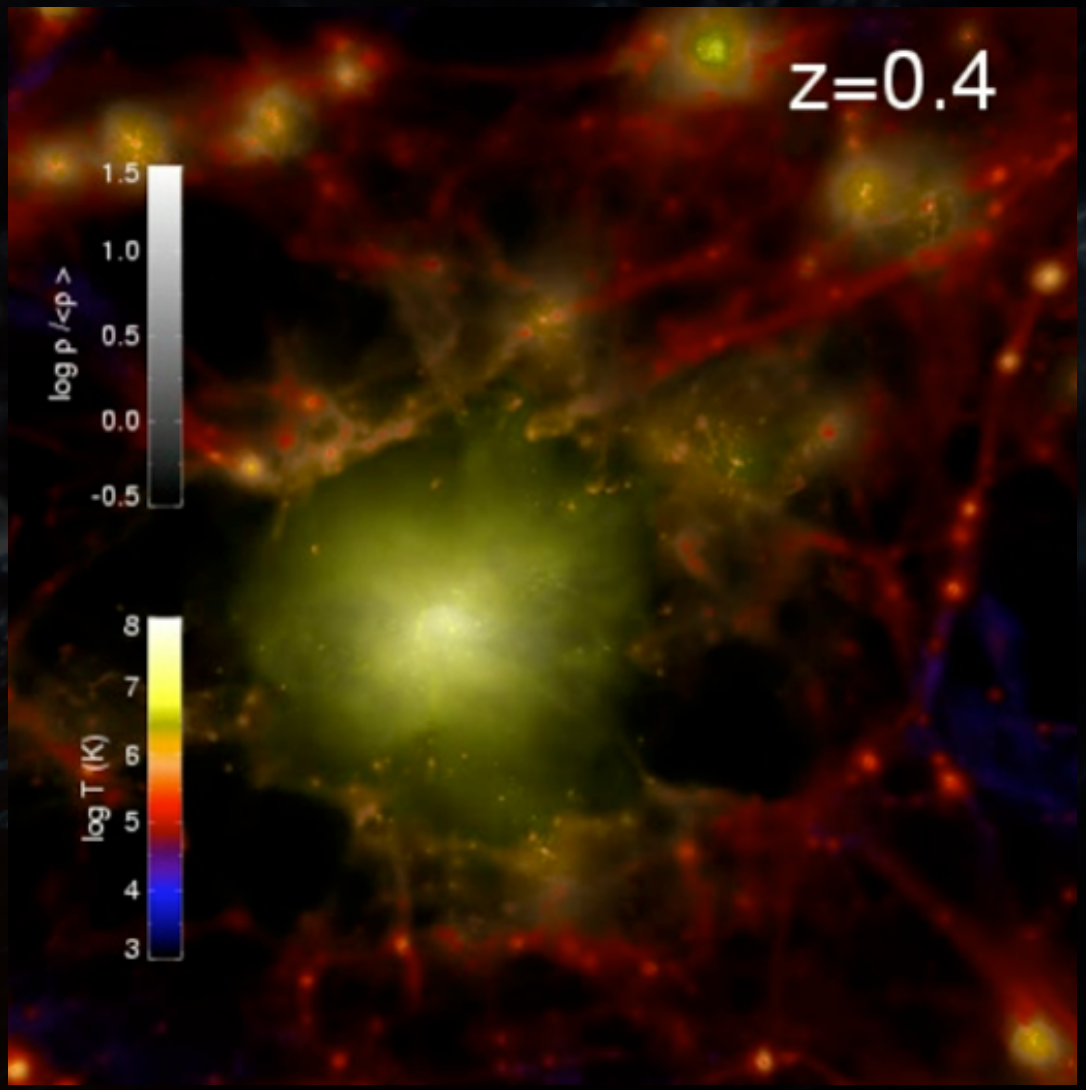
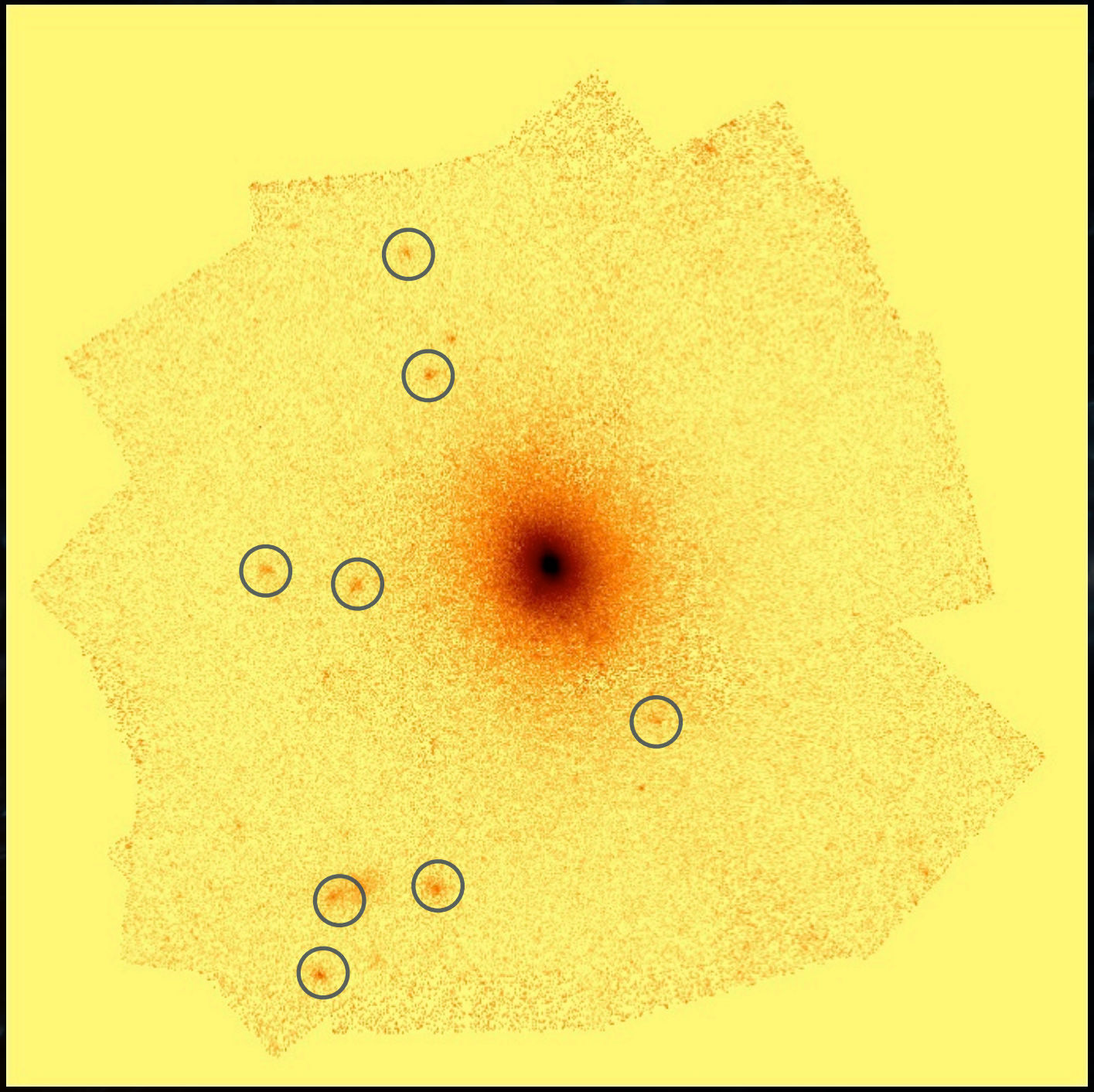
Probing hot galactic environments with X-ray quasars

Rik Williams
Carnegie Observatories

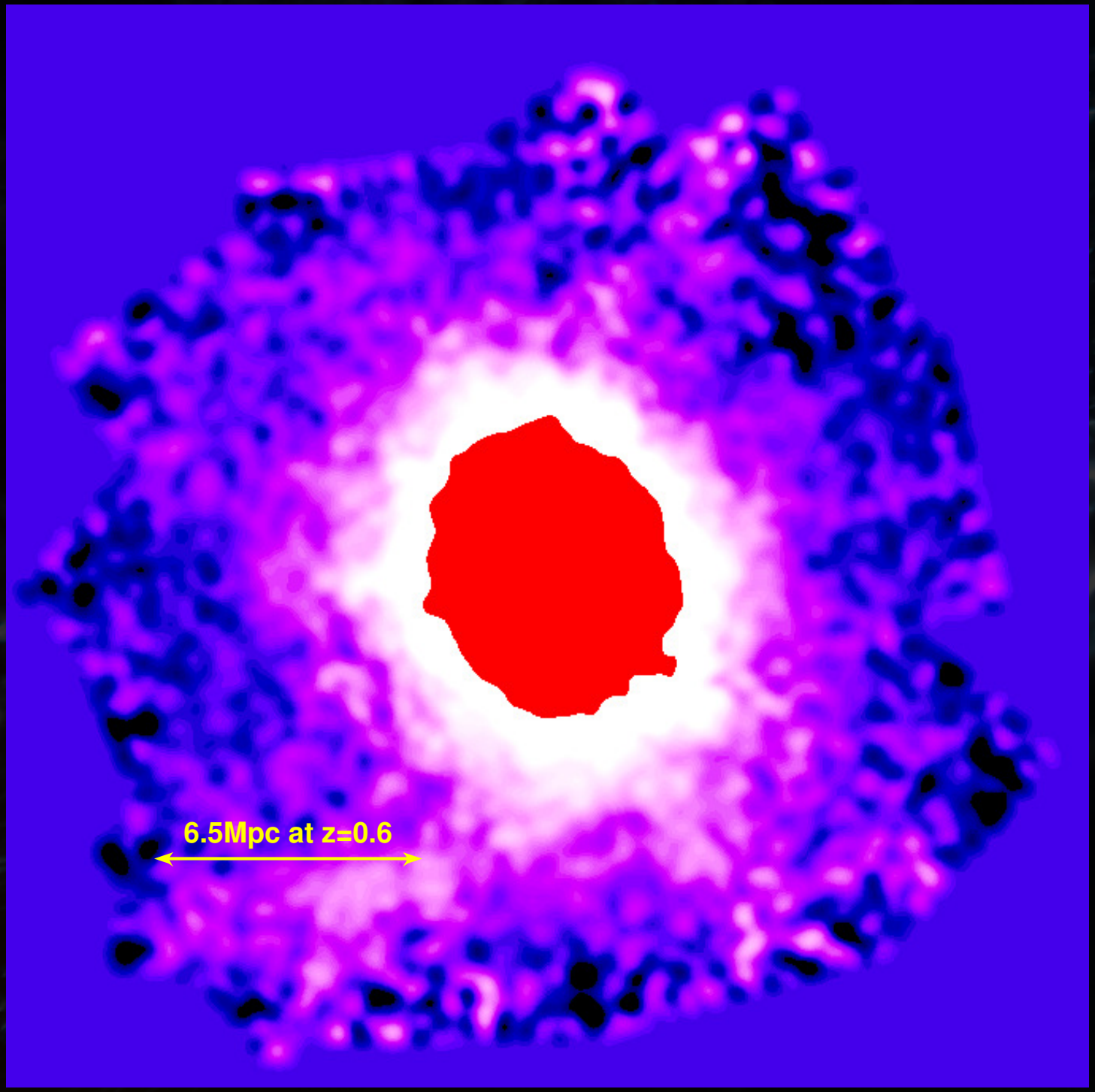
The low-z universe should be full of ~10^6 K gas



simulation courtesy B. Oppenheimer



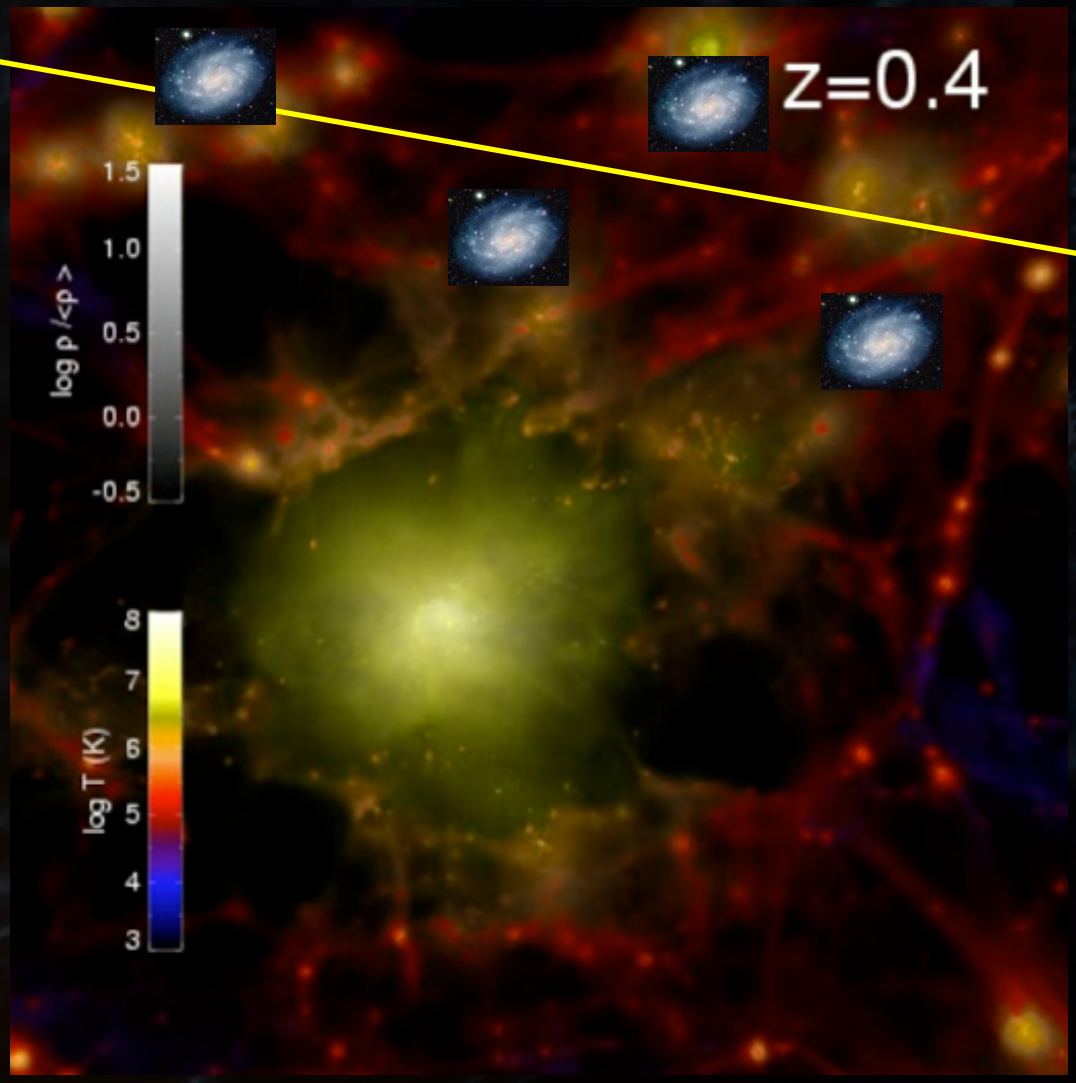
Abell 133 and surroundings - A. Vikhlinin / J. Mulchaey

