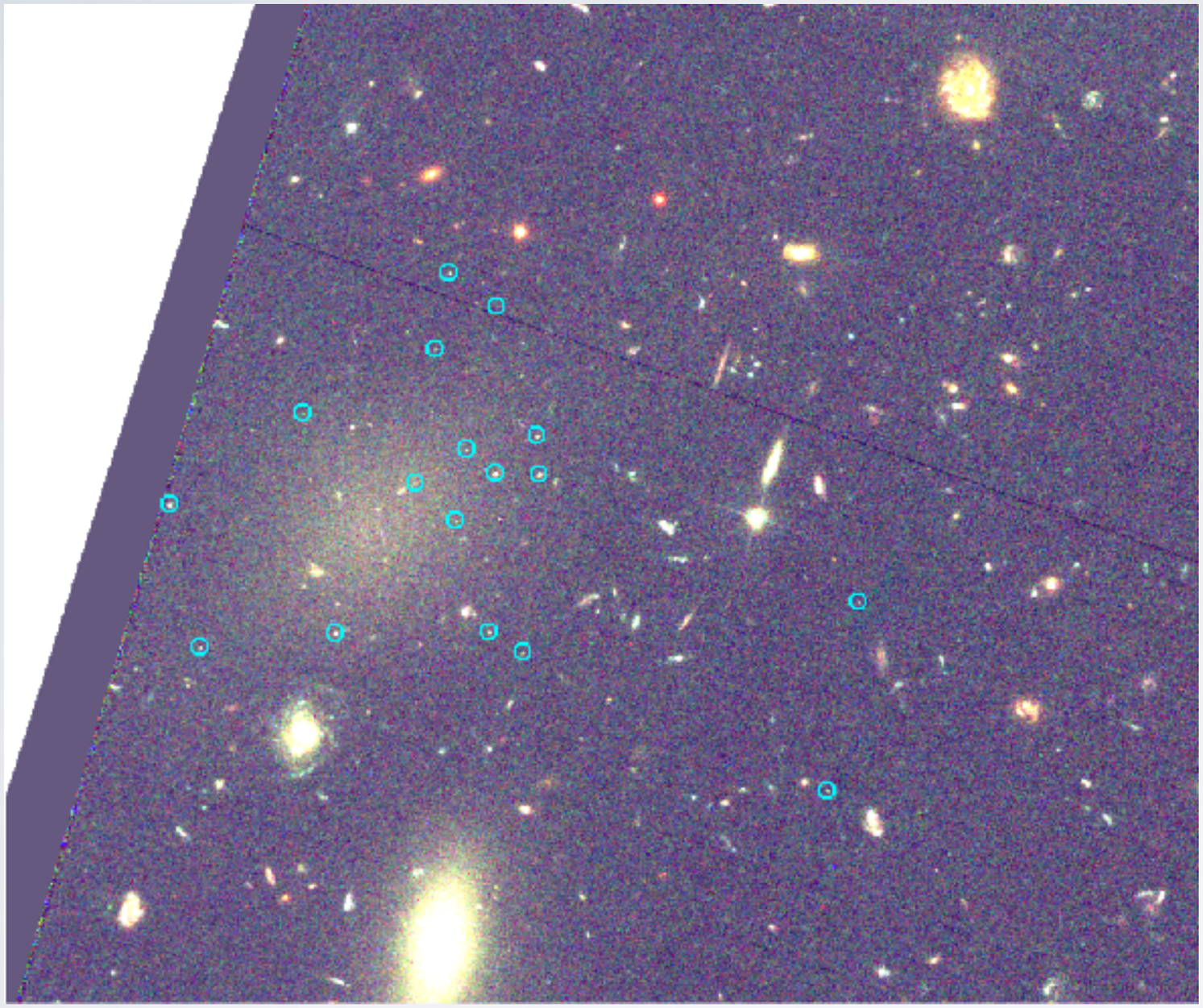
Old galaxies today

Same final stellar masses
Different [a/Fe], S_N



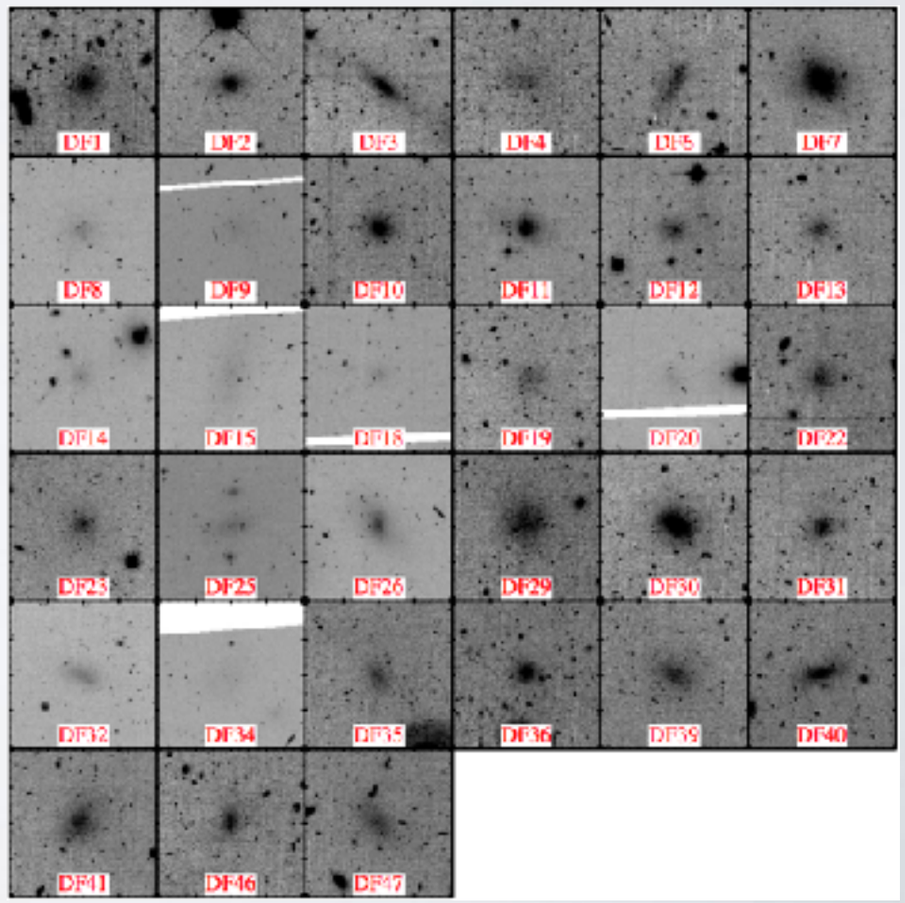
Massive GC systems, like galaxies themselves, are formed as a combination of “in-situ” and “ex-situ” (accretion) star formation, but specifics of massive star cluster formation mean different weighting between the two.

A Rich Globular Cluster System in an Ultra-Diffuse Galaxy
Are UDGs pure stellar halo populations?

