Discs all the Way Down: The Origin of Quenched, Low Mass Galaxies Using MaNGA IFU Spectroscopy

Samantha J. Penny
Institute of Cosmology and Gravitation
University of Portsmouth
Karen Masters, Anne-Marie Weijmans, Kyle Westfall
+MaNGA team

The Changing Face of Galaxies
20th September 2016

University of Portsmouth
ICG Portsmouth
SDSS

The cluster dwarf galaxy population

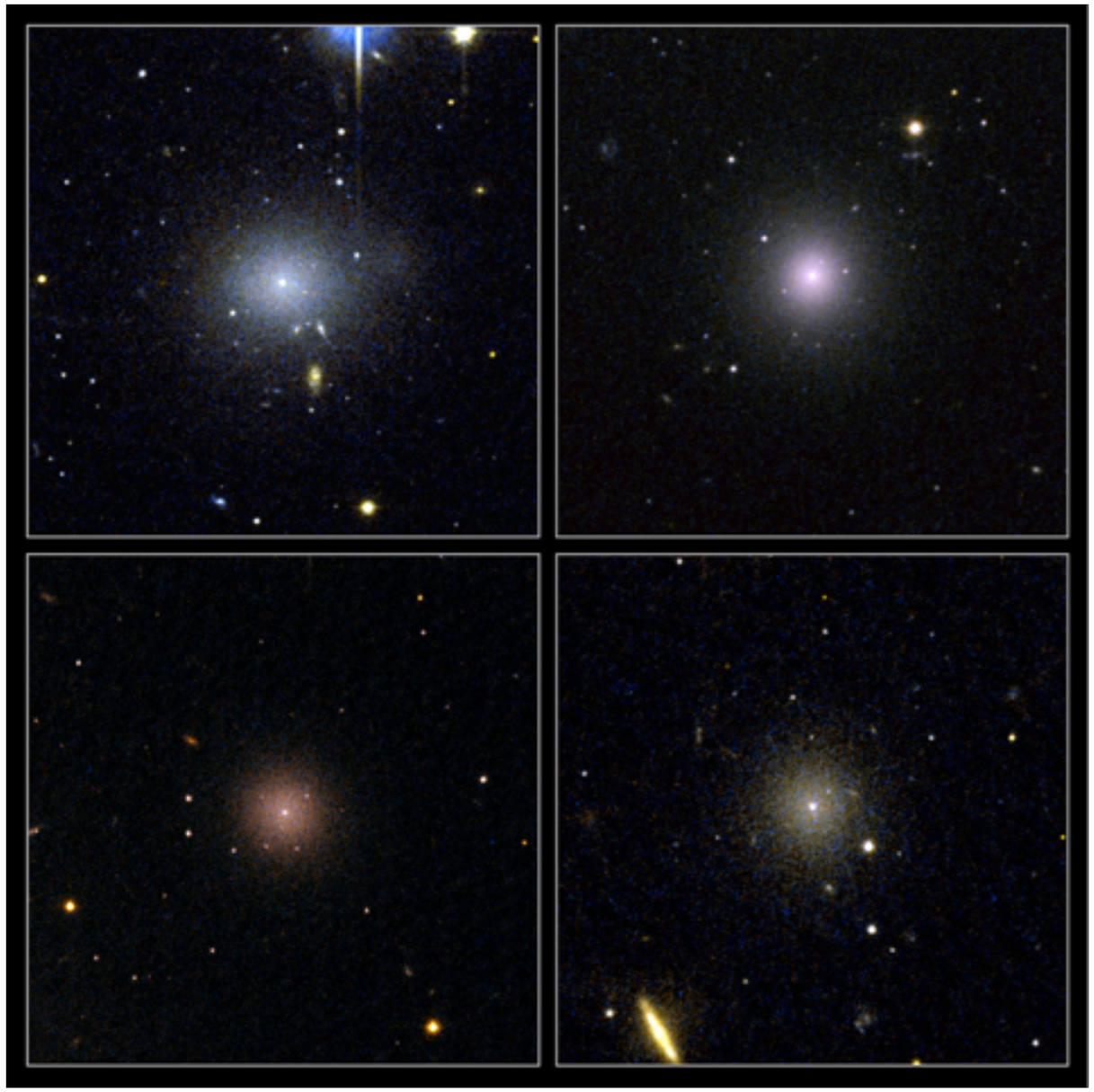
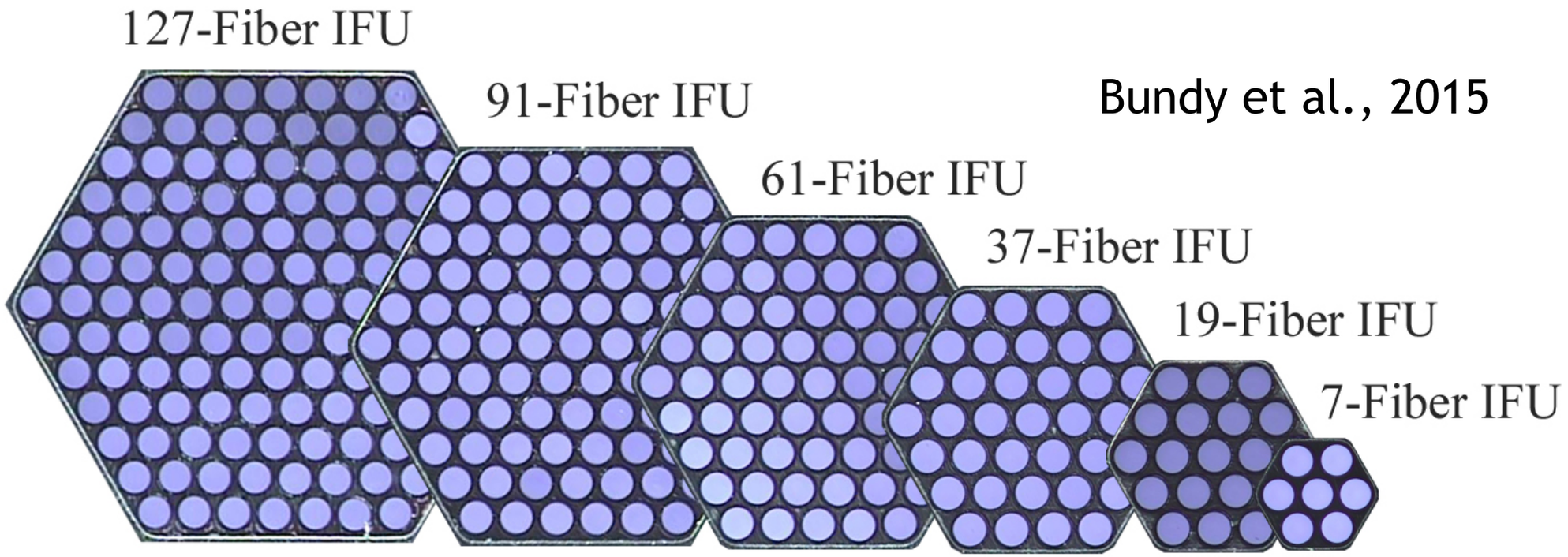


Image credit: STScI, ESA, Conselice & Penny

- Exhibit a wide range of age (1-12 Gyr) and metallicity (e.g. Penny & Conselice, 2008)
- Virgo dEs often exhibit faint, discy substructure (e.g. Lisker et al. 2006)
- dEs in the core of Virgo typically rotate slower than those in the cluster outskirts (Toloba et al. 2015)

Do dwarfs in other environments show evidence for a disc origin? We need kinematics to show this.