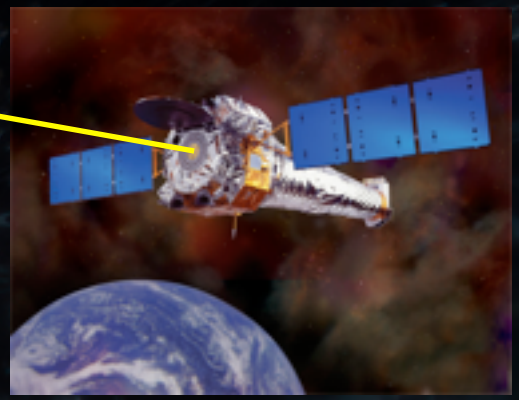


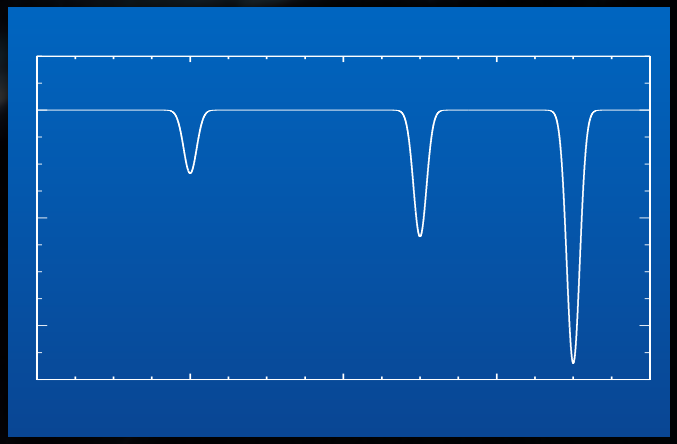
Abell 133, smoothed - A. Vikhlinin / J. Mulchaey

X-ray emission mainly picks out hottest, highest column density gas (i.e. clusters, massive galaxies)

