Science and strategy with PFS

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PFS has unique characteristics. One should make use of them to do things in new and unique ways.

PFS can observe more galaxies and go deeper than current surveys. The real question is: can we learn something new?

Can PSF be used for a new type of measurement?

We should see how it can do things *differently*.

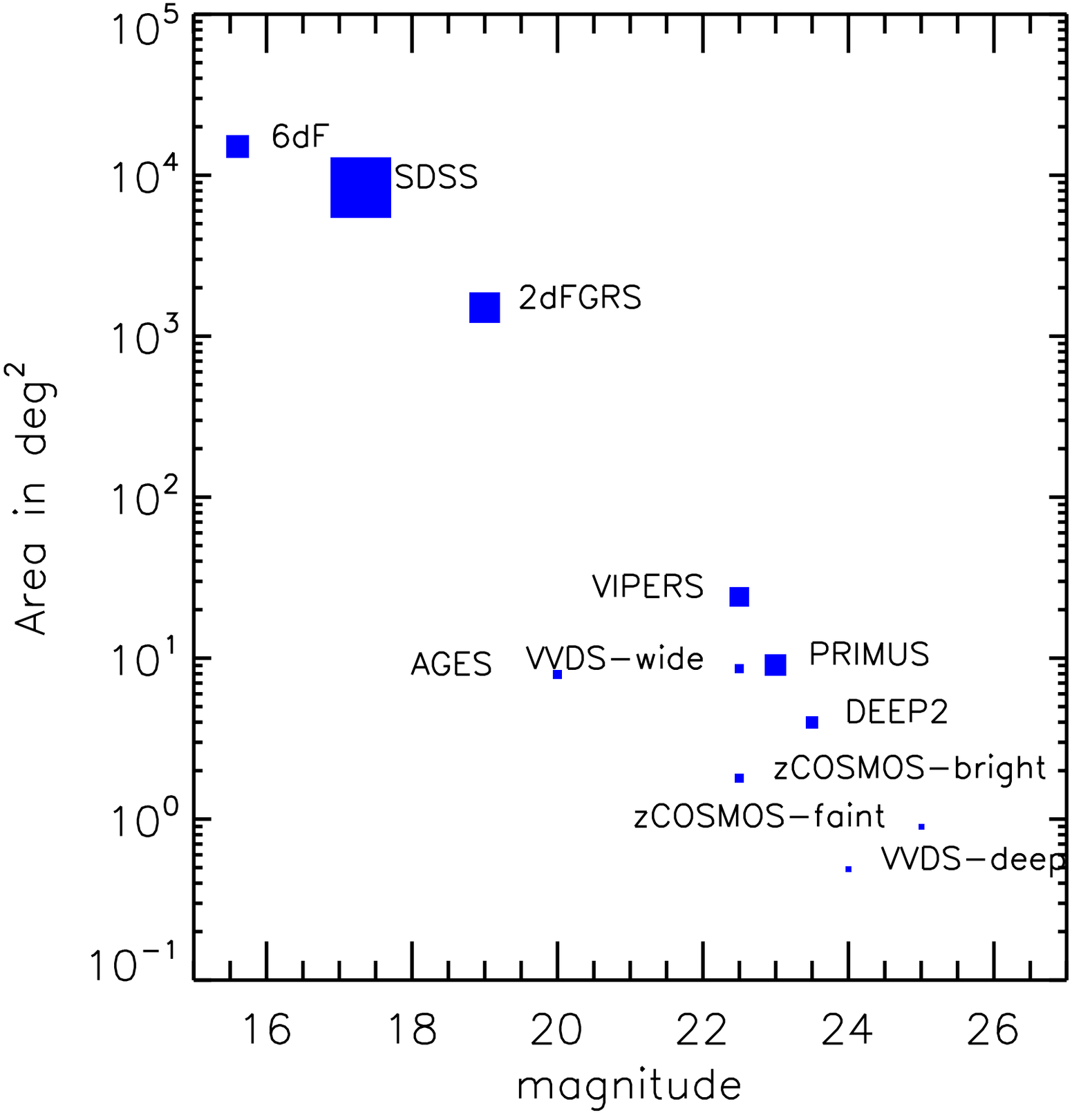
Question: What is the best merit of such a survey?

Survey parameters

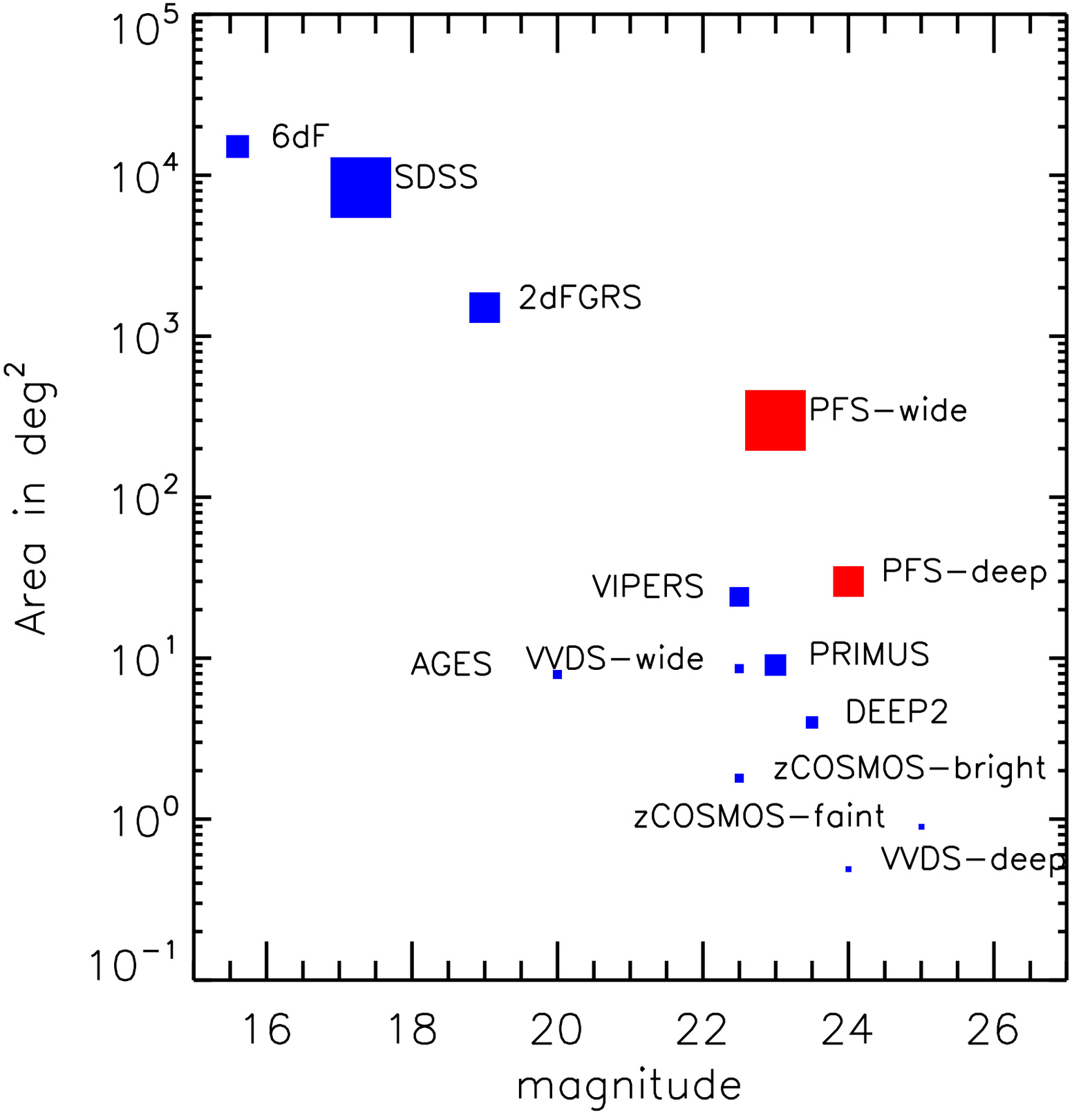
Survey = F (wavelength range / resolution / number of fibers , number of nights , area / depth, ... / sampling)