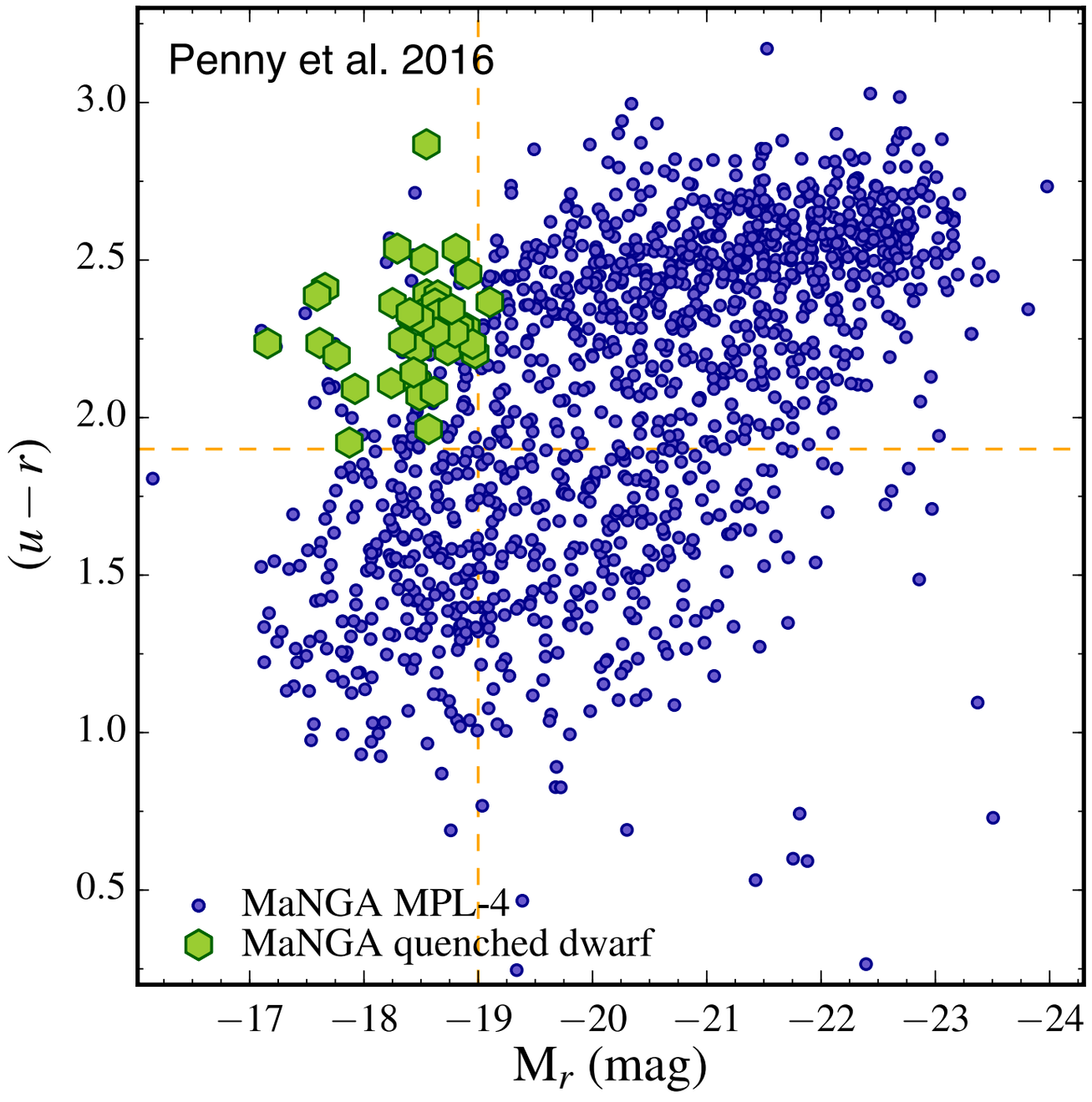
MaNGA: Mapping Nearby Galaxies at APO



Bundy et al., 2015

- Multi-object IFU survey, part of SDSS-IV
- Will target ~10,000 galaxies with $M_\star > 10^9\ M_\odot$
- Colour-enhanced sample of 1700 galaxies ensures faint red galaxies, “green valley” galaxies, and bright blue galaxies are targeted.

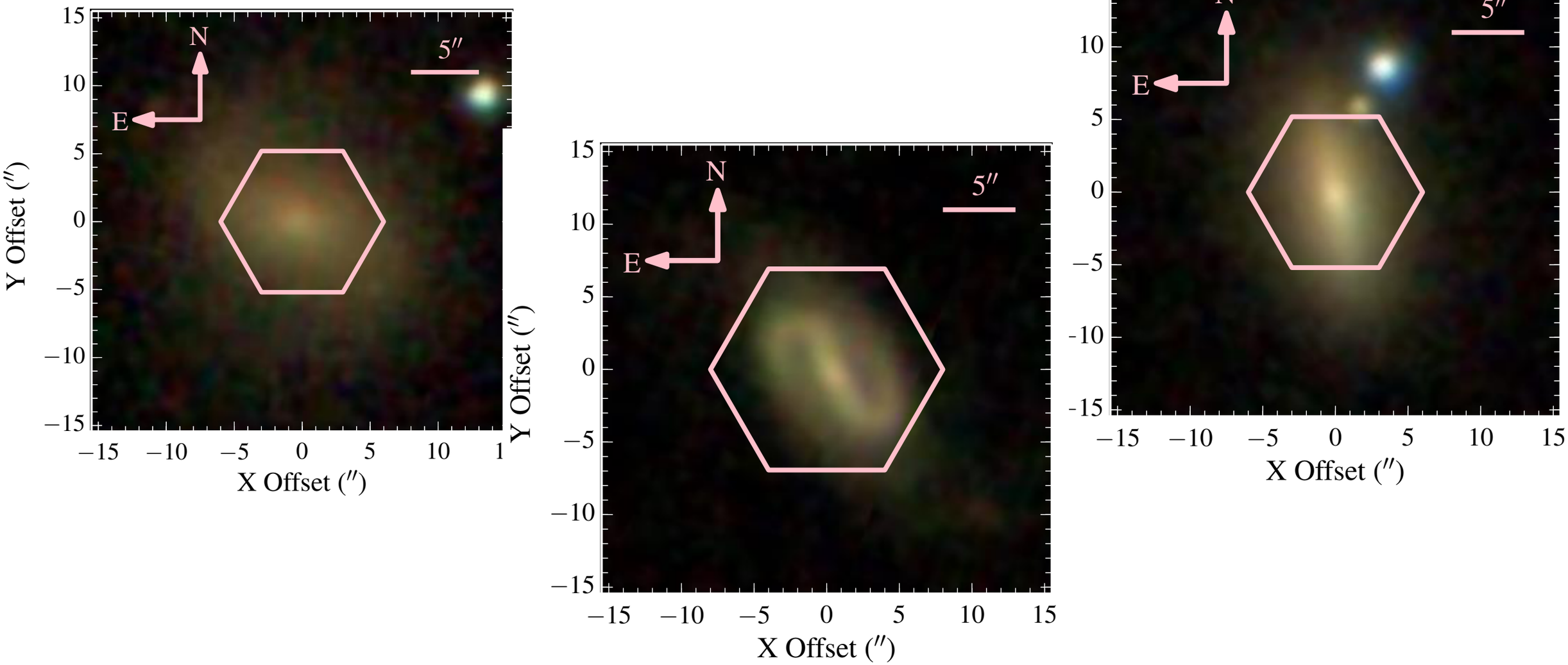
MaNGA quenched dwarf selection



- Use first year of MaNGA data: MPL4 (SDSS DR13, public July 2016)
- Select galaxies fainter than M_r = -19
- Quenched objects selected with Ha_{EW} < 2 Å
- *(u-r)* > 1.9

