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Probing galaxy groups with Absorption Line Systems

Mostly taken from arXiv:1607.03386

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DEX 2017

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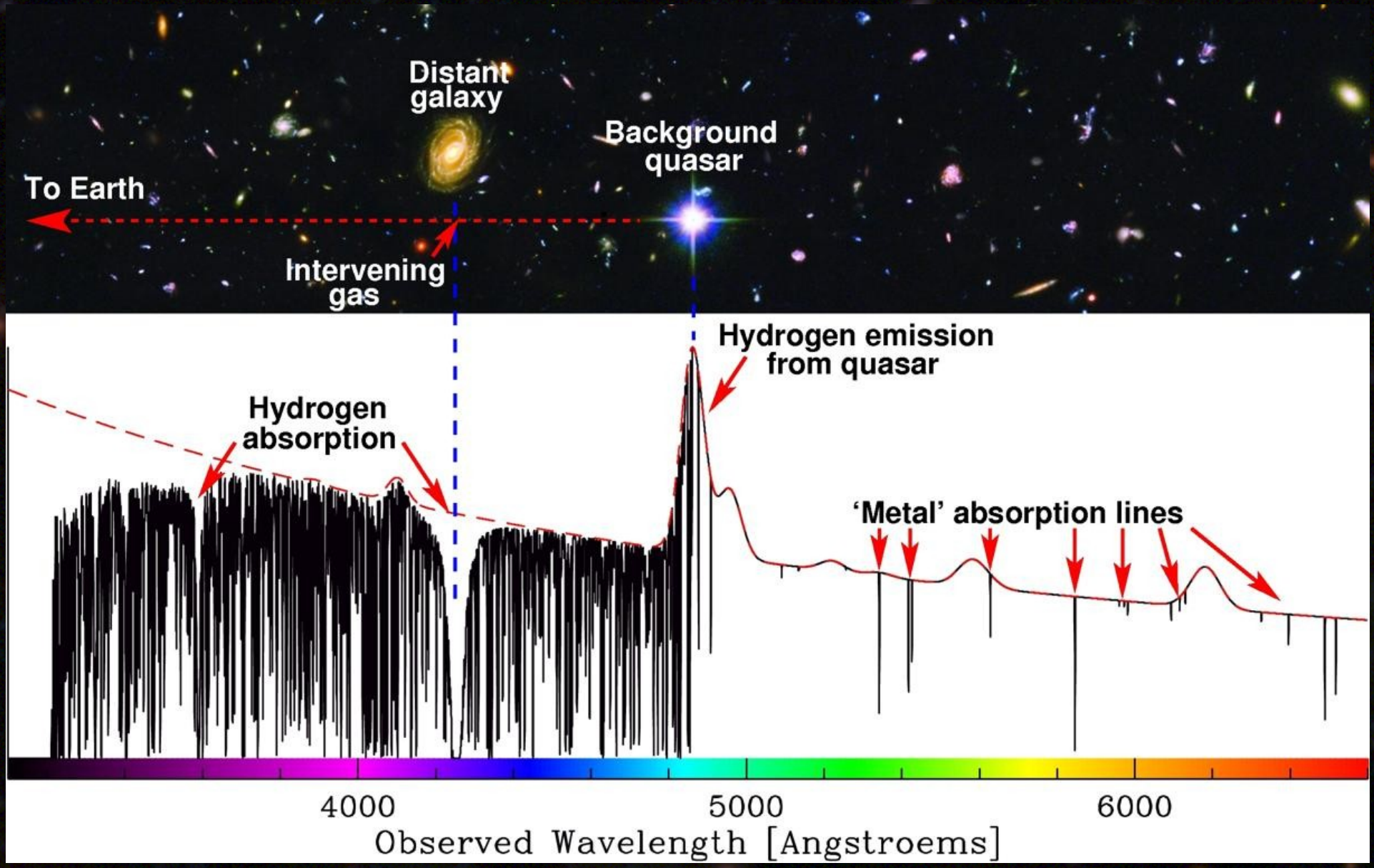
Sightline absorption systems



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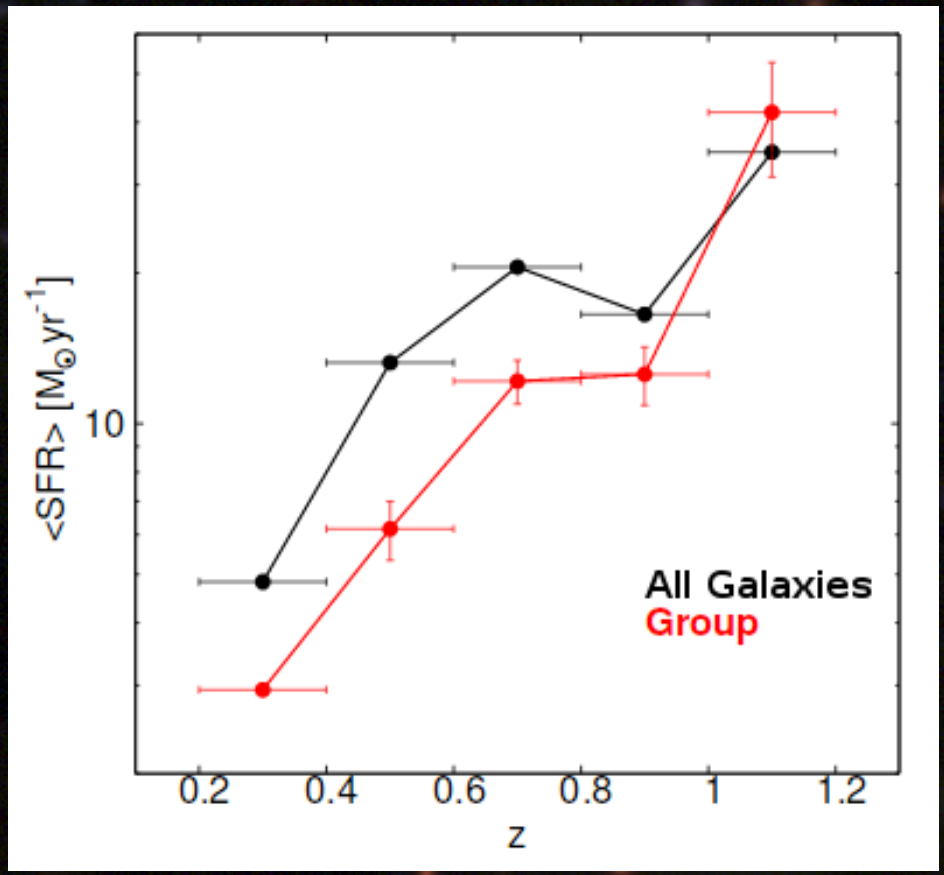
Background – Cool gas in groups

- Many absorption line studies focus on either ‘isolated’ galaxies (or just pick-out nearest galaxy ignoring environment).
- But, galaxy groups are where a lot of the interesting stuff happens!
- E.g. Erfanianfar+2014
  - SFR in groups falls by ~ 0.1dex from z~1 to present day.