Fixed — of order ~100 — to be discussed

Survey parameters



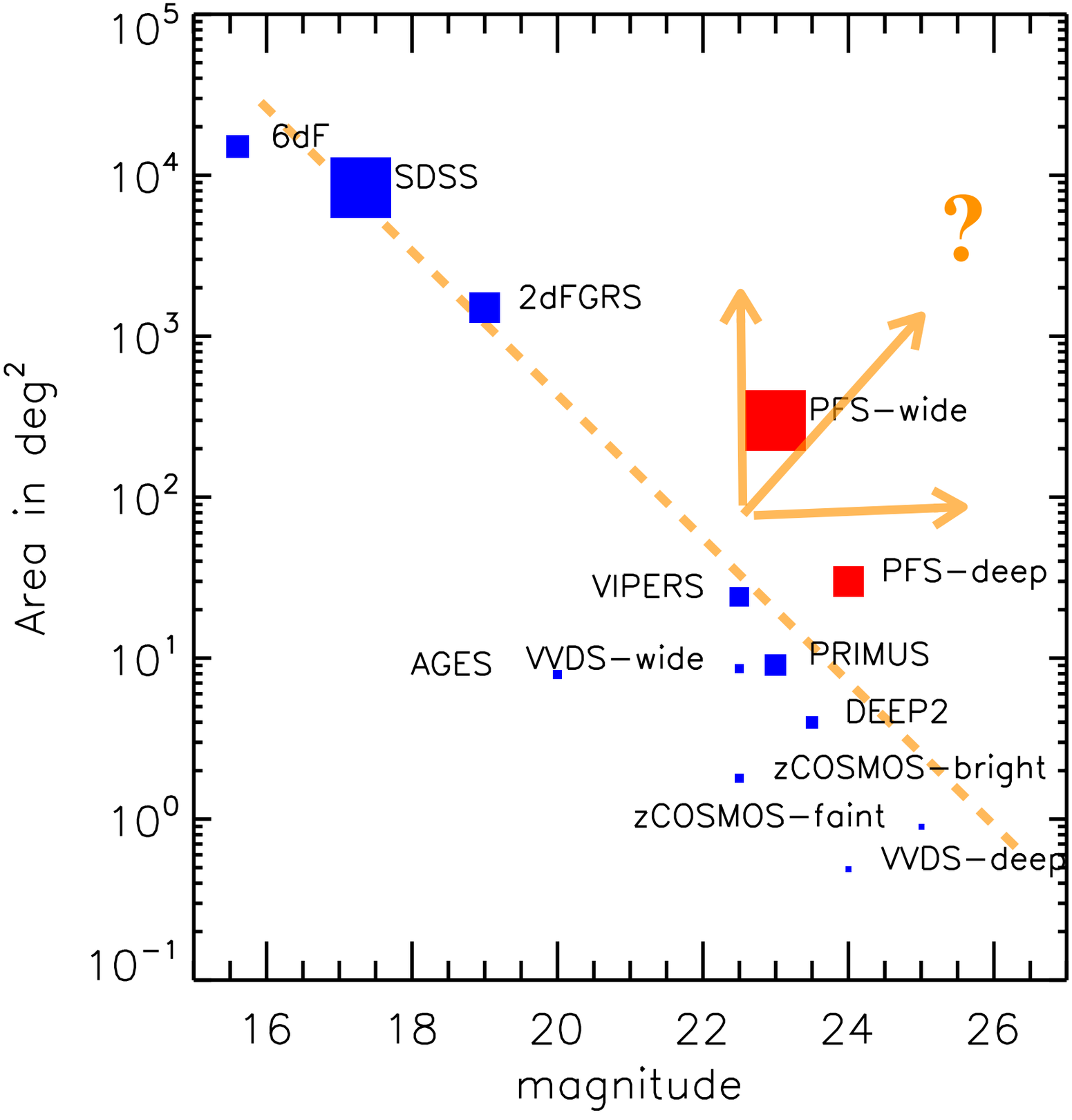
Survey parameters



- **PFS wide:**
  300 deg^2
  m = 23
  1 million galaxies

- **PFS deep:**
  30 deg^2
  m = 24
  250,000 galaxies

Survey parameters



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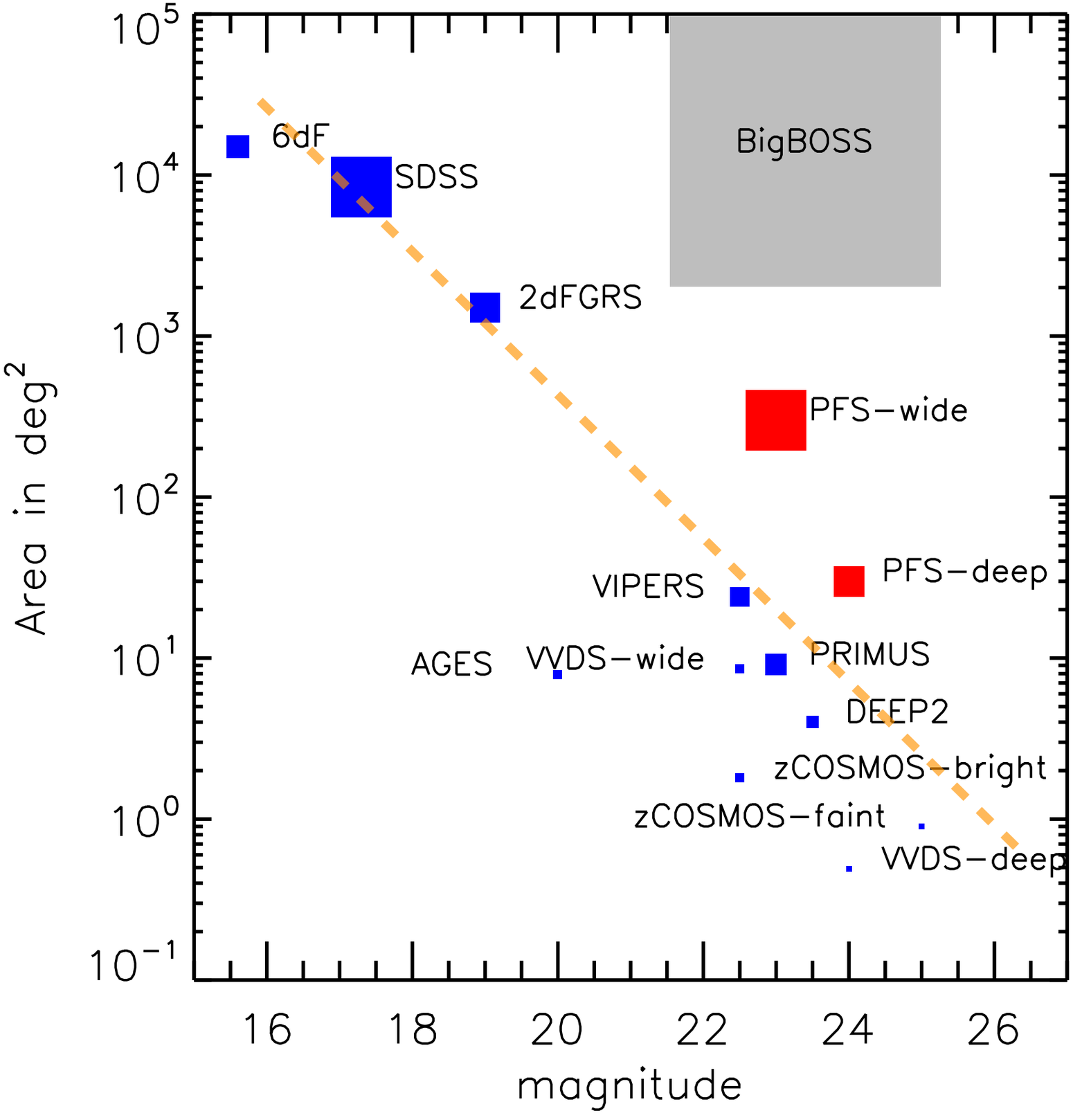

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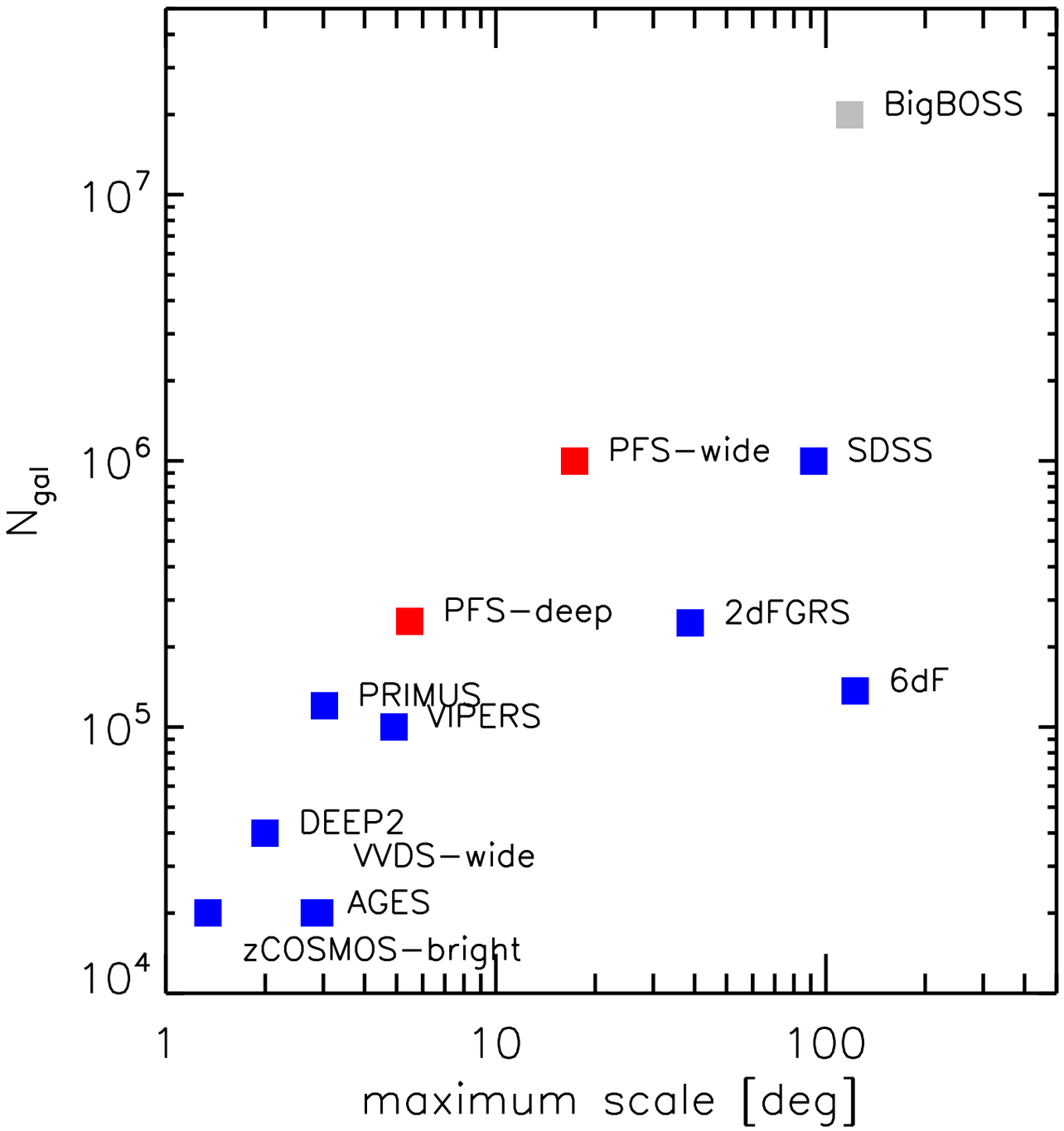
Object-based analyses

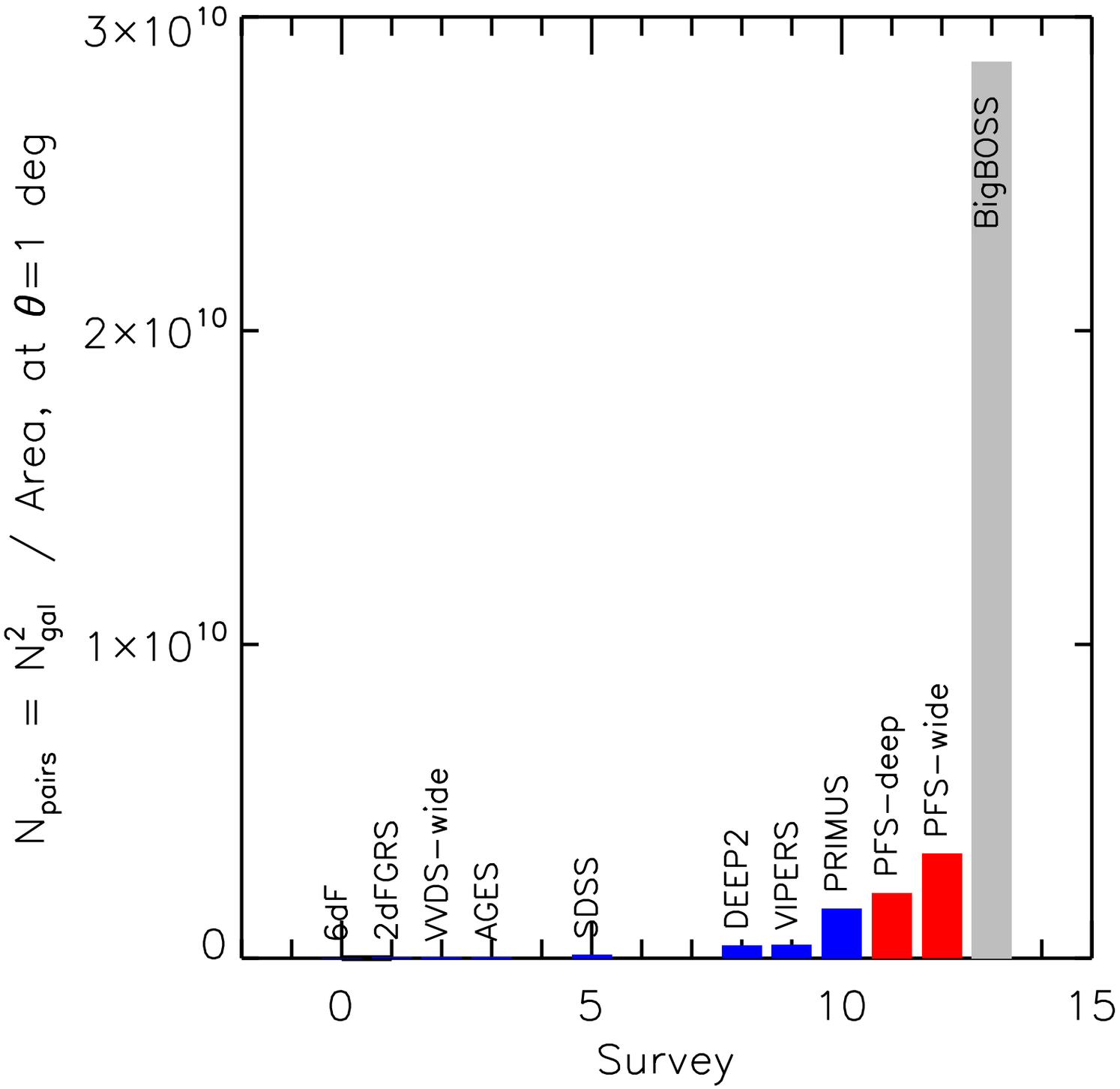


The figure of merit ~ N_{gal}

PFS is not in the best position for:
- finding rare objects
- spatial one-point statistics
- stacking spectra in source rest frame