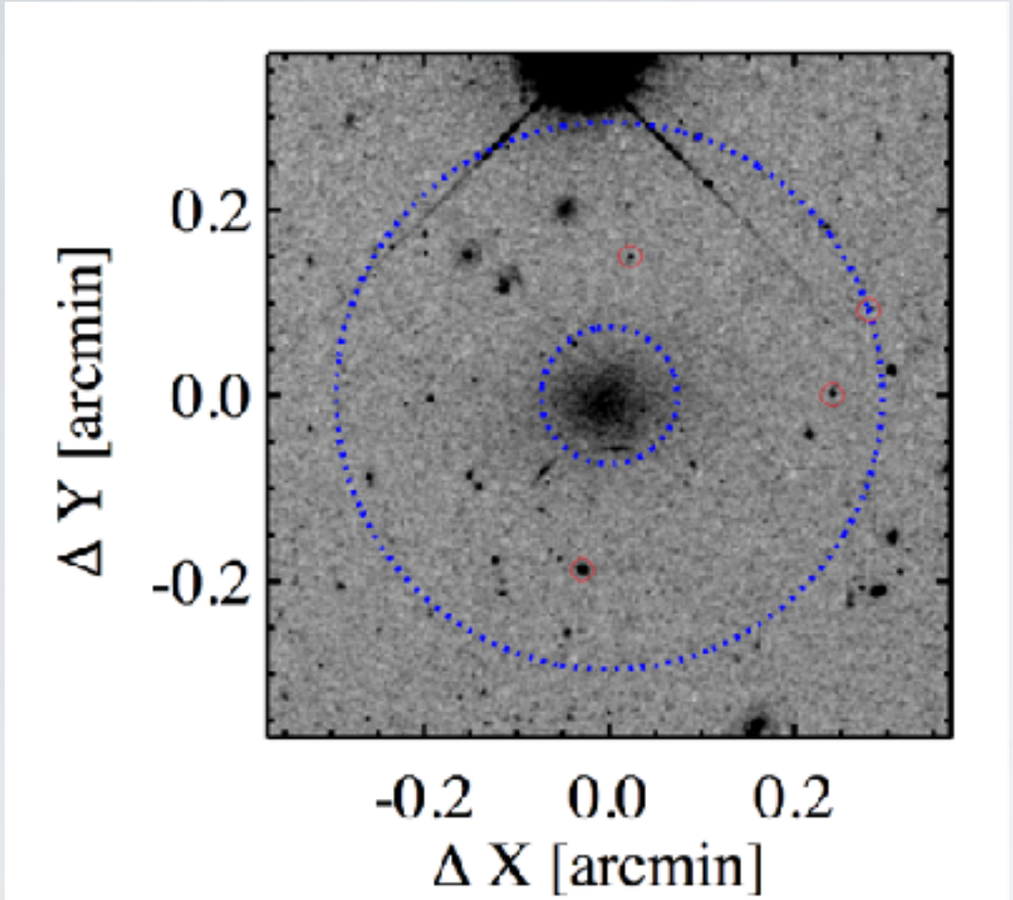


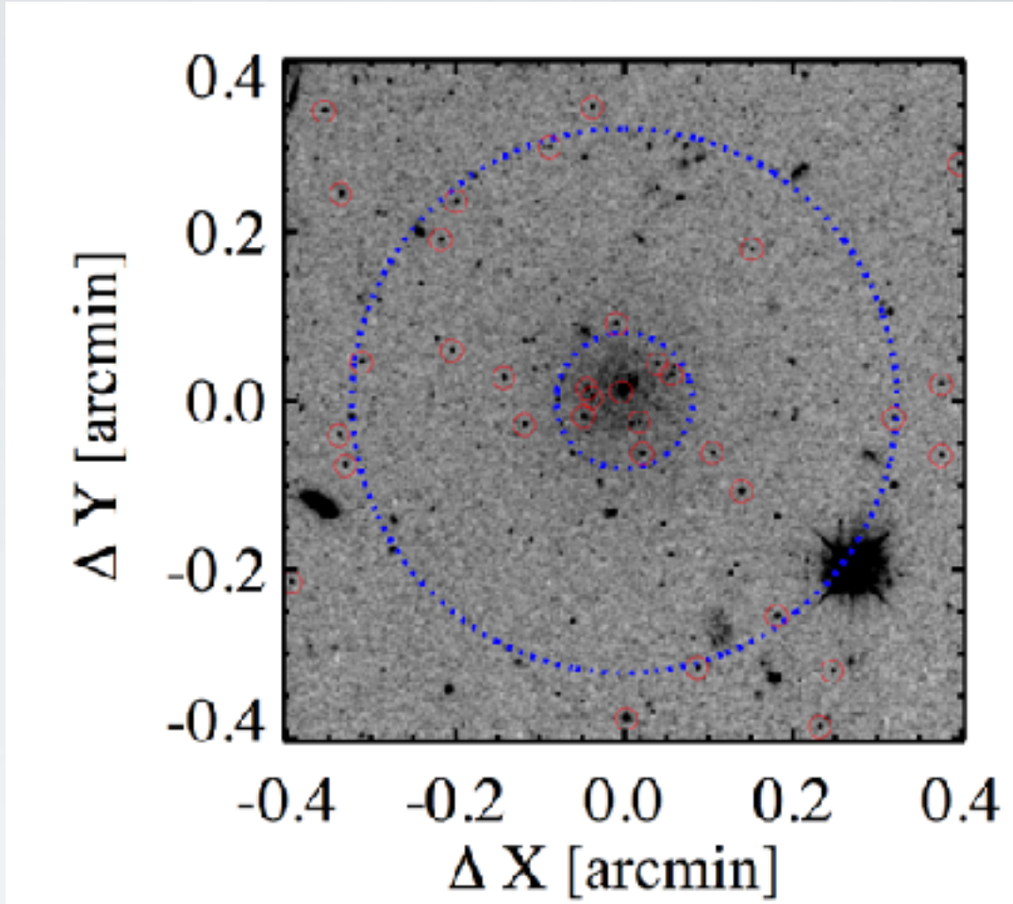
Peng & Lim (2016)