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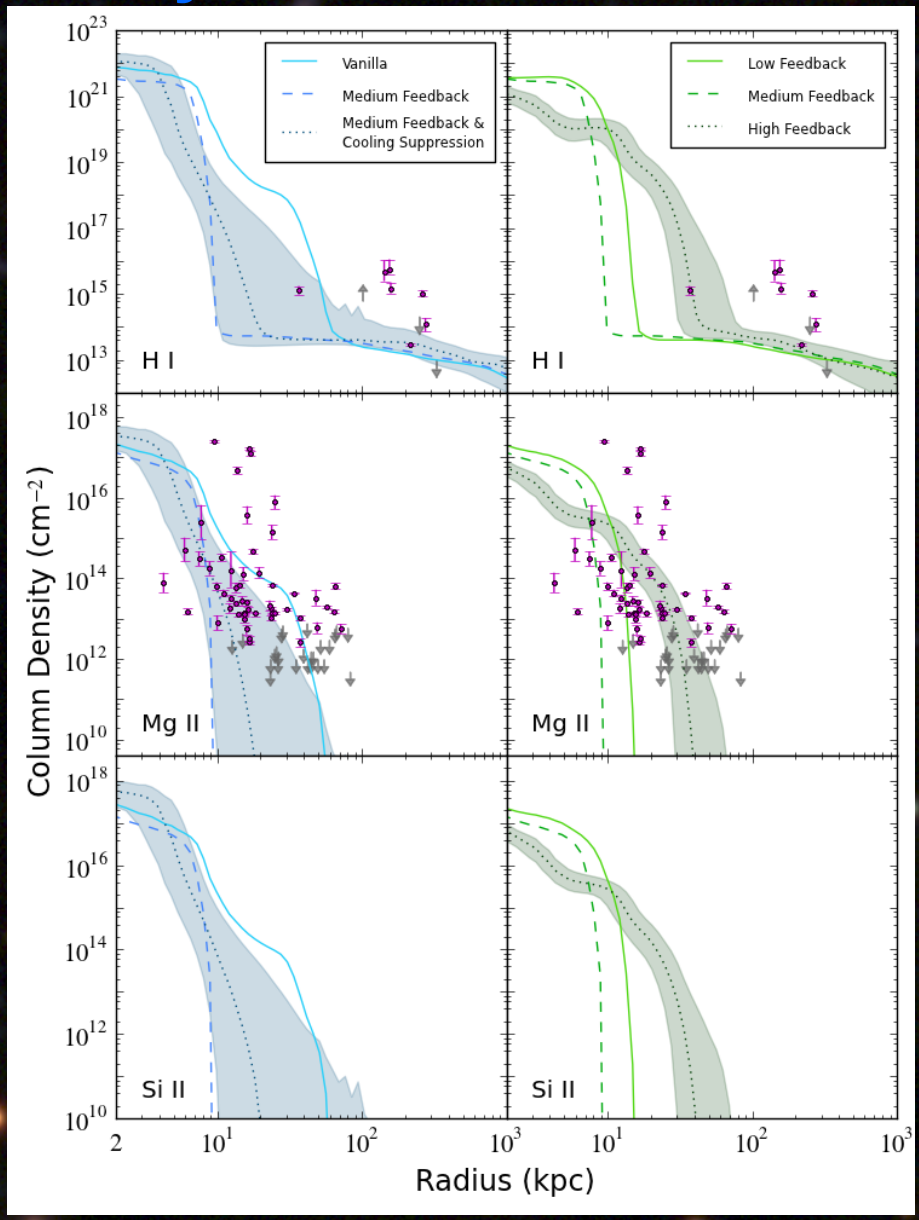
Tracing cool gas via low-ionization absorption line systems

- Tracing cool gas
  - Low ions seen in absorption in QSO sightlines
    - MgII, SiII, etc
    - T ~ 10^4 K
    - Can trace a range of gas:
      - embedded in outflows;
      - Infalling material;
      - Orbiting halo material.
- What is it good for?!
  - Hummels+12 make predictions using cosmological hydrodynamical simulations of a wide range of ionization species, illustrating predicted effects/constraints from such observations.
  - Aim to make predictions of infalling/halo material using EAGLE also.



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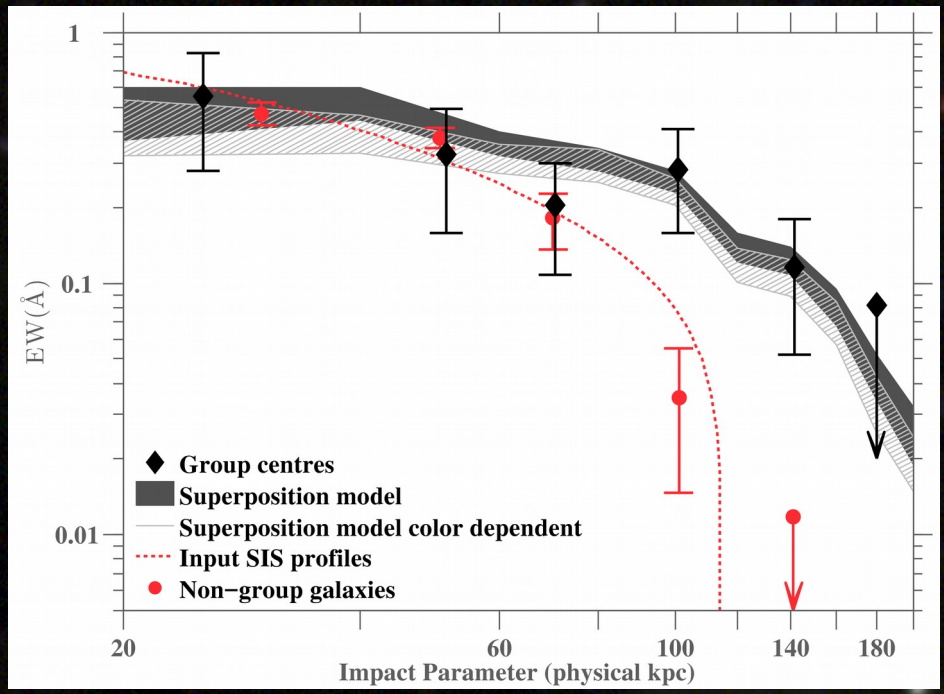
Background – Cool gas in groups

- Relatively small amount of research on absorption sightlines in the group environment.
  - Messy – difficult to disentangle associations.
- Bordoloi et al (2011):
  - Cool gas traced by MgII absorption;
  - MgII in groups more extended than around ‘field’ galaxies.
  - Extension potentially explained by superposition/clustering
    - i.e. Multiple individual MgII systems associated with different local galaxies.
- Can we inform/flesh out this statistical analysis with more detailed views of individual systems?