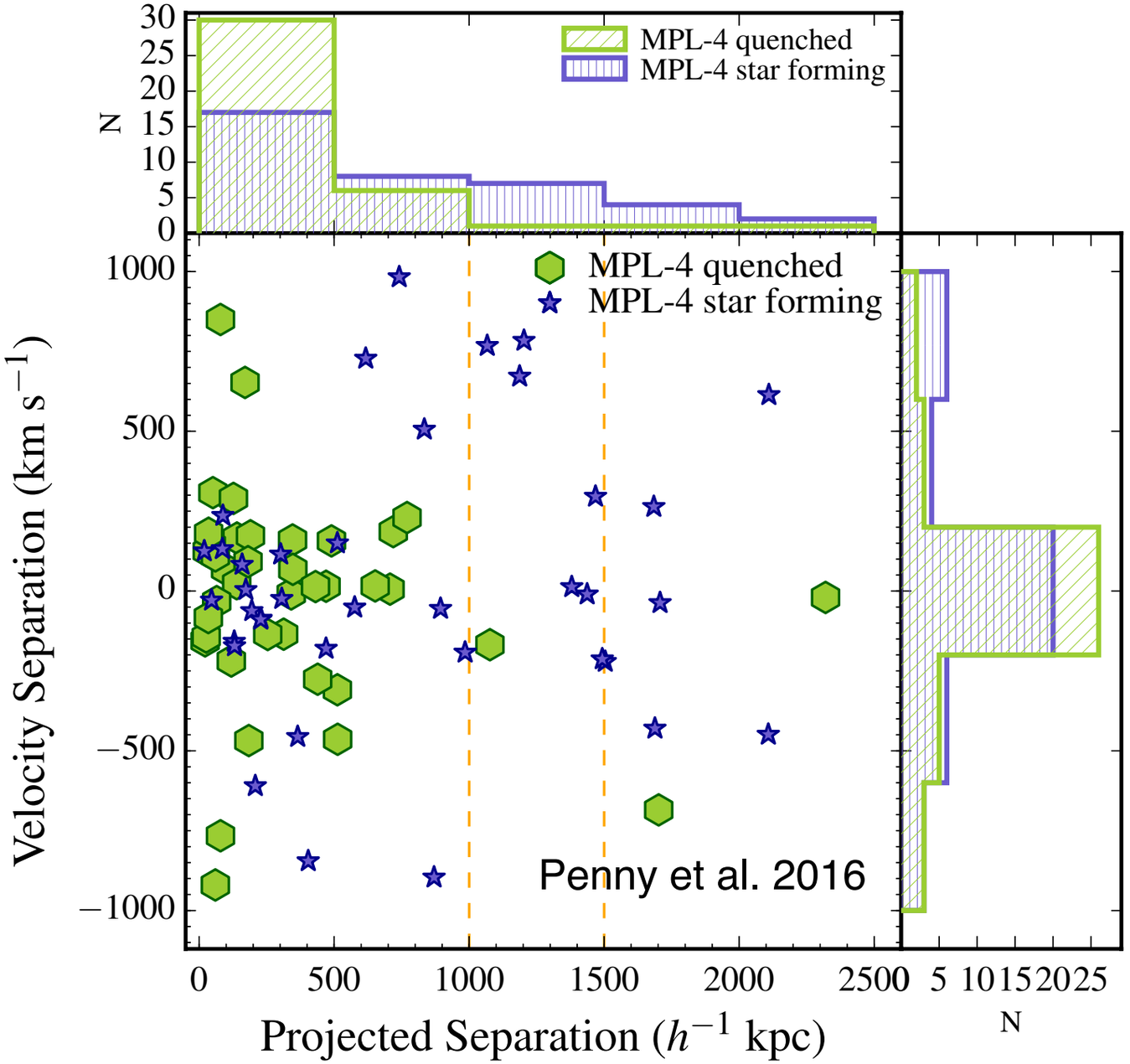
➡ Identify 39 quenched dwarfs (dEs) with half-light radii <2 kpc.
➡ 16 are from the "colour enhanced" sample.

Evidence for a spiral/disc origin



➡ **Clear spiral and disc features that would be erased in a dense cluster due to tidal interactions**

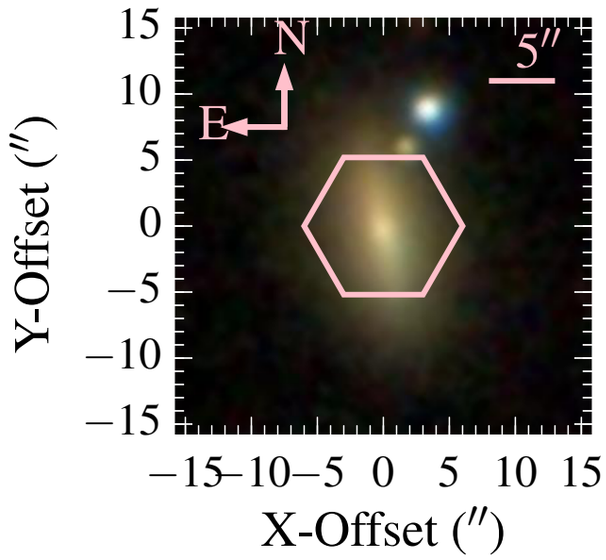
Local Environment

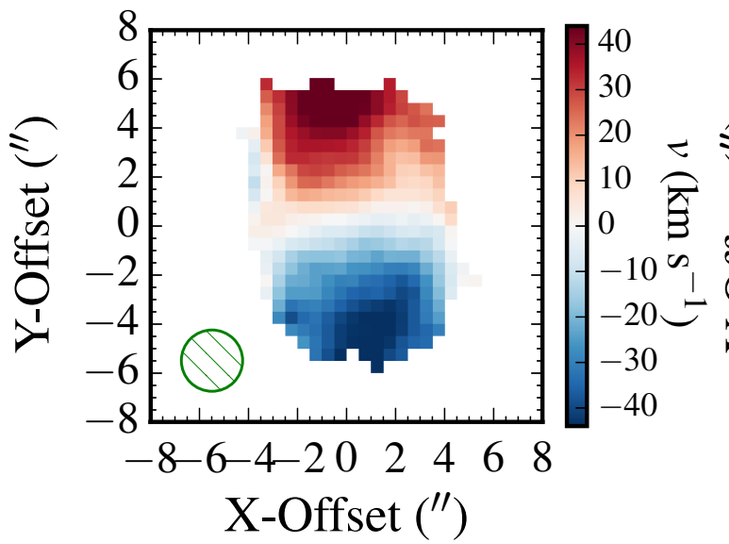


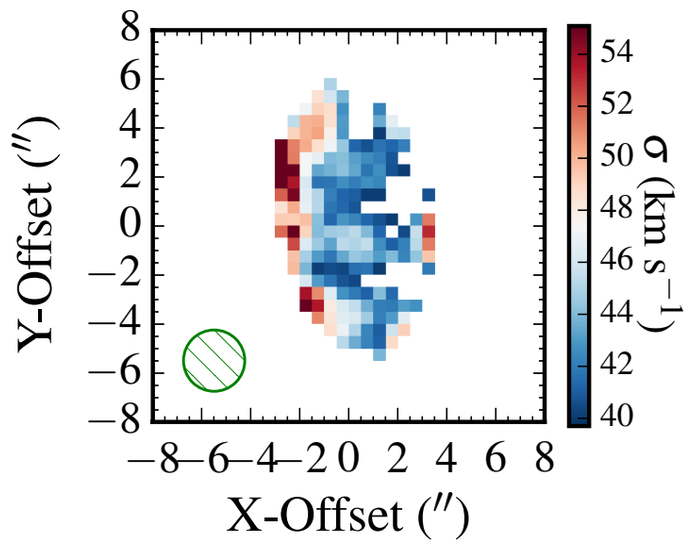
- Find the distance to the nearest galaxy in the 2MASS redshift survey (Huchra et al. 2012) + SDSS with $M_K < -23$.
- Quenched dwarfs have a different projected separation distribution to a star forming comparison sample (KS-test $p = 0.0094$).