Sungsoon Lim (PKU)



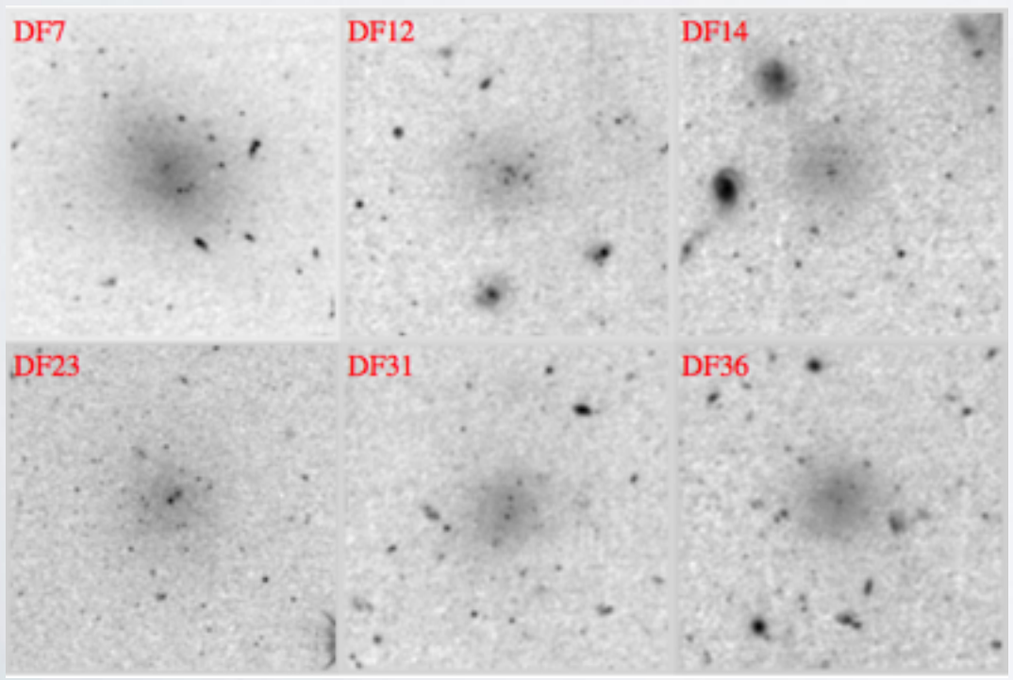
26 orbit program with ACS and WFC3
Targeted 33 Dragonfly UDGs with R_e>2 kpc