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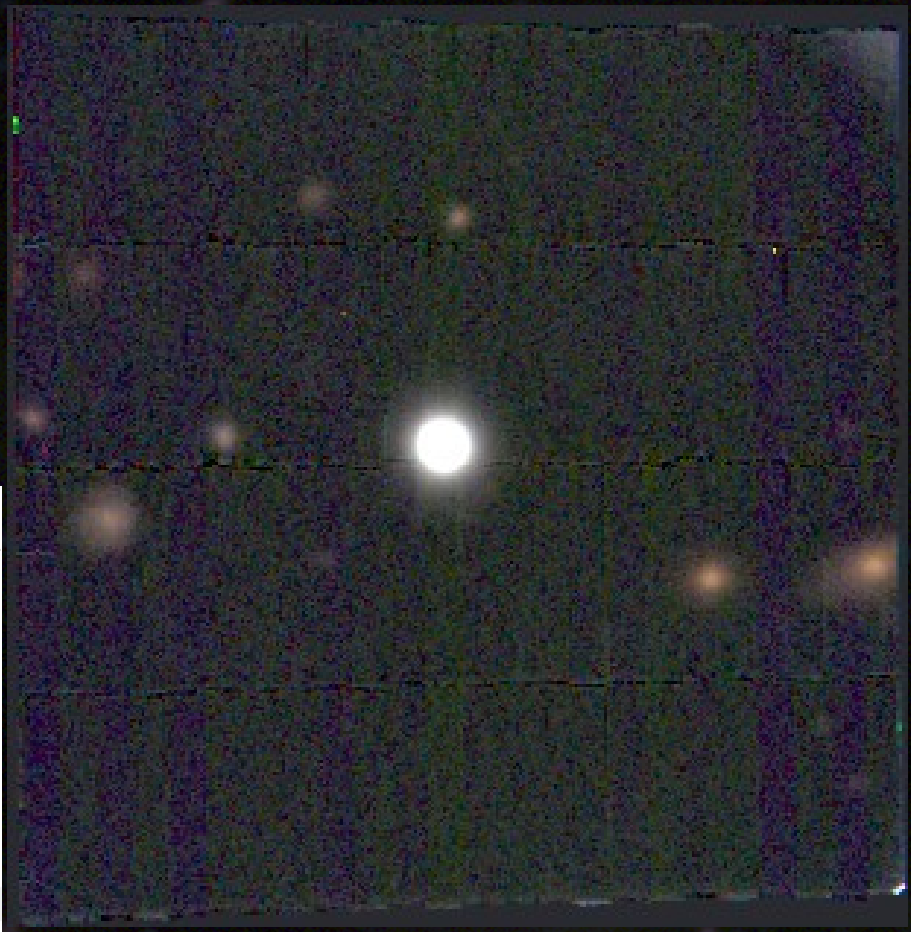
MUSE observations of HE0515-4414

- 25 mins integration with MUSE (out of 240mins requested) centred on the QSO HE0515-4414 (z=1.7).
- 5 galaxies detected at z = 0.282-0.283.
  - Spread around the background quasar position all within 200 kpc.



OB Details

OB 1115738 (Raw) - (Reduced) | **03:02:24** > **03:52:38** | 00:50:14 | SERVICE Mode | F:See|THN Loss |

Instrument	MUSE
Name	WFM QSO B0515-4414 OB_1
Target	QSO B0515-4414
PI	Rich Bielby
Run	094.B-0304(A)
Container	-
Public Comments	06 Feb 03:52 : Done out of constraints as no OBs for the conditions was found. THN conditions FLI=0.99 FWHM~0.9"
Weather	ACD

Constraint	Fulfilled	Requested
Seeing	No	0.6
Sky Transparency	No	CLEAR
Airmass	Yes	2.8
FLI	No	0.4
Moon Distance	No	90

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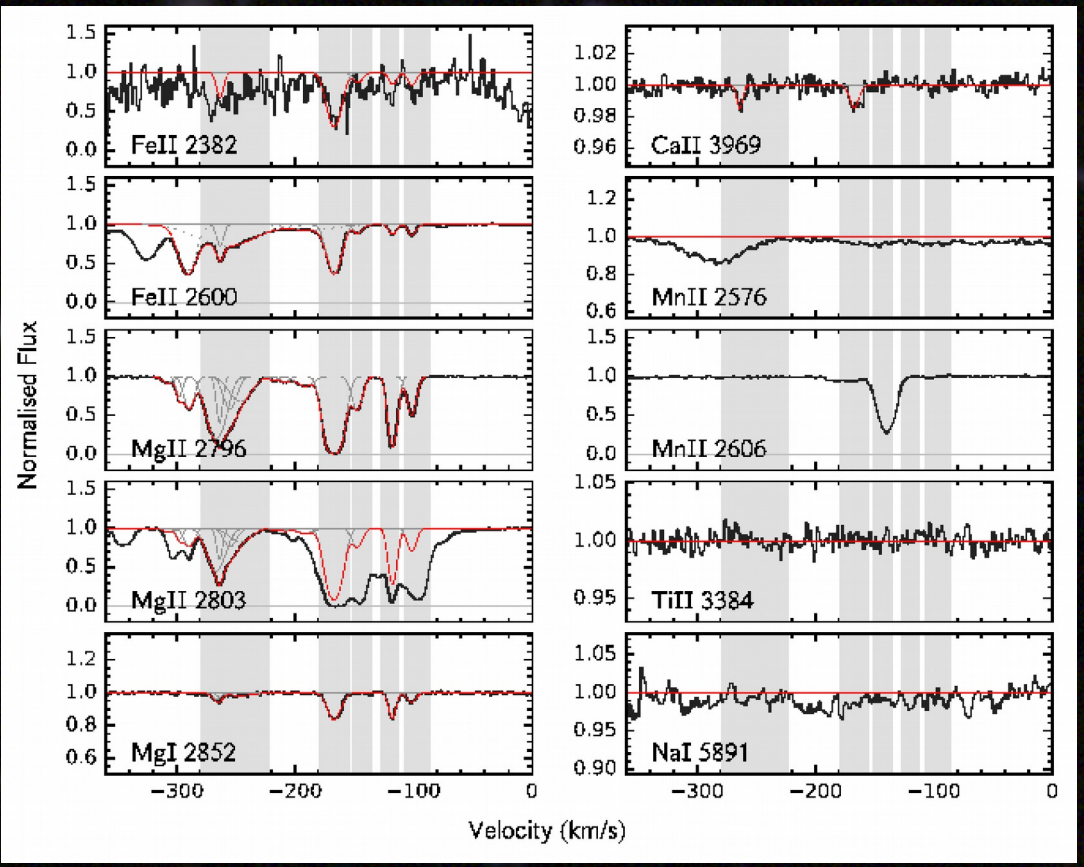
Absorption line systems co-incident with z = 0.28 galaxy group