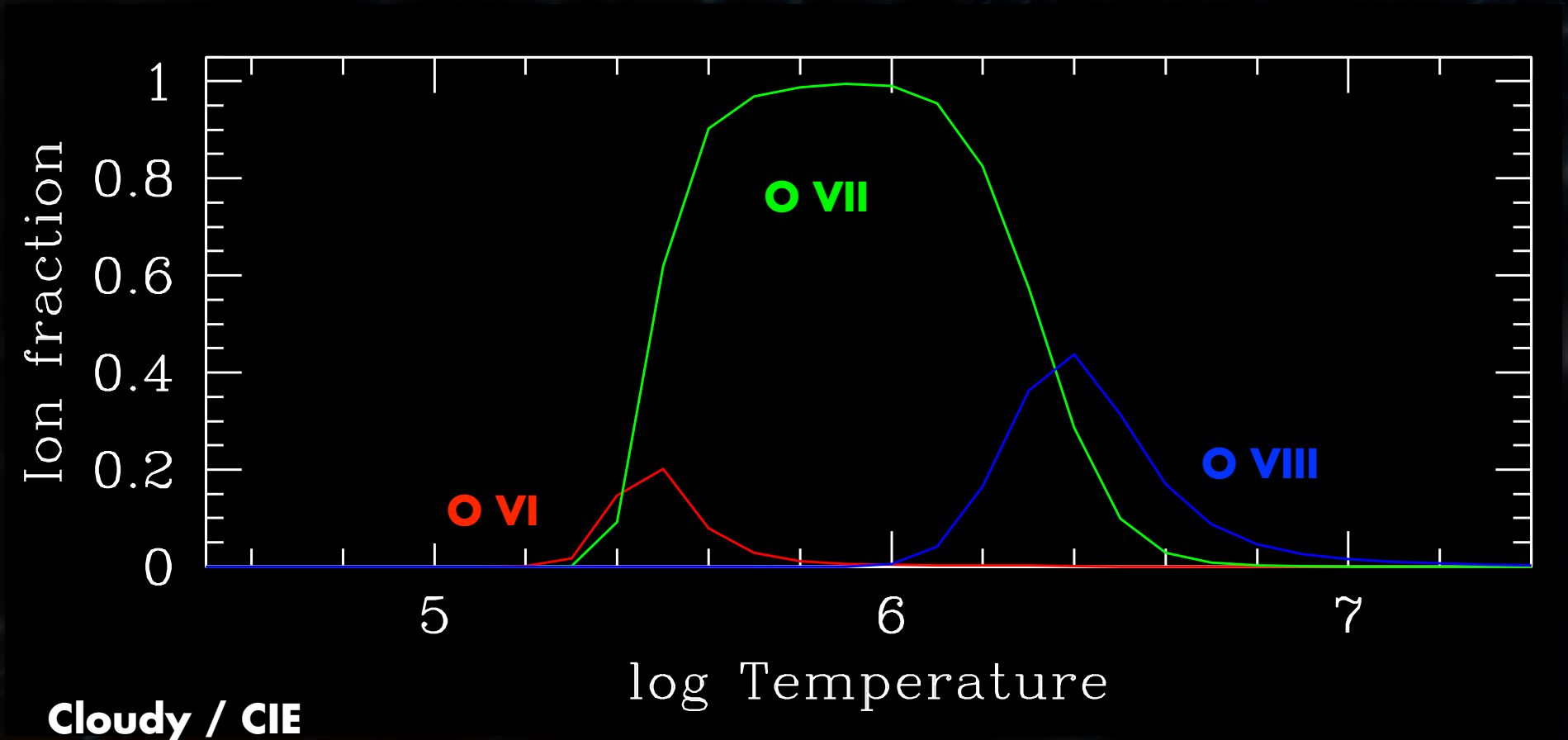
Hot gas in absorption





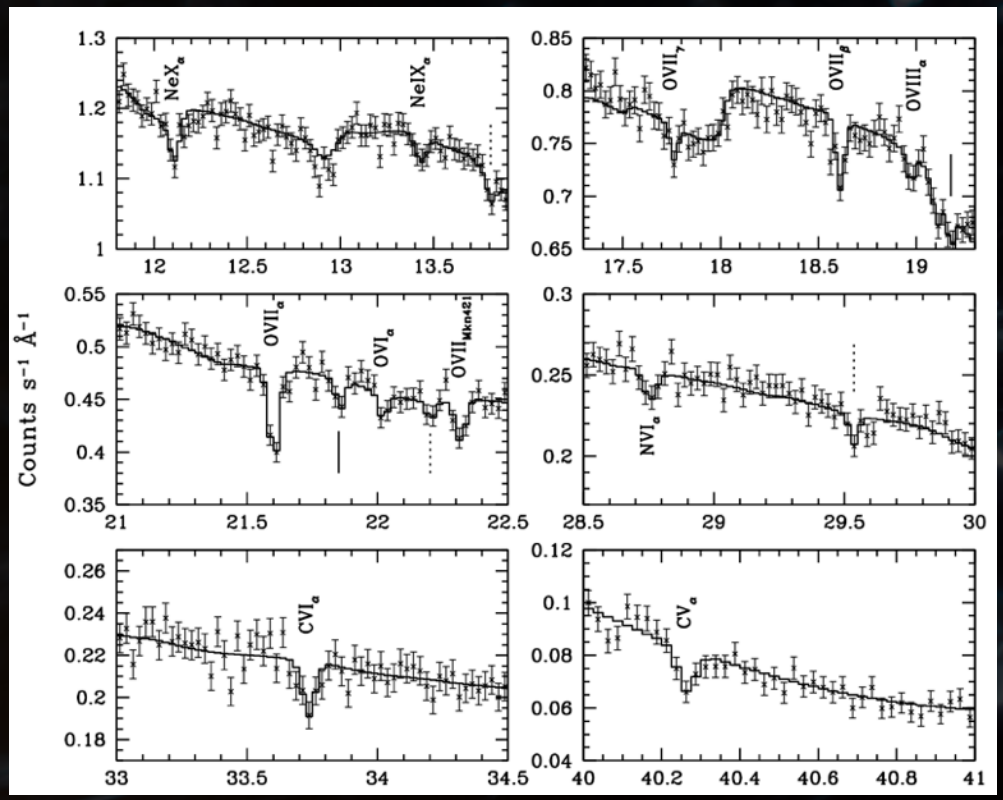


Hot gas in absorption

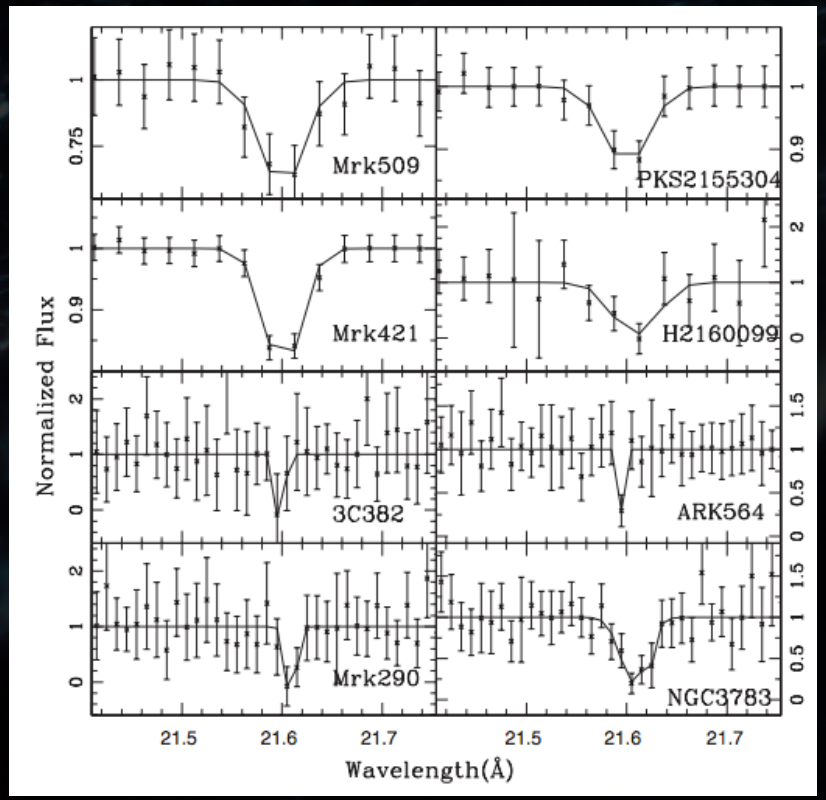


Cloudy / CIE

Warm-hot gas around our Galaxy



Mkn421 - RJW et al. 2005



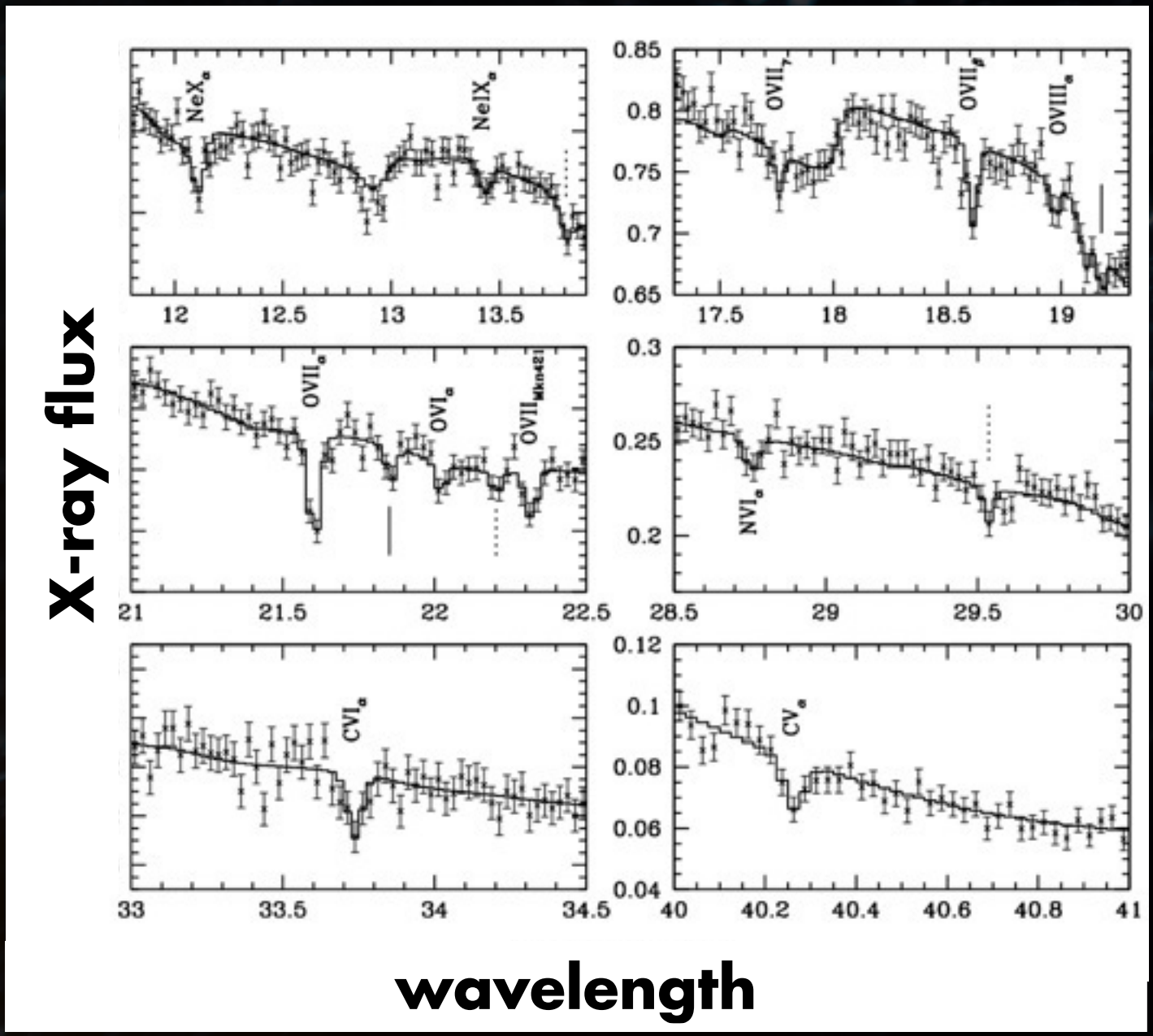
Gupta et al. 2012

X-ray absorbers at z>0

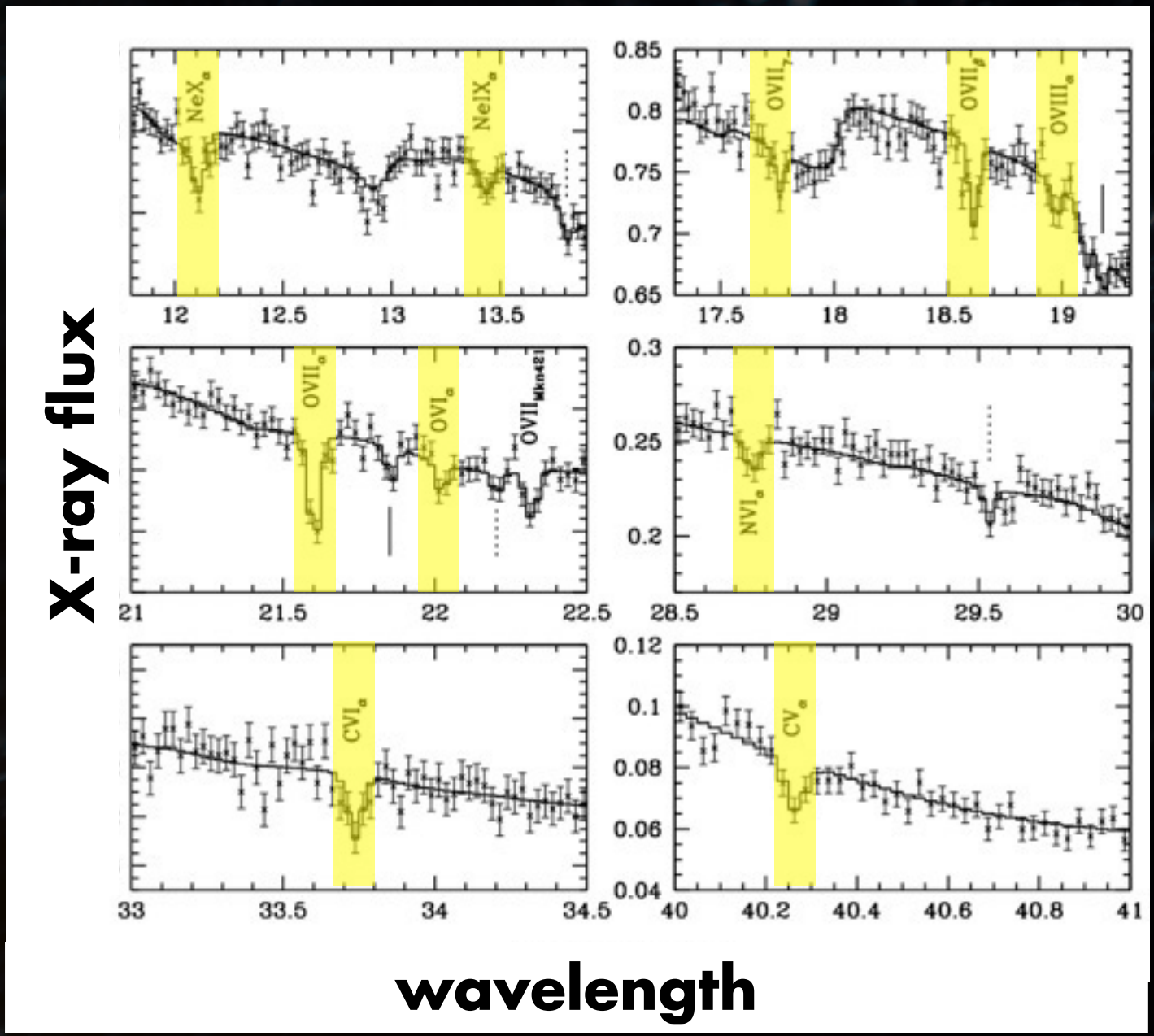
1. **Mrk 421:** Blind search

2. **Sculptor Wall:** Targeting known large-scale structures

X-ray absorbers at z>0

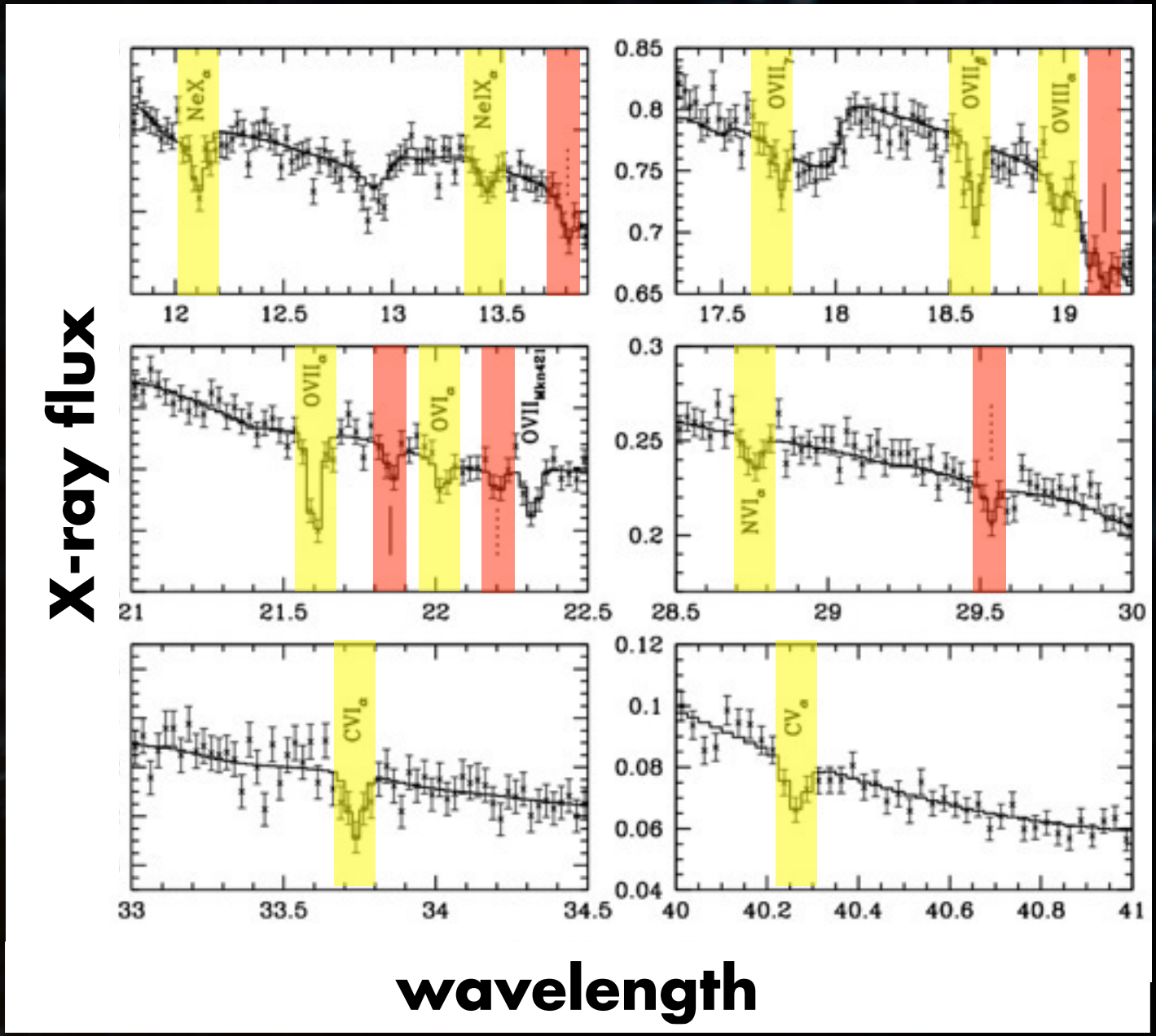


X-ray absorbers at z>0