Spatial analyses

The figure of merit is then ~ Npairs which goes like N_{gal}^2 / Area



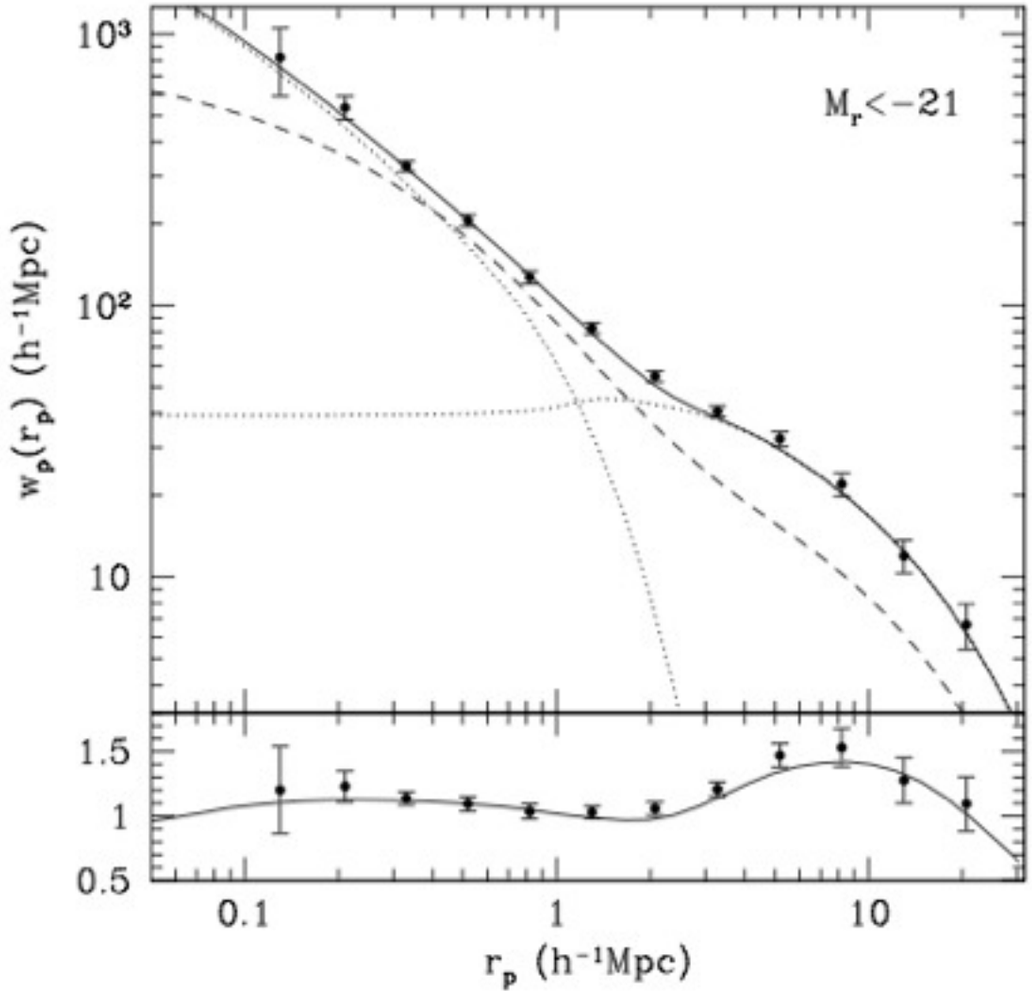
Survey = F (wavelength range, resolution, number of fibers , number of nights , area, depth, ...)

sampling

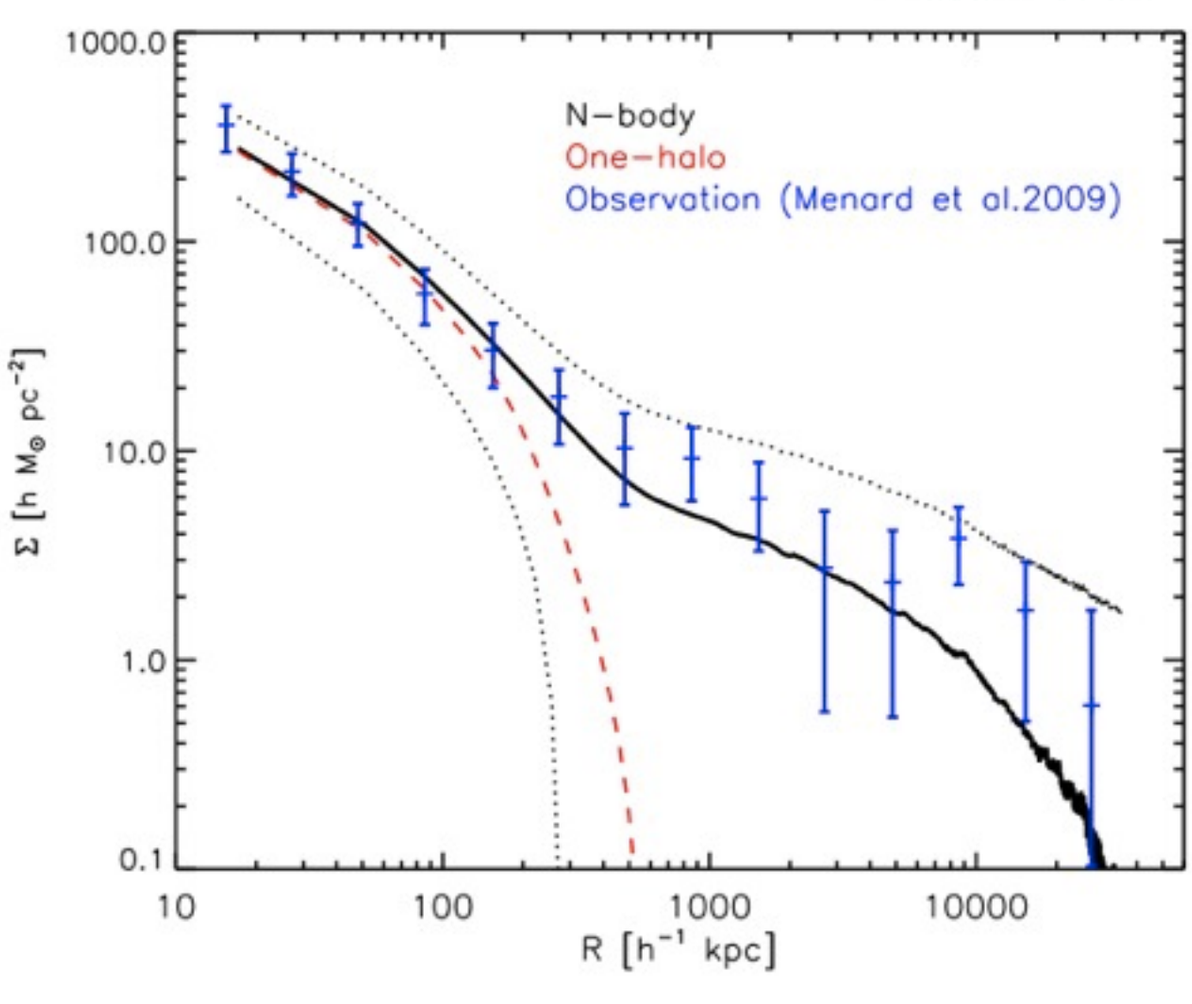
2dF, 6dF, SDSS, BOSS, BigBOSS have sampling limitations due to fiber collision: no sampling on scales smaller than ~1 arcmin

→ this is the galaxy-halo regime

Zehavi et al.

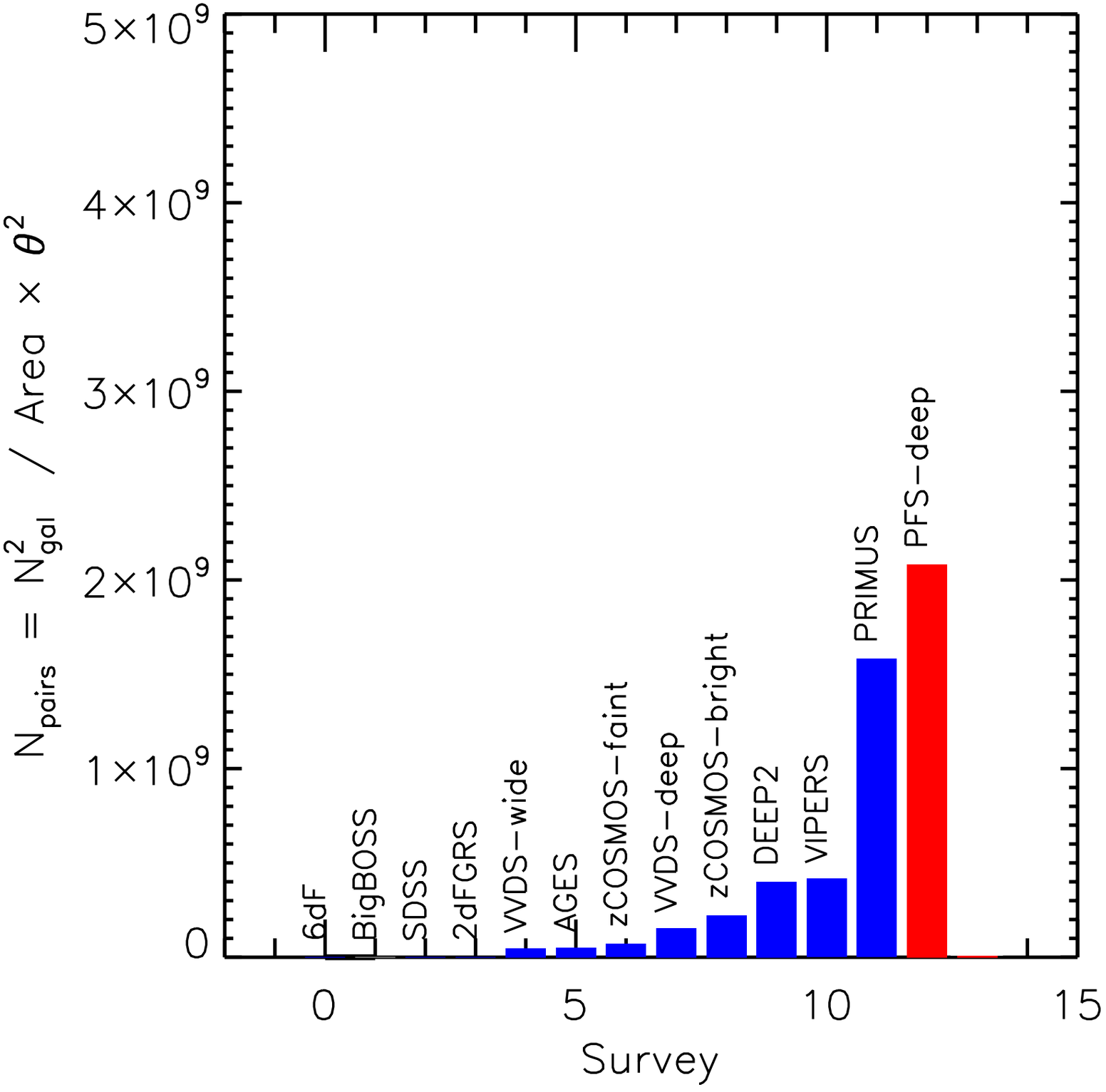


Masaki et al.



A galaxy halo

Spatial analyses in the 1-halo regime



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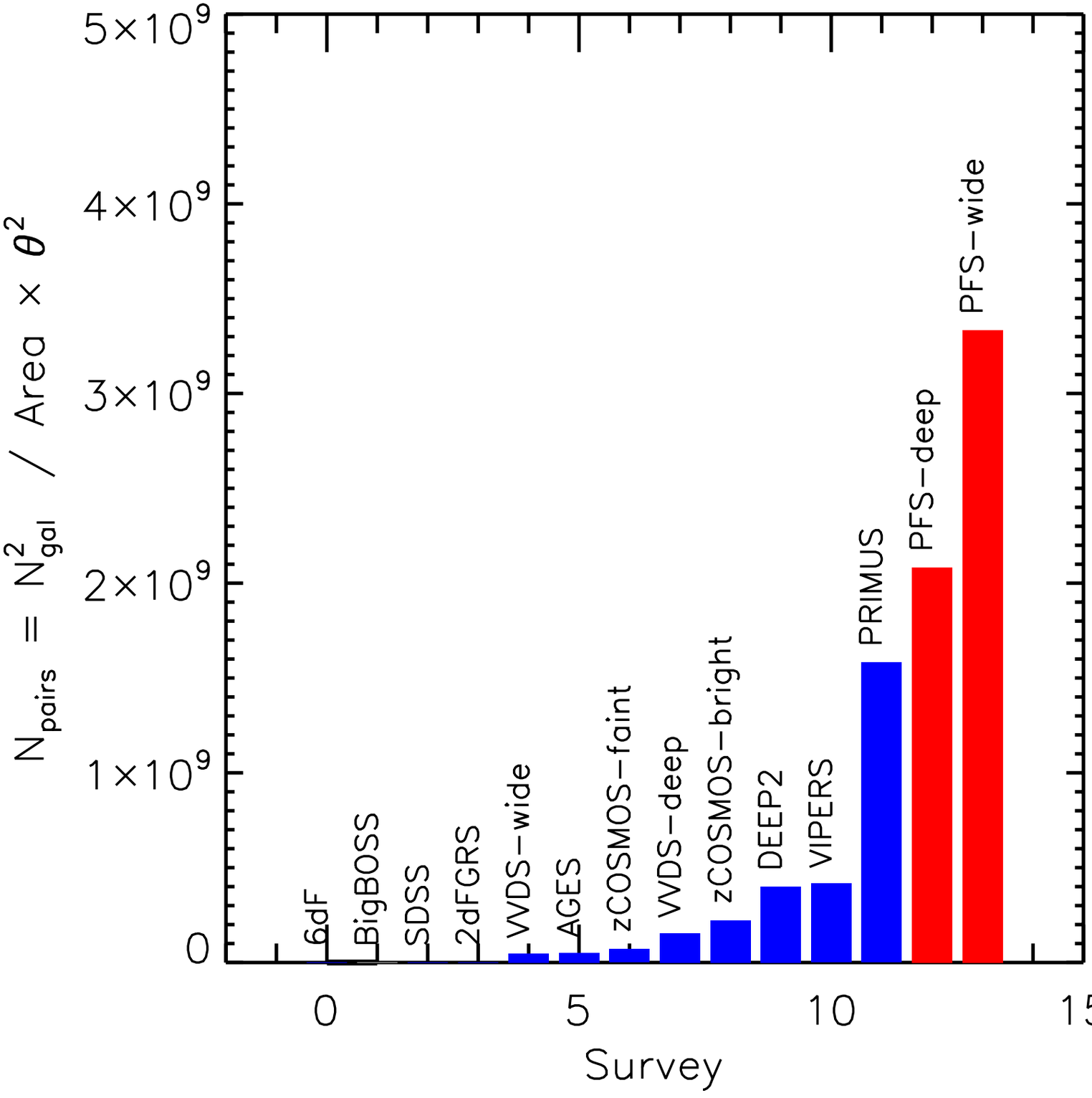


