



Subaru HSC-MB+PFS Survey: Exploring Large Scale Structure at high-redshift

すばるHSC-MB+PFSサーベイ: 高赤方偏移における大規模構造の探査

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2024年度 国立天文台の将来シンポジウム

2024年12月4日、国立天文台

Cosmology by Large Scale Structure

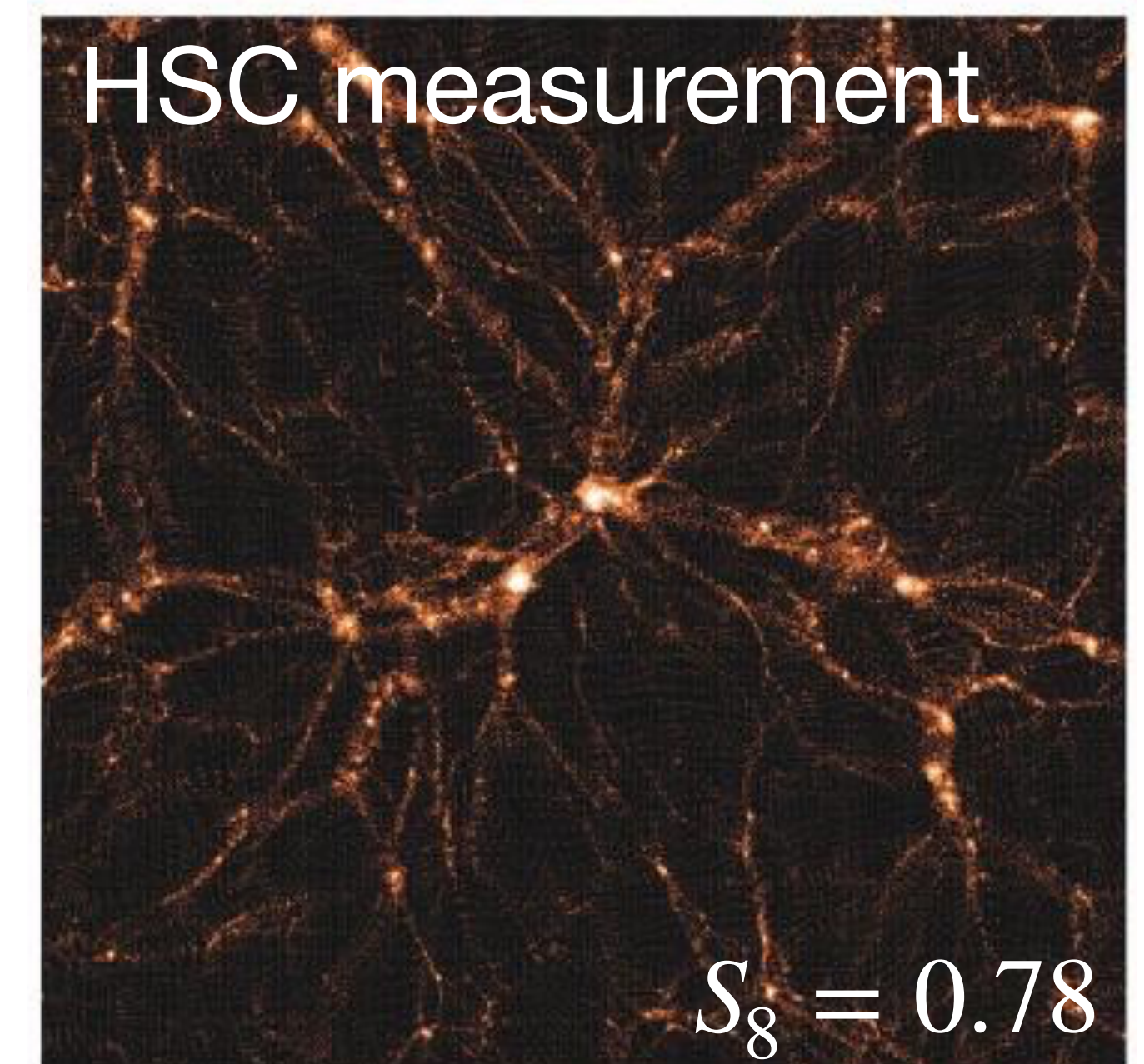
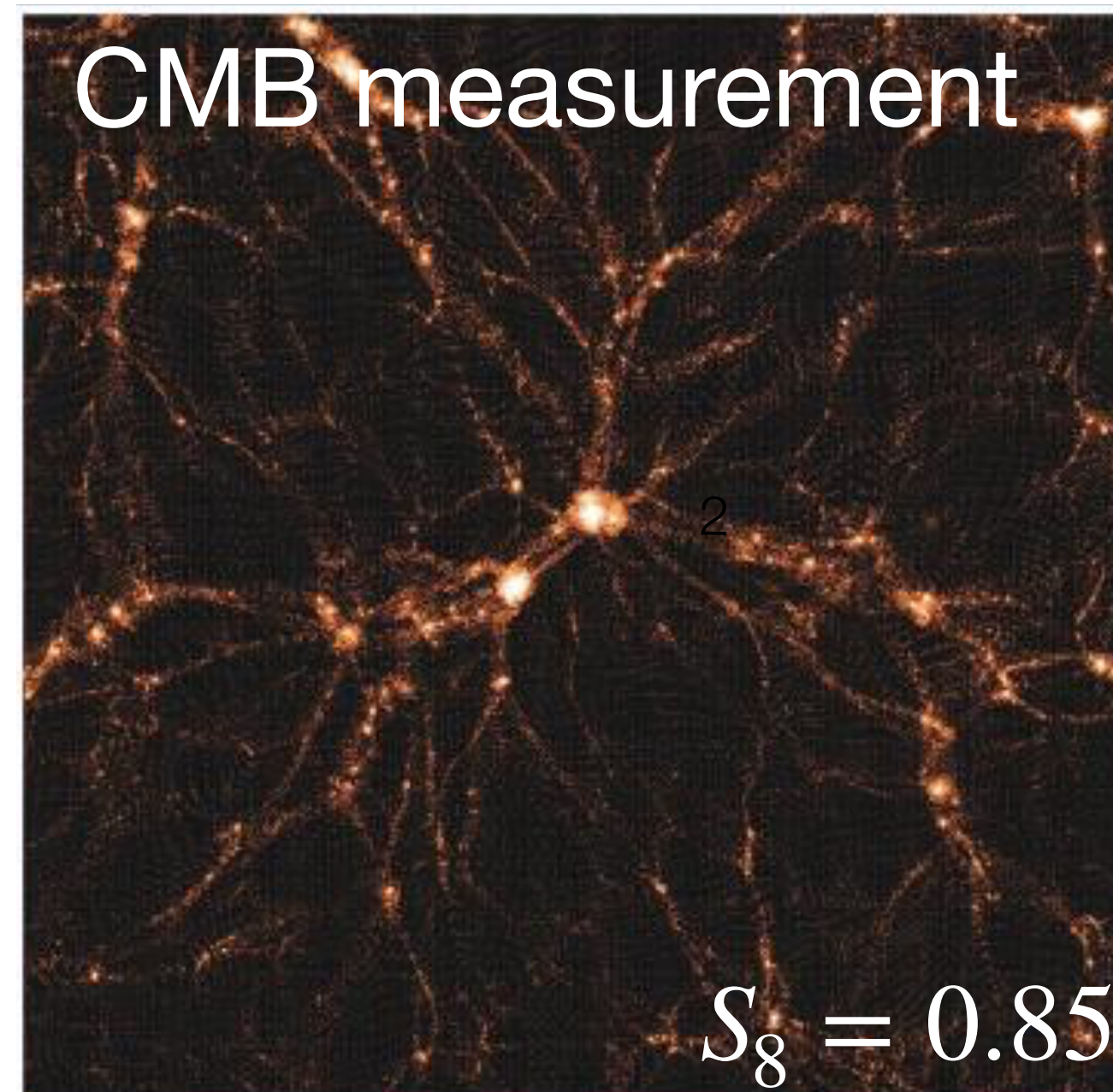
Clumpiness of the Universe