Local

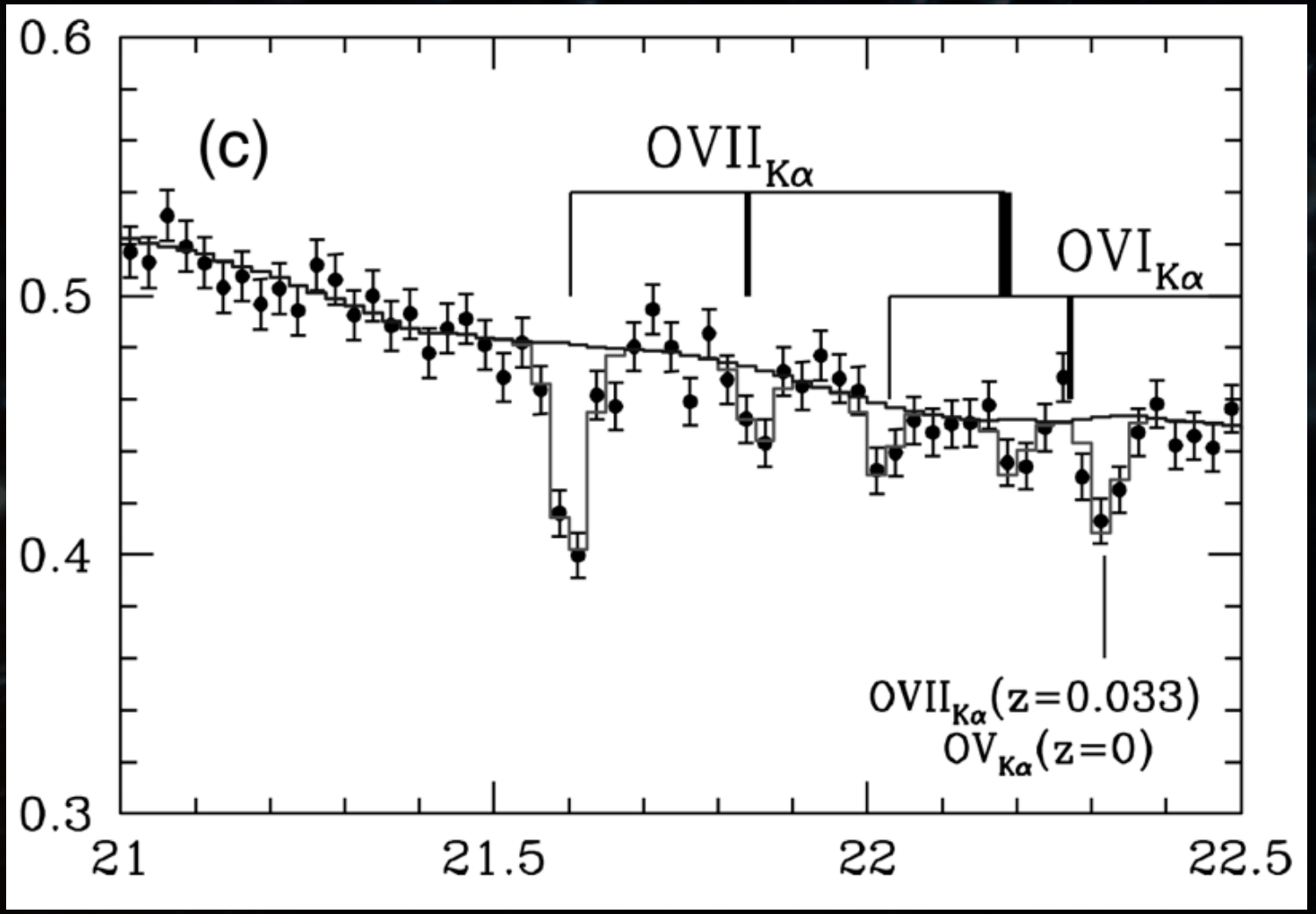
X-ray absorbers at z>0



Local

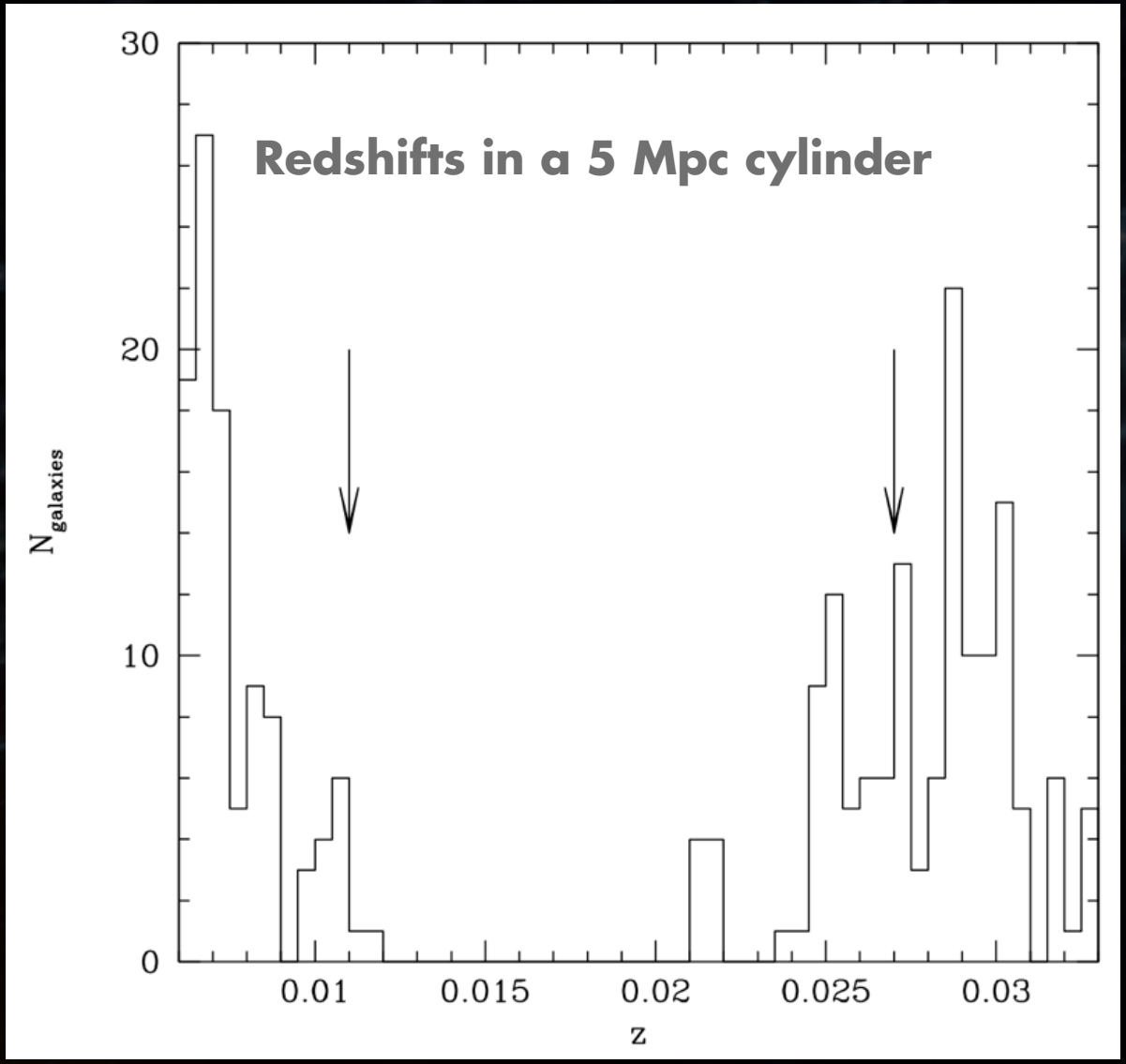
Groups/ Filaments?

X-ray absorbers at z>0



Nicastro et al. (2005)

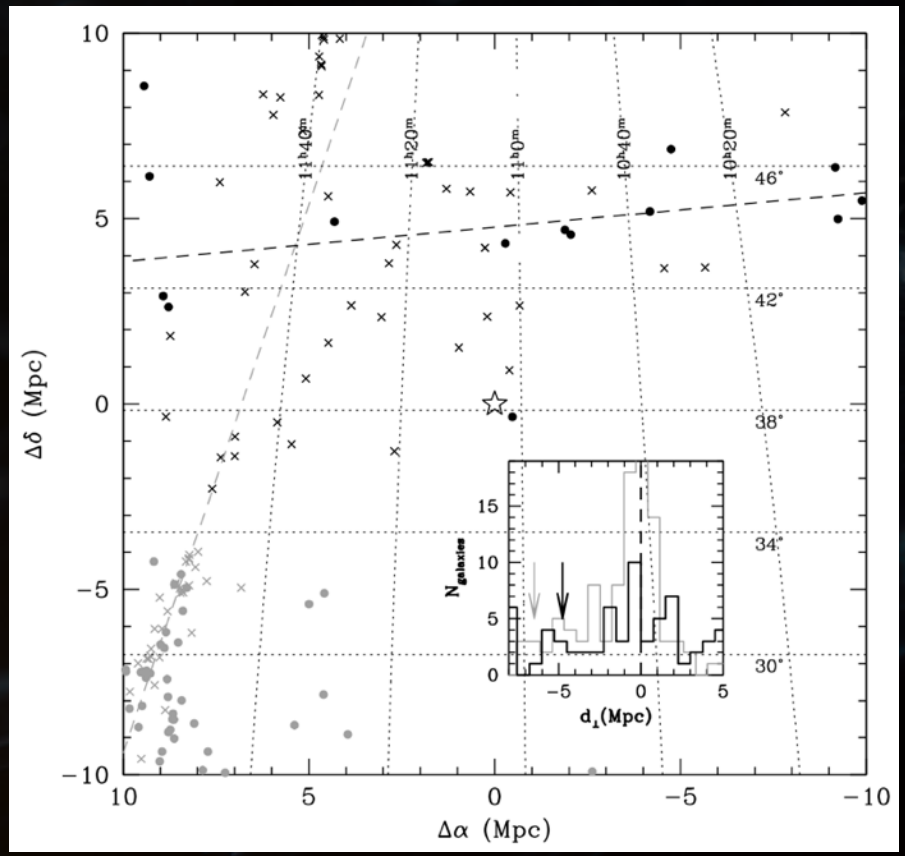
Mrk 421 and SDSS



RJW, Mulchaey, Kollmeier, Cox (2010)

Mrk 421 and SDSS

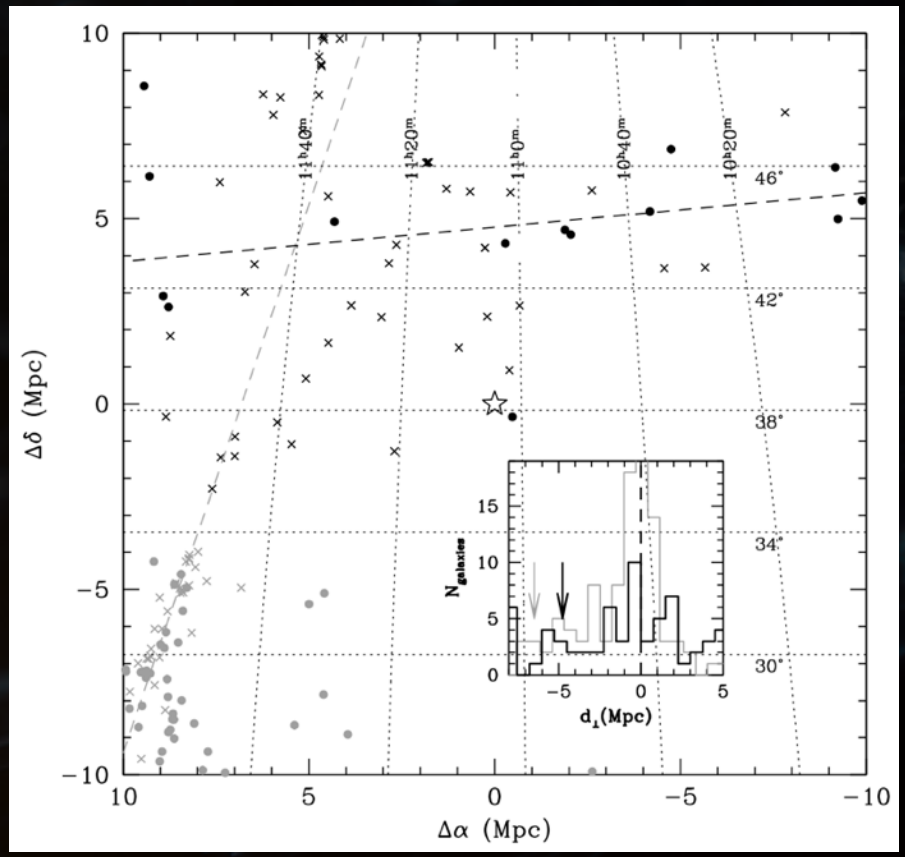
z=0.011



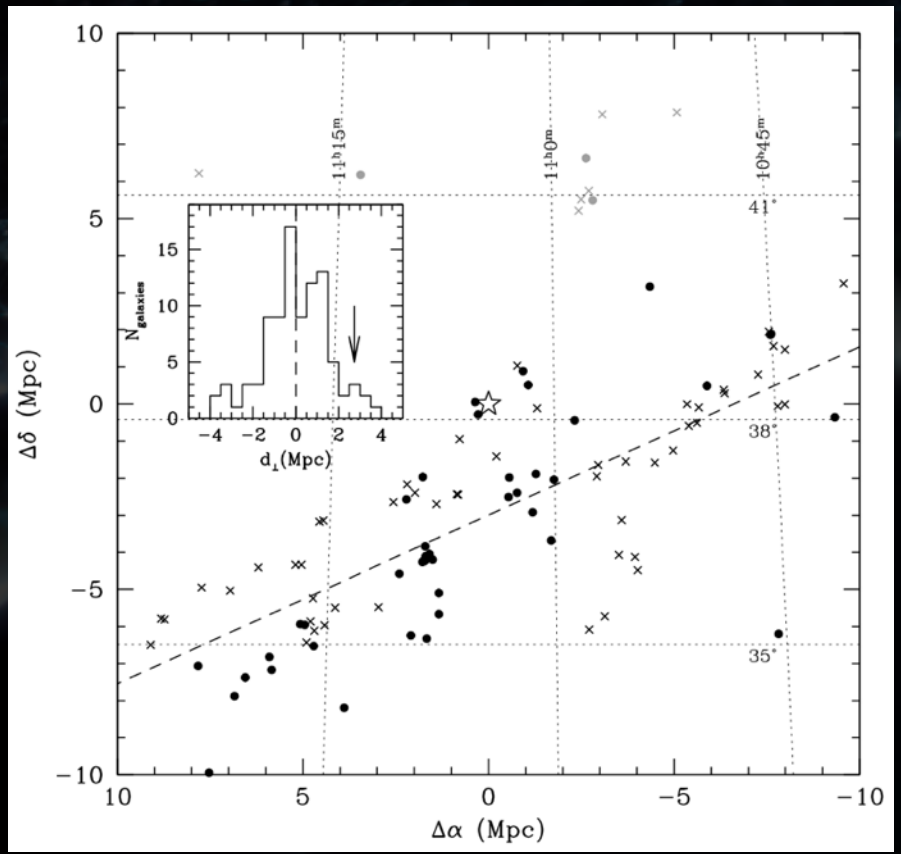
RJW, Mulchaey, Kollmeier, Cox (2010)

Mrk 421 and SDSS

z=0.011



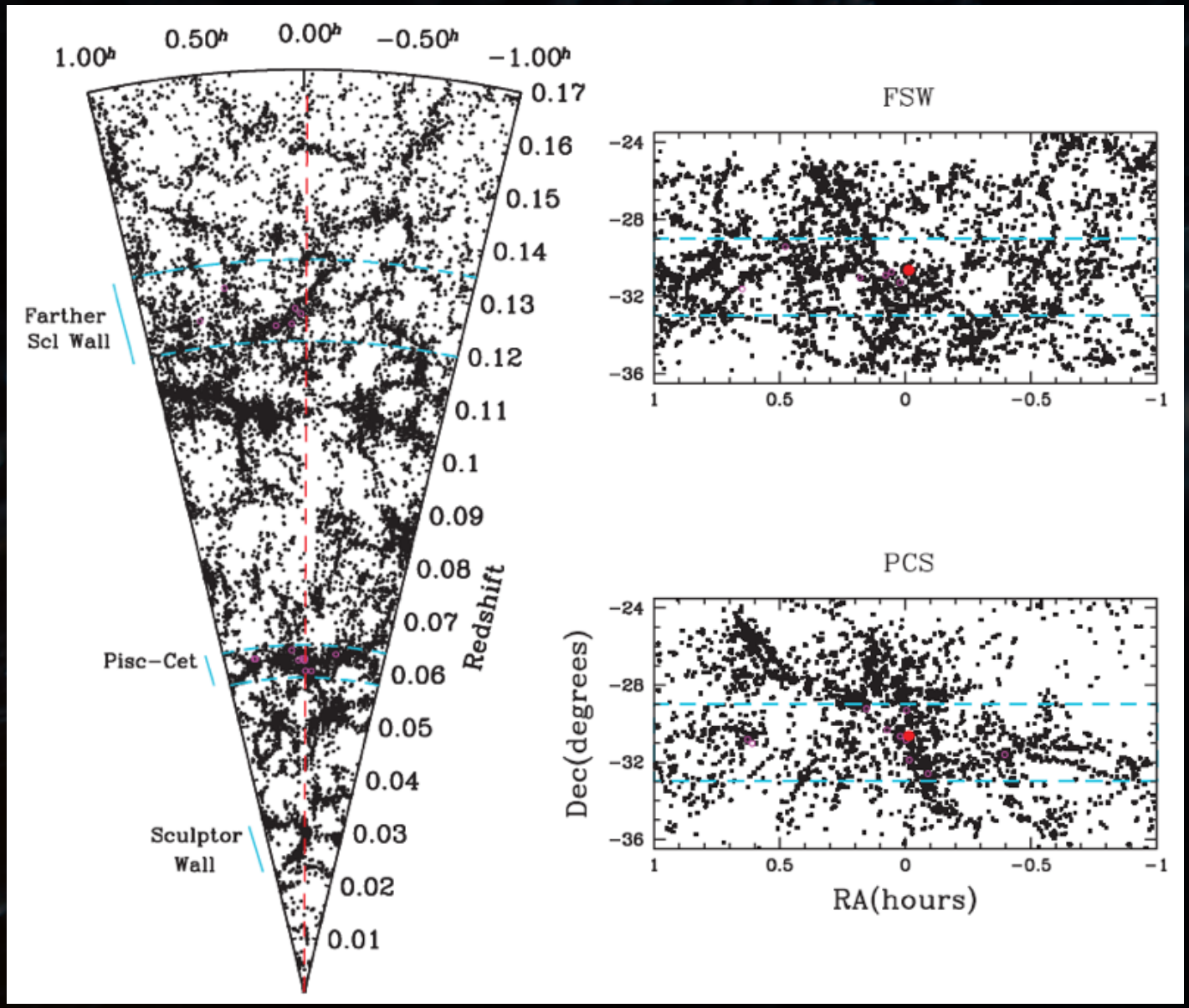
z=0.027



RJW, Mulchaey, Kollmeier, Cox (2010)