- Co-incident with galaxy group, we find multiple low-ionization species:
  - FeII, MgII, CaII.

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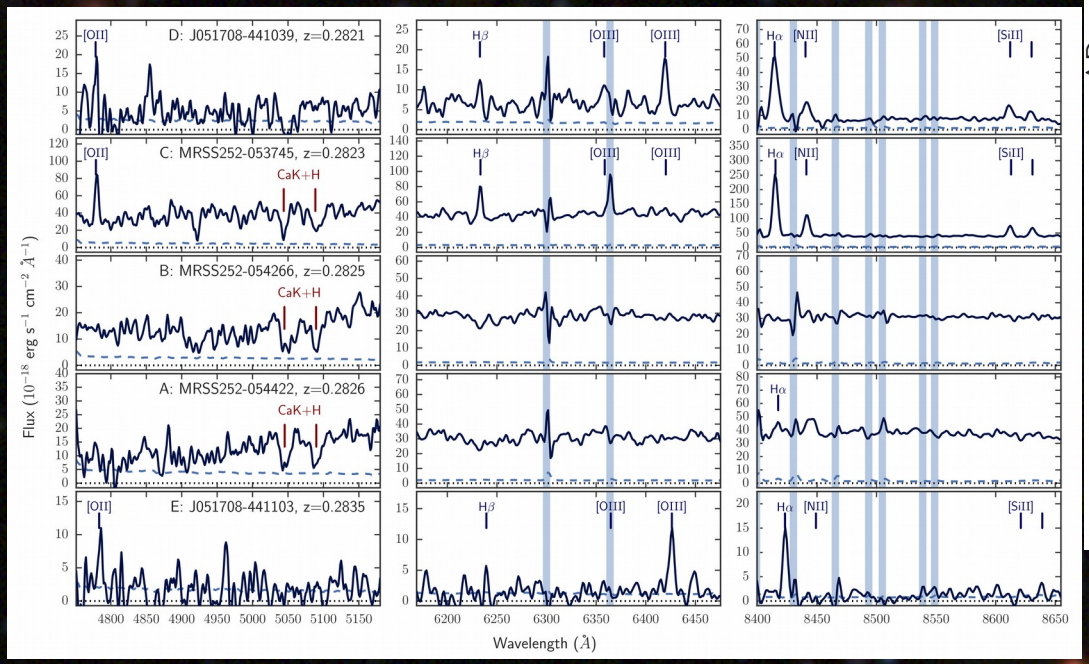
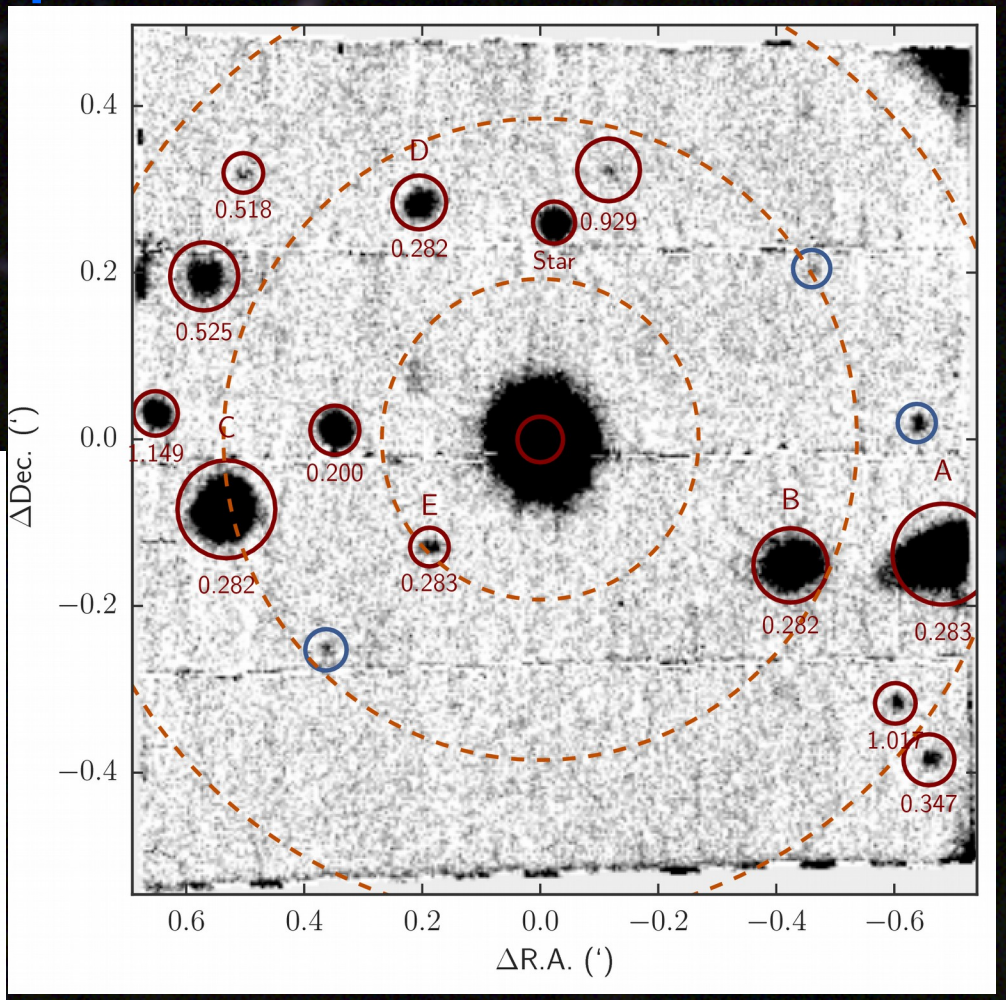
Gas structures within and around galaxy groups

- By using MUSE, we may now zoom in on individual systems, discerning the details hidden within the broad trends.





