The environment of AGN at z~1

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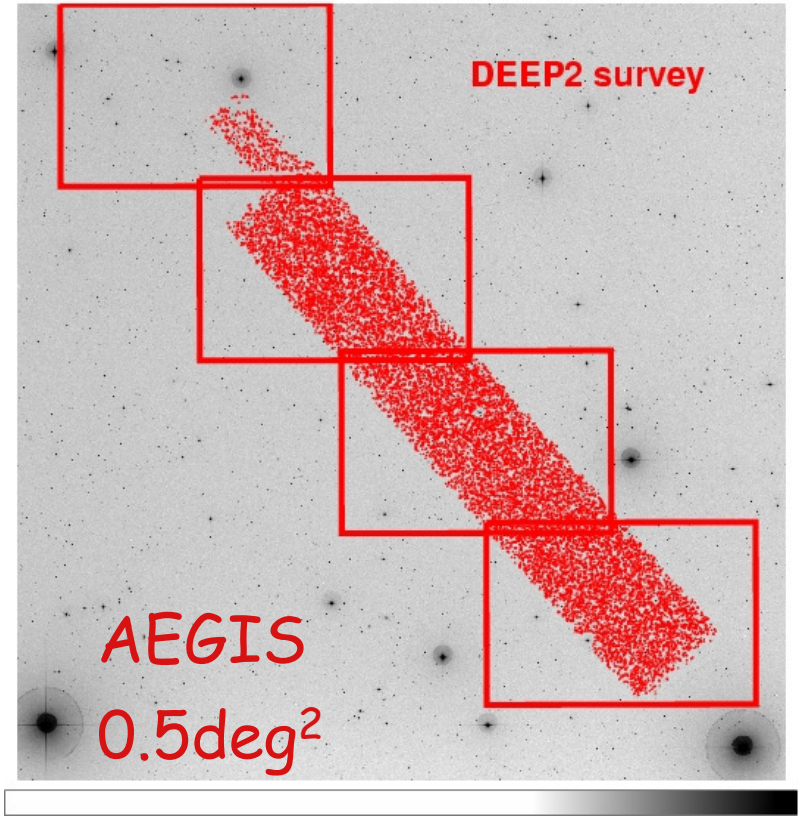
K. Nandra & the AEGIS collaboration

All-wavelength Extended Groth strip International Survey (AEGIS)

- Wide area (0.5deg^2; ~15Mpc at z~1)
- DEEP2: 9000 redshifts, (R<24.1 to z=1.4)
- Deep Chandra data:
  - 200ks per pointing
  - L_X~10^{42}erg/s @ z~1



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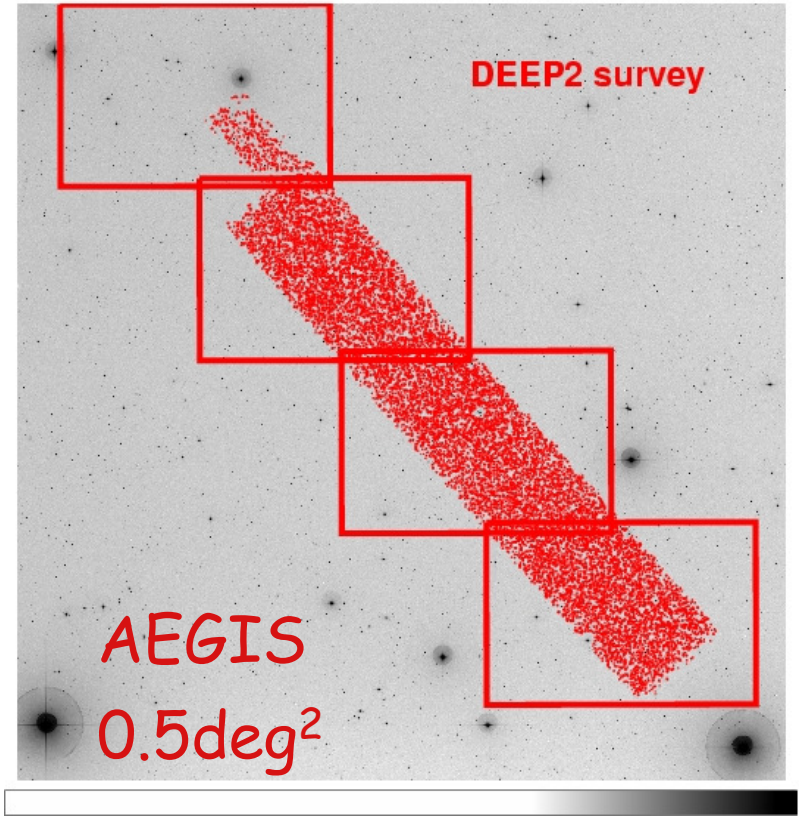

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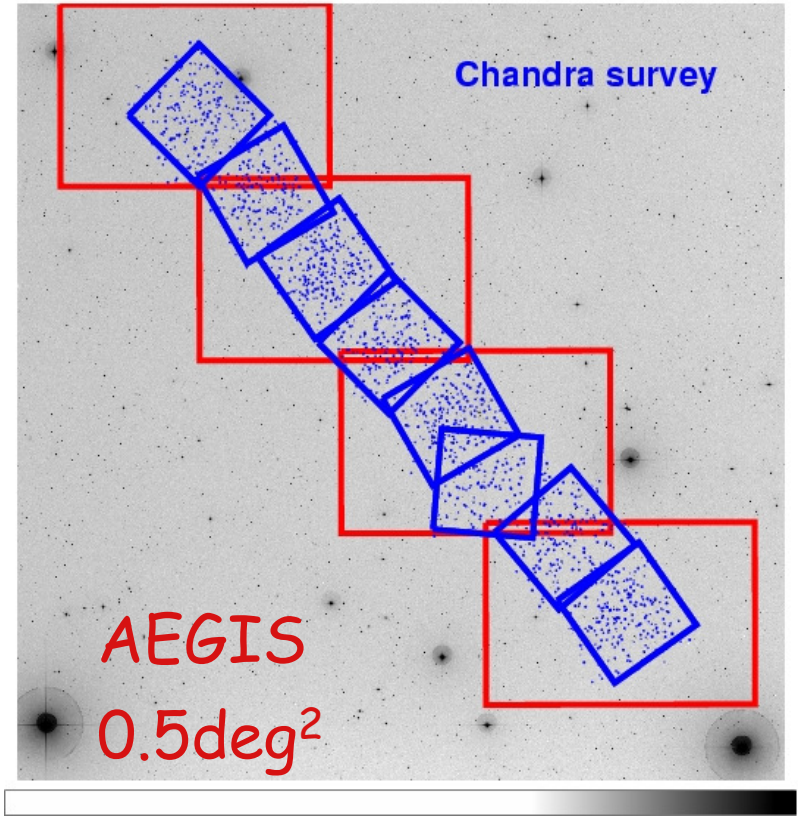
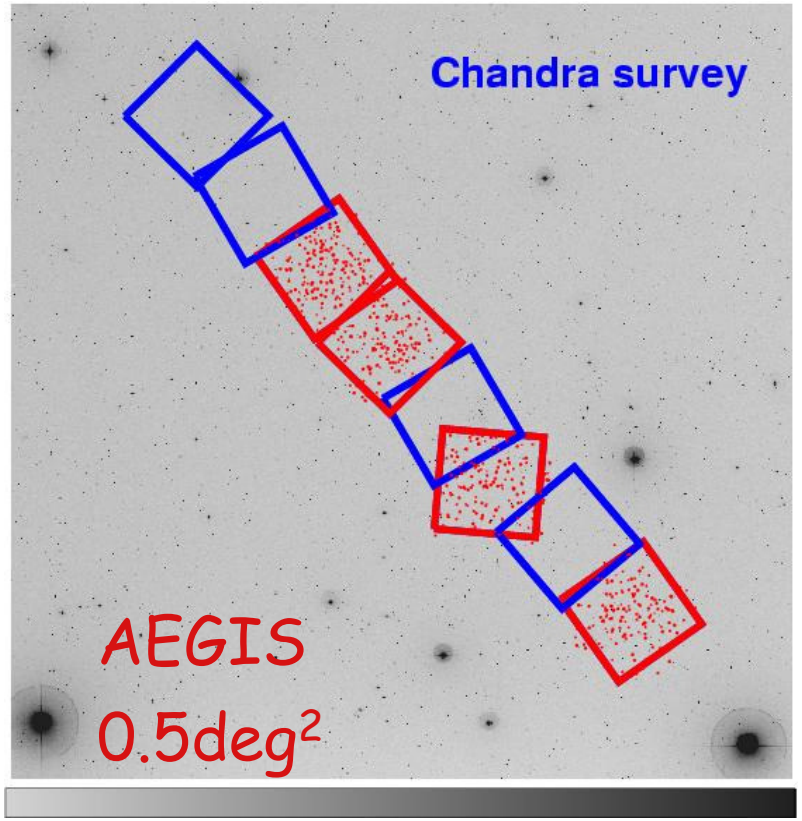