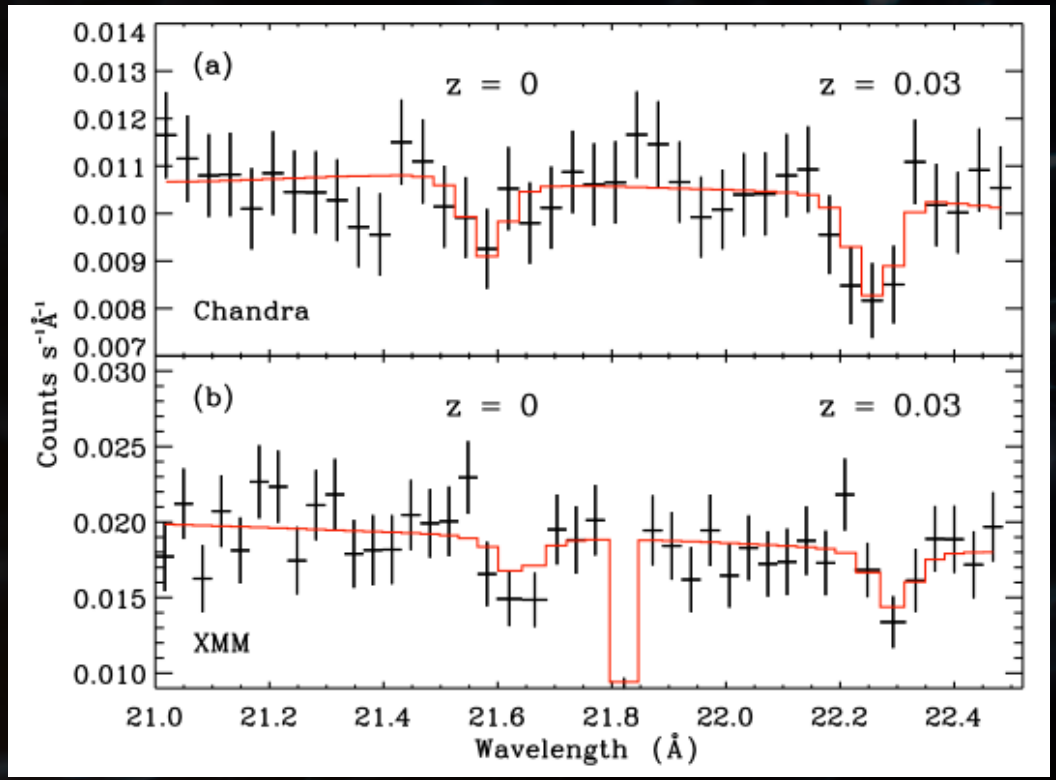
Mrk 421: One absorber is associated with a galaxy filament; possibly a group

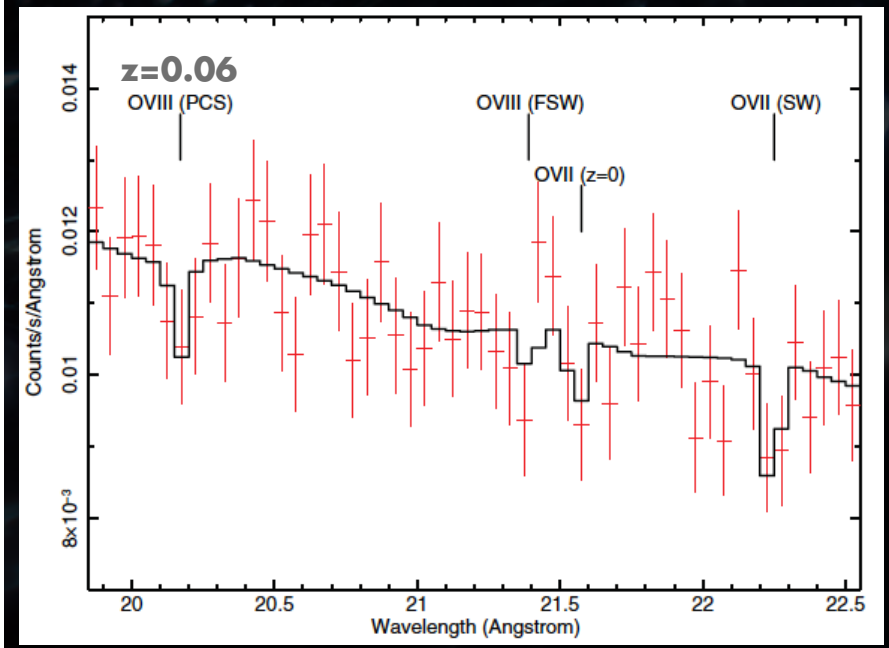
Sculptor Wall



Zappacosta et al. (2010)

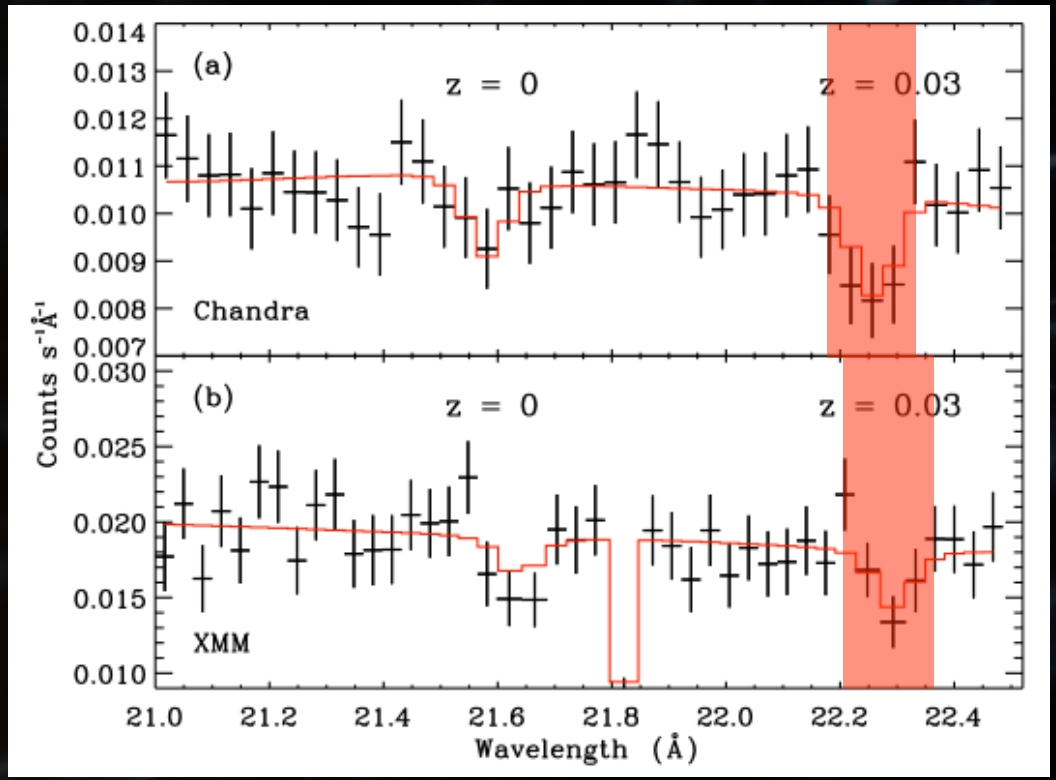
H2356-309: The Sculptor Wall

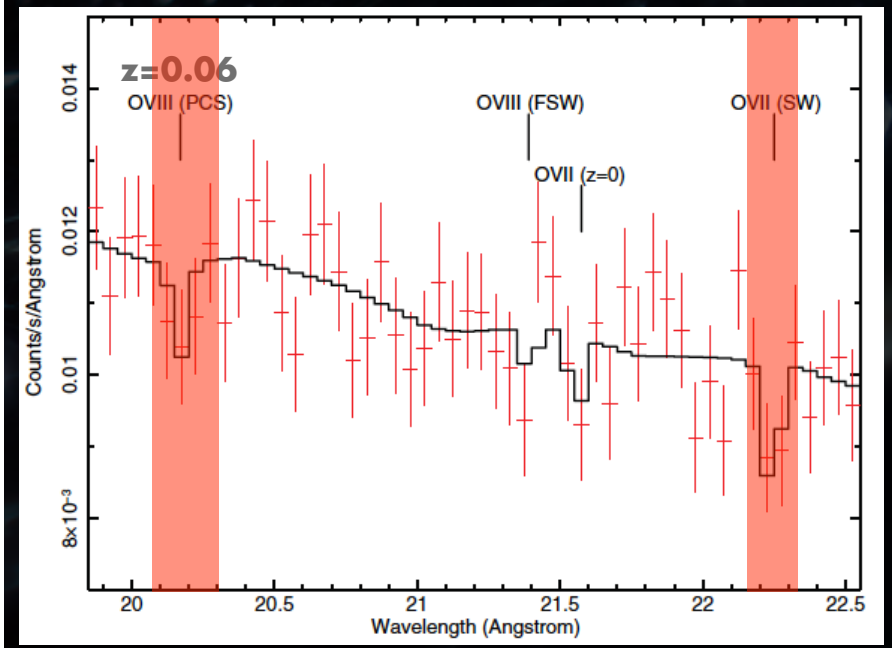




Zappacosta et al. (2010)

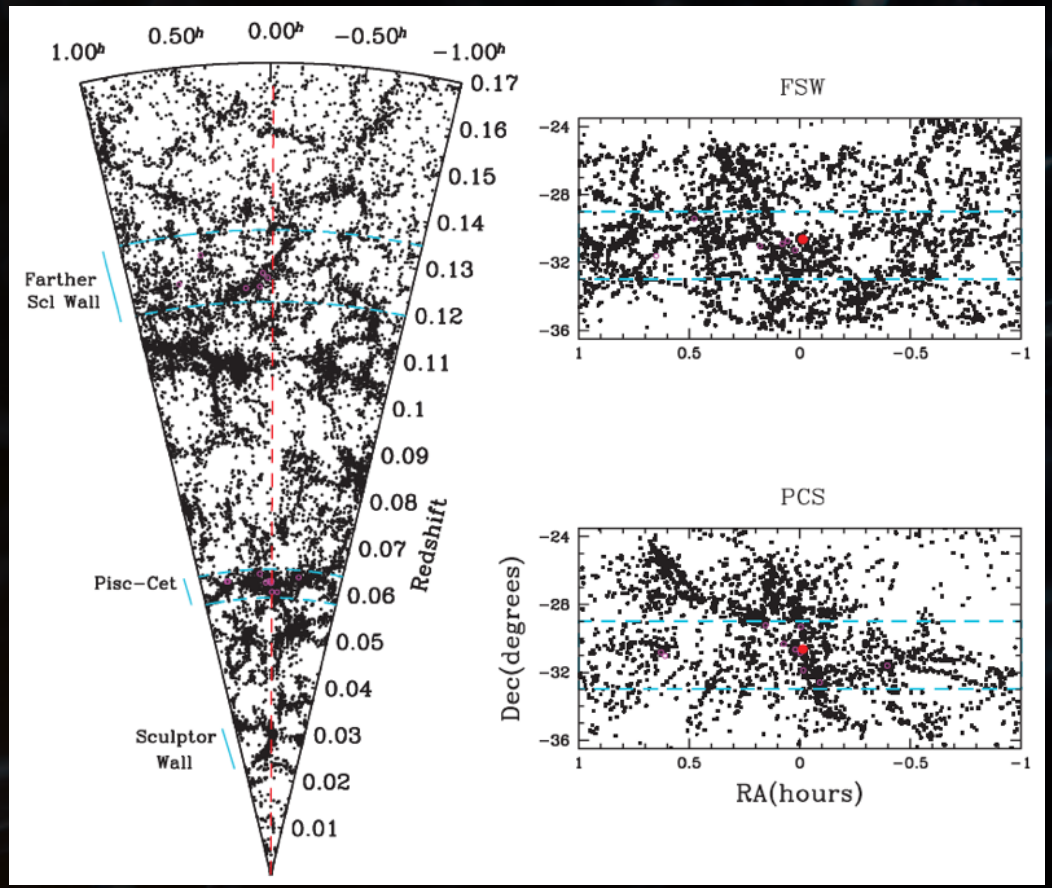
H2356-309: The Sculptor Wall





Zappacosta et al. (2010)