A lot look like this…

…but a few look like this

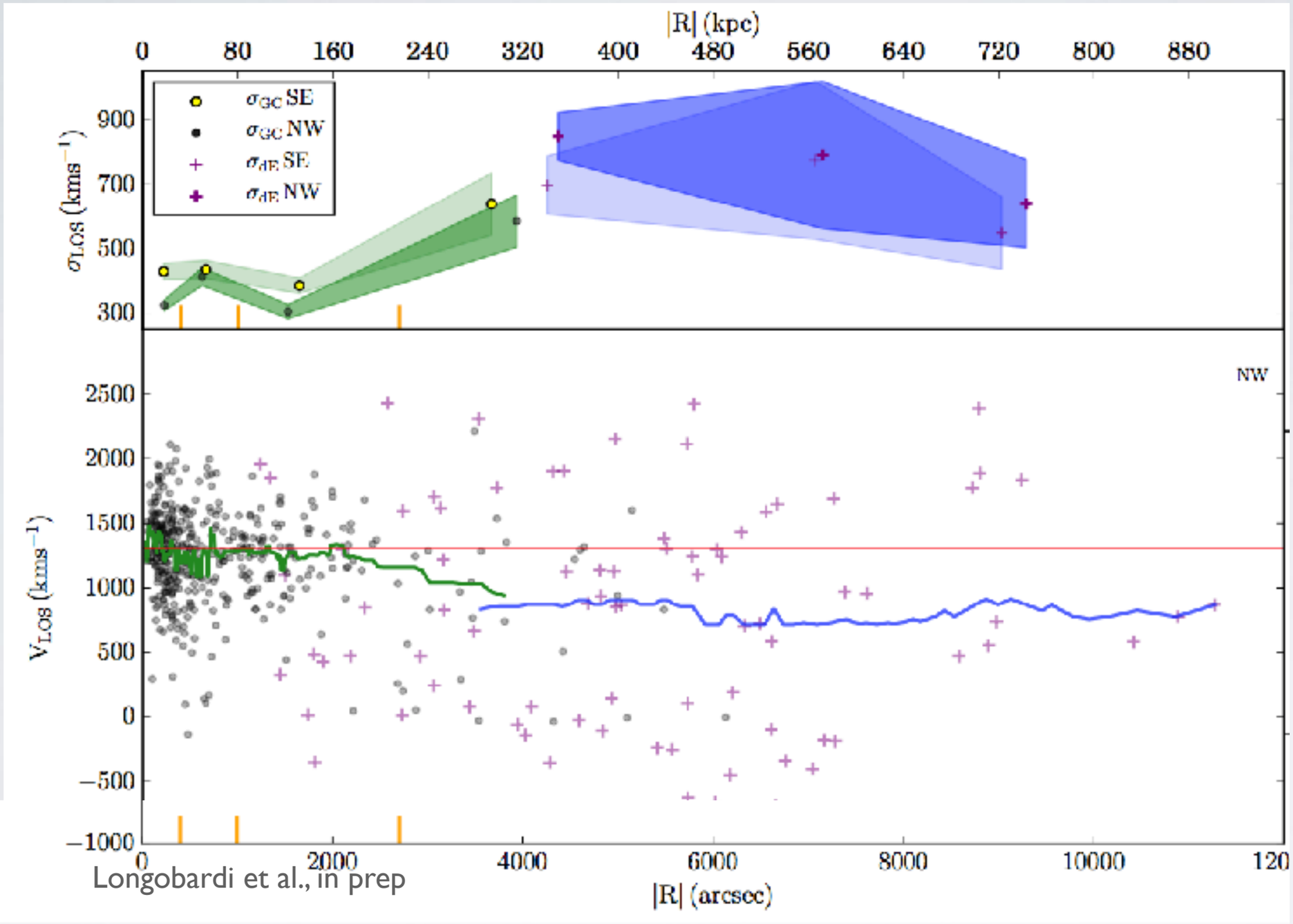


And 6/33 may have a nuclear star cluster
(Compare to Ruben's work and den Brok+14)

Lim et al., in prep

Intracluster GCs in the Virgo core

Alessia Longobardi (KIAA/PKU)