All-wavelength Extended Groth strip International Survey (AEGIS)

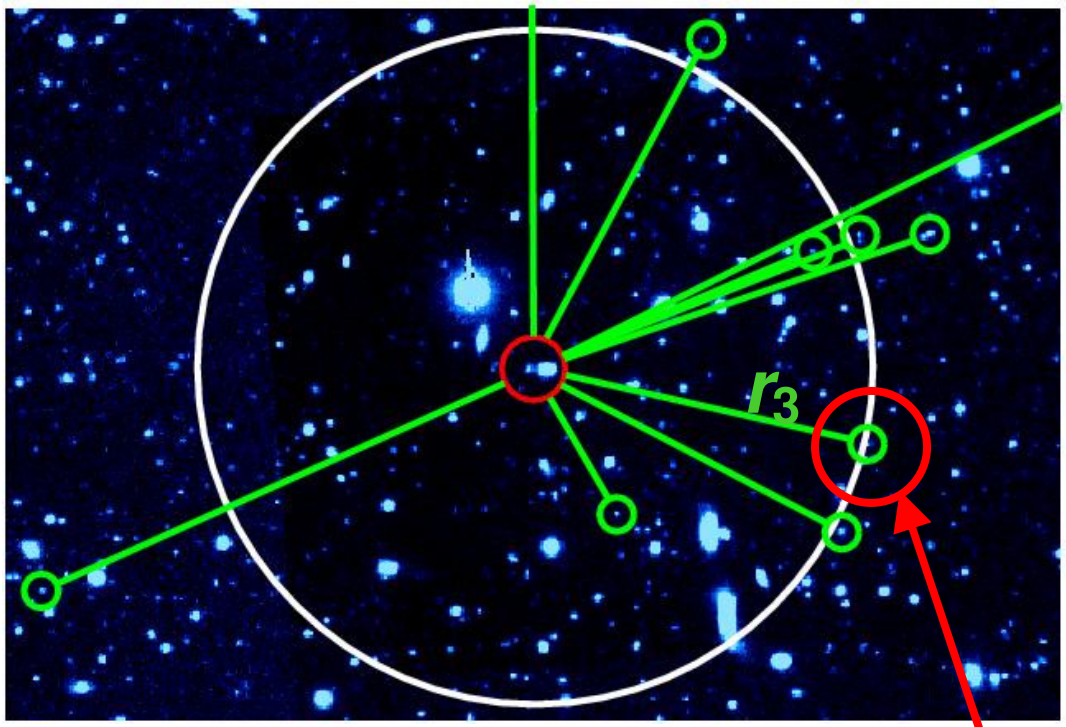
- Select systems with
  - $0.7<z<1.4$
  - $18.5<R<24.1$mag

- 77 X-ray sources (AGN)
- 5500 optical galaxies (comparison sample)



Environment estimator: projected surface density (δ_3)

Cooper et al. 2005, 2006

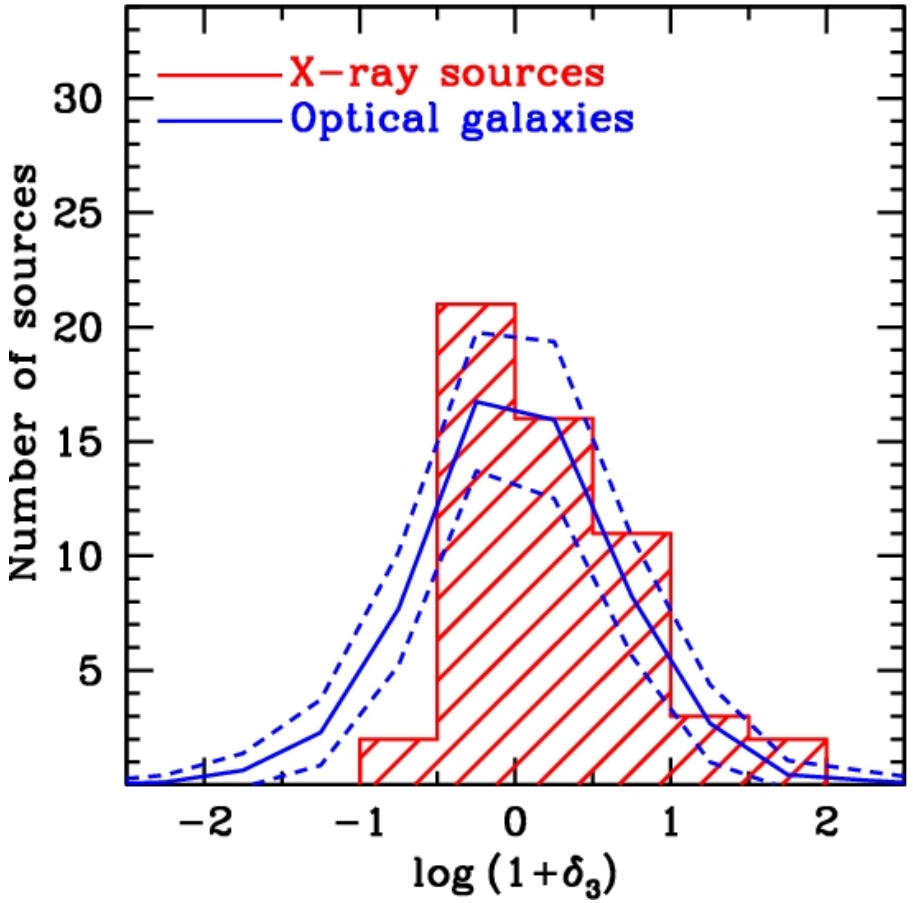


- Pick X-ray source
- Search for neighbours within $\Delta v = \pm 1000$km/s
- r_3: projected distance to 3rd nearest neighbour.
- projected density:

$$\delta_3 = 3/\pi r^2_3$$

3rd nearest neighbor

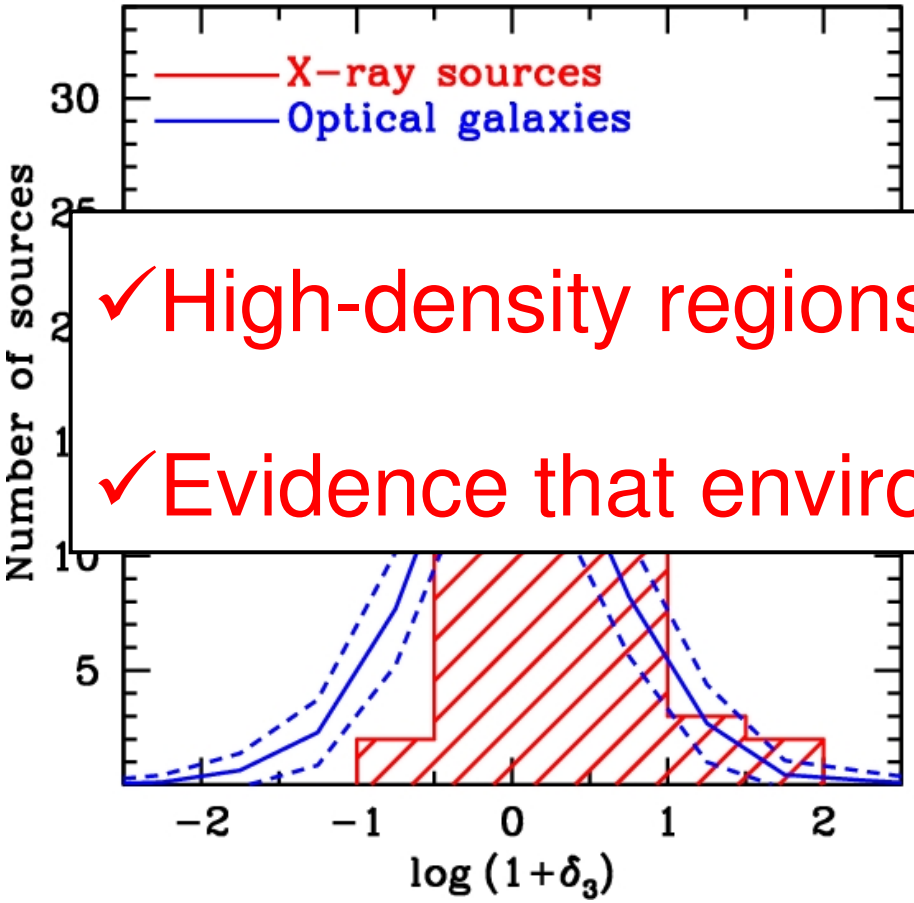
What is the environment of X-ray sources?



log(1+δ_3) distribution:

- Control sample: randomly select optical galaxies
- X-ray and control samples different (99.89%)
- Opposite to low-*z* AGN (e.g. Kauffmann et al. 2004)

What is the environment of X-ray sources?



log(1+δ_3) distribution:

- Control sample:

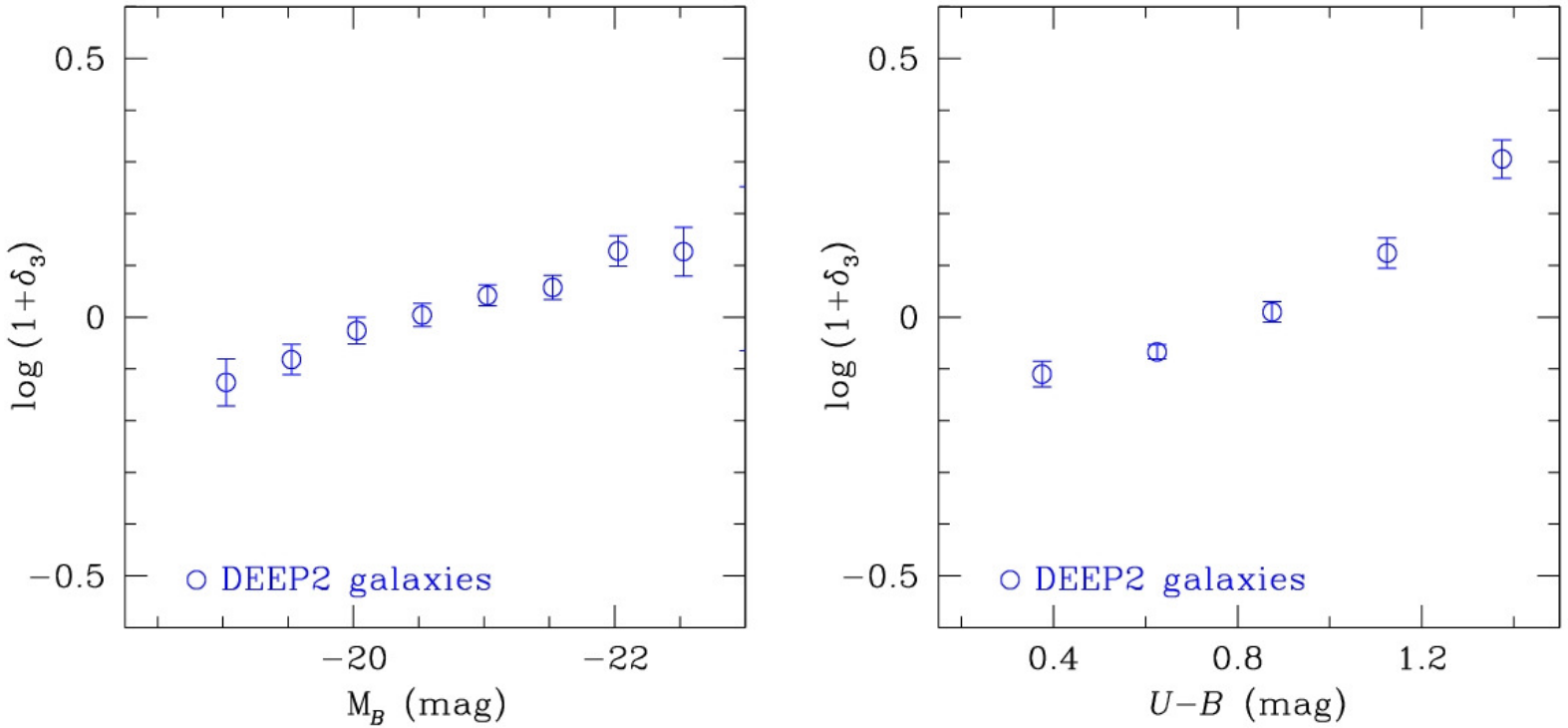
✓High-density regions more active at *z*~1

✓Evidence that environment triggers AGN?