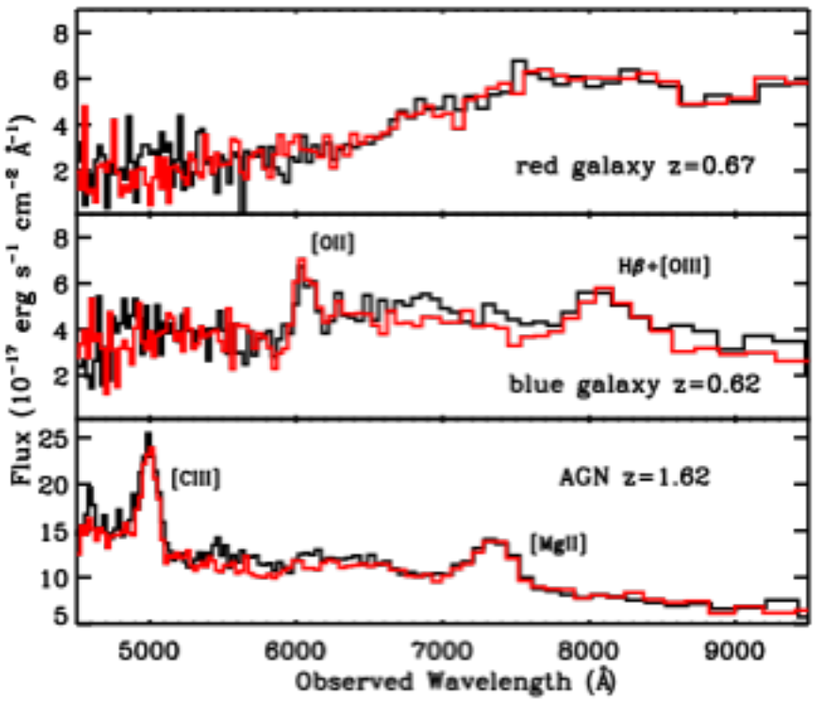
- **PFS wide / 2 visits:**

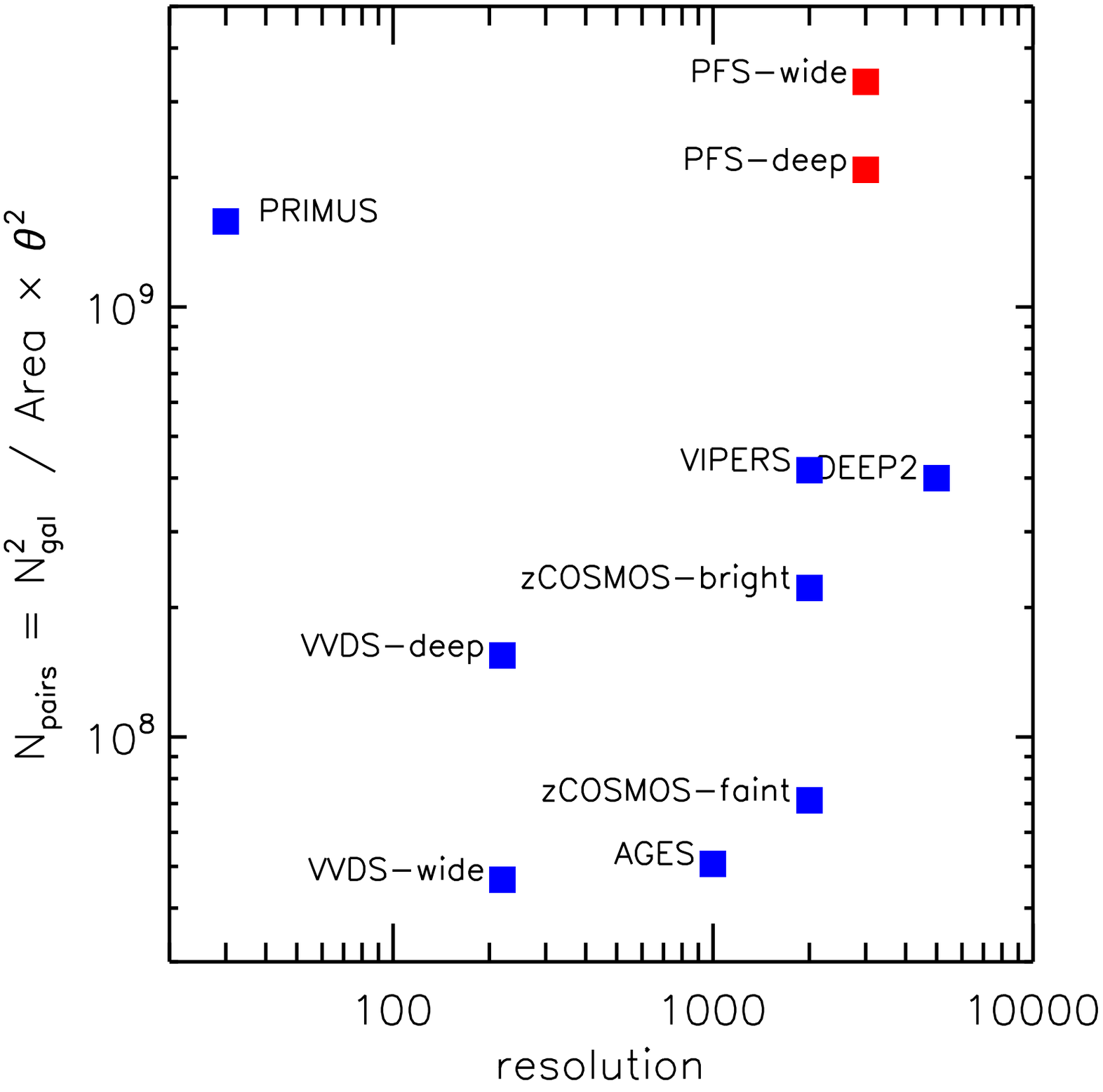
300 =>150 deg^2

m = 23

1 million galaxies

Spatial analyses in the 1-halo regime





Question: What is the best merit of such a survey?

Most of the science is based on the detection of emission lines.
Goal: 2D survey => 3D

5000 pixels => 1 number: redshift

In addition, we get metallicities, SFR, etc.

Table 4.1: Primary and secondary spectroscopic features.

	primary features	secondary features
Redshift measurements	[OII], CaII H+K, G-band, Hβ, MgI, [OIII], Hα	—
SFR measurements	Hα+Hβ, or Hα	Hβ or [OII]
Stellar mass measurements	Hδ and D_{4000} or spec-z and broad-band colors	
AGN identification	Hβ, [OIII], Hα and [NII]	either Hβ+[OIII] or Hα+[NII]
Gas-phase metallicity	[OII], [OIII], Hβ, Hα, [NII]	either [OII]+[OIII]+Hβ or Hα+[NII]
Stellar metallicity	Mg, Hβ, and Fe	—

5000 pixels => a few numbers.
Can we extract more information?

Question: What is the best merit of such a survey?

Question: Can we extract more than a few numbers from the spectra?