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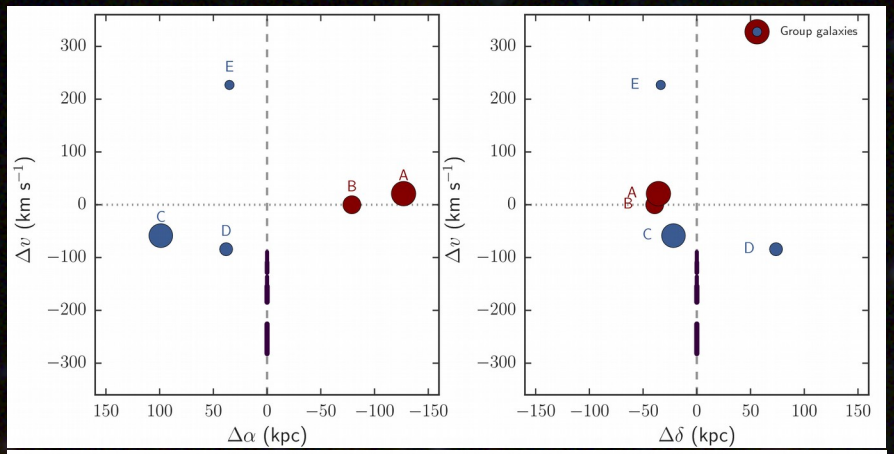
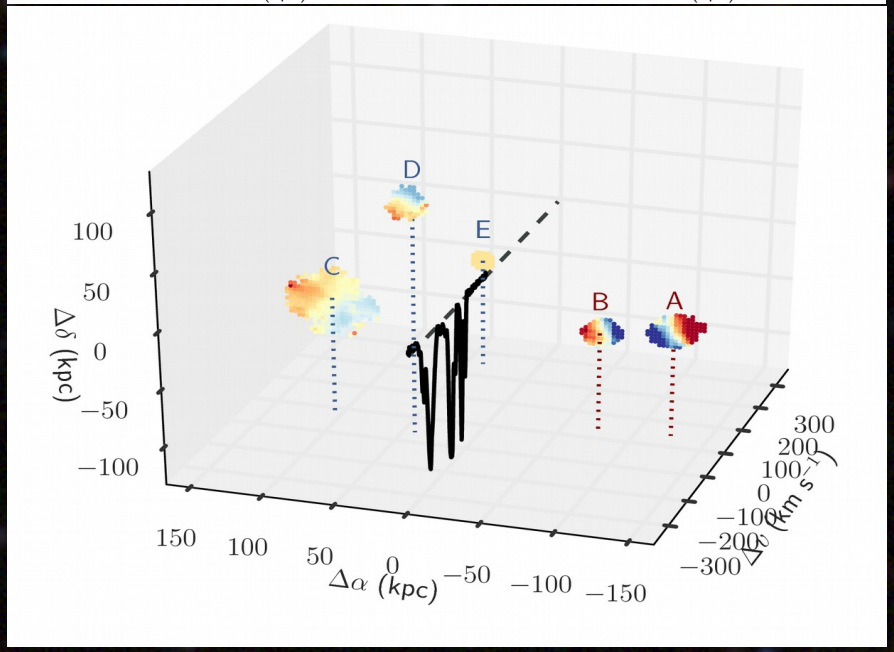
Overview of the group kinematics





- Detailed kinematics derived for 4 of 5 group members
- to inform on relationship between galaxies and gas.
- Is the absorbing gas tracing…
  - outflows;
  - co-rotating halo gas/superposition of multiple galaxy halos;
  - intra-galactic medium?

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Nature of the absorbing gas

- Outflowing
  - Absorber is blue-shifted by ~ 250-500 km/s from SF galaxy redshifts.
  - Nearest galaxy is SF, but only ~0.10±01M_{solar}/yr
    - too low to power outflow to 50 kpc?
  - Two further SF galaxies at distances of 80 kpc, unlikely to power ouflow at that distance given relatively low SFRs (<3M_{solar}/yr).
- Co-rotating material
  - Accreting material co-rotating with a single galaxy (e.g. Steidel+02, Churchil+05)?
  - Much higher EW than predicted for any of the individual galaxies based on observational studies by e.g. Chen+10.
  - Kinematically, it is difficult to explain velocity offset in all cases except assumed brightest group galaxy.
- Intra-group medium
  - All galaxies are well within R_{vir} of sightline: is it physically realistic to think of five distinct halos?
  - The ALS kinematics are consistent with the rotation of the brightest group galaxy.
  - Sightline lies at ~ 0.3-0.4x estimated virial radius of the group.