(99.89%)

- Opposite to low-*z* AGN (e.g. Kauffmann et al. 2004)

Galaxies: M_B and U-B dependence on density

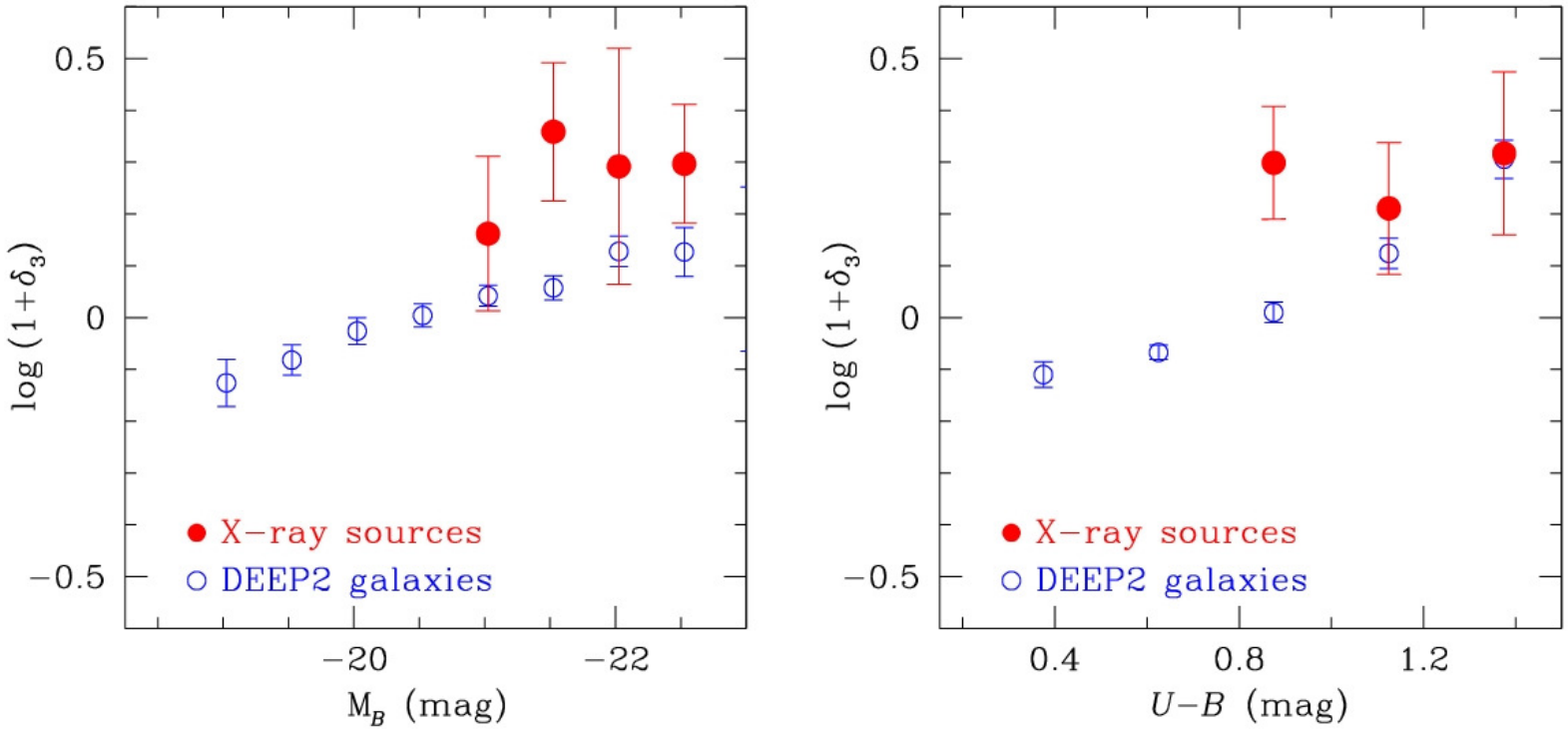


Luminous & red: high densities

Faint & blue: low densities

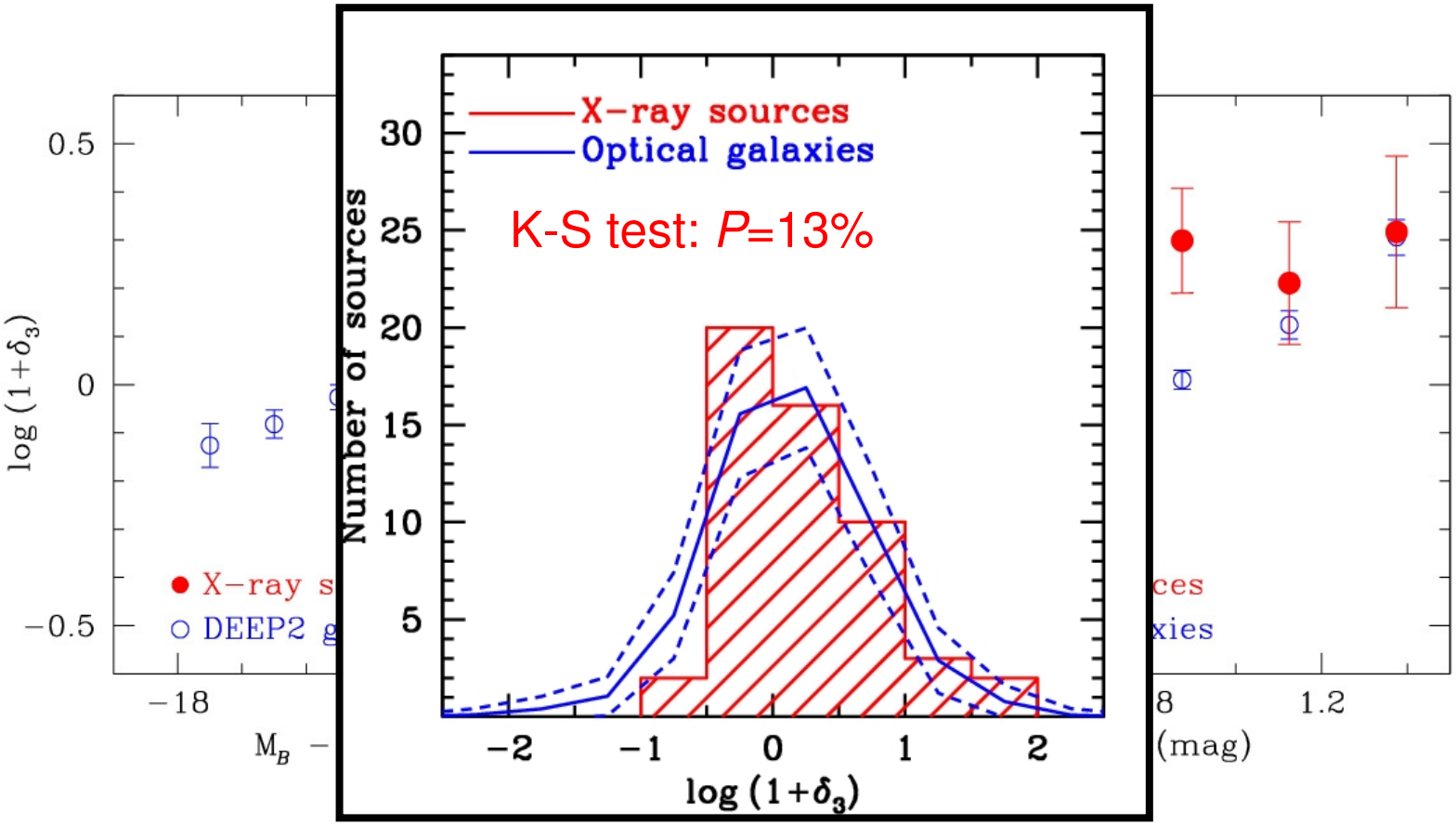