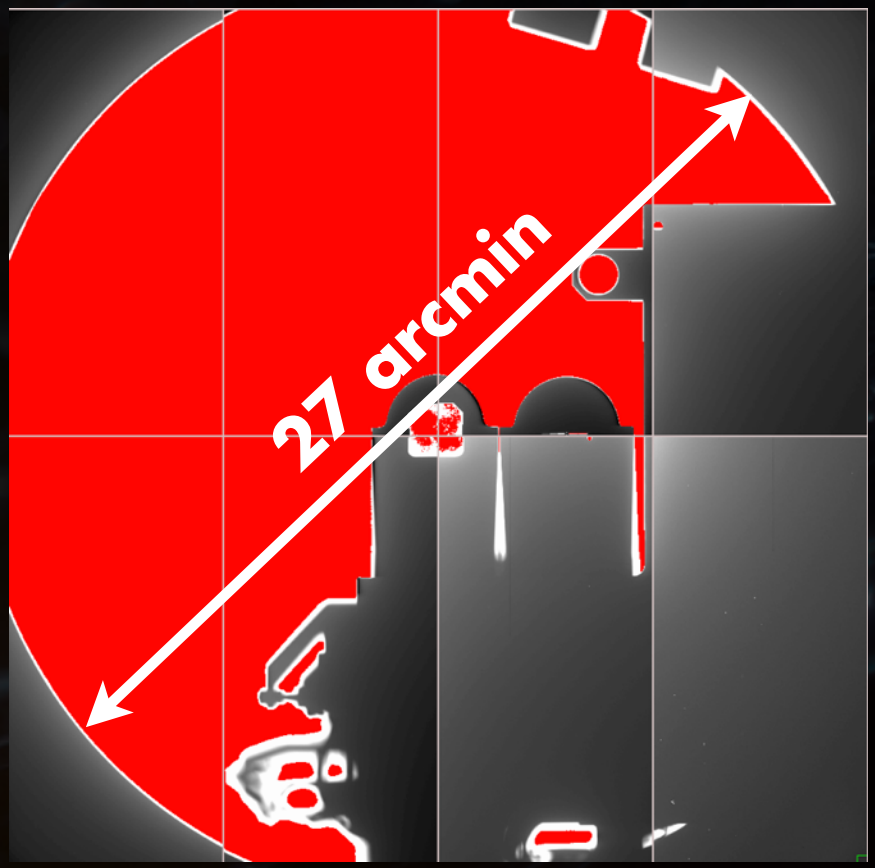
H2356-309: The Sculptor Wall

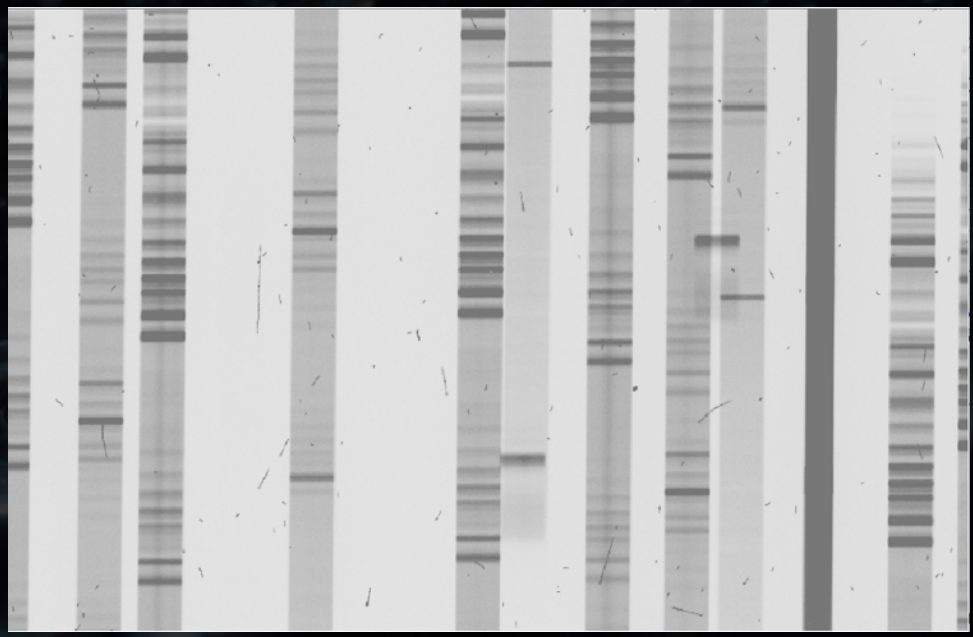


Zappacosta et al. (2010)

Are missed groups and/or galaxies contributing to the absorption?

IMACS survey of the H2356 field

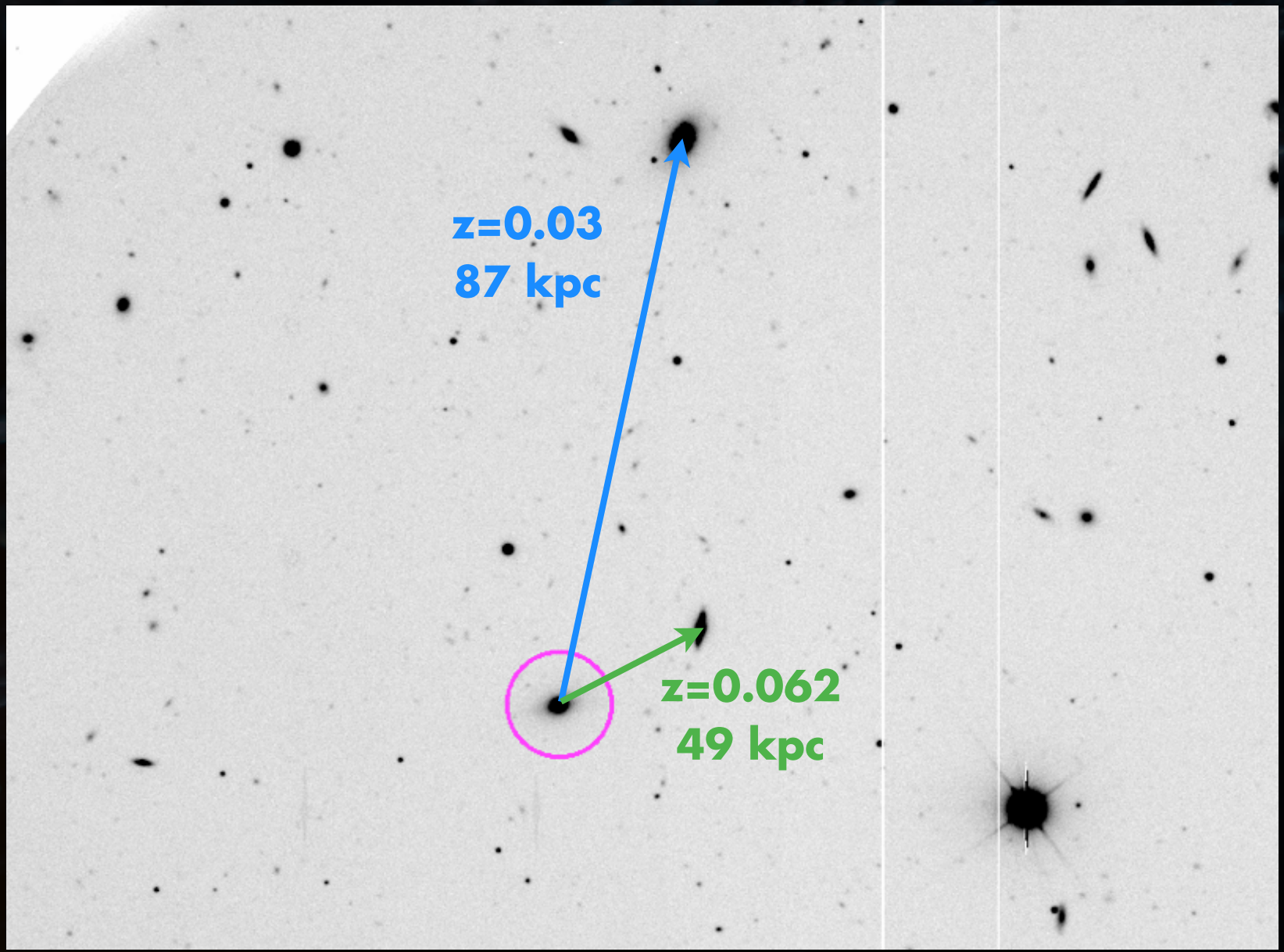




- IMACS field of view covers r=500 kpc at z~0.025

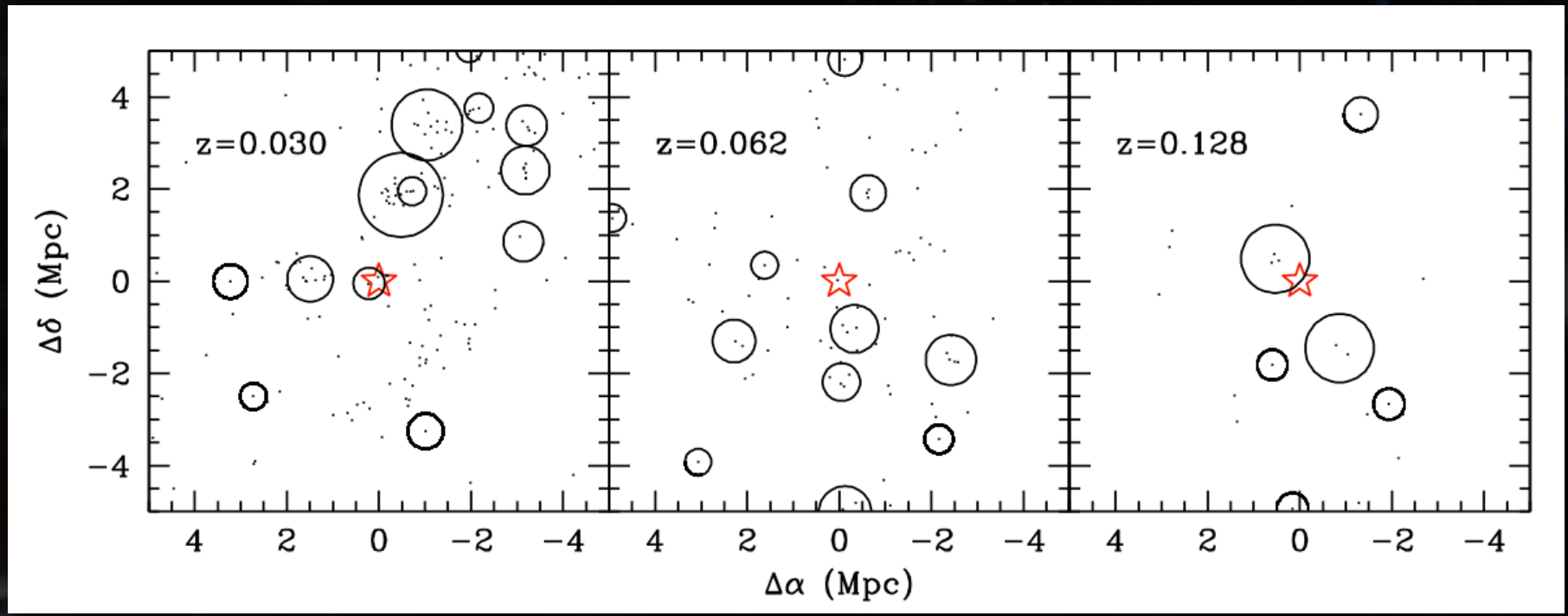
- ~100 spectra per mask

IMACS survey of the H2356 field



Williams, Mulchaey, & Kollmeier 2013

2dF groups in the H2356 field



Williams, Mulchaey, & Kollmeier 2013

Where there's OVII, there are galaxies

Summary

- X-ray absorbers seem to lie within galaxy or group virial radii (small N notwithstanding...)

- Putative "WHIM detections" may in fact be hot CGM

- 10^6 K gas definitely exists around bound structures (including the Milky Way), but is it ubiquitous?