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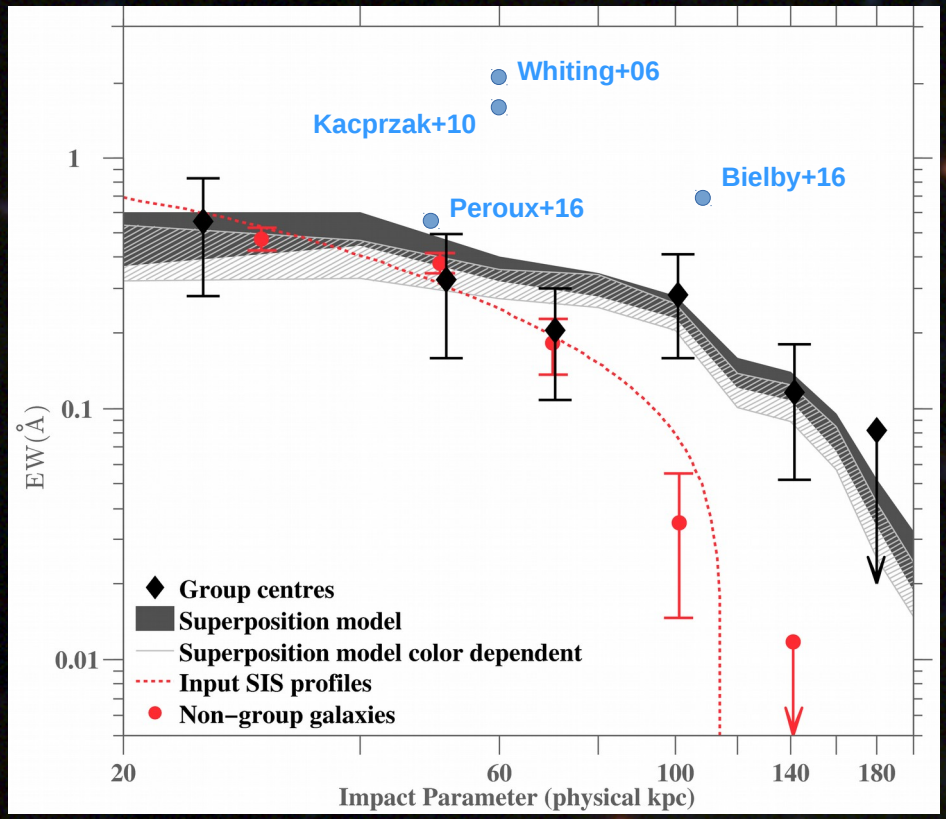
Combining detailed sightlines

- Well studied individual systems alongside the averaged results of Bordoloi et al. (2011)
  - If we take the 5 galaxies around our sightline, the predicted EW based on Bordoloi+11 model is:
    - EW = 0.56±0.10 Å
    - compared to 0.73±0.02 Å measured.
  - Individual systems generally high outliers in terms of MgII EW.
  - i.e. not particularly representative of the whole (and don't necessarily fit the superposition model of Bordoloi et al).



Sightline	Absorber redshift	Impact: Group centre	Impact: Nearest galaxy	MgII EW
HE0515-4414 (B16)	0.283	110 kpc	49 kpc	0.72±0.02Å
PKS2126-158 (W06)	0.666	60 kpc	26 kpc	2.2±0.2Å
Q1127-145 (K10)	0.312	60 kpc	18 kpc	1.77±0.01Å
HB892128-123 (P16)	0.431	50 kpc	50 kpc	0.58±0.07Å

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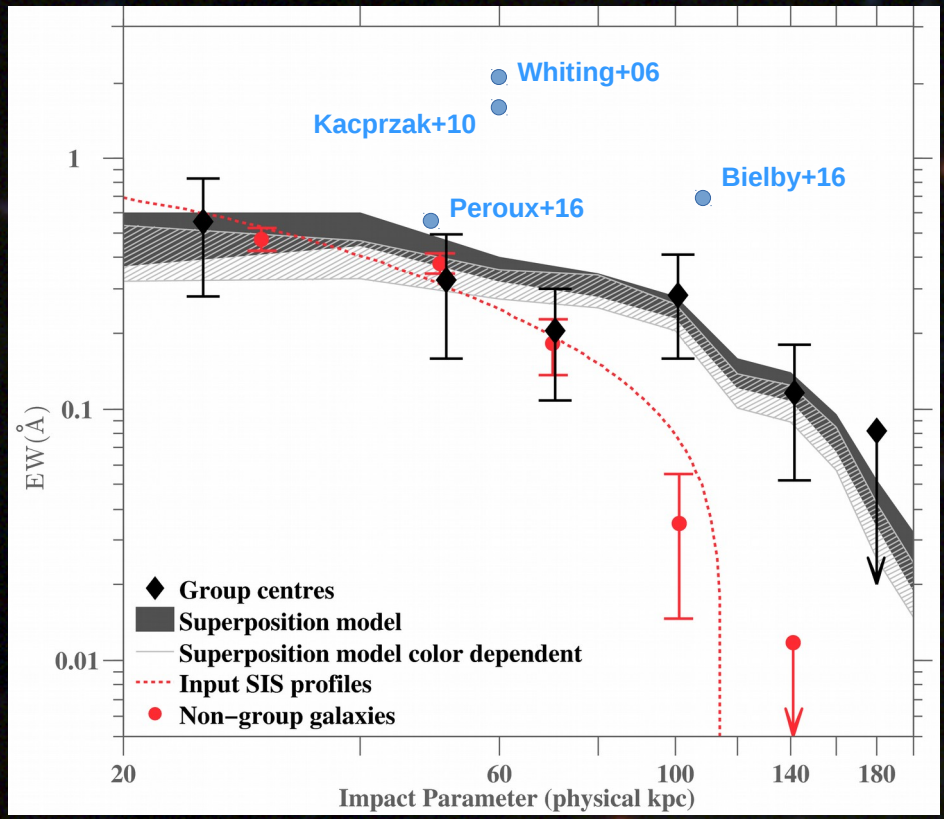
Combining detailed sightlines

- Each of the four studies conclude that the cool gas is most likely intra-group gas.
  - e.g. stripped material.
- Absorber-galaxy properties are generally concluded to be inconsistent with outflows in all four studies.



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Summary

- MUSE can provide invaluable insights into the environment of absorption line systems associated with galaxy groups.
  - Blind surveys of galaxy population
  - Galaxy kinematics
- Cool gas (traced by MgII, FeII etc.) detected in galaxy group environments.
  - Surmised to be intra-group medium/group halo material.
  - Ultimately, using simulations (e.g. EAGLE), the distribution of metals in the group environment can feed our understanding of the declining SFRs in group galaxies.