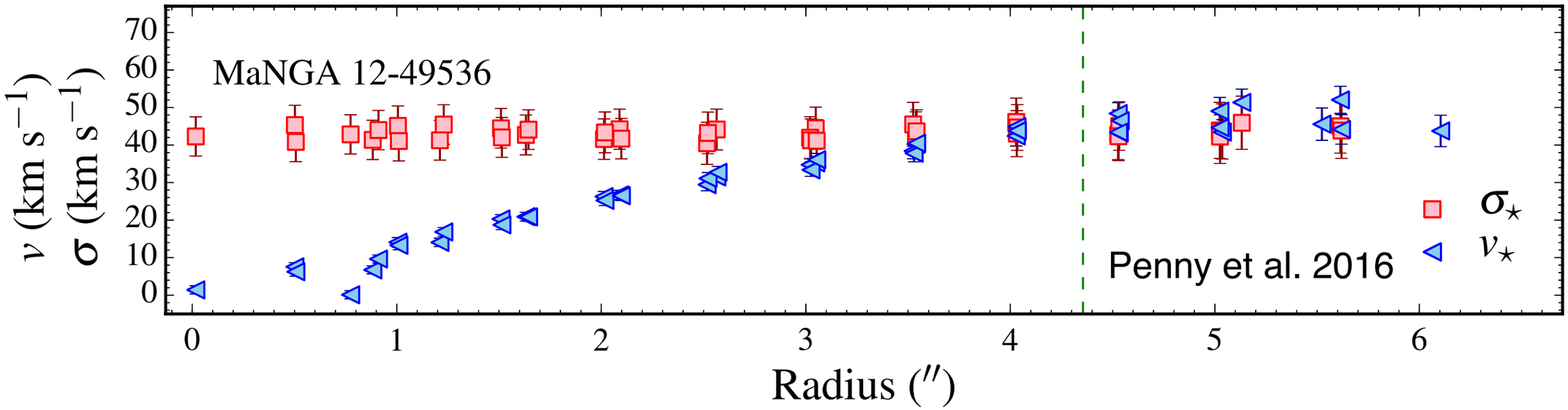
➡ Most found within 1.5 Mpc of a massive galaxy, in agreement with Geha et al. 2012 ($M_\star < 10^9\ M_\odot$)

Quenched dwarfs- kinematics

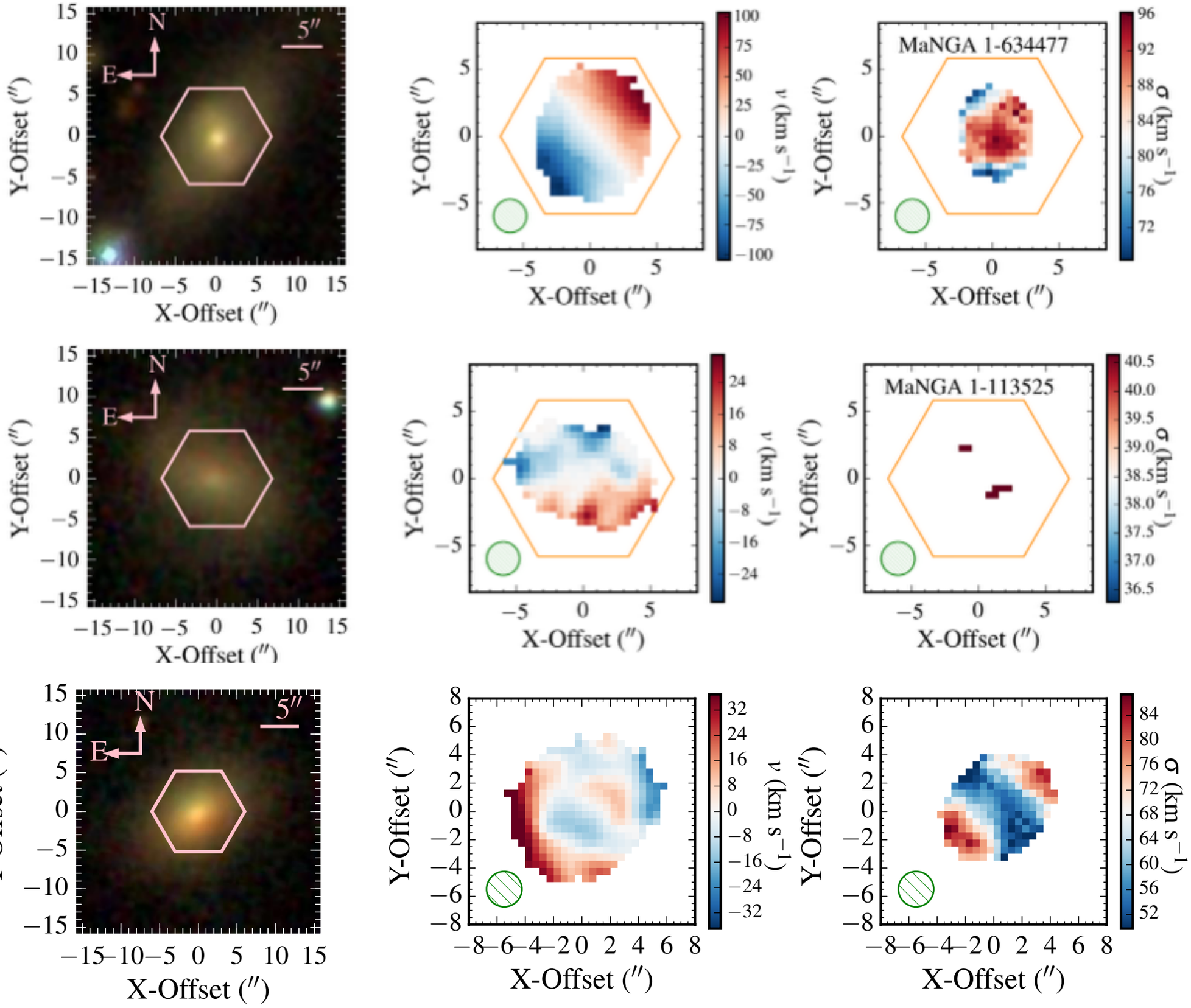






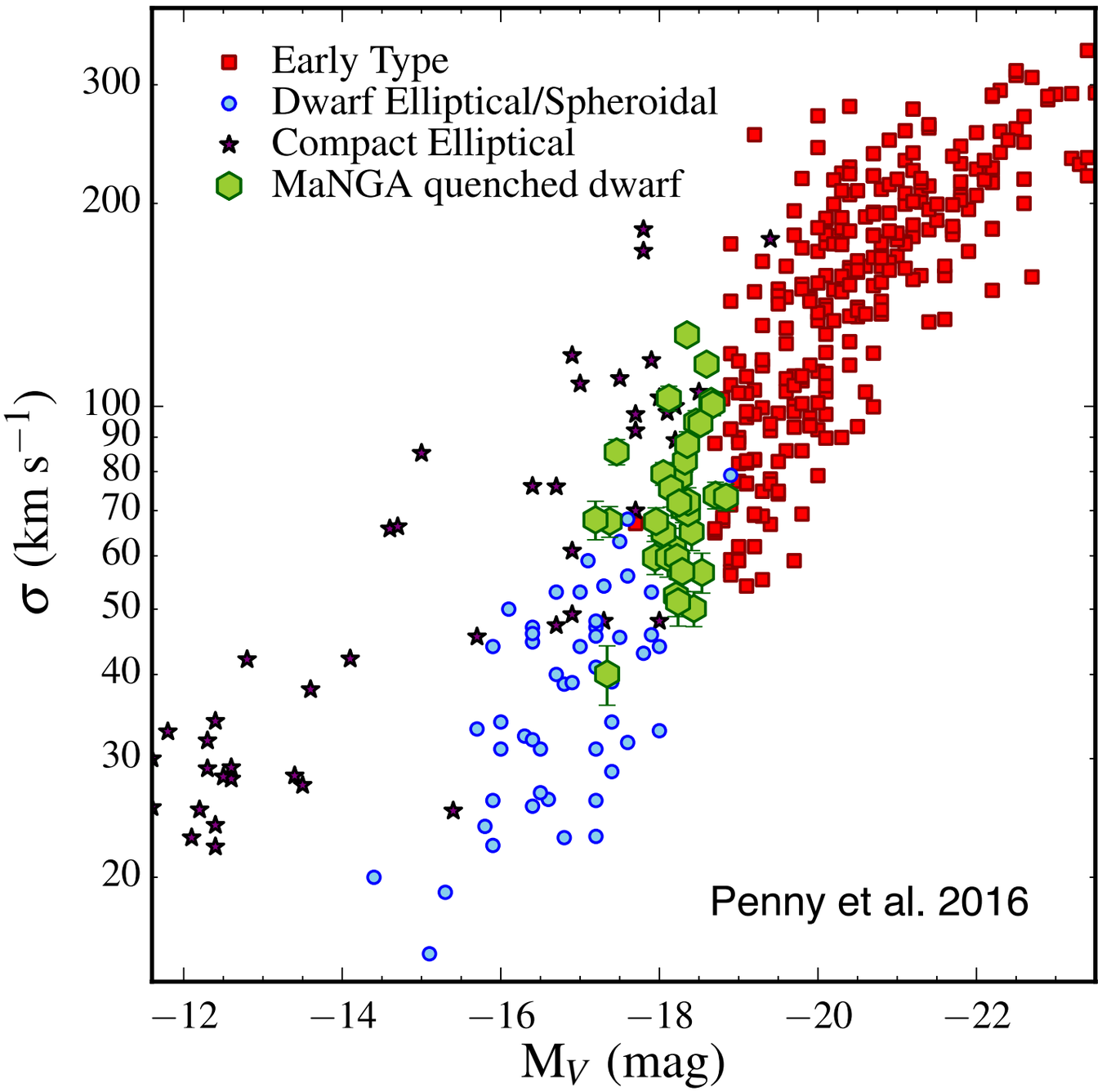


- Use the Penalised Pixel-Fitting method (pPXF) method (Cappellari & Emsellem, 2004) to measure *v* and *σ*
- Kinematics taken from the MaNGA Data Analysis Pipeline (DAP, Westfall et al., in prep.)