$$S_8 \equiv \sigma_8 \sqrt{\Omega_m / 0.3}$$

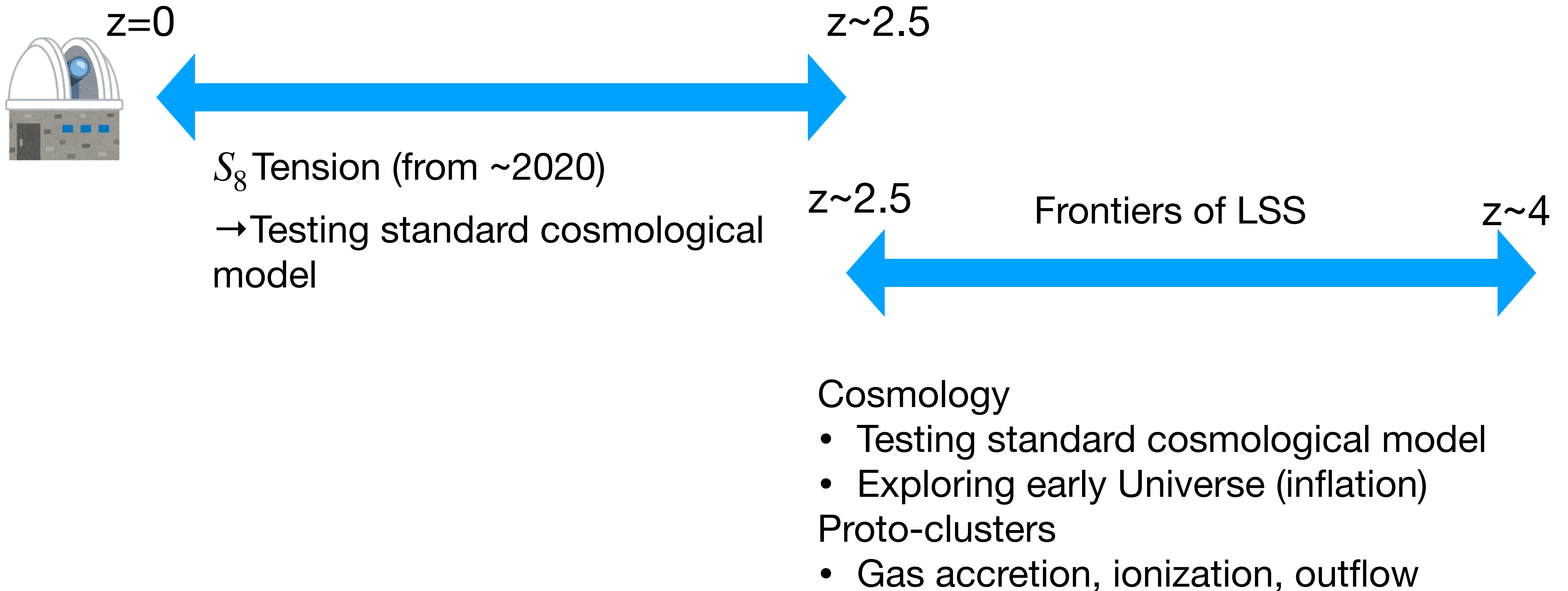
Matter energy density

Simulations of large scale structure

credit: 東京大学/西道啓博



Exploring LSS at high-redshift



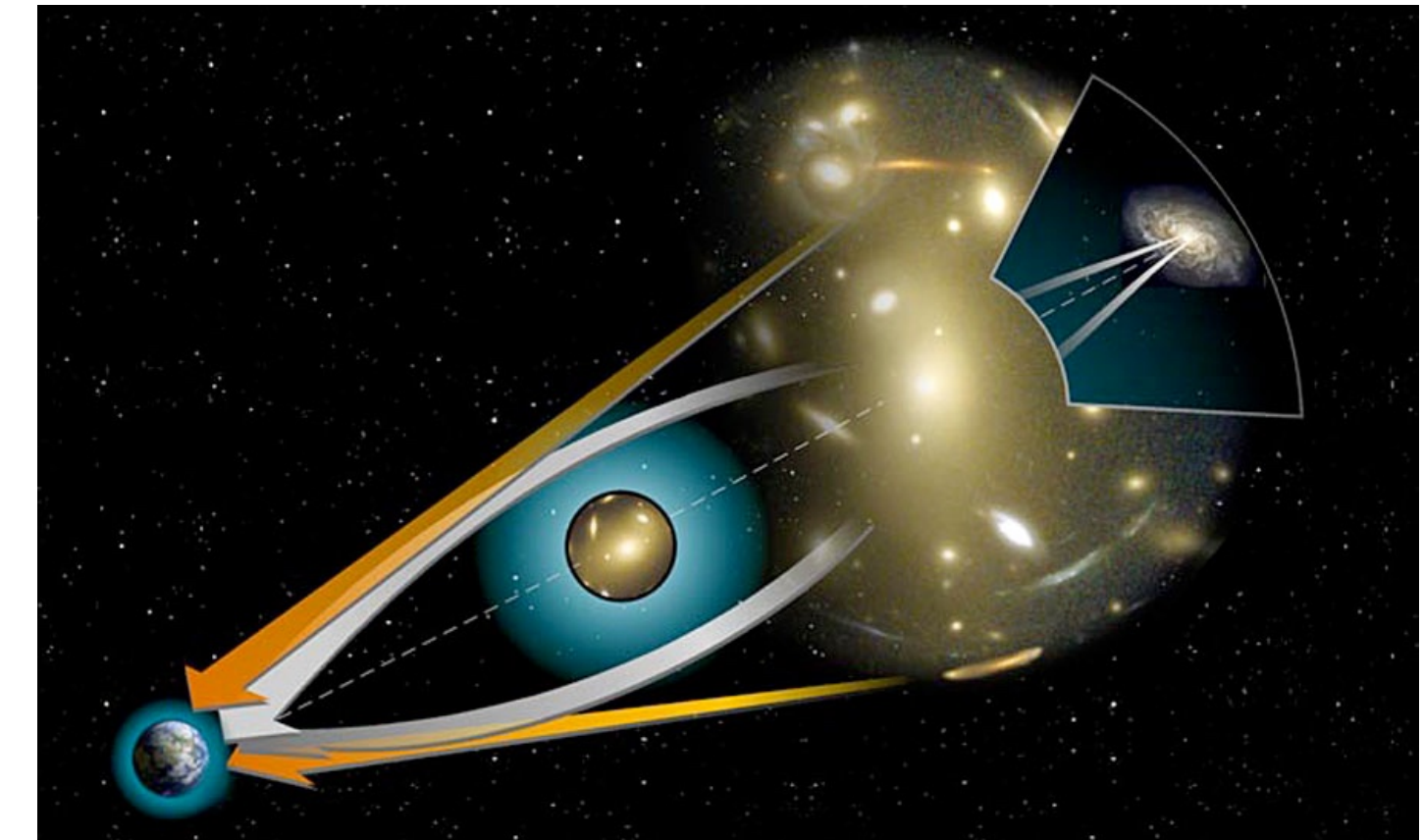
Large Scale Structure Measurements

Dark Matter, which make up most of the structure, cannot be observed through light

Method 1: Gravitational Lensing

- Distant sources (galaxy and CMB) are distorted by intervening matter.