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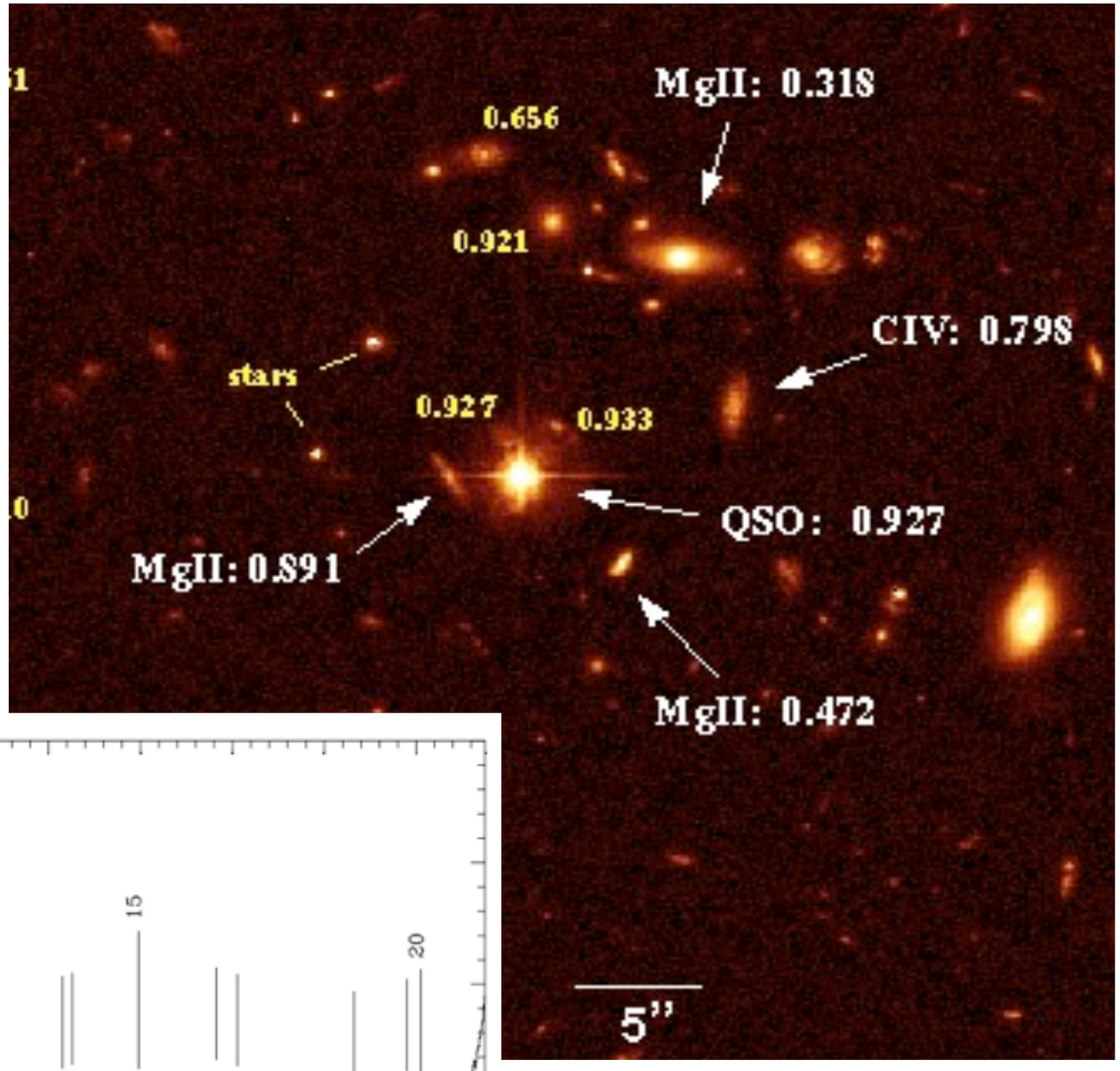
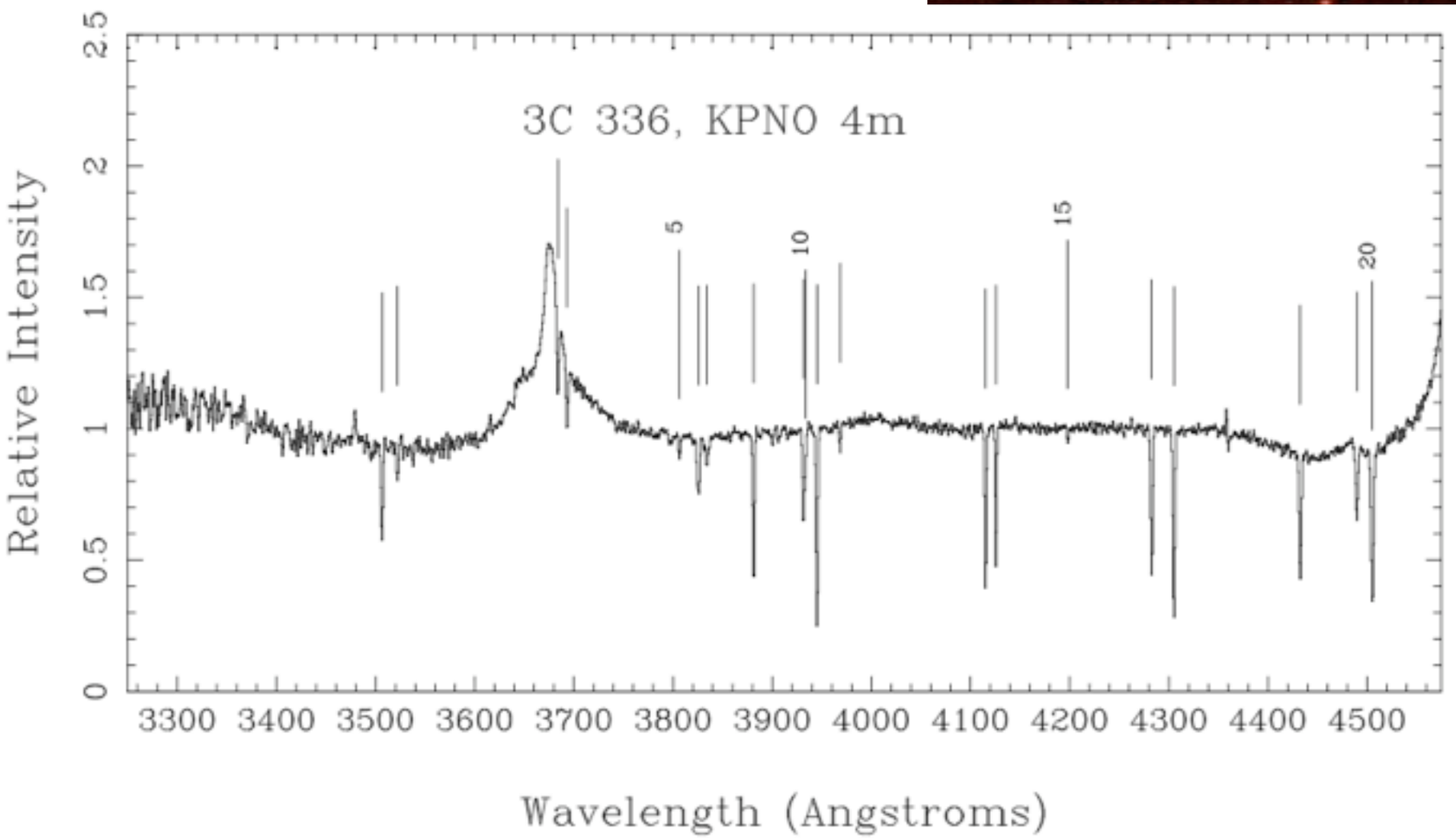
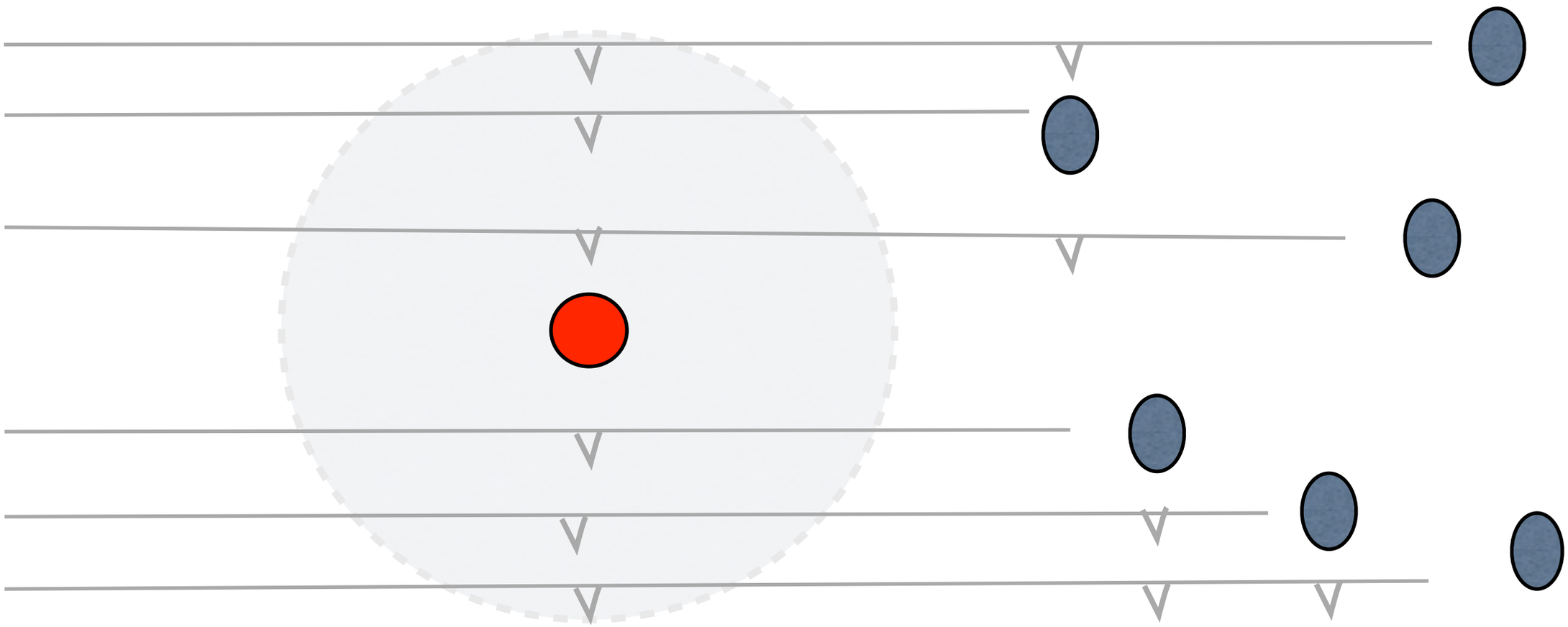
Statistical absorption: a new window on the distribution of baryons

Absorption line spectroscopy



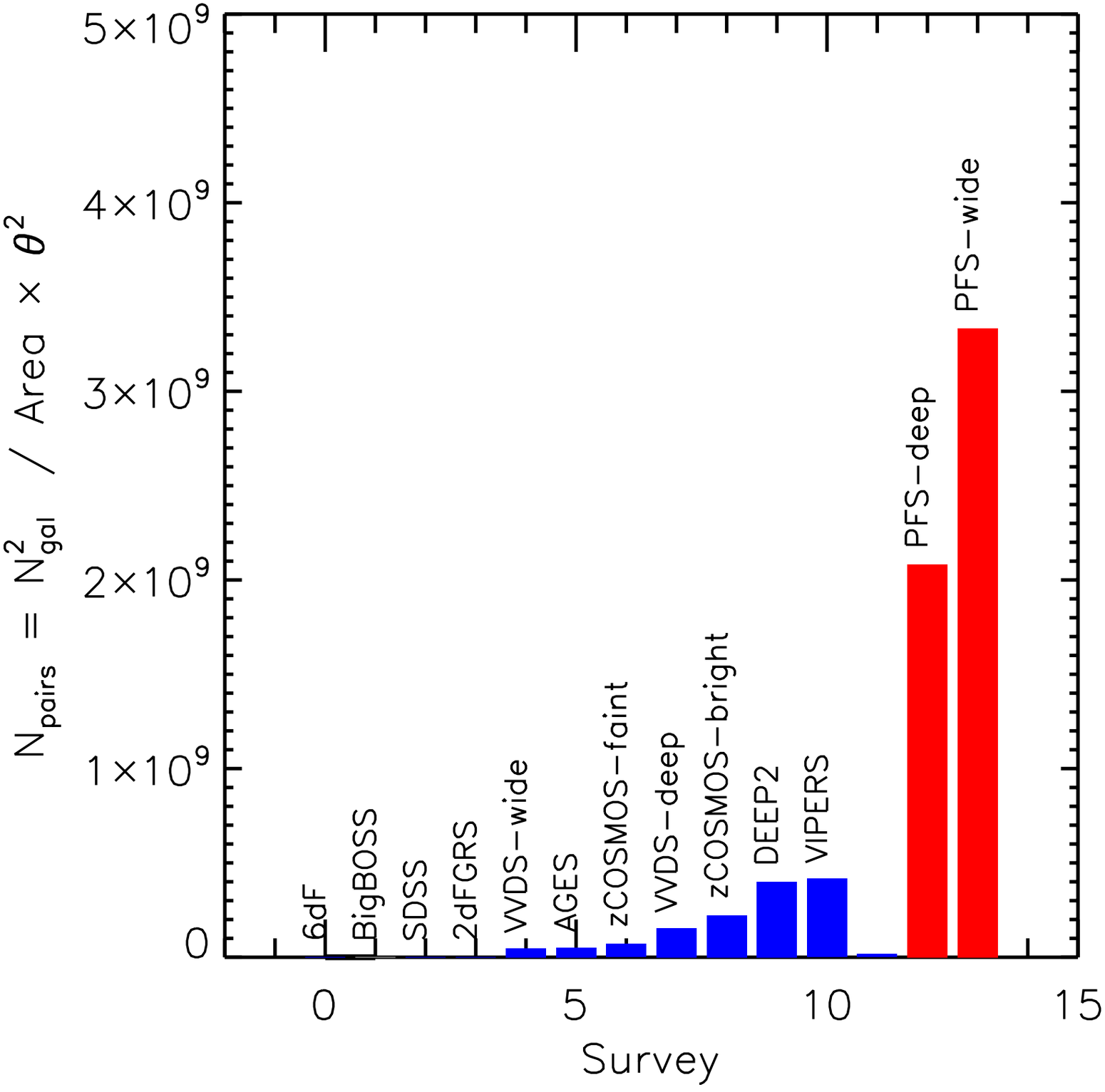


Steidel et al. (1997)