Majority (34/39) of passive dwarfs have significant rotation at 1R_e

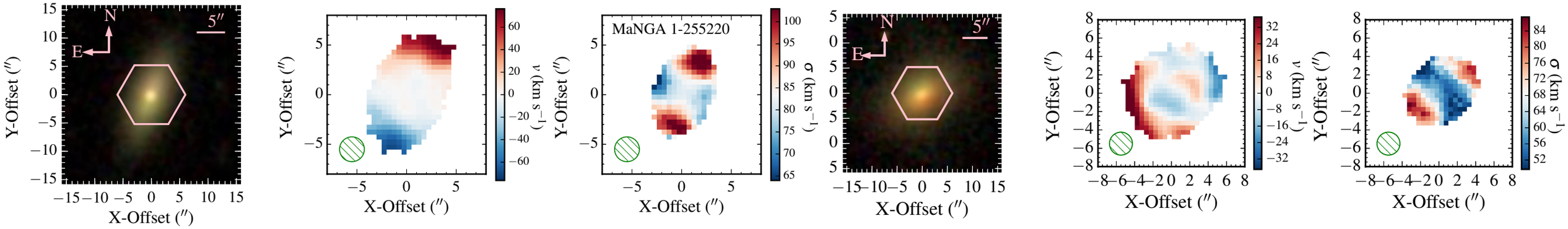
The σ-luminosity relation

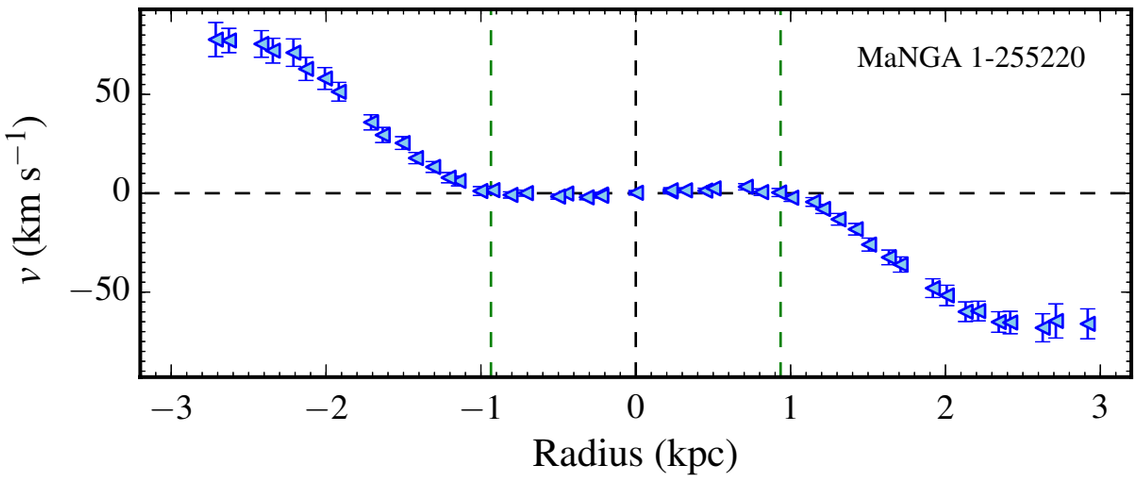


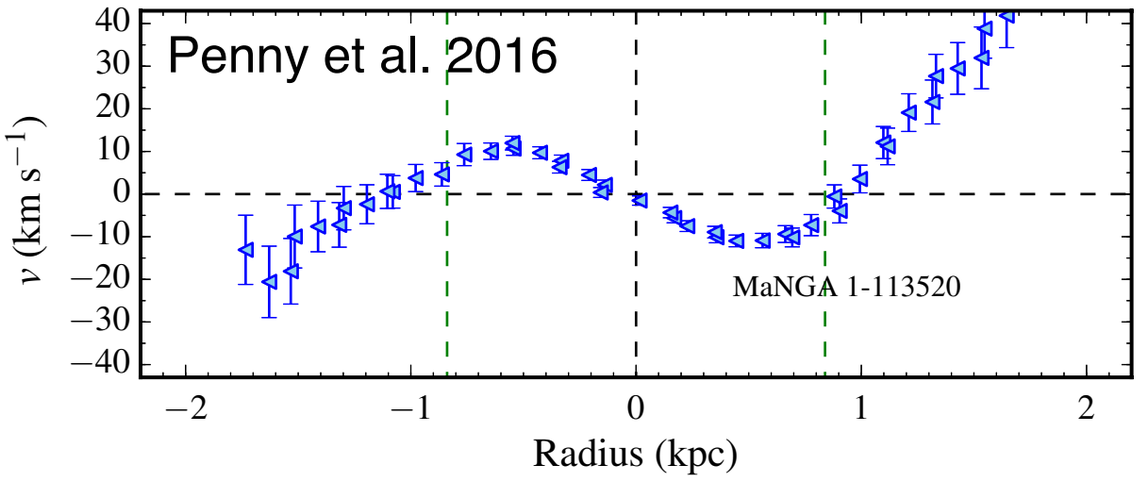
- Determine the velocity dispersion within 1 R_e
- Measure $\sigma_{\star,e} < 40$ km s^{-1} to 130 km s^{-1}

Will measure the stellar angular momentum to determine the fraction of fast vs. slow rotators