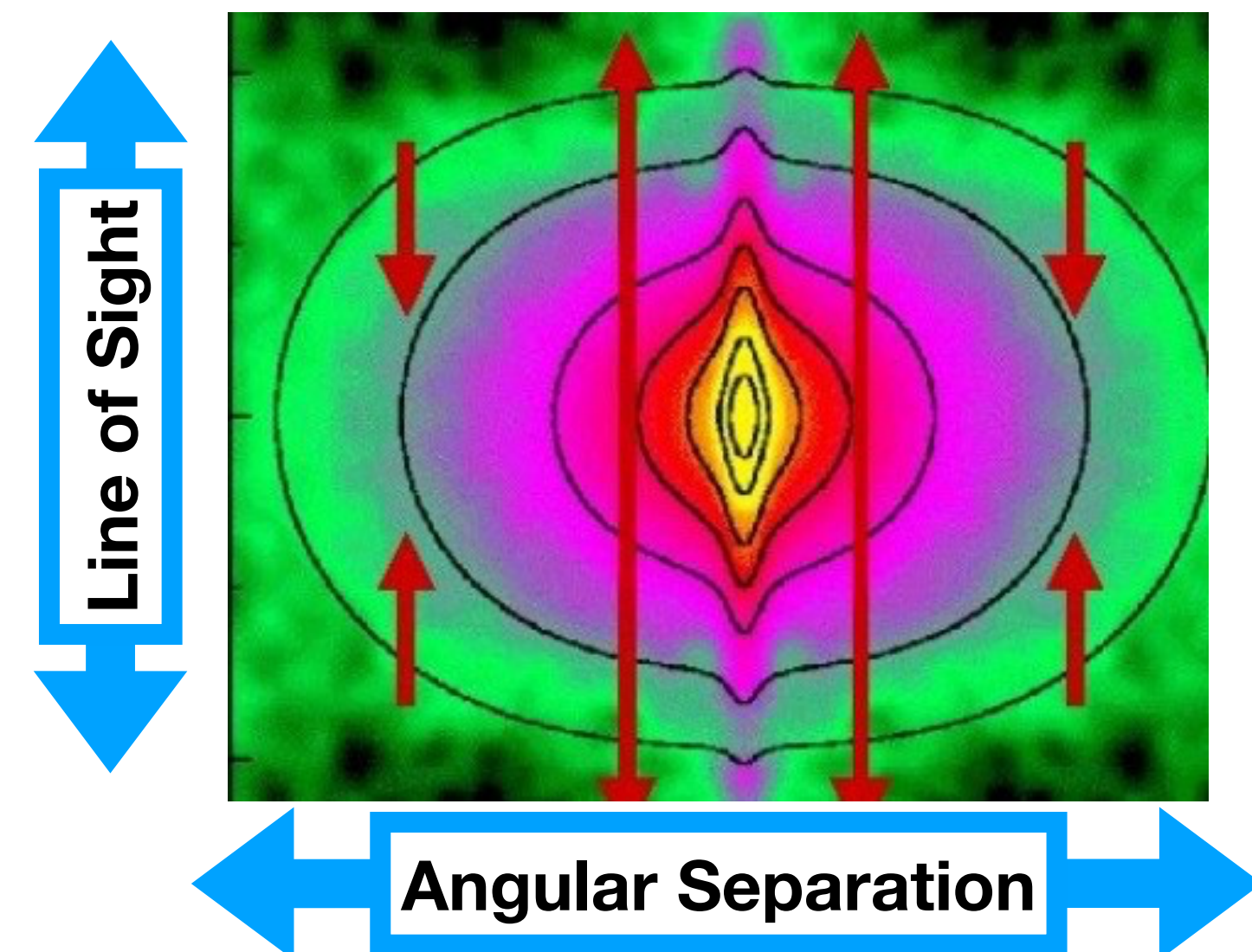
➡ Imaging Data



Method 2: Galaxy Clustering

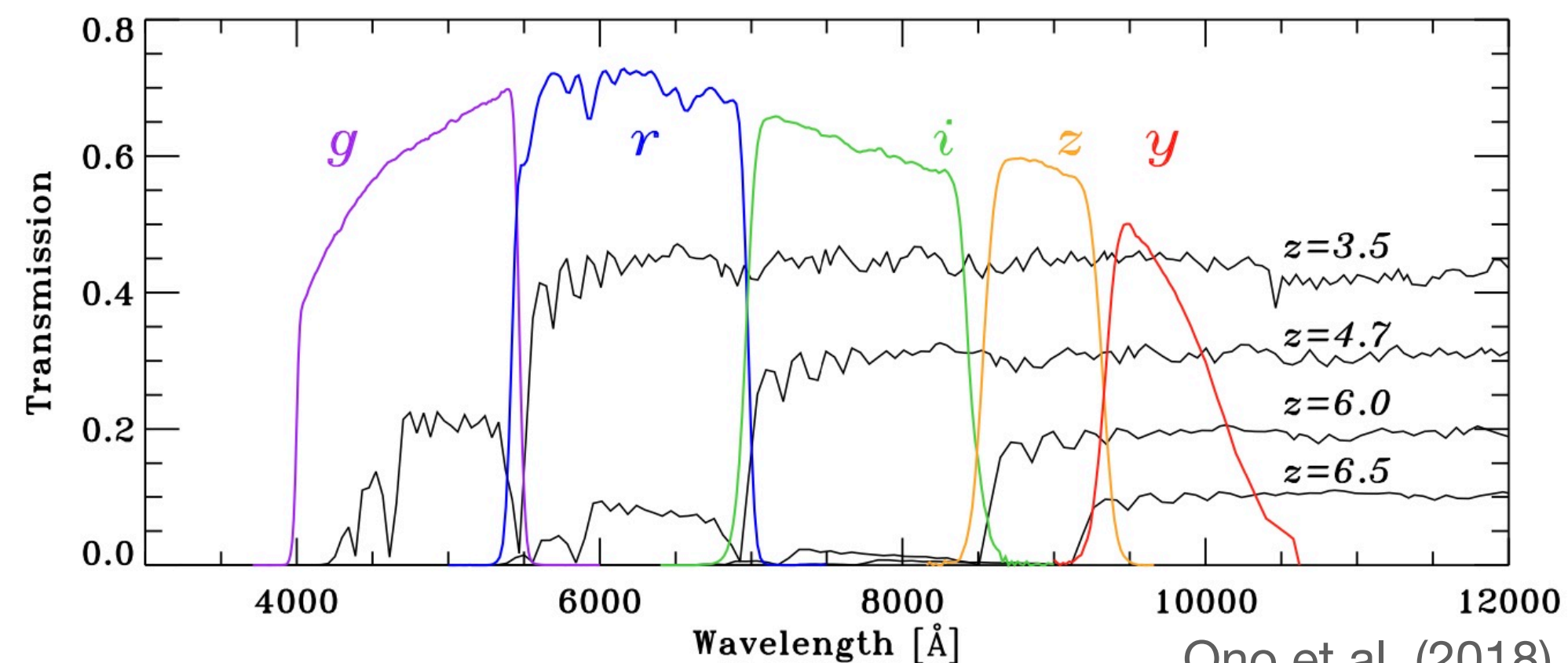
- Redshift Space Distortions: Systematic effects on peculiar velocity at large scales due to gravity.
- Full-shape analysis with 3-d clustering is being developed.