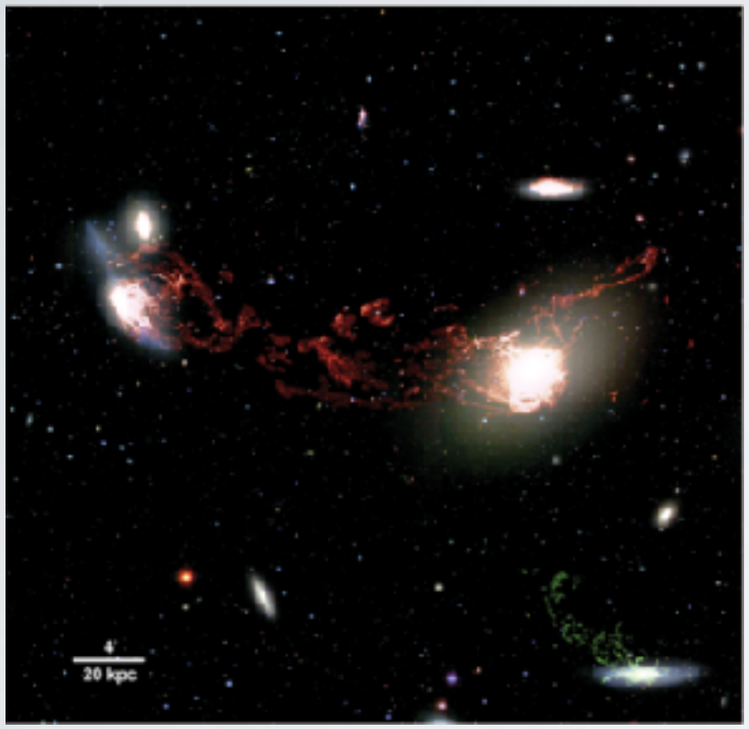


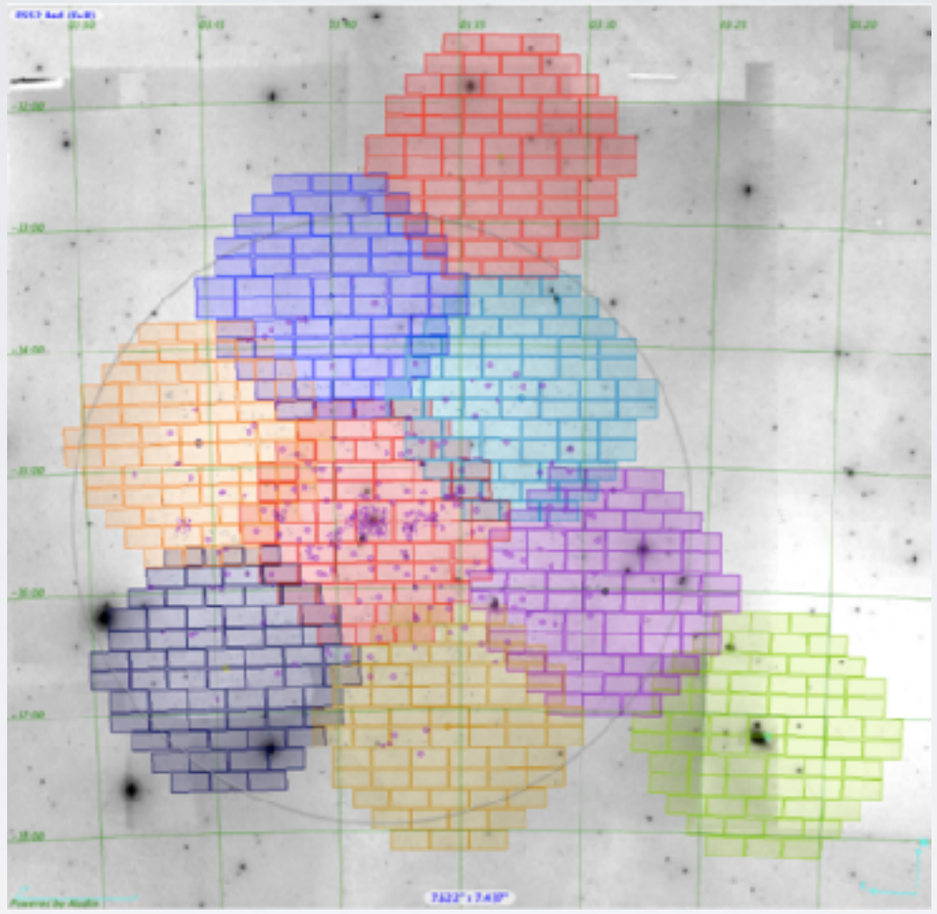
Longobardi et al., in prep

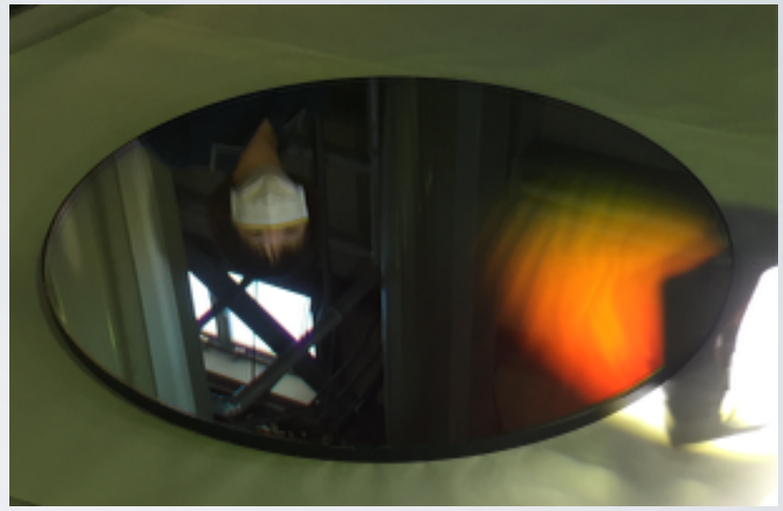
885 GCs with velocities

- See the rise in GC velocity dispersion indicative of intracluster population
- Drift in mean velocity away from M87 to lower mean cluster velocity