Kinematically decoupled cores



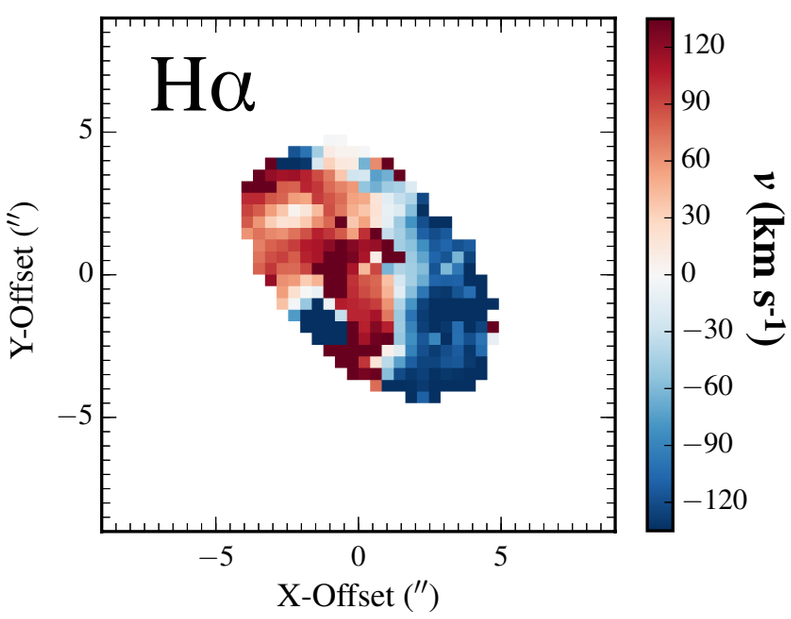


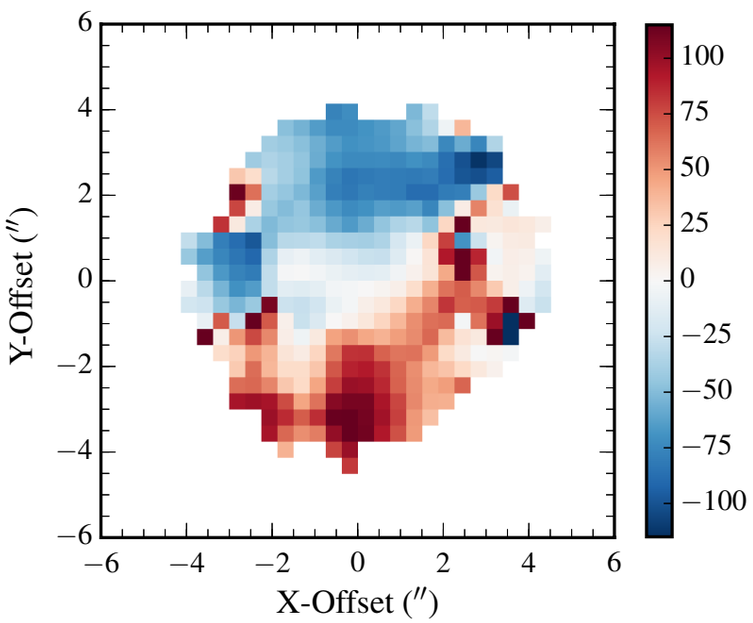


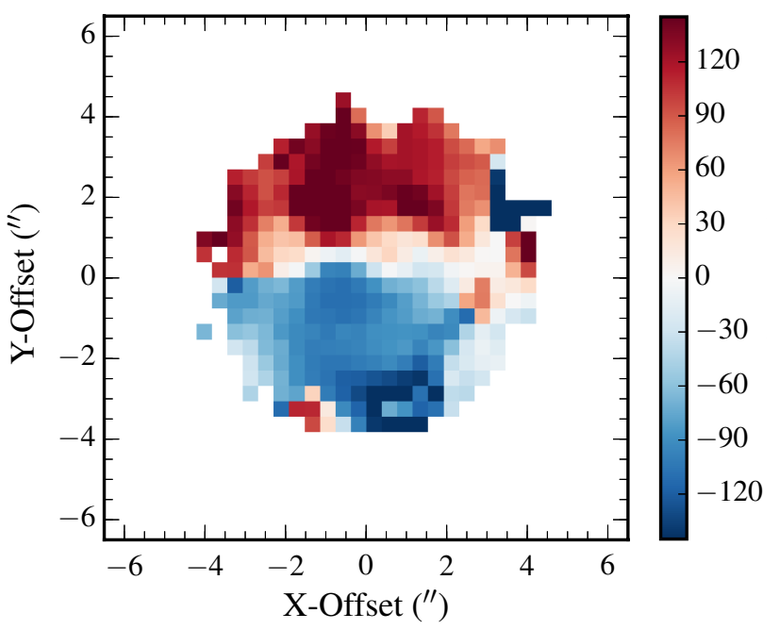
Both dwarfs host counter-rotating discs

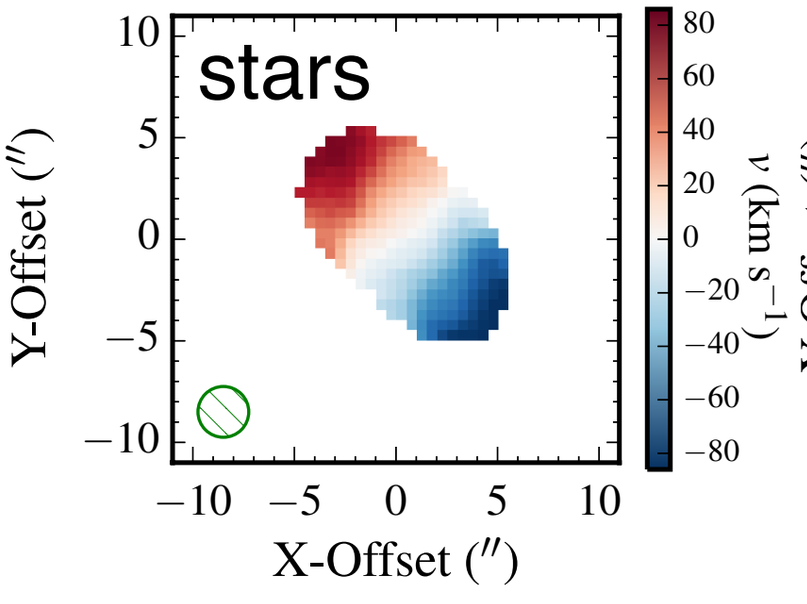
Evidence of a merger: either satellite or gas accretion

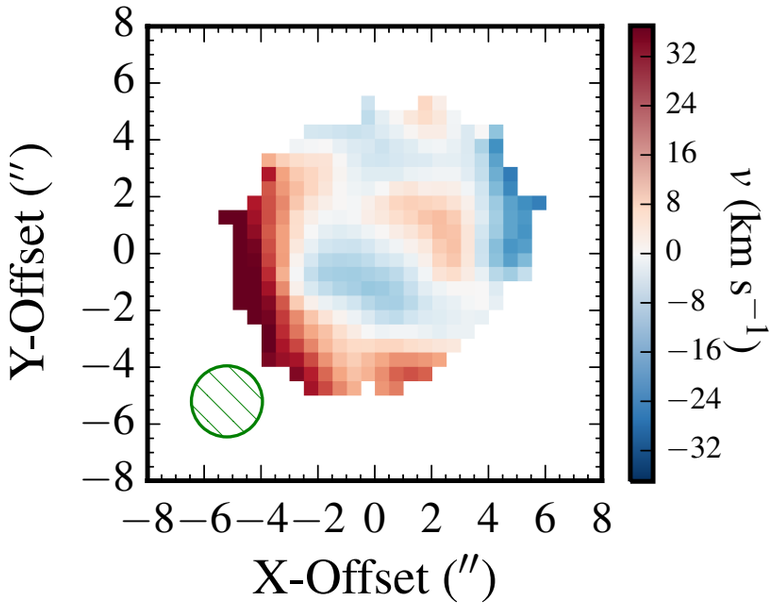
Some still retain an ionised gas component- typically misaligned