➡ Spectroscopic Data

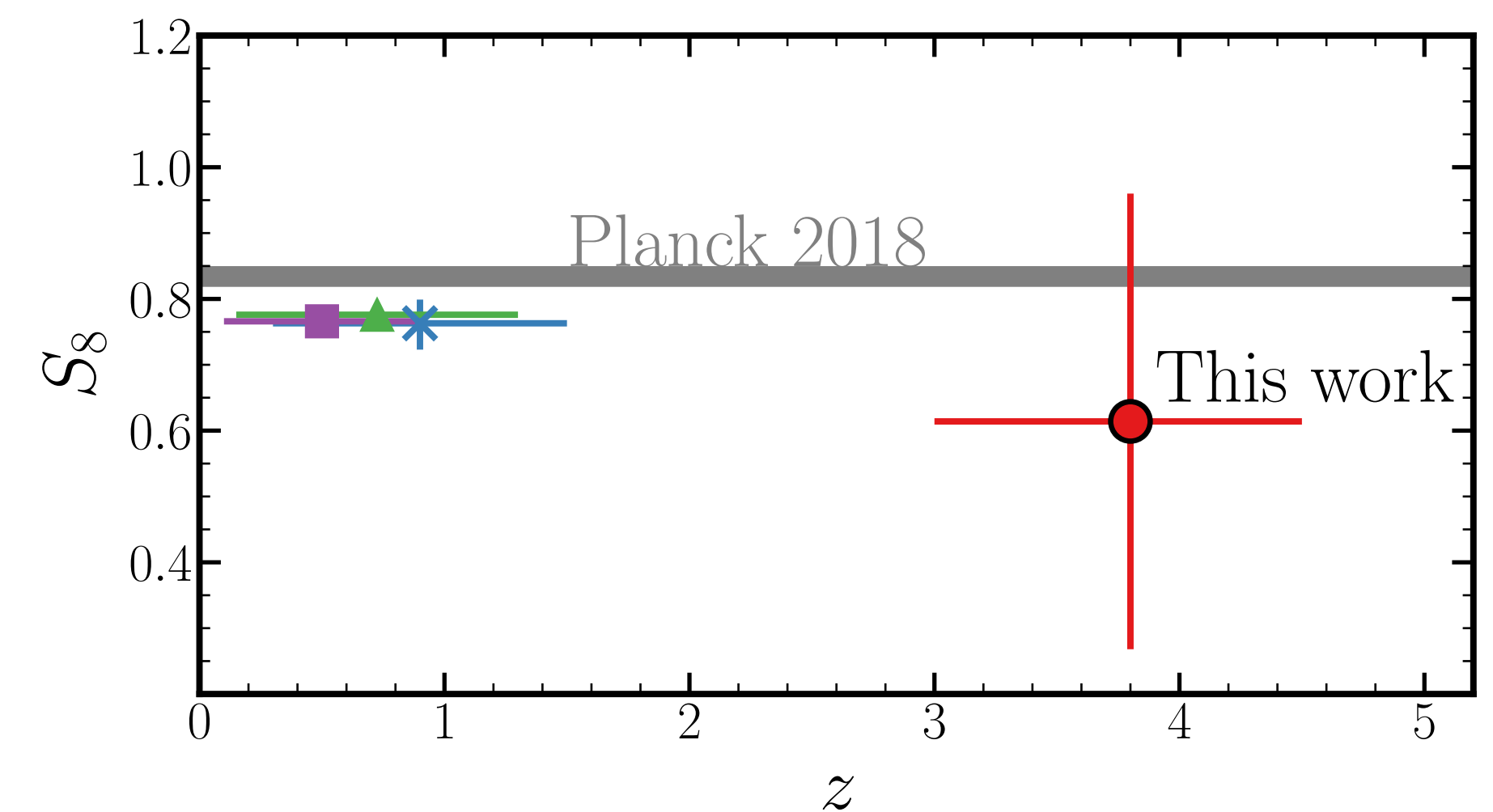
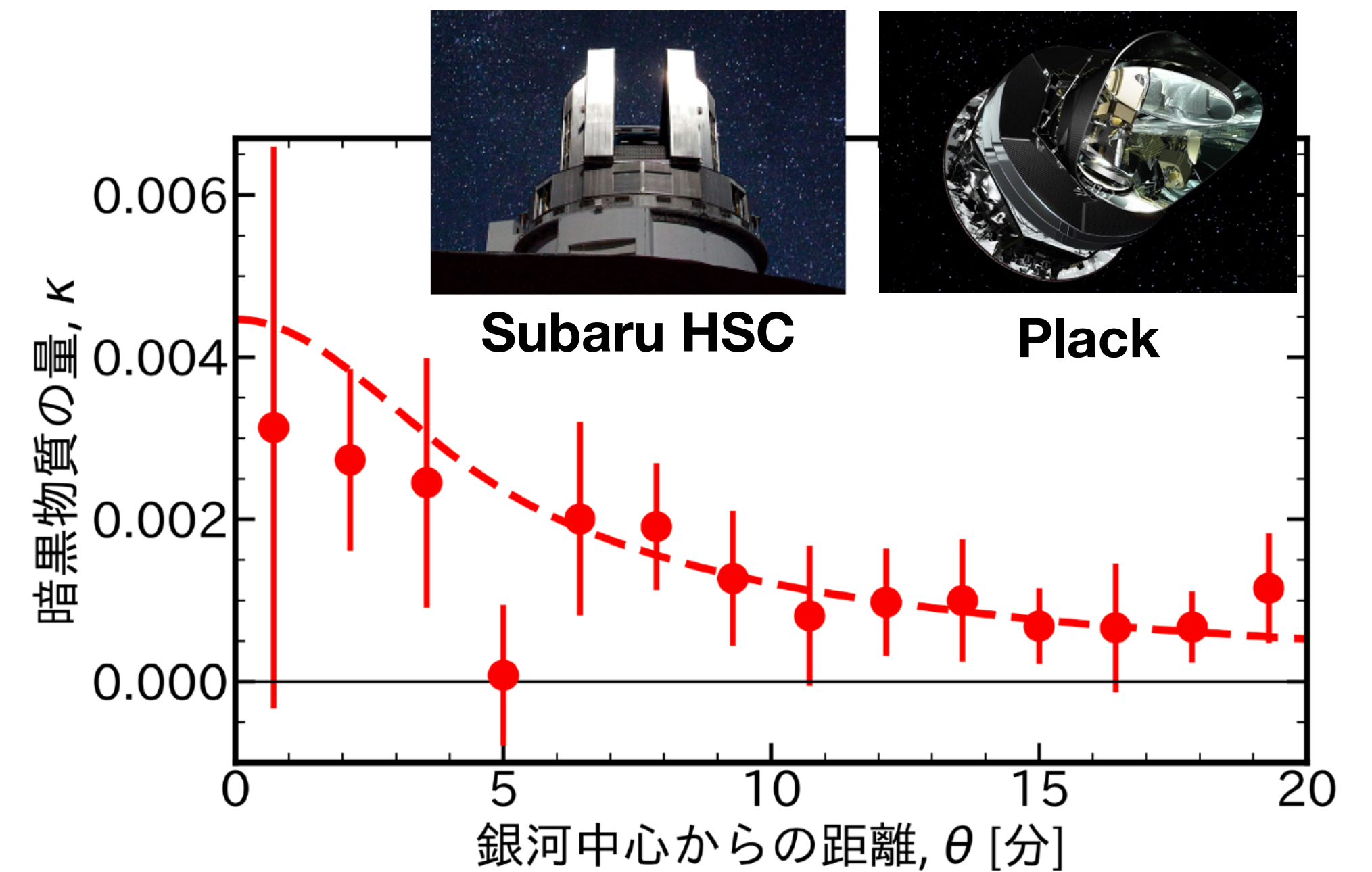


Large Scale Structure Measurements with CMB Lensing

- **Dark matter distribution around Lyman Break Galaxies (LBGs; 1.5M; Harikane+, 2022)** at $z \sim 4$ discovered by HSC was measured for the first time.
- Top 0.2% attention score among PRL published so far
- Challenges
 - More statistics
 - Contamination of low- z galaxies due to LBG selection with broad-band filters.