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What Matter(s) Around Galaxies

Resolving the physics of the Circumgalactic Medium

19th-23rd June 2017

SOC:
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Claudia Cicone
Valentina D'Odorico
Simon Morris
Peng Oh
Claudia Scarlata
Joop Schaye
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Tom Theuns

LOC:
Michele Fumagalli (co-chair)
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Ryan Cooke
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Image Credit: Robert Gendler/Adrien Thob

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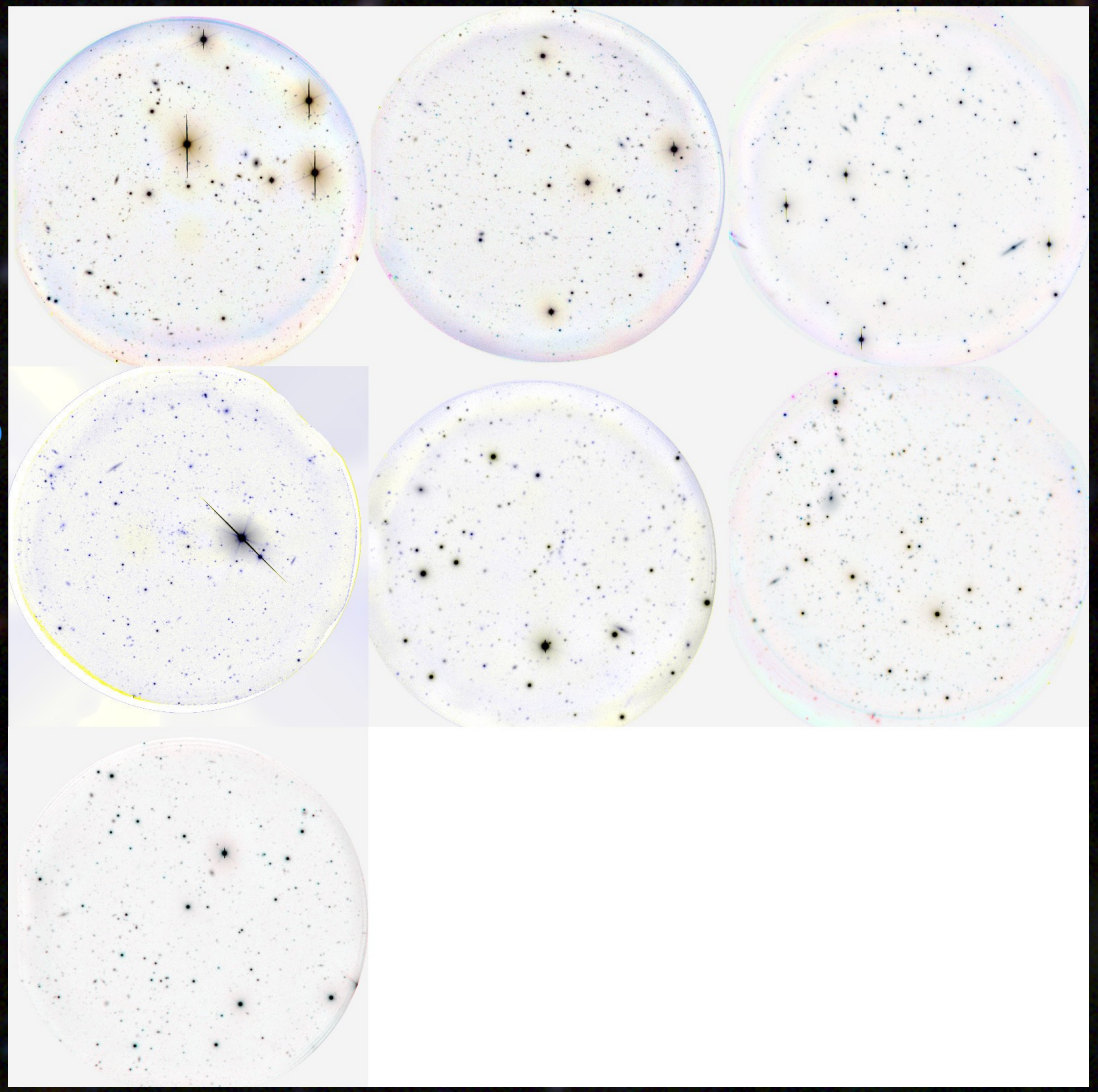
Slight aside: QSAGE

- Data presented here was partially taken in support of our large HST program:
  - QSO Sightline and Galaxy Evolution (QSAGE) survey
- Deep NIR grism data on WFC3 on 12 fields.
  - Hα coverage: 0.7<z<1.5
  - Each field 3'x3'
  - Each field centred on a bright background QSO already observed with HST-STIS.
- Developing deep datasets for each field intended to be useful for a wide range of galaxy evolution studies.
  - 7 fields observed with deep *gri* imaging with WHT-ACAM, 4 more applied for.
  - 5 fields covered with VLT-MUSE IFU observations, making plans for more.