H-alpha surveys using CTIO/DECam



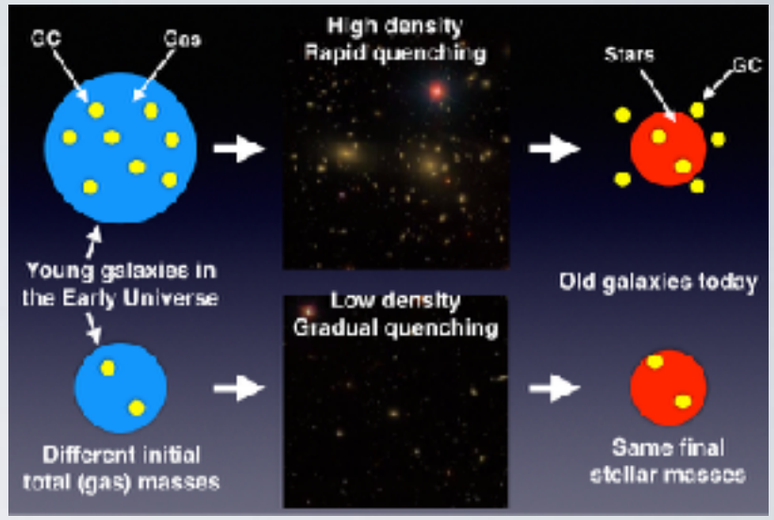


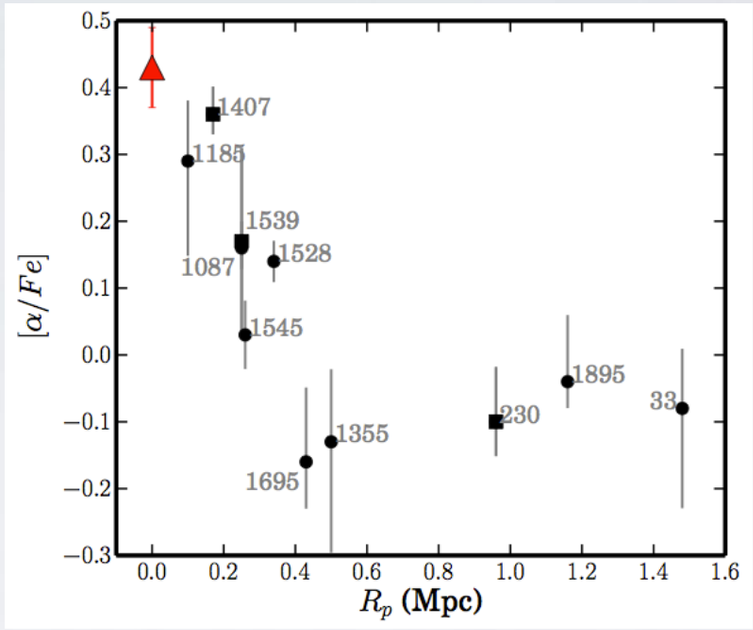


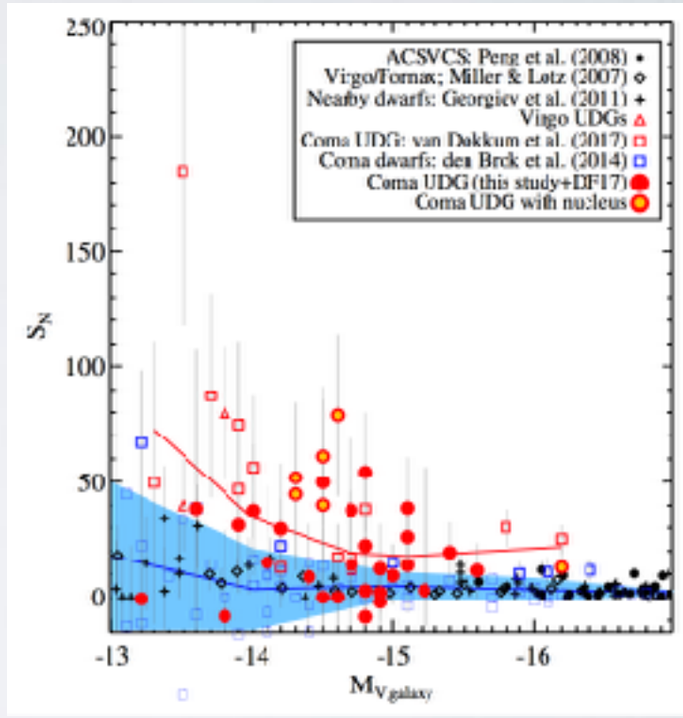
- Co-PIs: E. Peng (PKU/KIAA), Thomas Puzia (PUC)
- Chosen as a China-Chile Joint Research Program
- H-alpha at -1200 km/s < v < 6500 km/s (172Å FWHM)
- CTIO 4m + DECam (2 deg diameter FOV) is an efficient survey machine
- Goals: star formation and quenching in galaxies, ionized gas in groups and clusters