Ono et al. (2018) 5

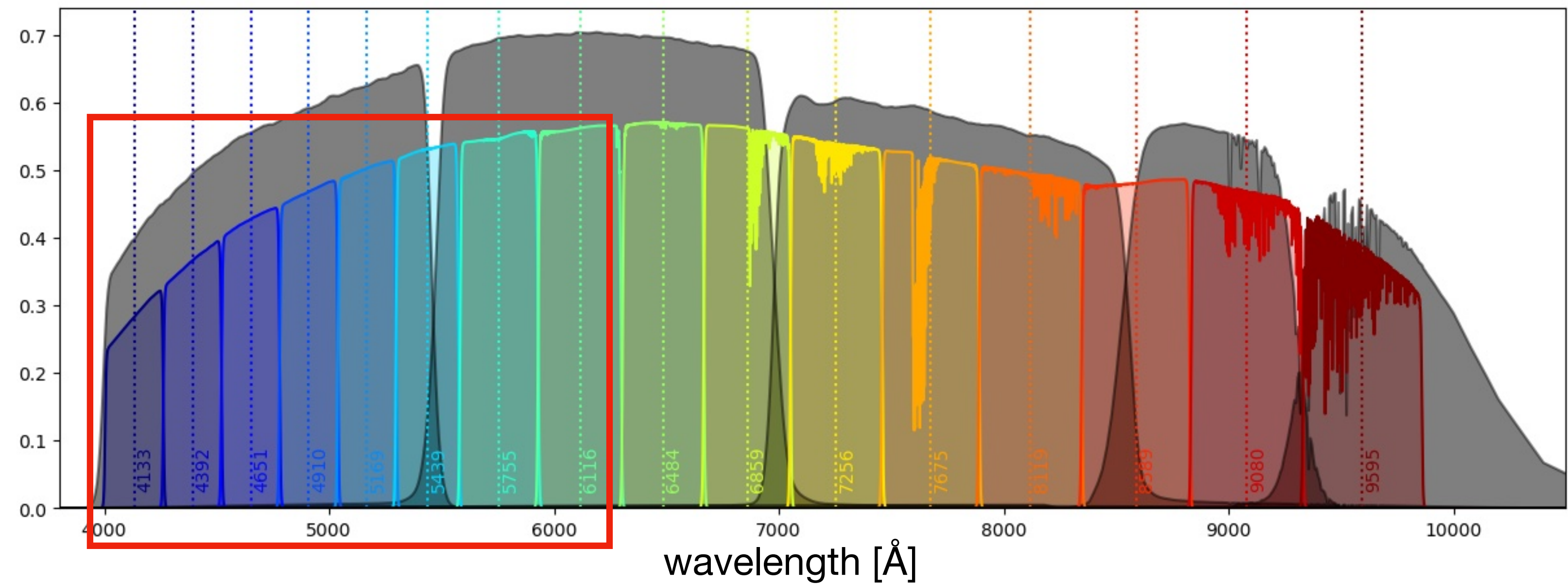


Miyatake et al. (PRL, 2022a)