Cooper et al. 2006

AGN hosts: M_B and U-B dependence on density



X-ray sources at z~1: luminous (M_B<–20) red (U-B>0.8) hosts

Are AGN biased relative to galaxies?



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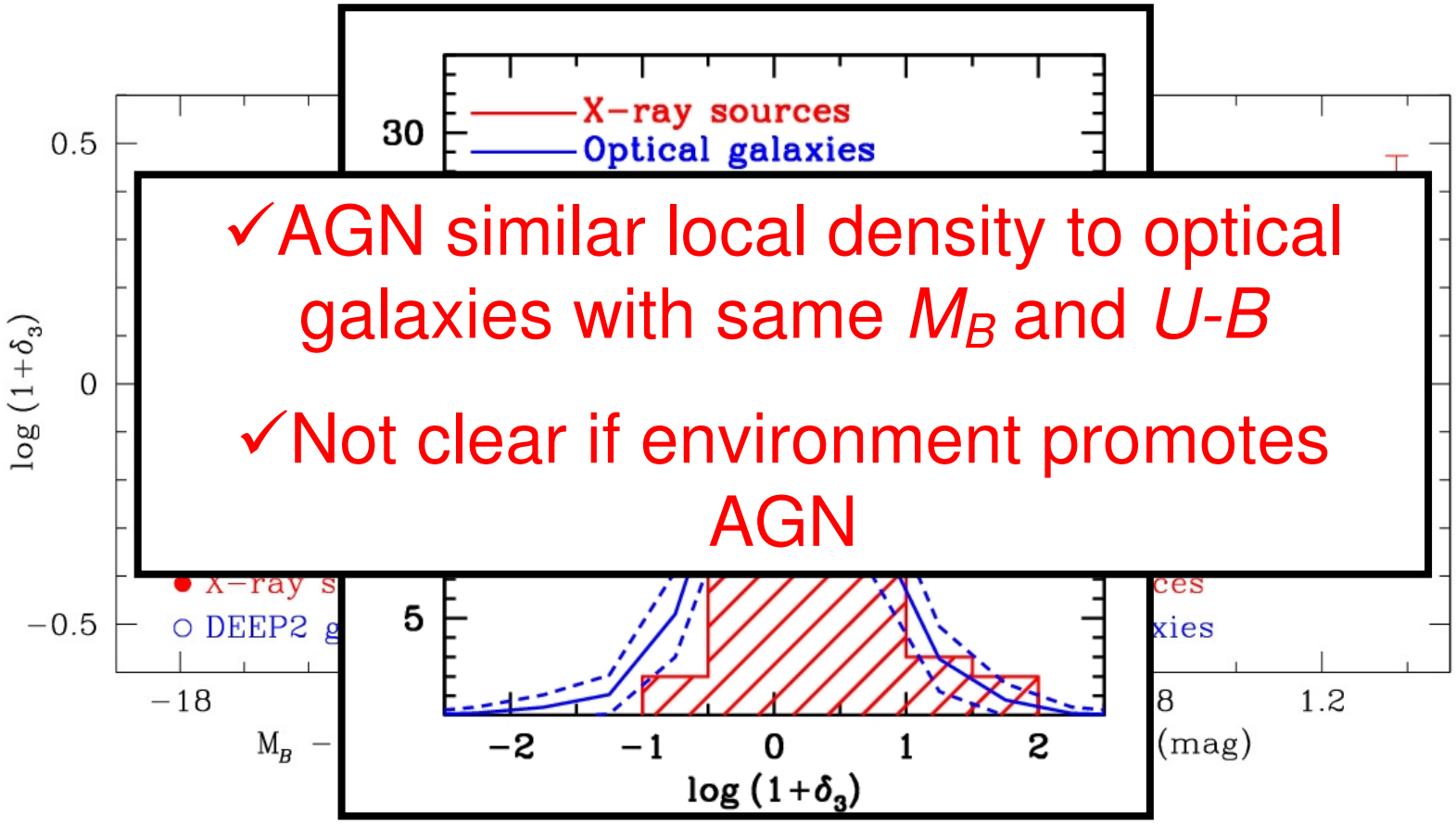