The sensitivity is proportional to N_{pairs}

Spatial analyses in the 1-halo regime



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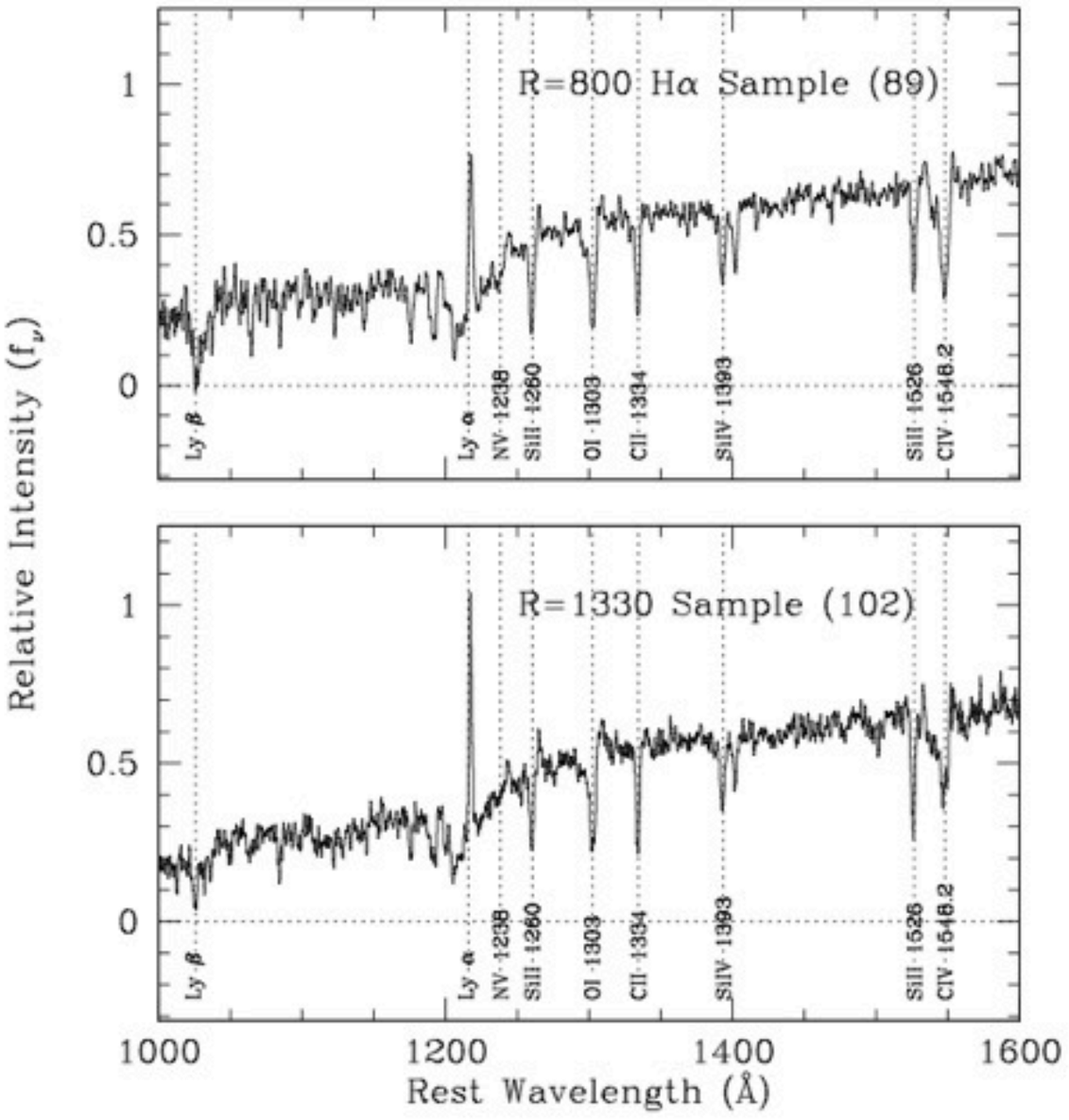
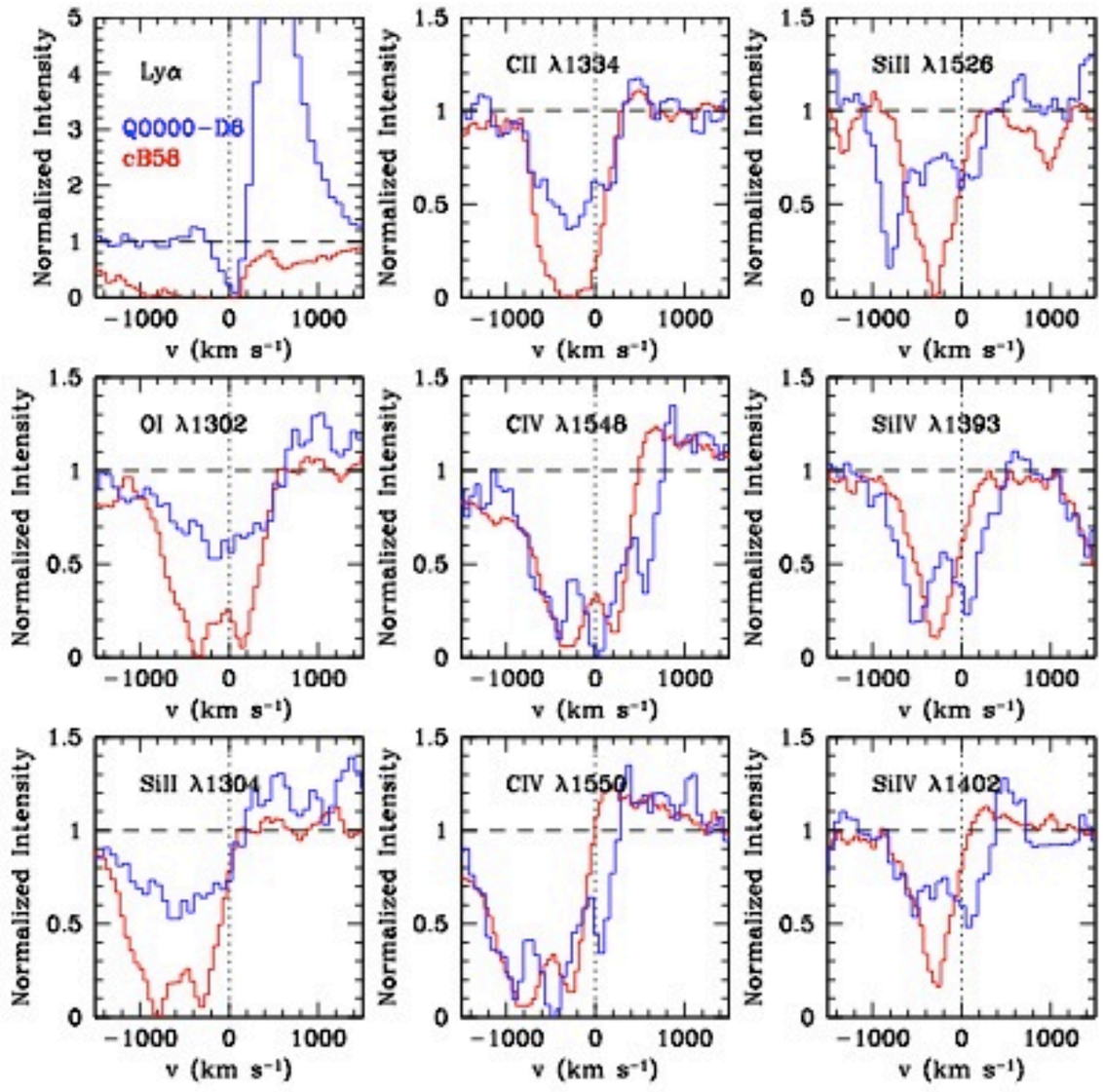
Statistical absorption in 0-D

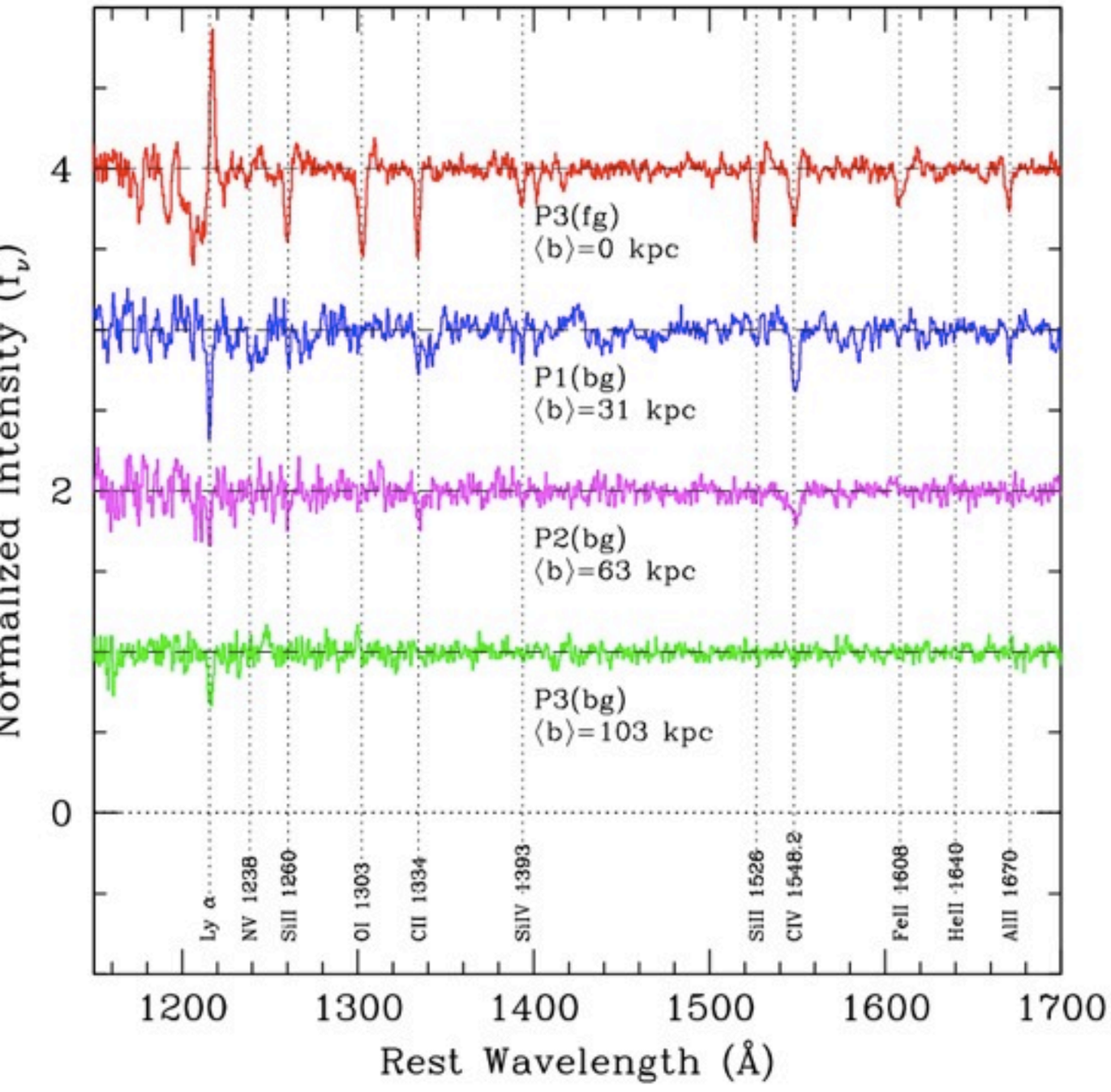


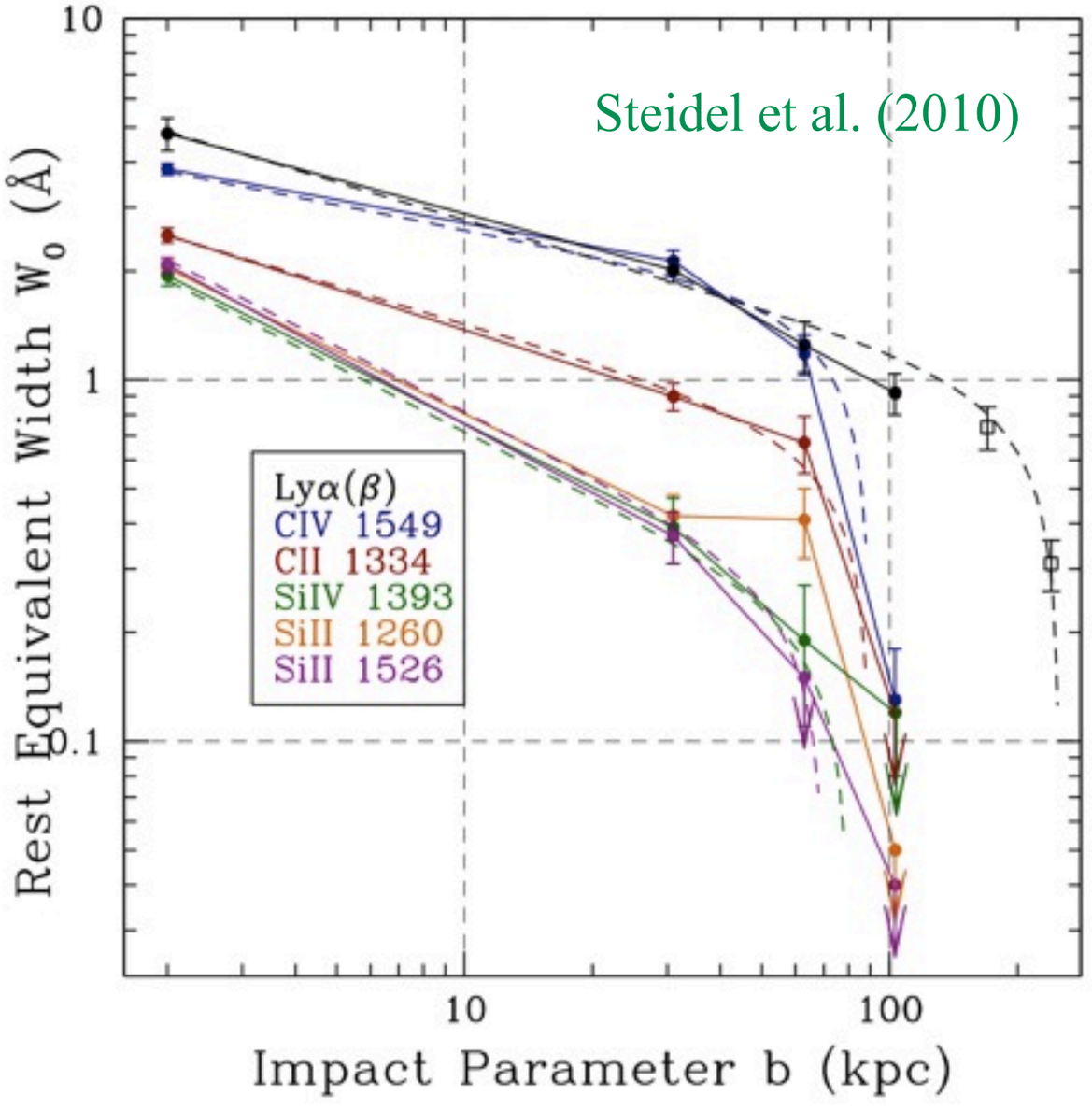


Steidel et al. (2010)