Hercules Supercluster

X-RAY ABSORPTION BY THE WARM-HOT INTERGALACTIC MEDIUM IN THE HERCULES SUPERCLUSTER

Bin Ren[1,2], Taotao Fang[1,3], David A. Buote[3]

(Received; Revised; Accepted)
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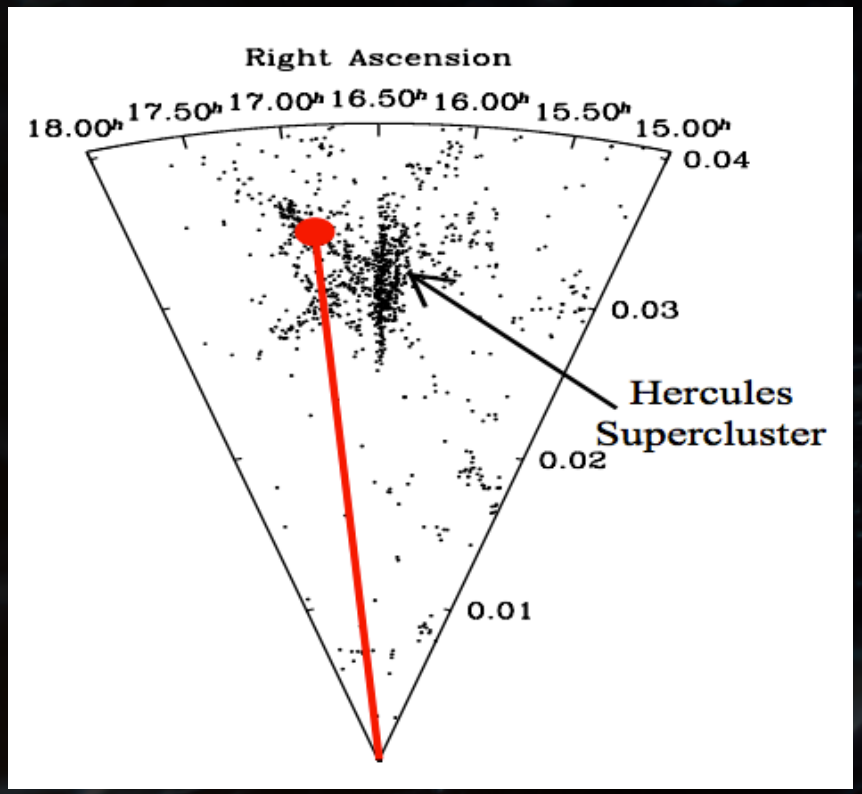
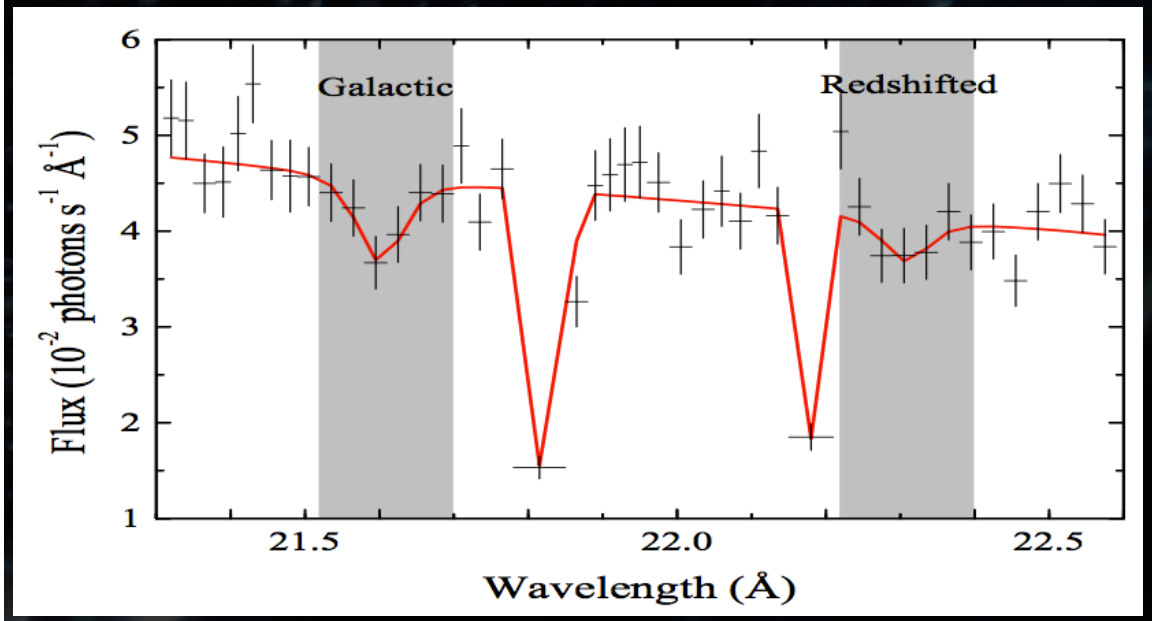
ABSTRACT

The "missing baryons", in the form of warm-hot intergalactic medium (WHIM), are expected to reside in cosmic filamentary structures that can be traced by signposts such as large-scale galaxy superstructures. The clear detection of an X-ray absorption line in the Sculptor Wall demonstrated the success of using galaxy superstructures as a signpost to search for the WHIM. Here we present

Hercules Supercluster

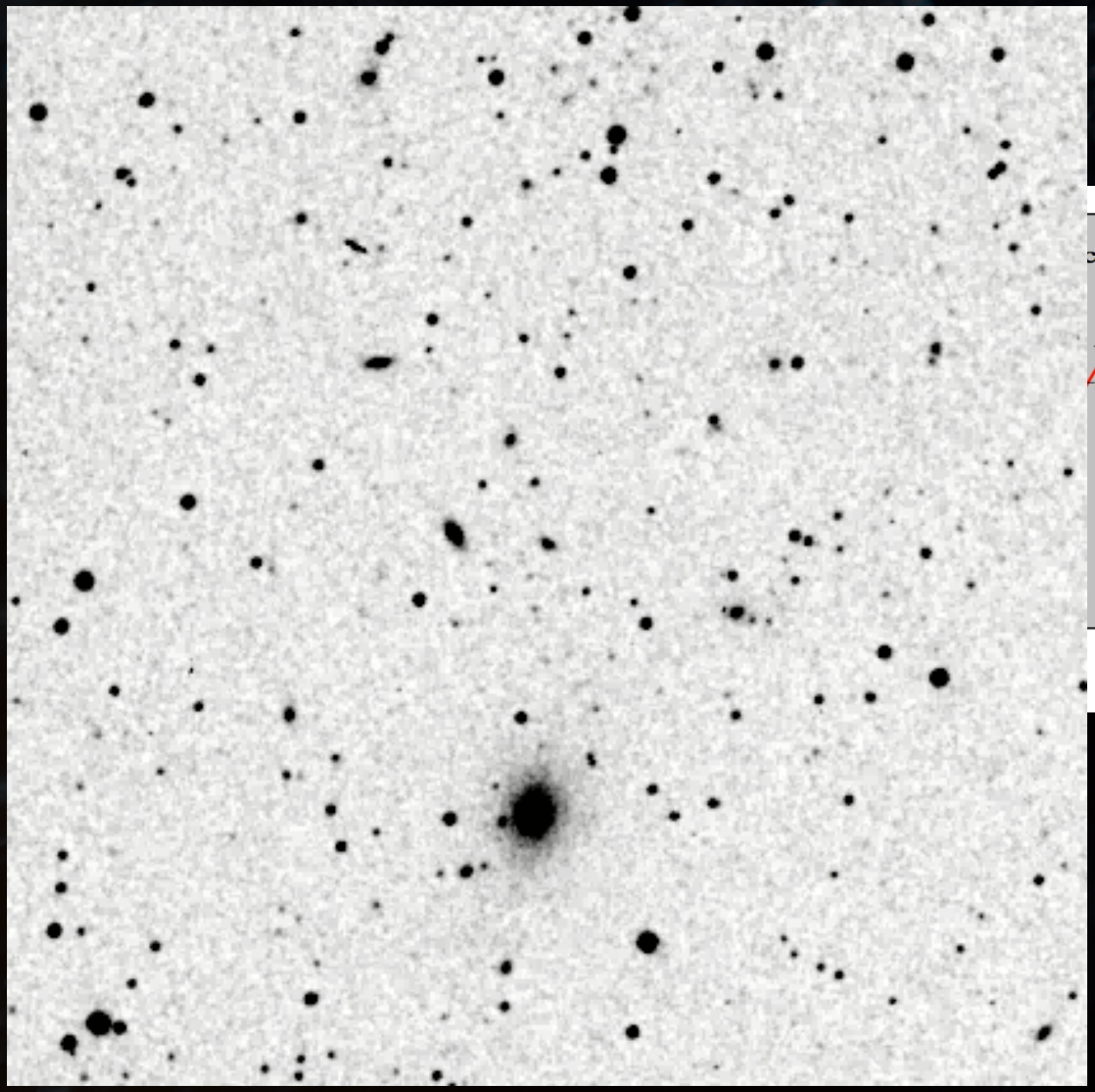


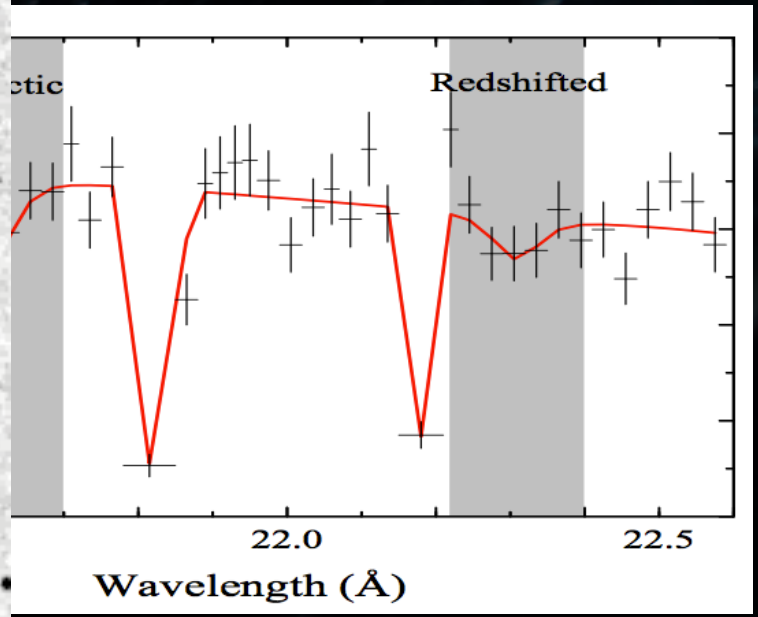


z=0.0329

Ren, Fang, & Buote (2014)

Hercules Supercluster





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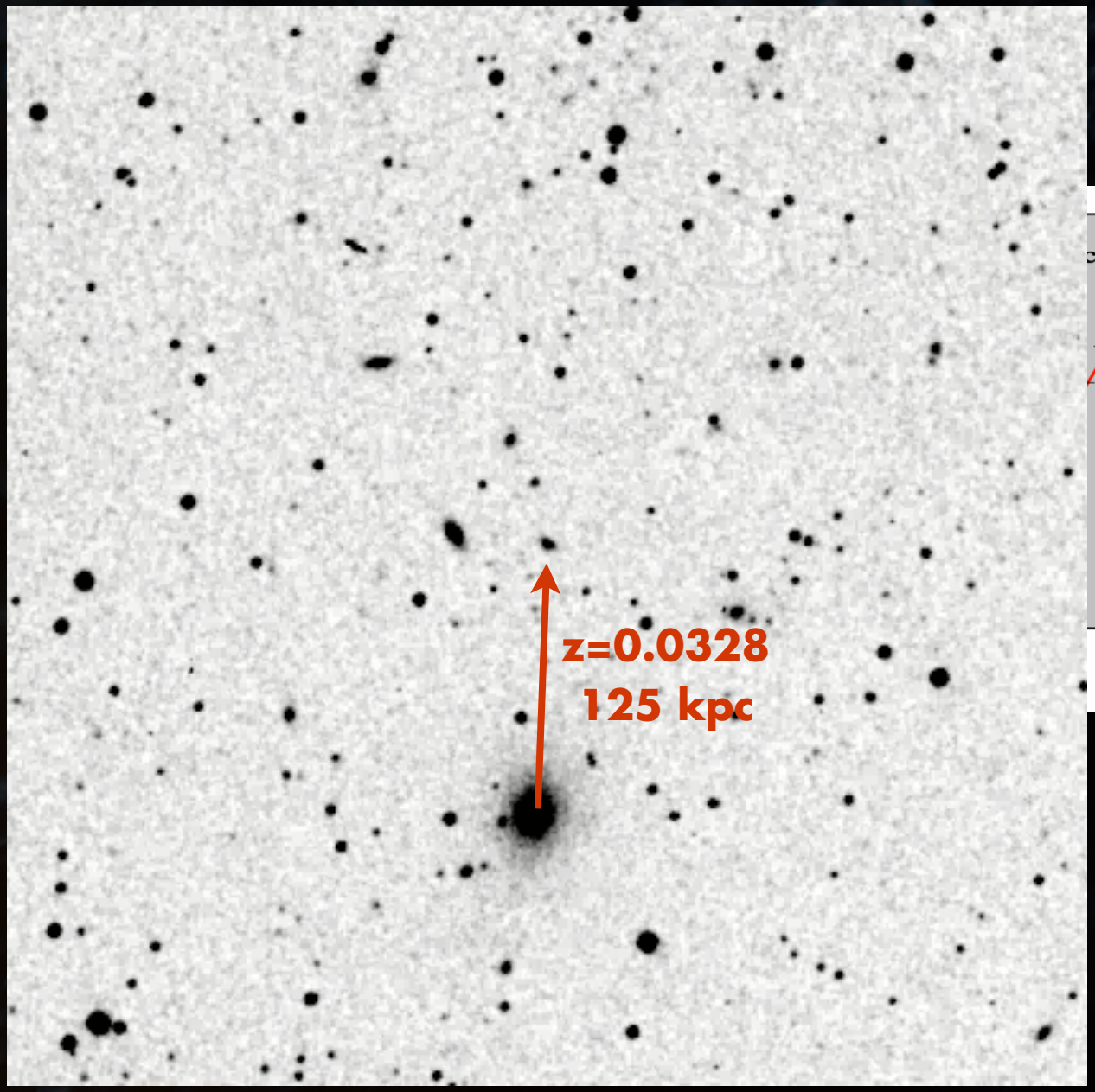
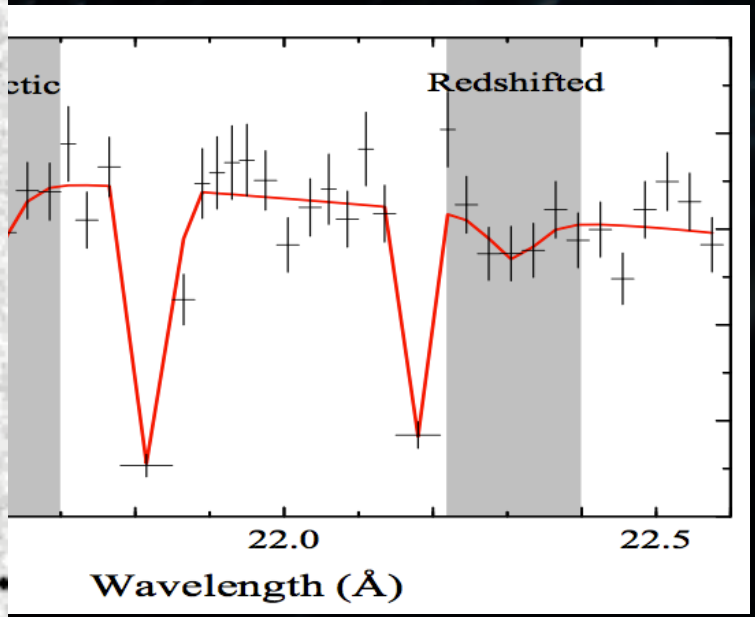
Ren, Fang, & Buote (2014)