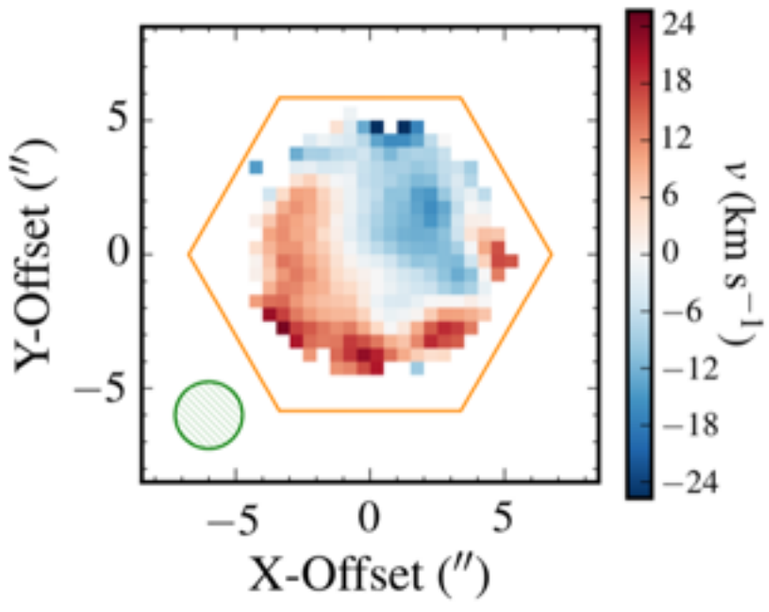






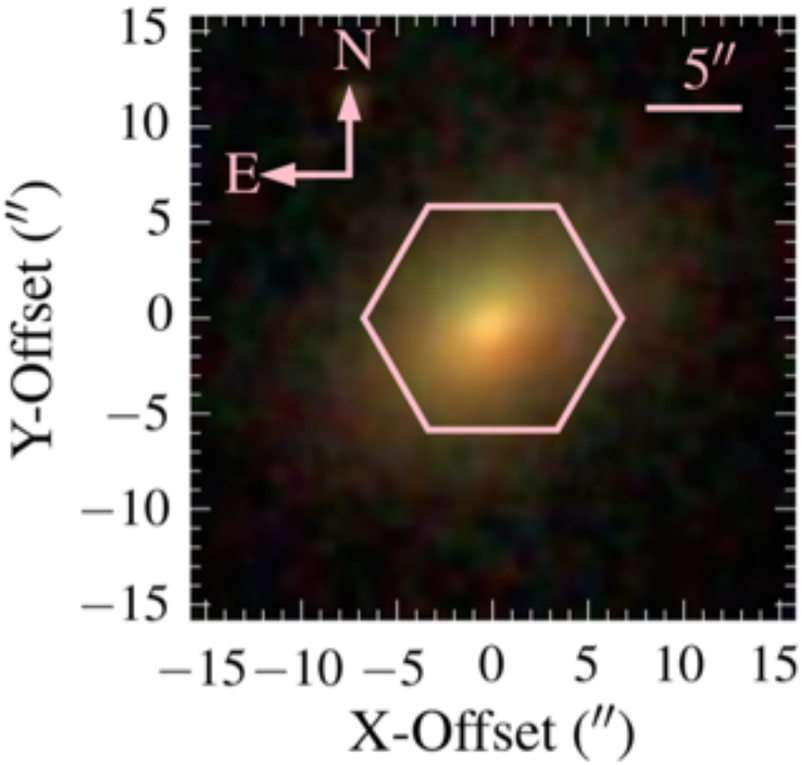


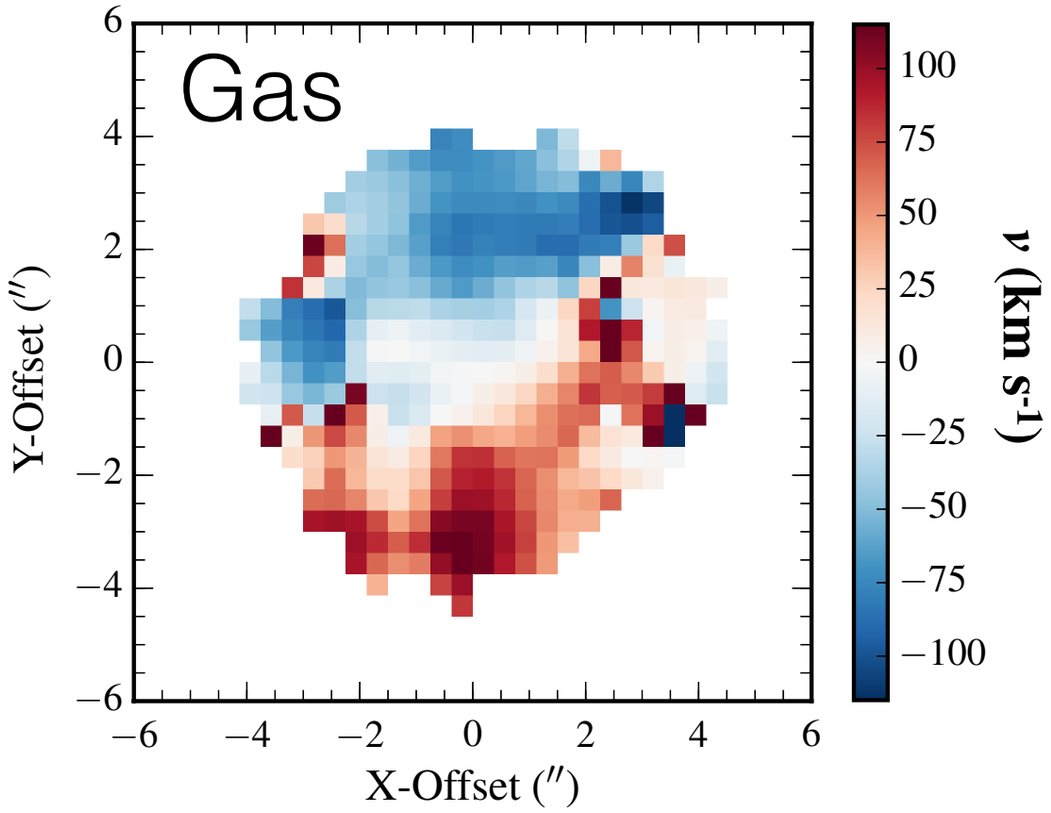


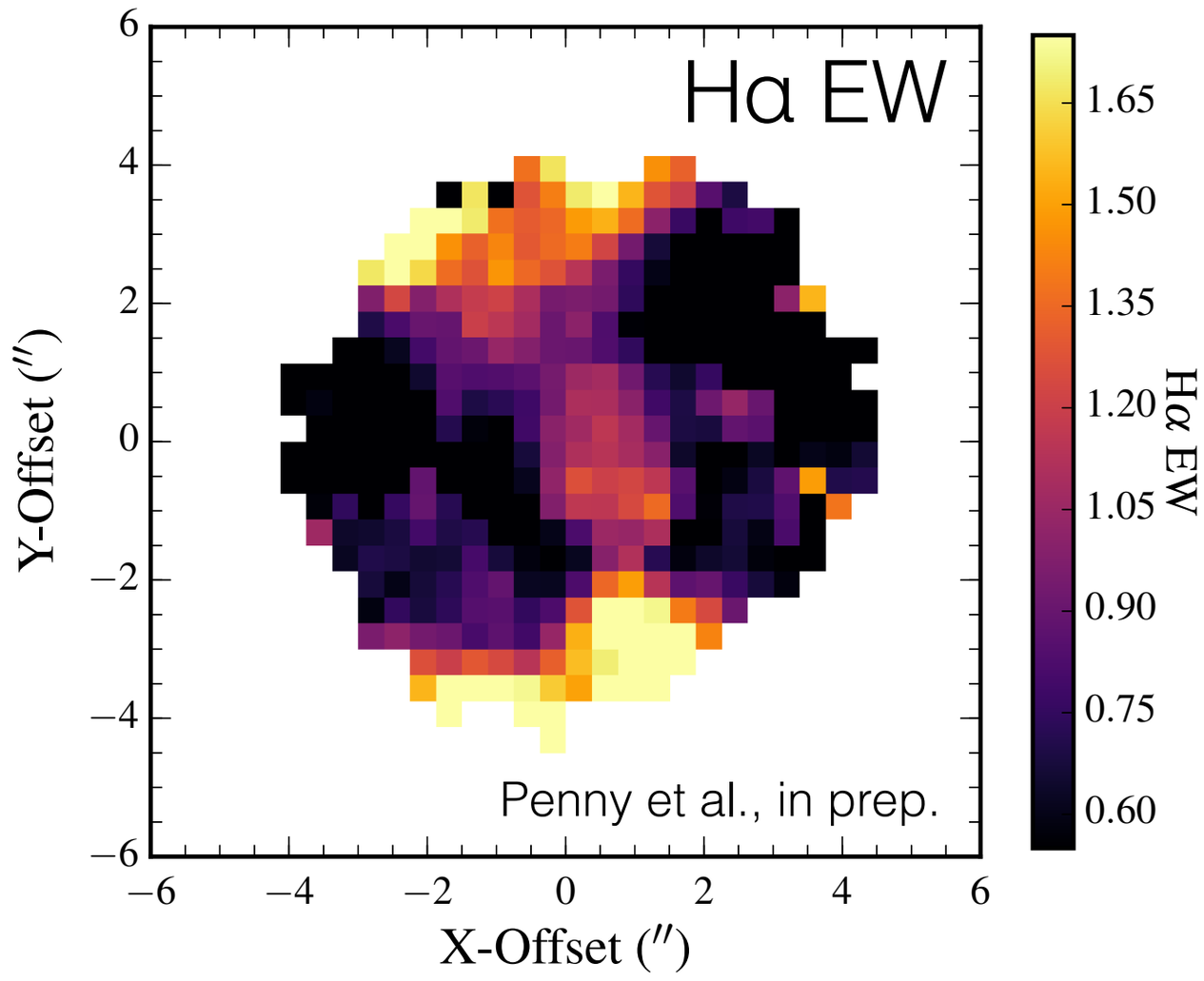


Ionised gas but no star formation

Bi-symmetric emission features

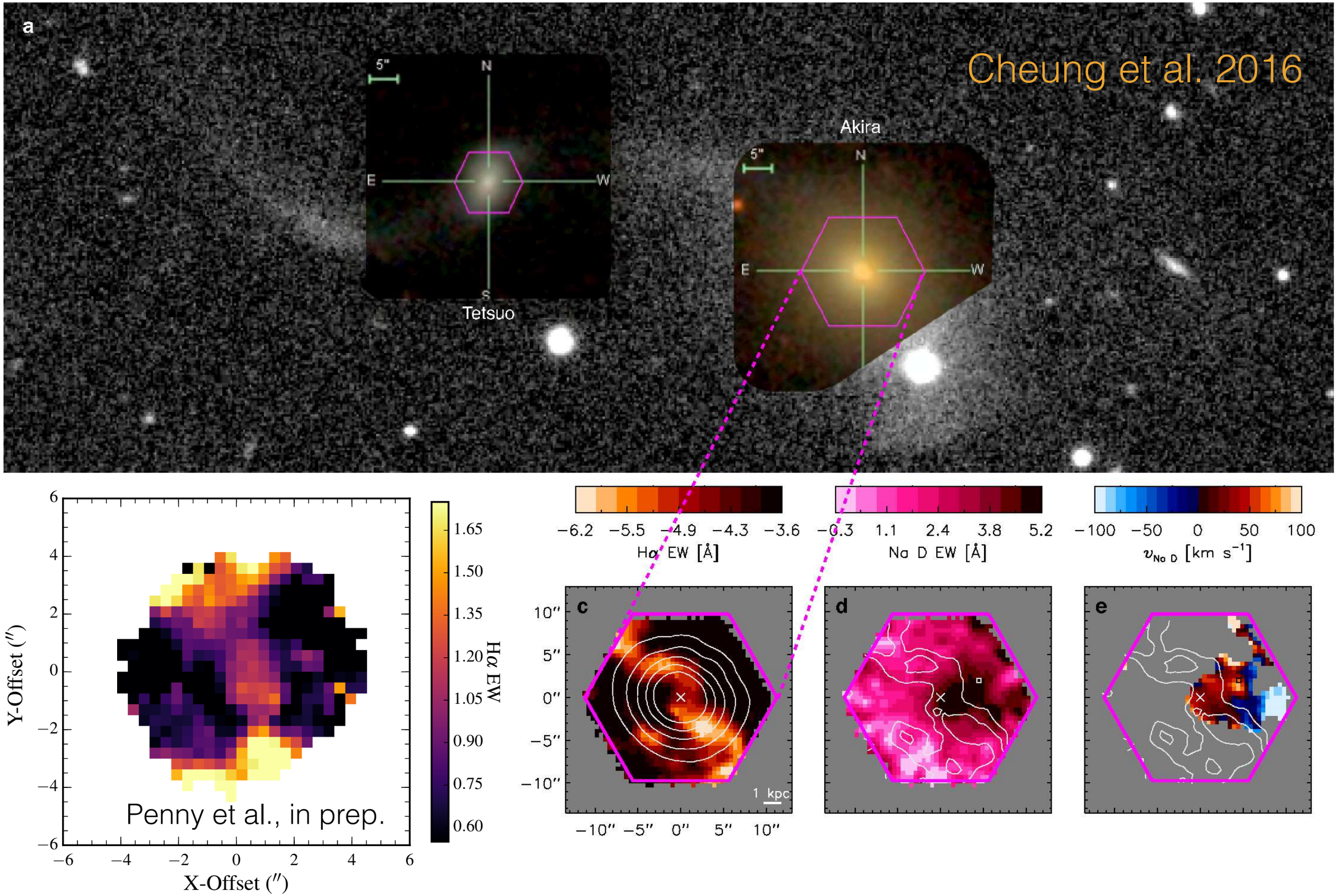






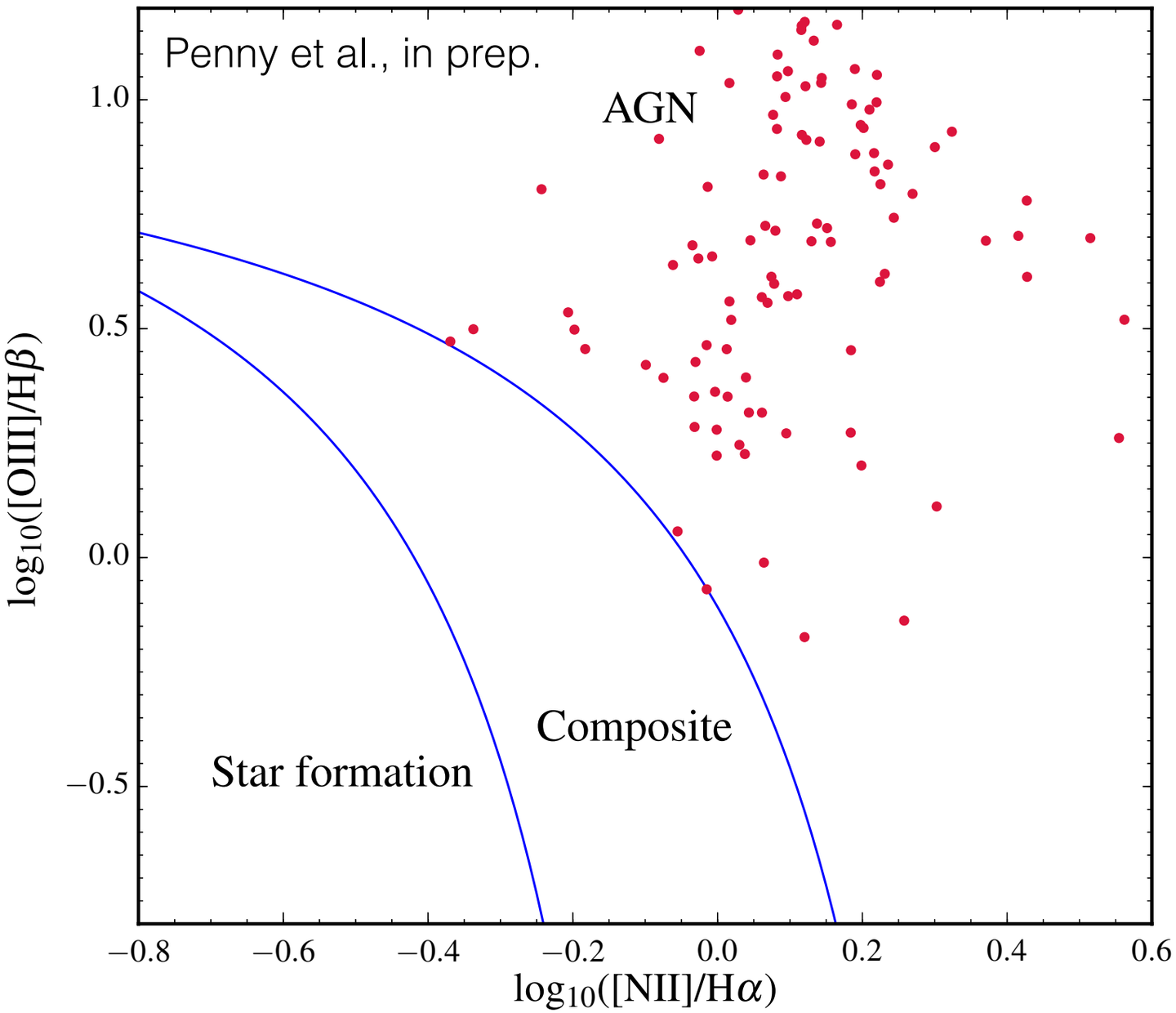
What is causing this emission?

Cheung et al. 2016



“Red Geysers”- maintenance mode AGN feedback prevents new star formation (Cheung et al., Nature, 2016)

The BPT diagram



- Dwarf is a “Red Geyser”
- Shock ionisation from an AGN wind results in bi-symmetric Hα emission features

Maintenance-mode feedback in a dwarf galaxy!
Follow-up observations needed.

Conclusions

- Low mass galaxies are mostly environmentally quenched.
- MaNGA IFU observations of a sample of bright quenched dwarfs across a range of environment show that most rotating at some level, with a disc origin.
- AGN driven winds may prevent further star formation in quenched dwarfs