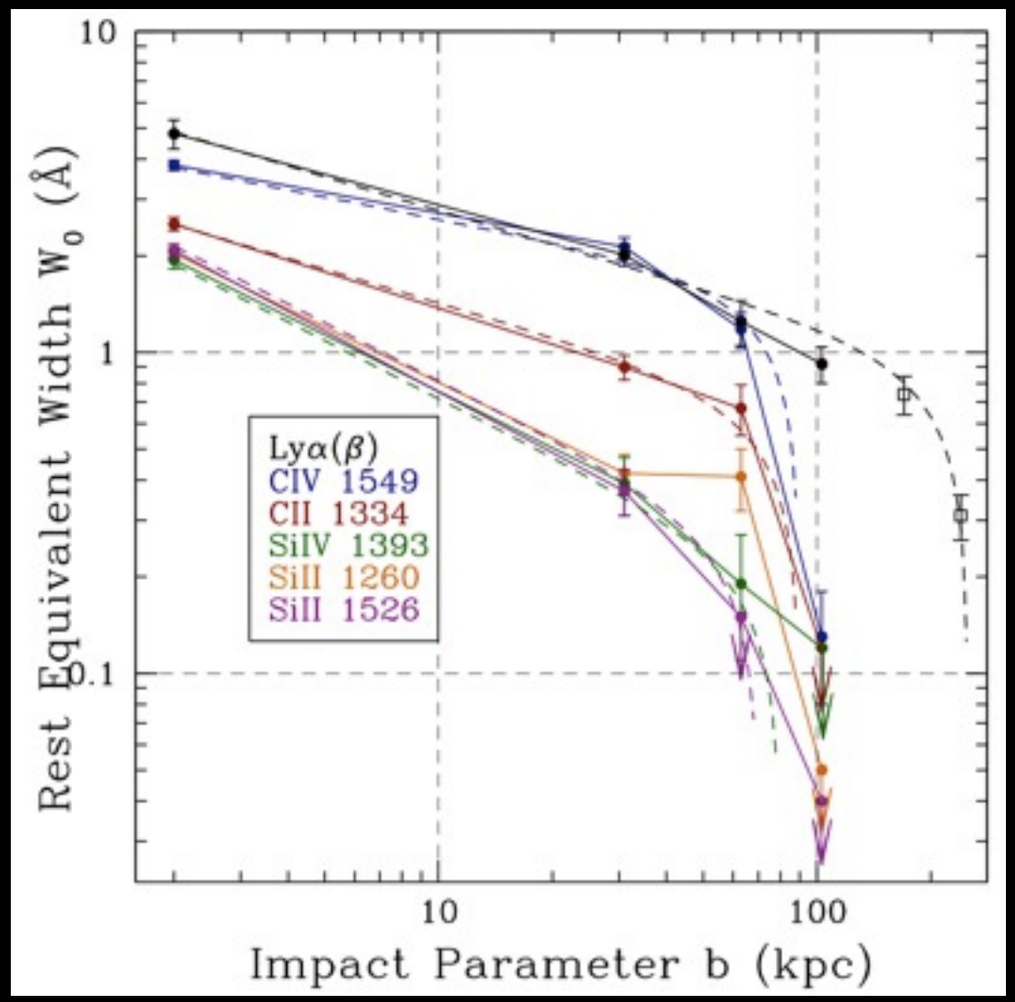
Composite spectra of galaxies: no spatial information

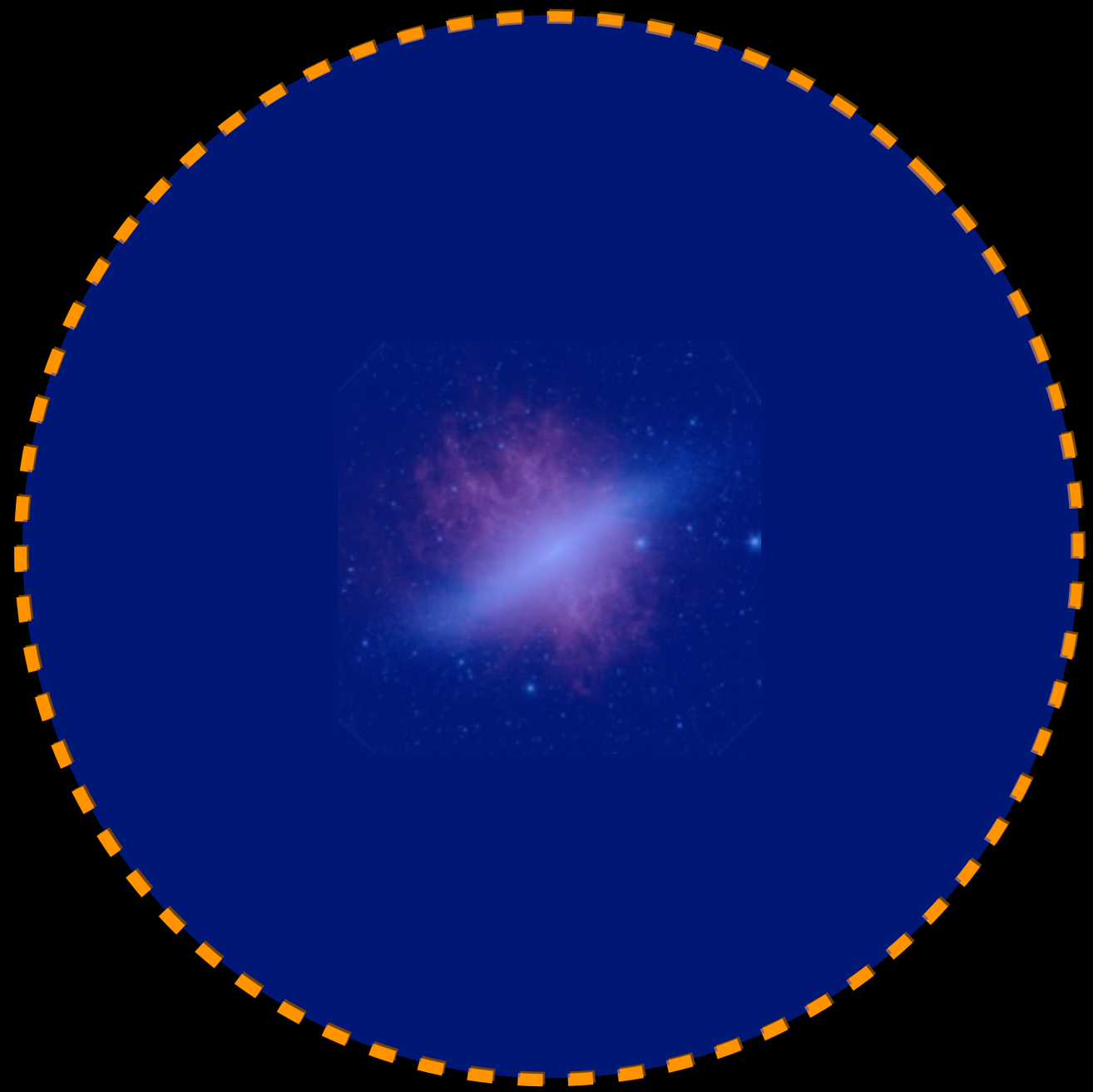
Statistical absorption in 1-D

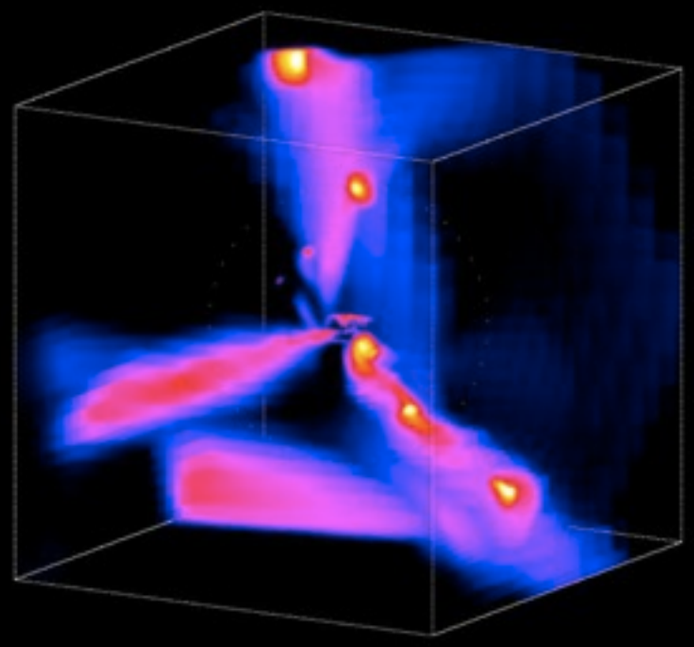


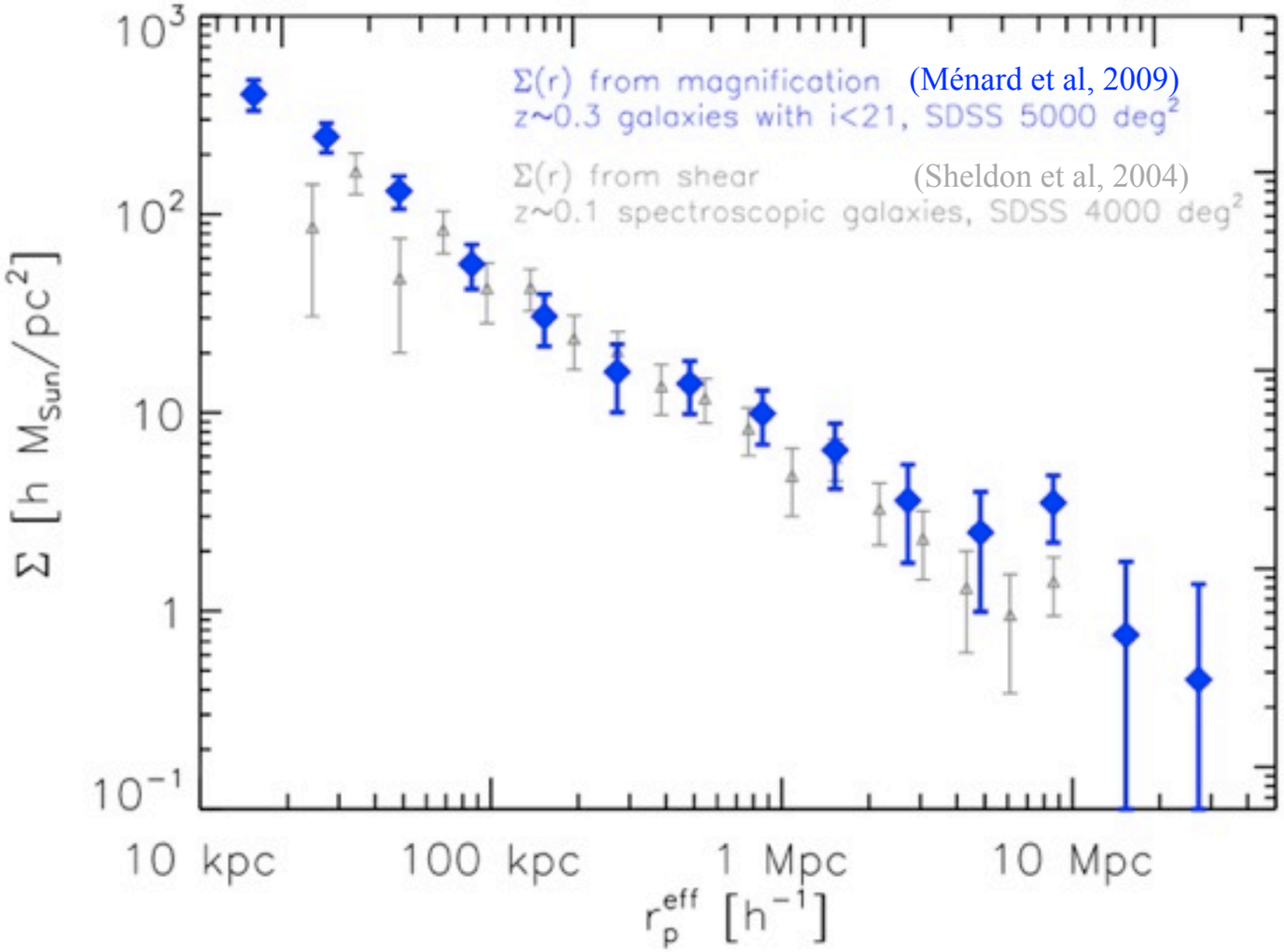


Based only on ~500 pairs. PFS will have ~ 1,000,000.