HSC Medium-band Filter



Nishizawa



2nd HSC MB workshop

HomeScience Casesfilter specification

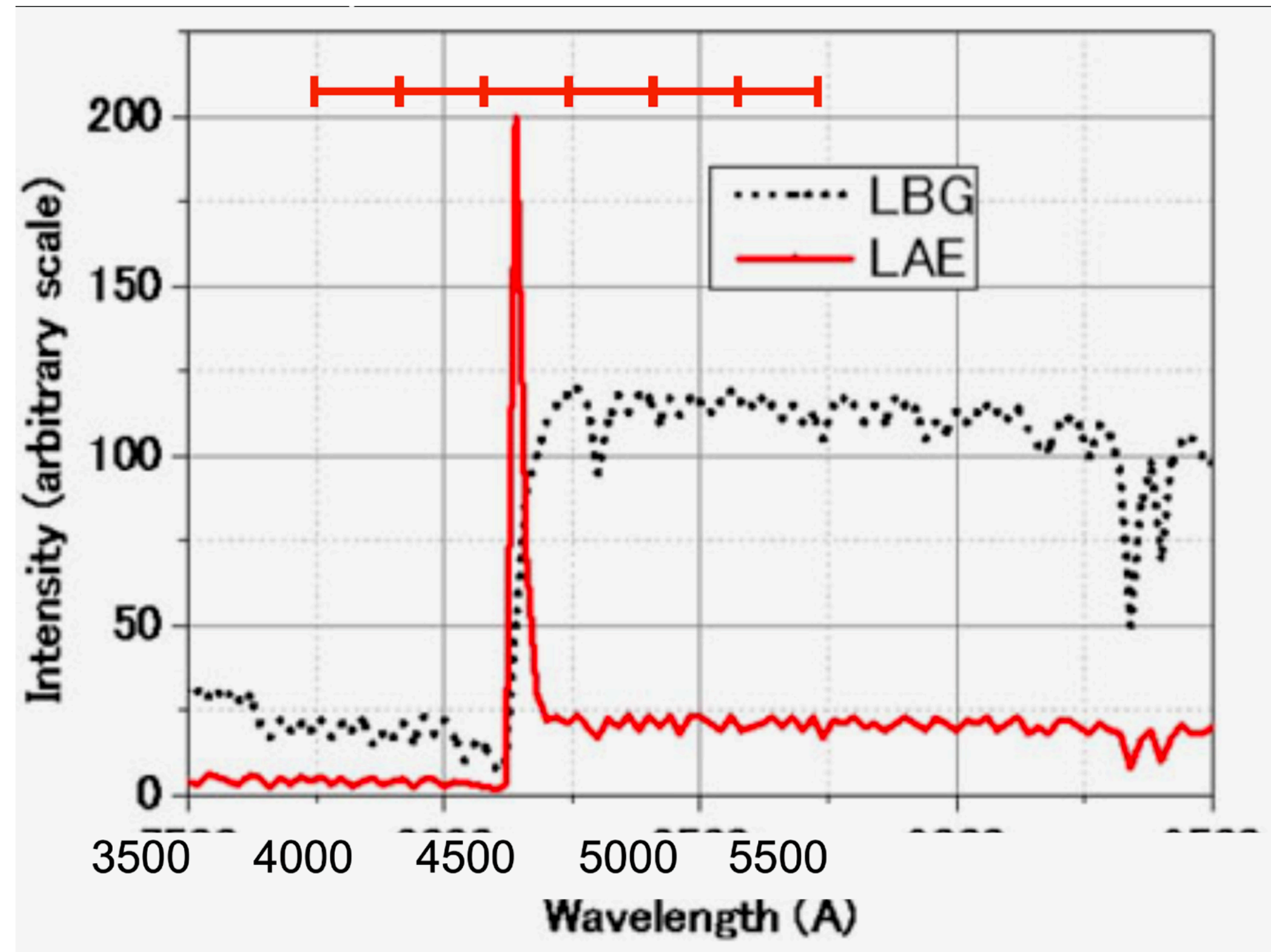
2nd HSC Medium-band Filter Workshop

November 27-28, 2024
Nagoya University, Japan