✓AGN similar local density to optical galaxies with same M_B and U-B

✓Not clear if environment promotes AGN

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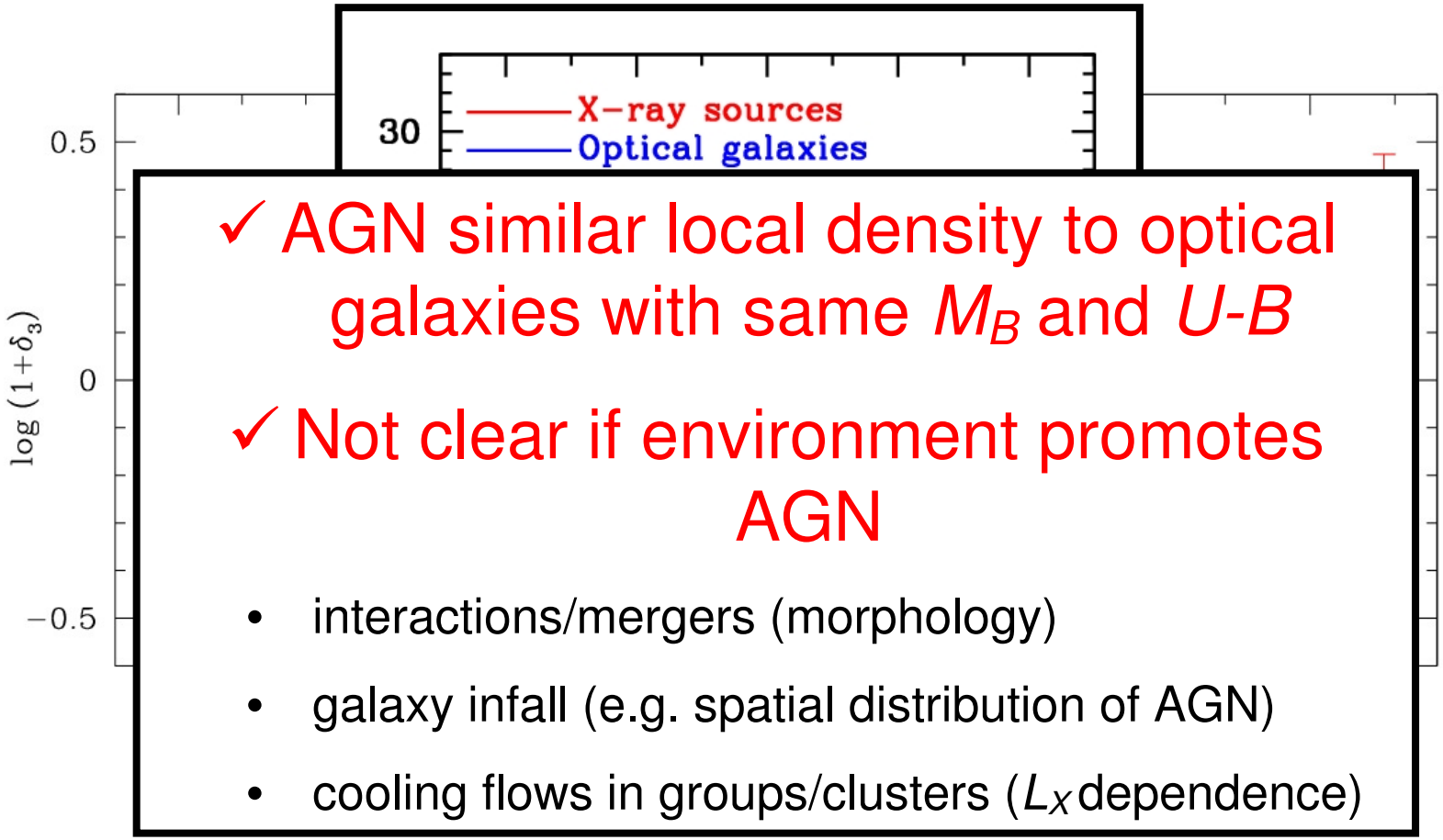


✓ AGN similar local density to optical galaxies with same M_B and U-B

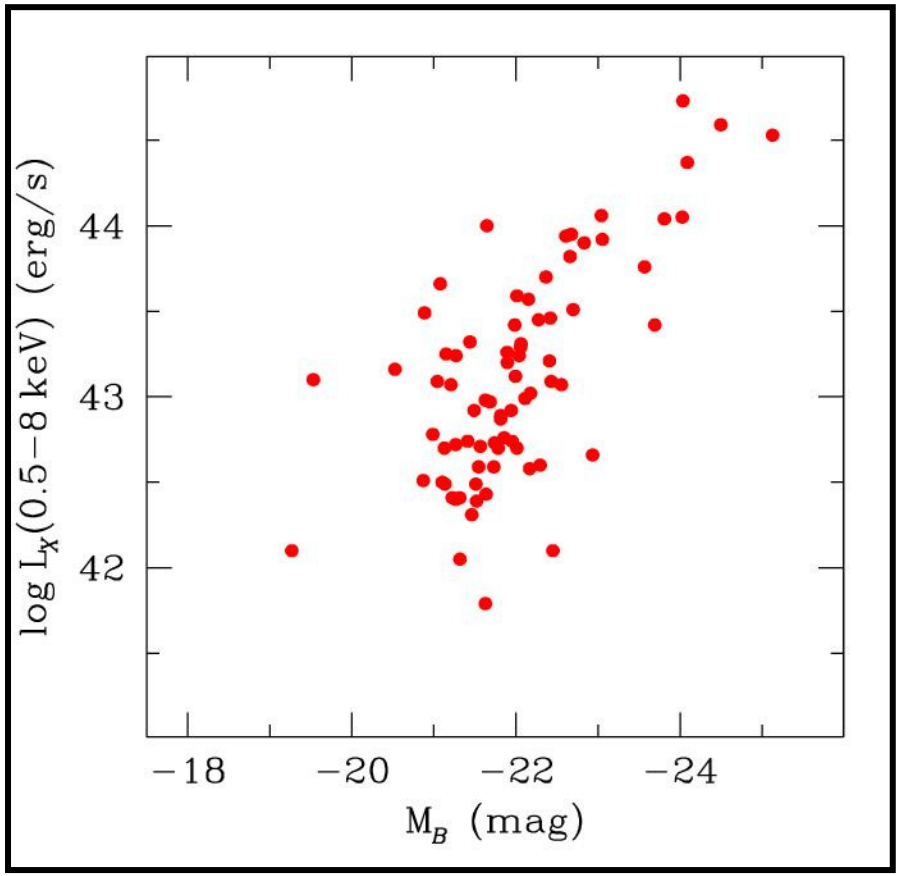
✓ Not clear if environment promotes AGN

- interactions/mergers (morphology)
- galaxy infall (e.g. spatial distribution of AGN)
- cooling flows in groups/clusters (L_X dependence)

Conclusions

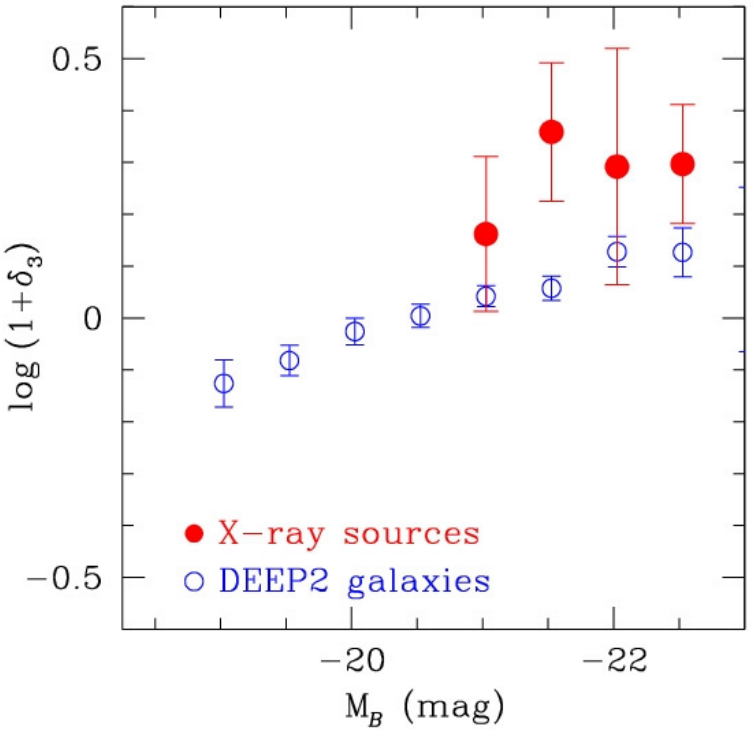
- AGN at z~1:
  - hosted by luminous/red galaxies
  - associated with rich environment
  - unbiased relative to galaxies of similar M_B and U-B
- Does environment promote AGN activity?
  - high density regions more active at z~1
  - BUT triggering mechanism not clear
- AEGIS can constrain different scenarios:
  - interactions/mergers (morphology)
  - galaxy infall (e.g. spatial distribution of AGN)
  - cooling flows in groups/clusters (L_X dependence)