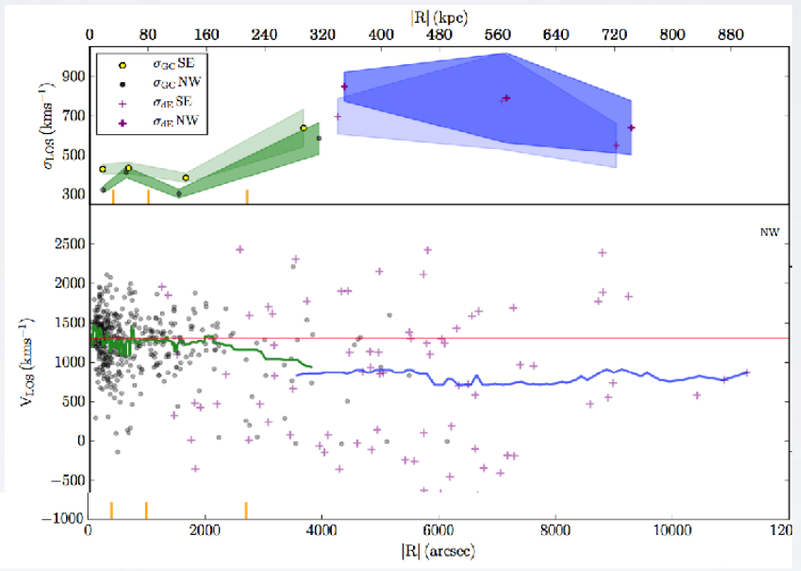
Summary

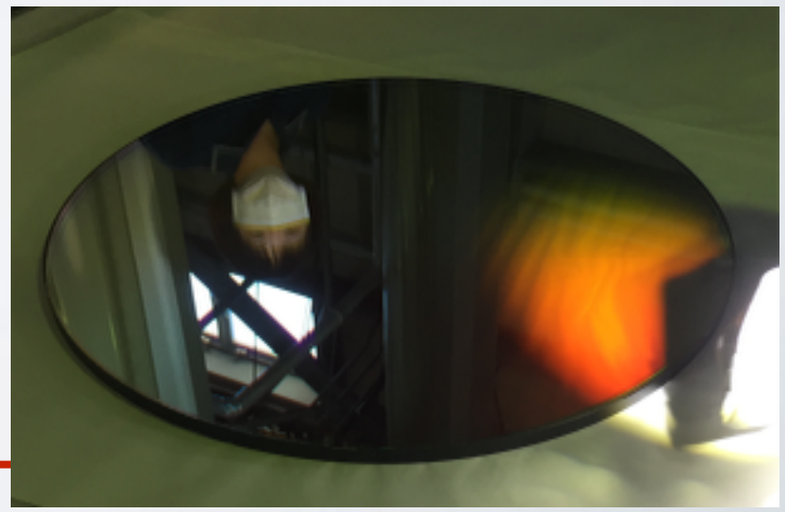
- GC systems of massive galaxies are made up of bursty low mass galaxies that efficiently formed GCs, but then rapidly quenched
- Coma UDGs show a wide range of GC S_N, with few extreme cases.
- IGCs in Virgo core found, and consistent with satellite dwarf kinematics











Higher S_N, [a/Fe], M/L, older