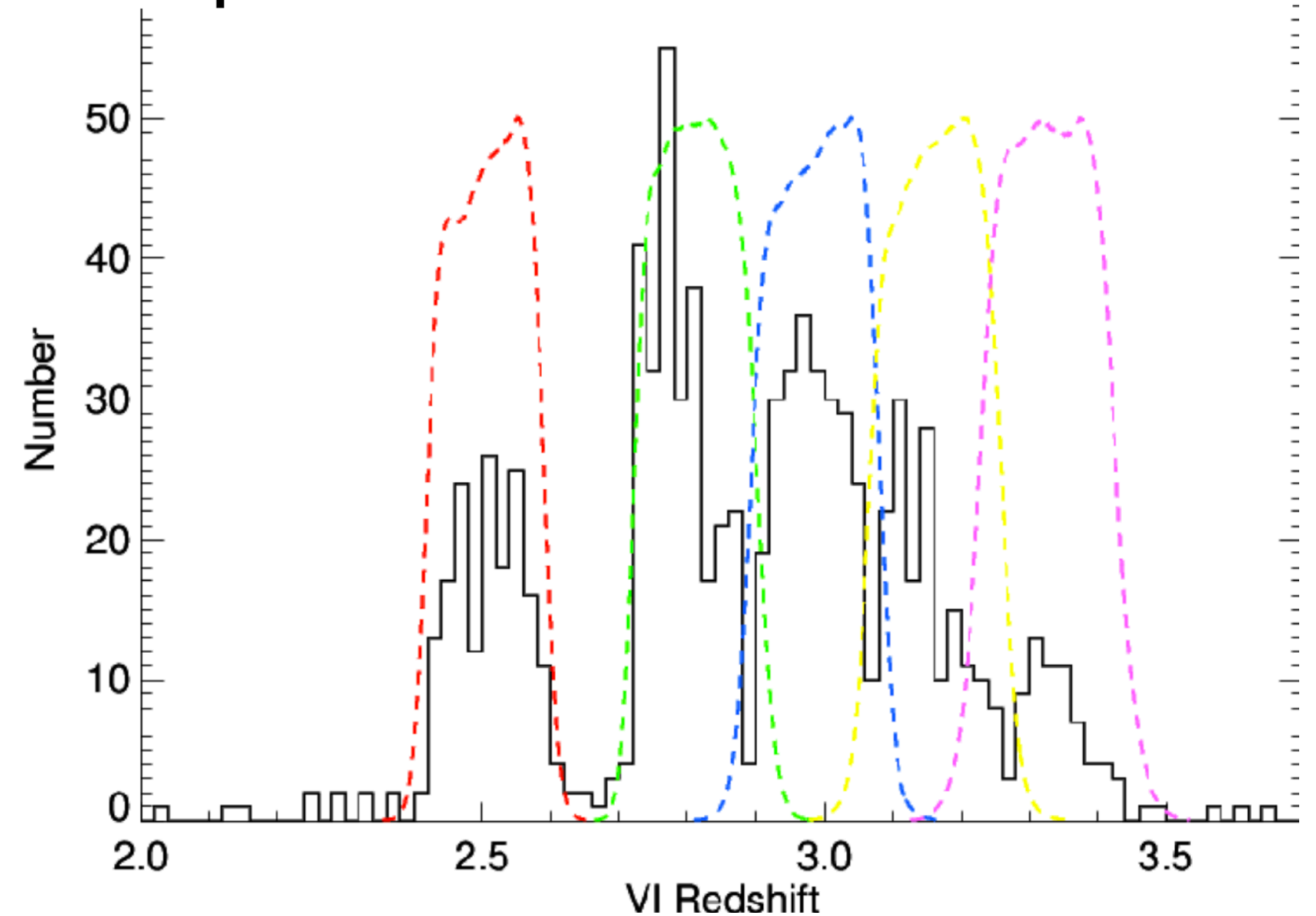


Detection of high- z galaxies by MB filters.



Dunlop (2012)

SuprimeCam MB filter selection



Credit: A. Dey

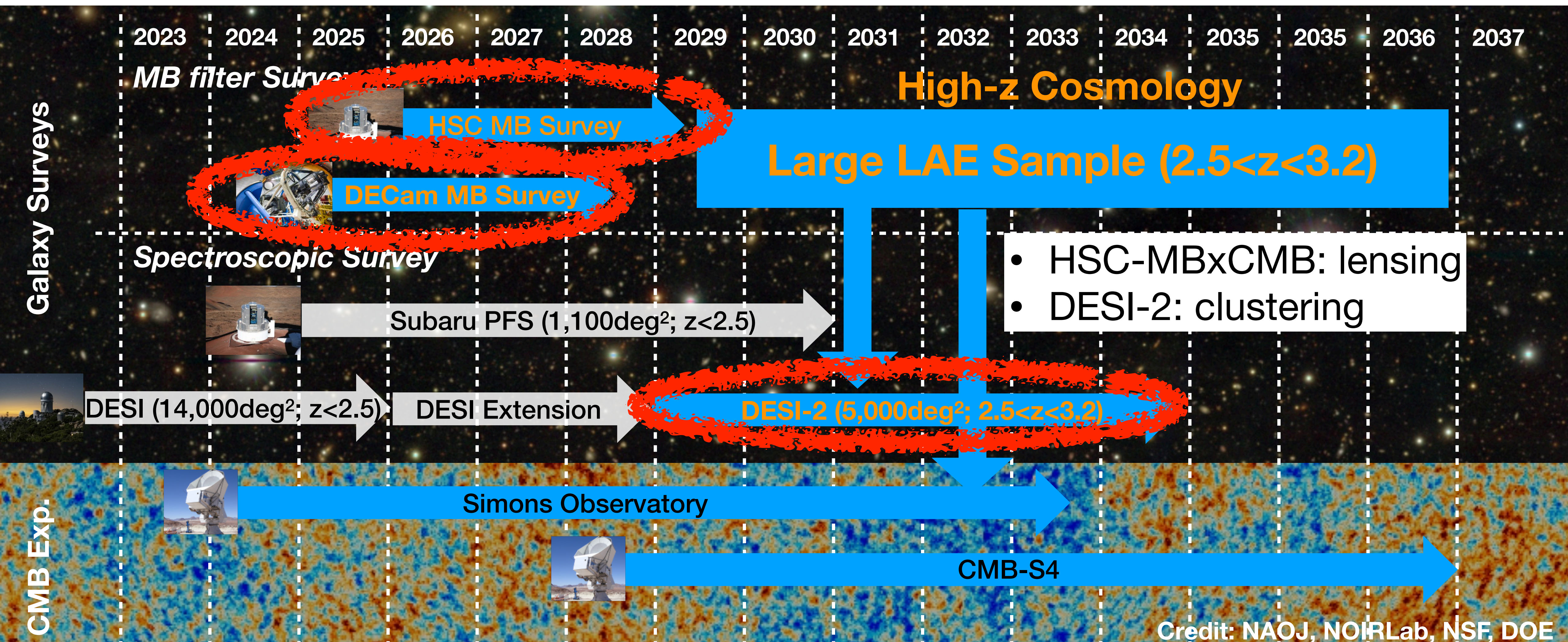
Ly- α emitters are detected!