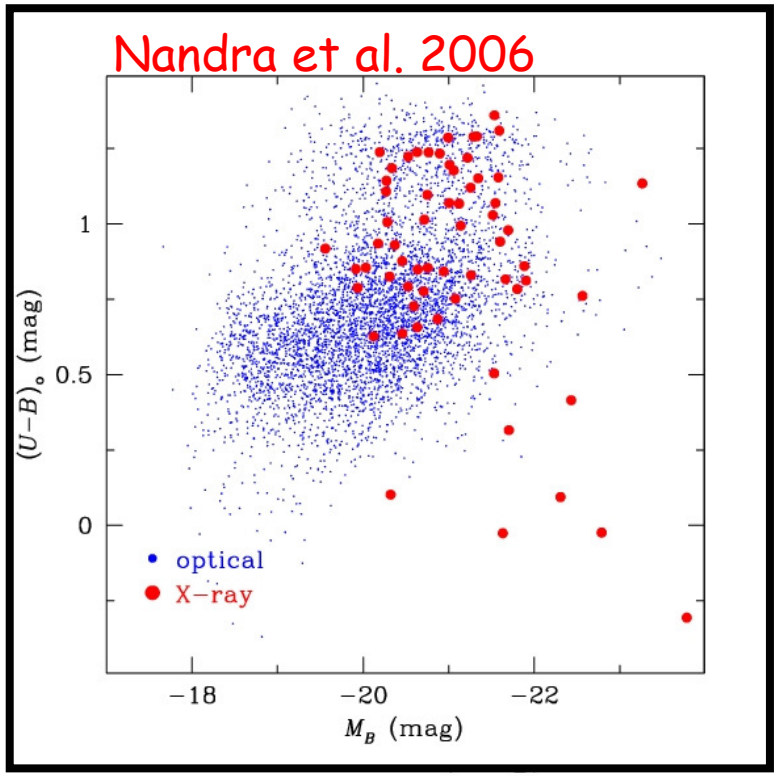
Dependence on M_B



- results not affected by X-ray flux limit
- M_B dependence real

AGN hosts: M_B and U-B dependence on density





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Environment estimator: projected surface density (δ_3)

Cooper et al. 2005, 2006

- **Pick X-ray source**
- Search for neighbors within $\Delta v = \pm 1000$km/s
- $r_{pr,3}$: projected distance to 3rd nearest neighbor.
- $\Sigma_3 = 3/\pi r^2_{pr,3}$: projected density
- Redshift effects: normalise by median Σ_3 at z of source

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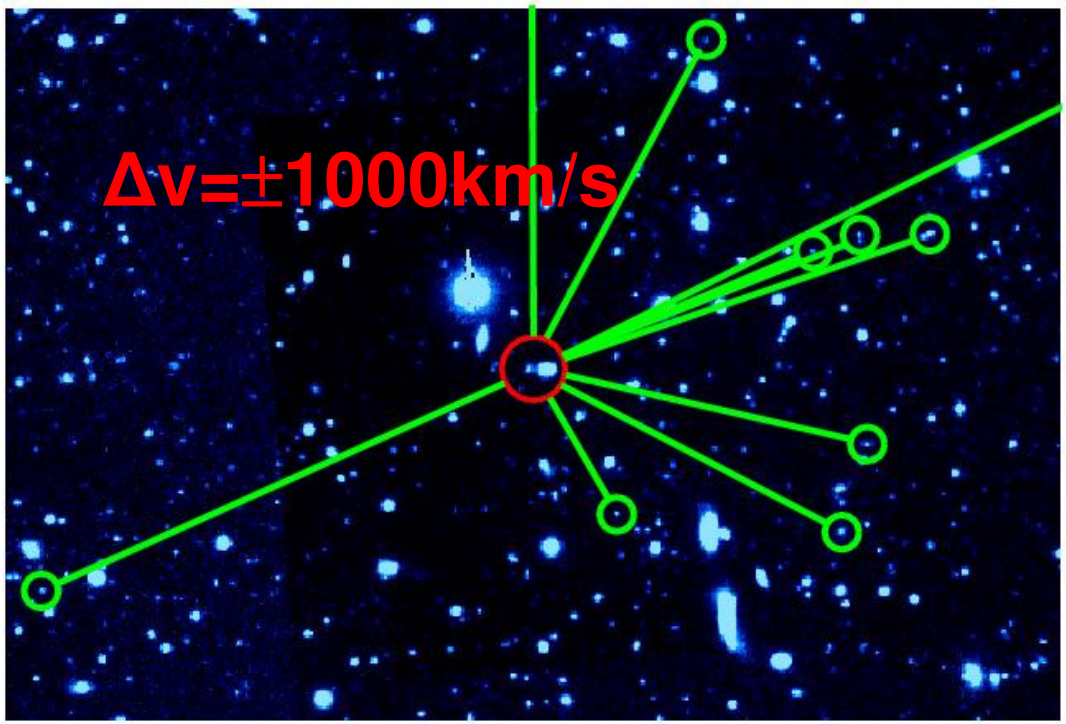

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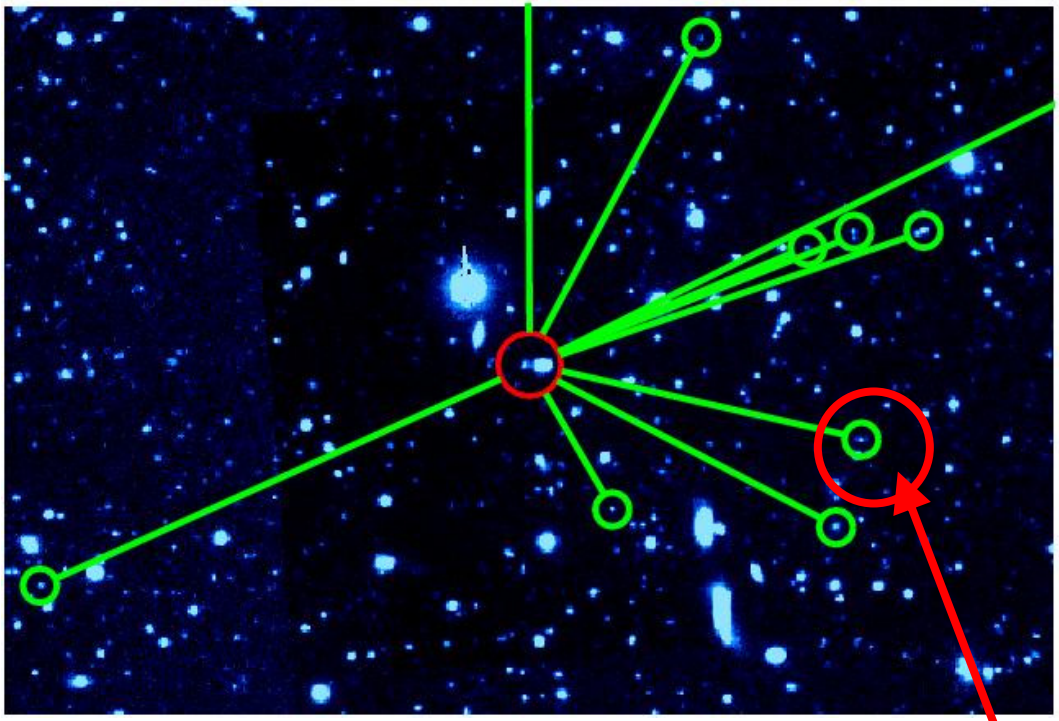