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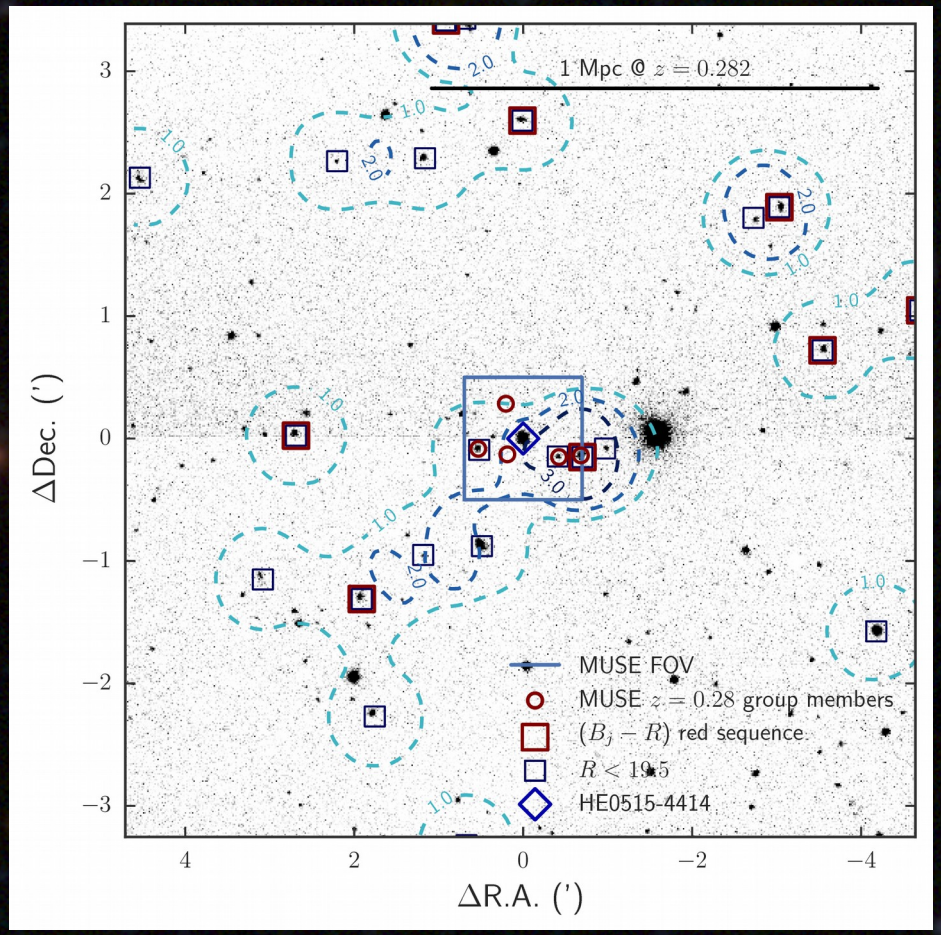
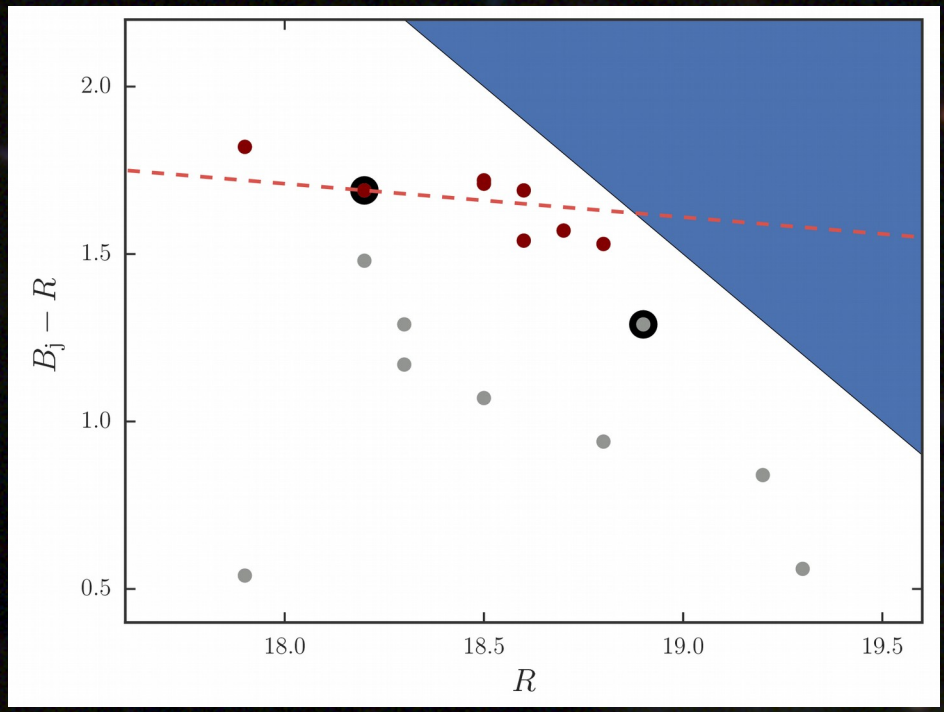
Wider group environment





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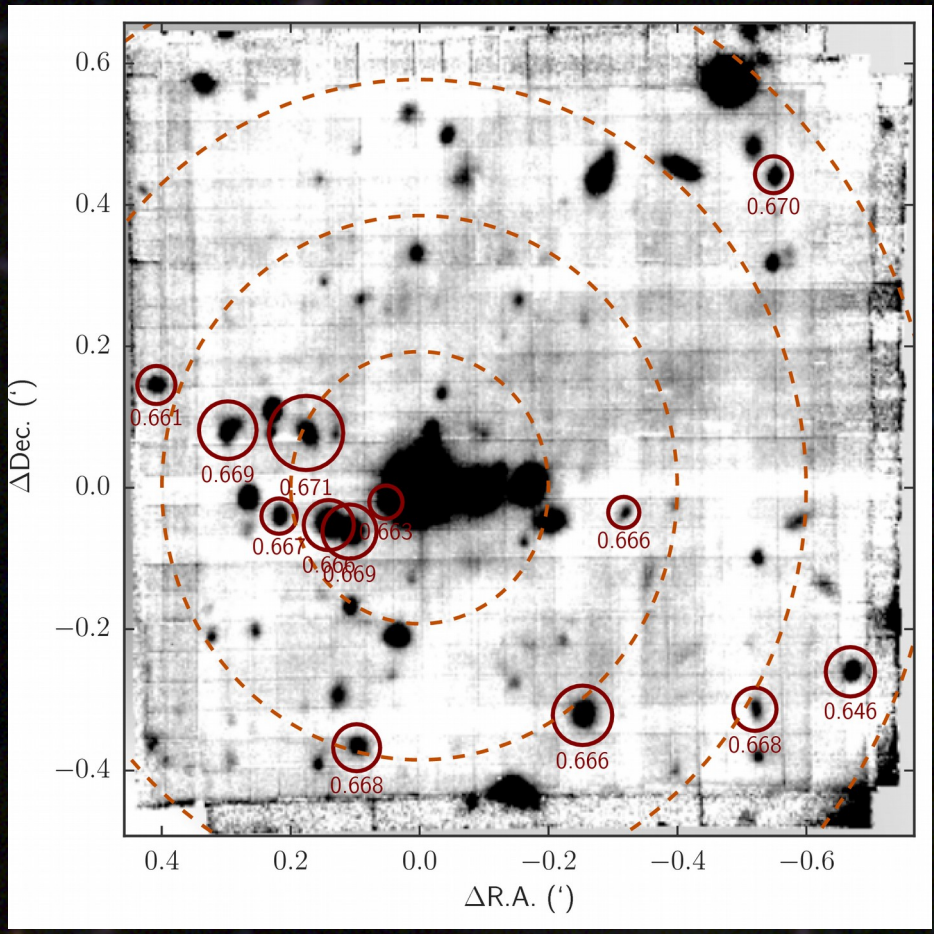
Update on PKS2126-158 sightline

- 4 hrs MUSE data.
  - Detect 13x z~0.66 galaxies.
  - 8 galaxies reported by Whiting+06, all Early Type.
    - But missed closest group member at 25kpc, which is star-forming.



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Update on PKS2126-158 sightline

- 4 hrs MUSE data.
  - Detect 13x z~0.66 galaxies.
  - 8 galaxies reported by Whiting+06, all Early Type.
    - But missed closest group member at 25kpc, which is star-forming.
- Applying Bordoloi+10 superimposed MgII absorber model:
  - EW_{pred} = 1.4±0.1 Å
  - Compared to EW_{pred} = 2.2±0.2 Å
- Not calculated galaxy kinematics for full analysis yet.
- To Be Continued….