Hercules Supercluster





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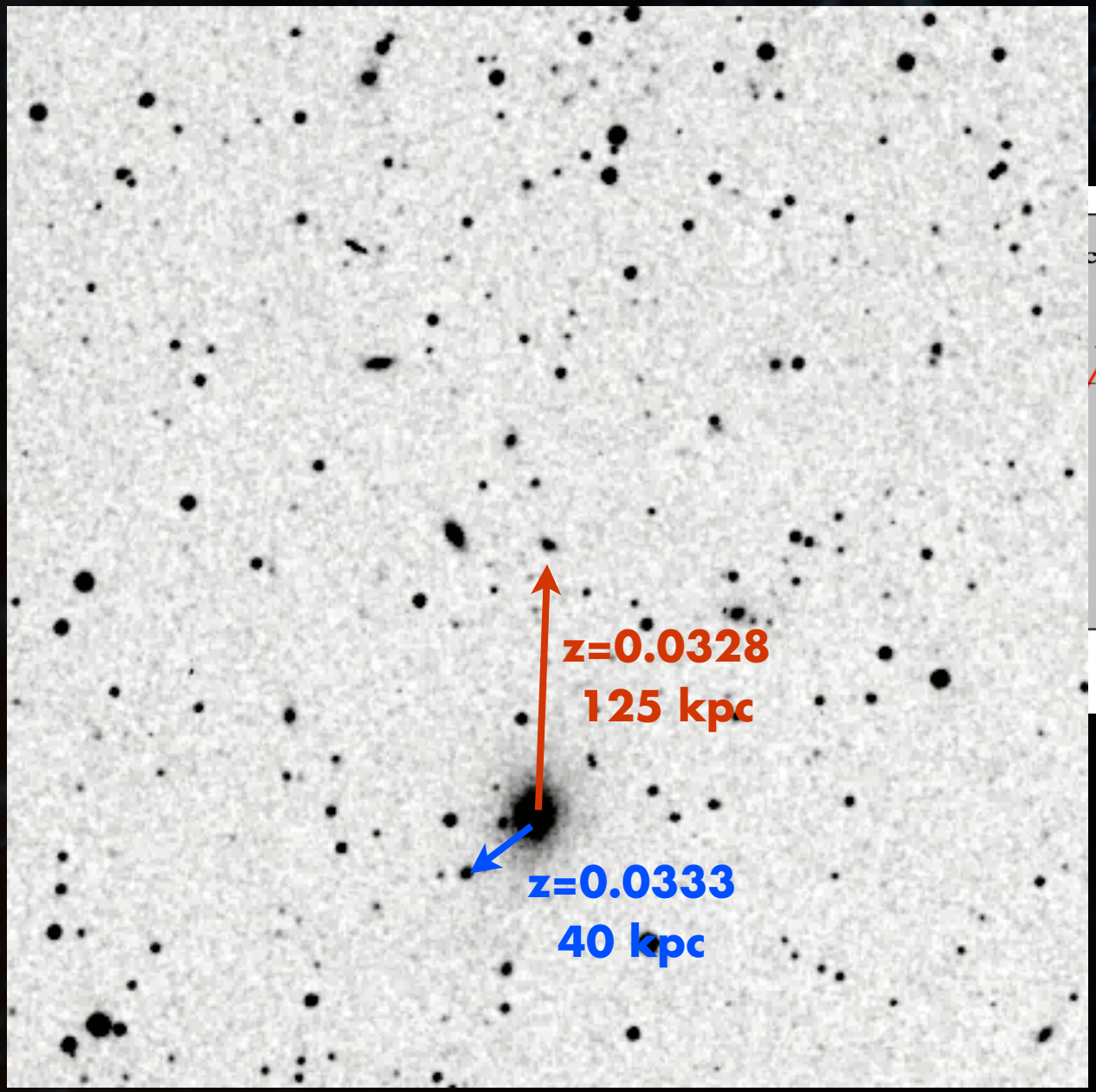
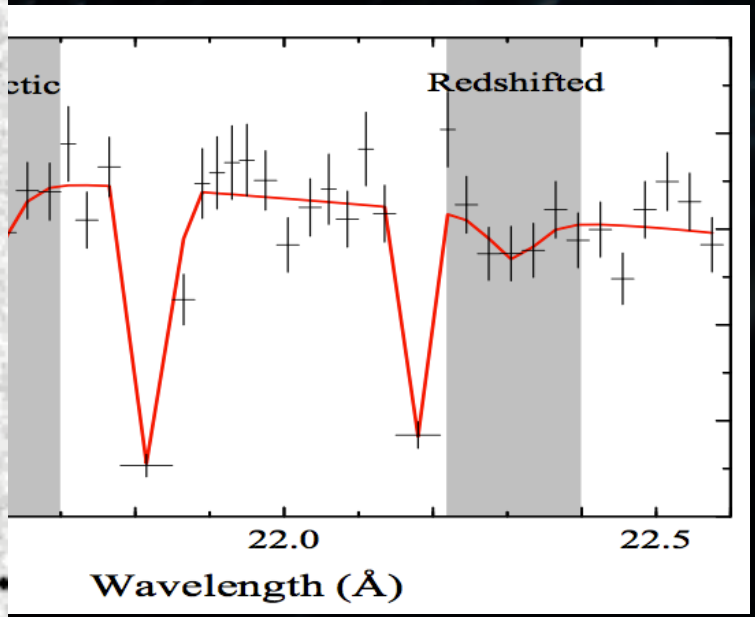
Ren, Fang, & Buote (2014)

Hercules Supercluster

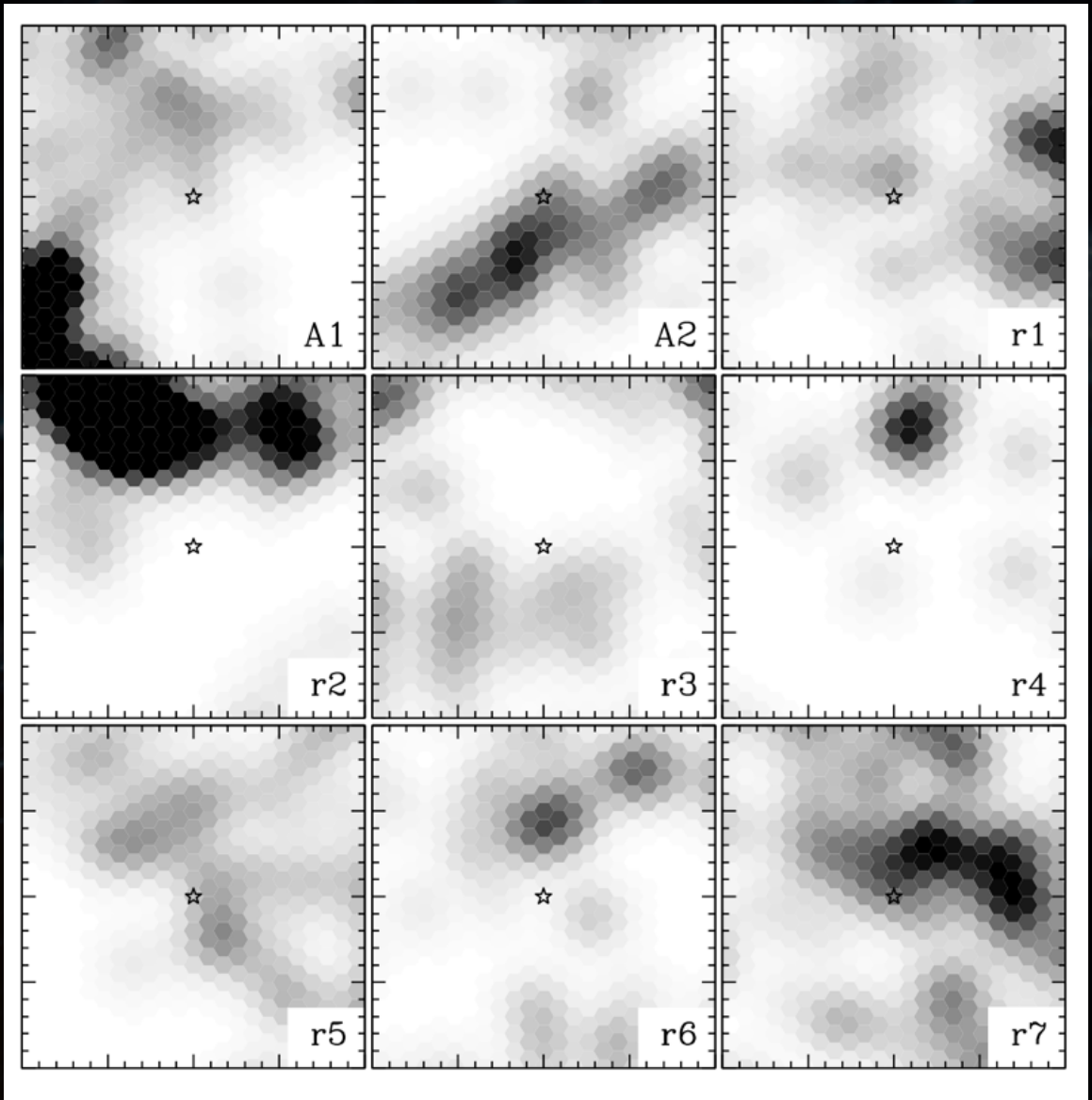




z=0.0329

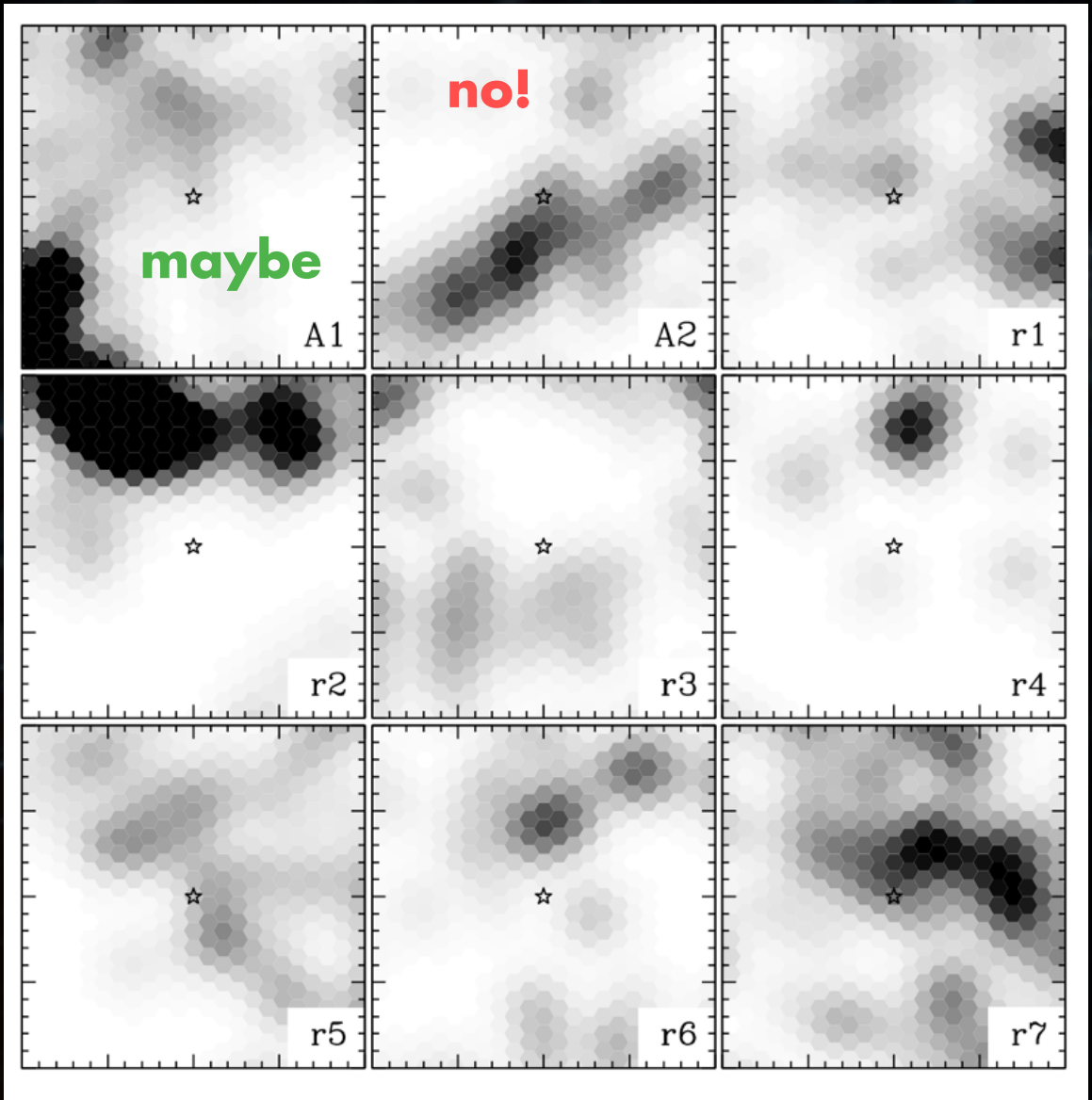
Ren, Fang, & Buote (2014)

Chance projection?



RJW, Mulchaey, Kollmeier, Cox (2010)

Chance projection?



RJW, Mulchaey, Kollmeier, Cox (2010)