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3rd nearest neighbor

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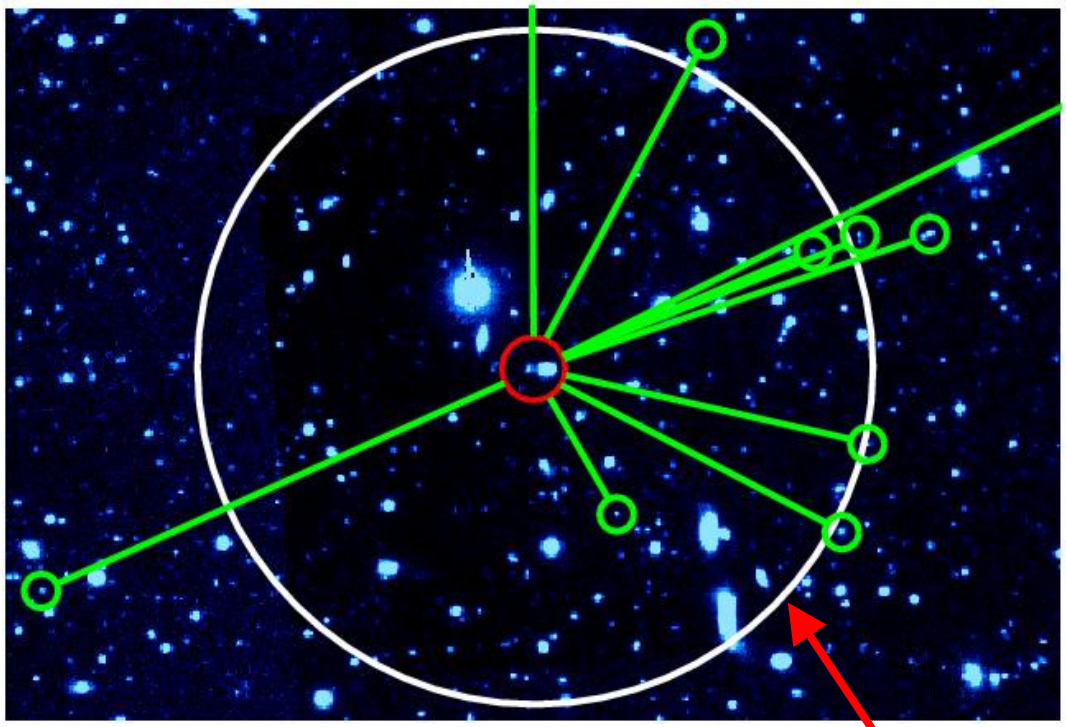

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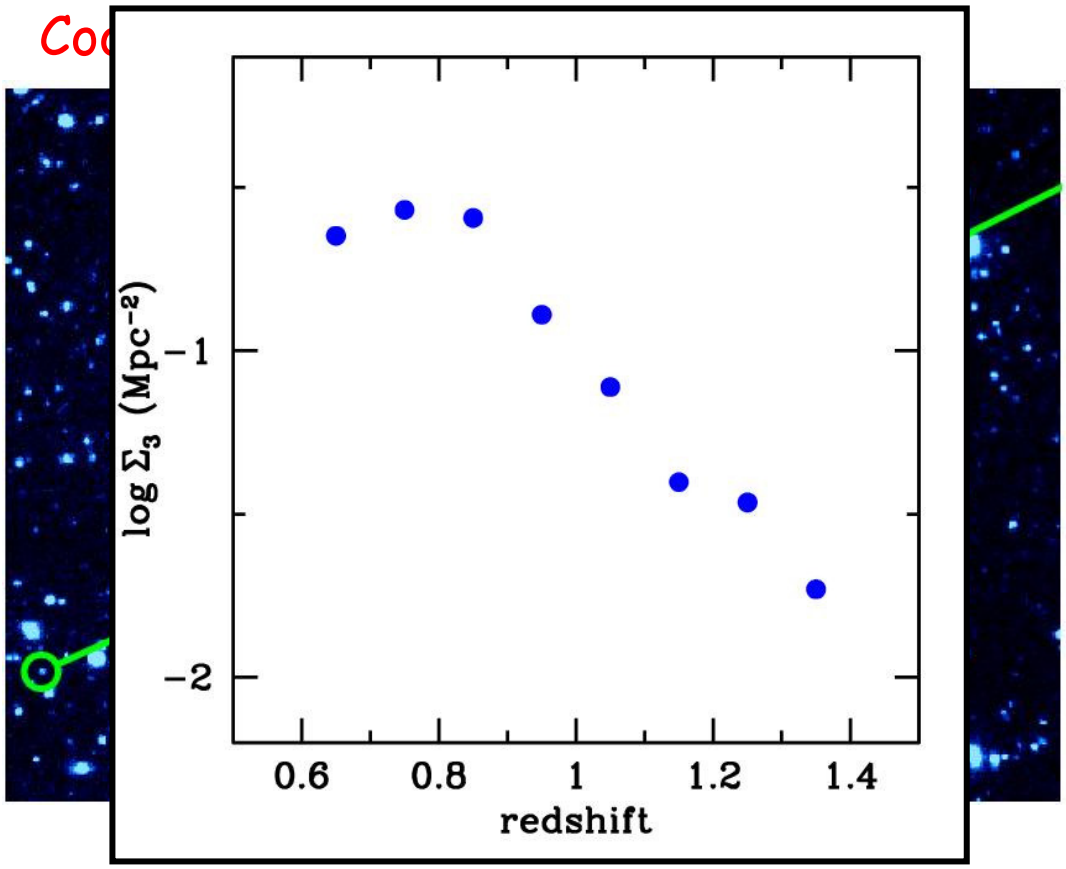
projected density within circle

Environment estimator: projected surface density (δ_3)



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  $1+\delta_3 = \Sigma_3/\mathrm{median}(\Sigma_3)$