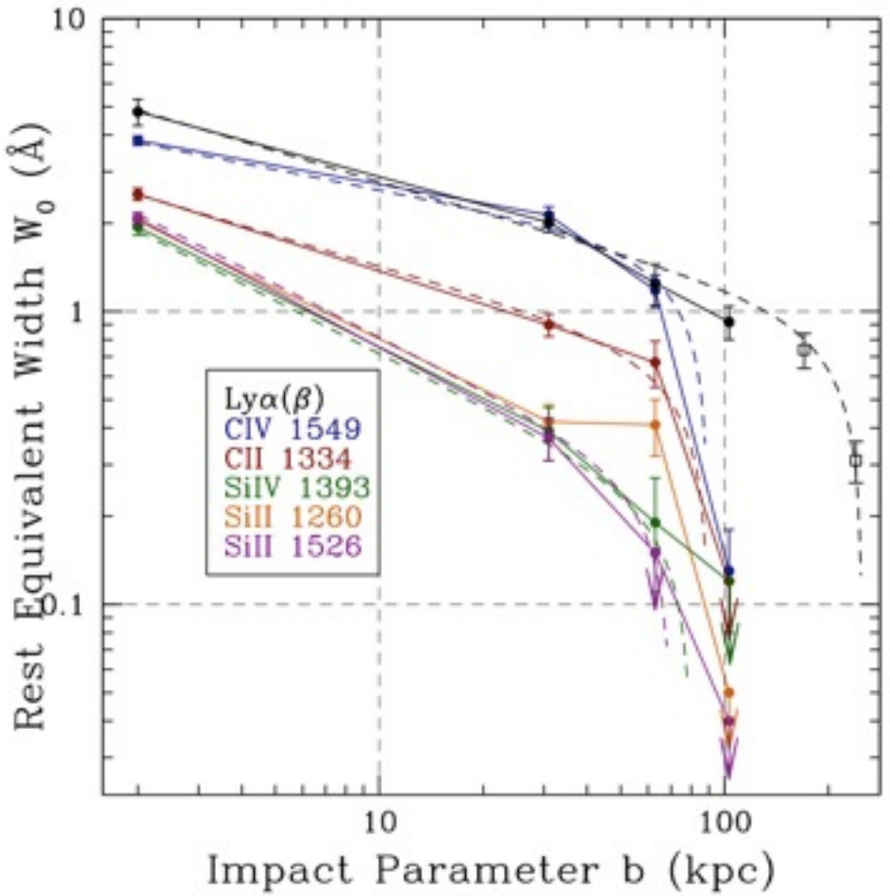

10
1
0.1
Rest Equivalent Width W_o (Å)
Lyα(β)
CIV 1549
CII 1334
SiIV 1393
SiII 1260
SiII 1526
10
100
Impact Parameter b (kpc)







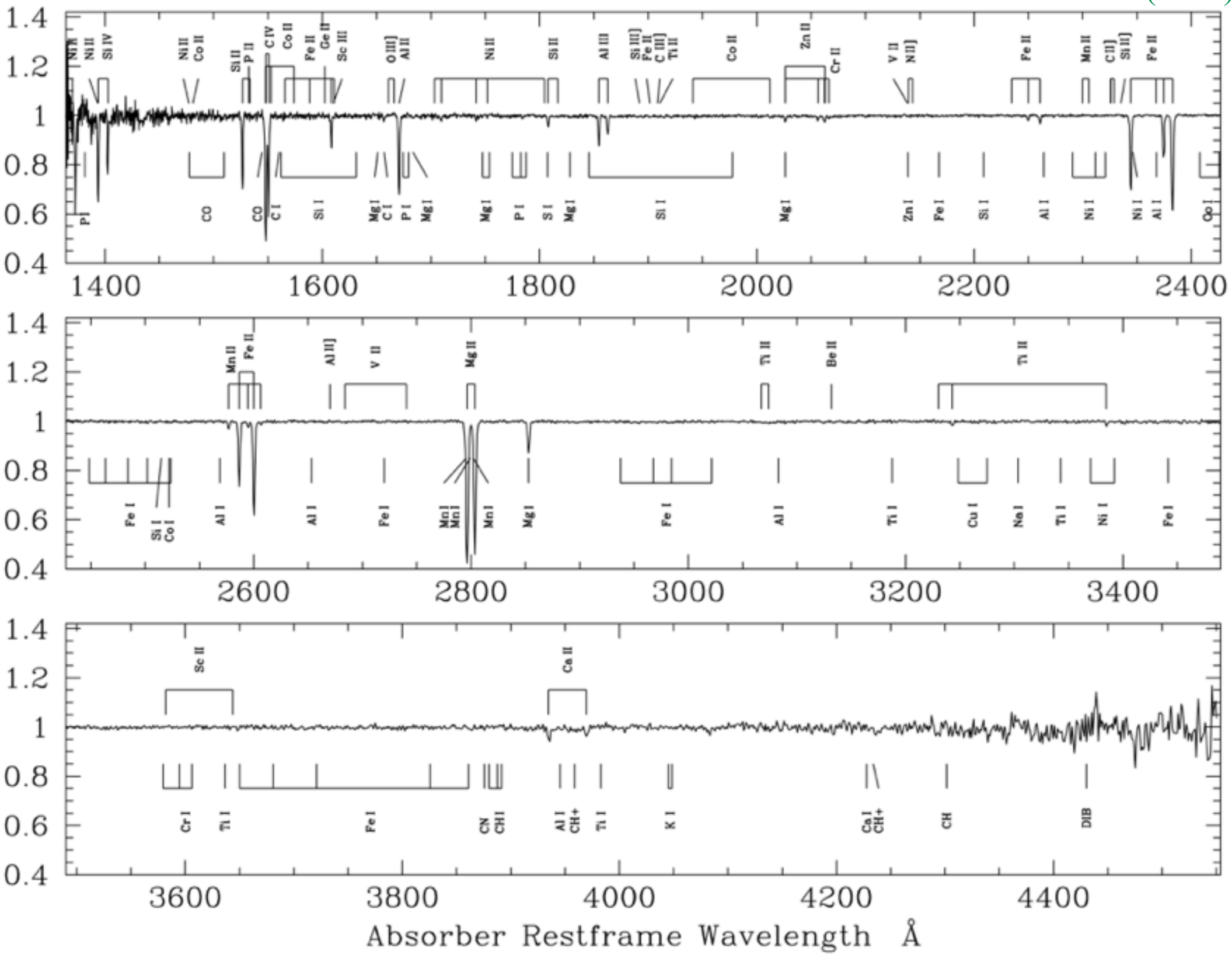
mass profile from
statistical lensing
(galaxy-galaxy lensing)



gas profile from
statistical absorption

Statistical analyses & composite spectra

York et al. (2005)



Statistical absorption

- Absorption lines can be found over the entire redshift range probed by PFS

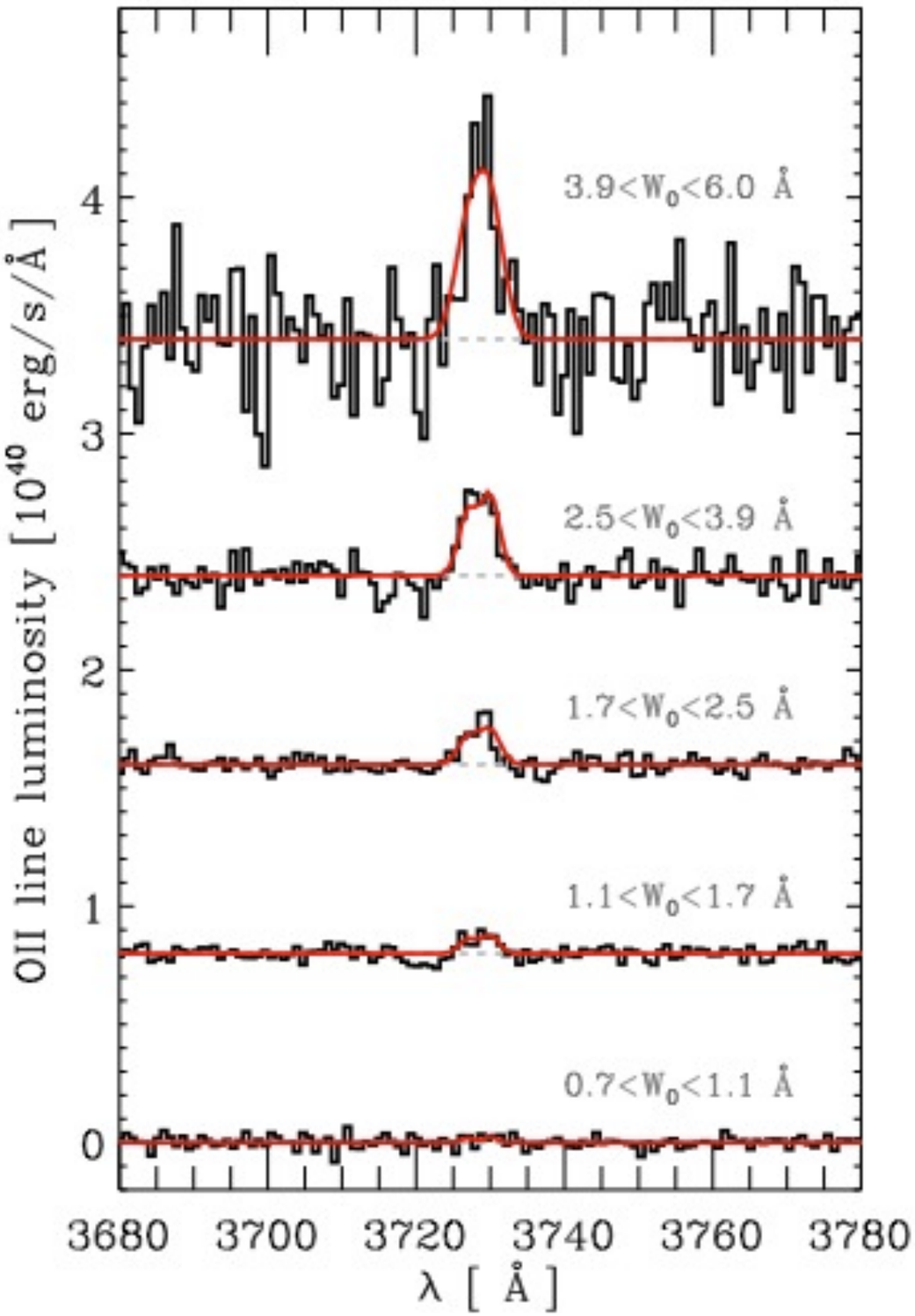
- Statistical absorption extracts information from virtually all pixels.

- It will open a new window on the spatial distribution of gas in the Universe. 0D => 1,2D

- Absorption lines carry information on gas Temperature, Metallicity, abundances, column density, velocity dispersion, dust depletion, etc. There is a lot of physics.

Statistical emission/absorption

Ménard et al. (2009)



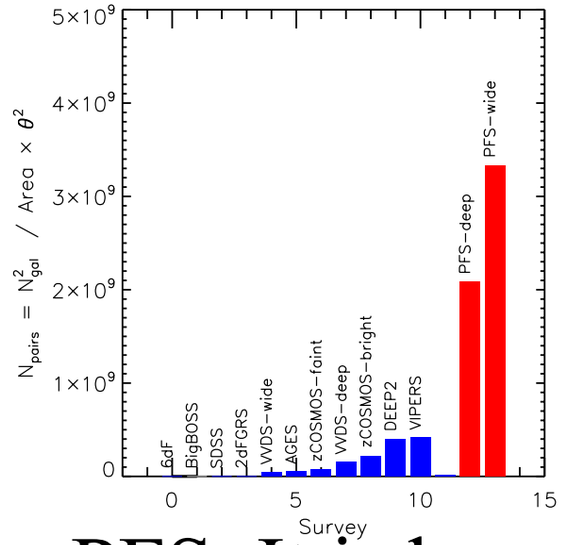
Statistical detection of OII emission at z=1 from unrelated SDSS QSO spectra

No stellar continuum detected!

The cross-correlation with absorbers along the line of sight allows us to detect emission lines statistically.

This demonstrates that statistical absorption is feasible. The only requirement is a large Npairs.

Conclusion



• One of PFS' strengths is measuring spatial correlations (~Npairs) in the 1-halo regime

• Statistical absorption is a unique opportunity for PFS. It is based on Npairs and extract information from all the pixels of all spectra.

• I think it will be go through a history similar to weak lensing over the past decade.

• We will be able to measure gas column density, metallicity, temperature, abundances, dust depletion, etc... as a function of scale.

→ It will provide us with a mapping of baryons in the Universe

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This is just one example. The PFS dataset will be a great opportunity for the Japanese community. Many unique projects for students.