Collaboration with DESI-2

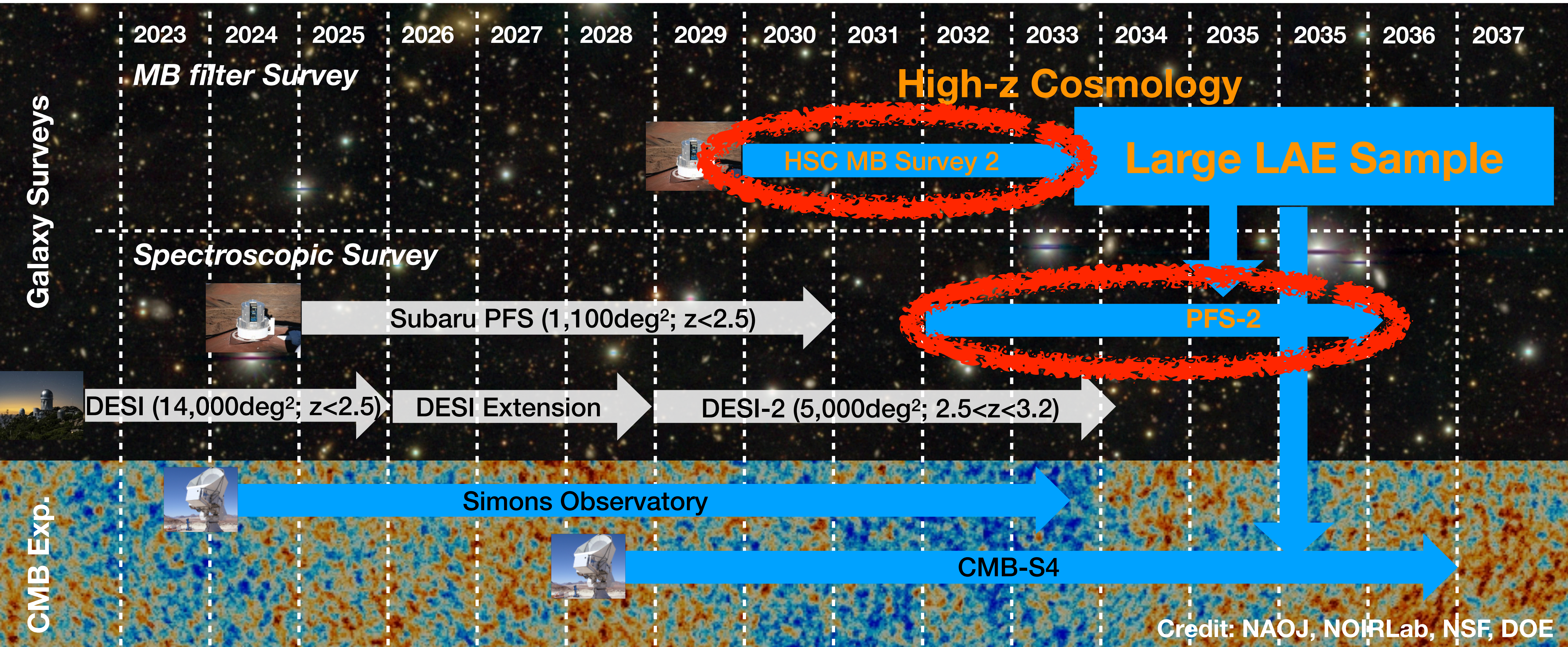
Can you work with us to increase target galaxies by adding HSC MB data to DECam MB Survey?
Great minds think alike.



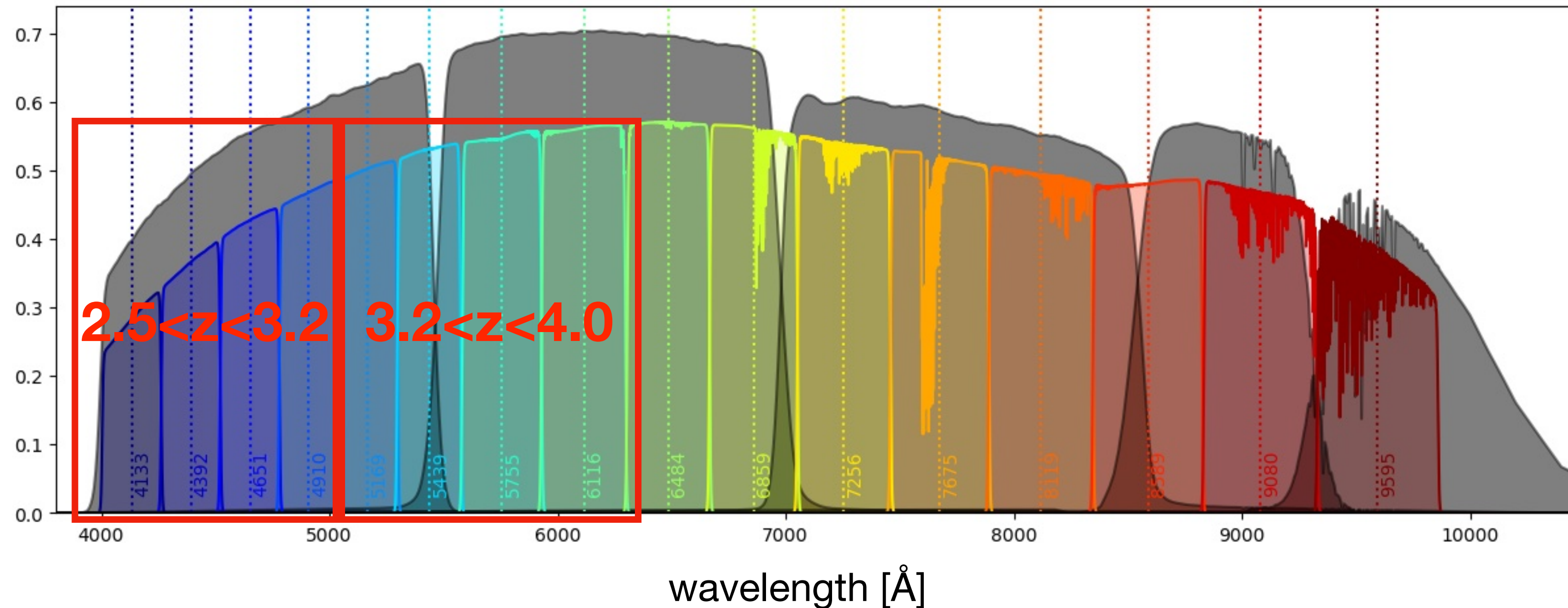
D. Schlegel (LBNL)



HSC-MB+PFS2 Survey (200-300 nights)



Strength of HSC MB-2+PFS-2 Survey



- No need to develop a new instrument → Can be one of the main programs of Subaru 3.
- Subaru has a larger primary mirror than DECam(4m) and DESI-2(4m), HSC-MB and PFS
Can go deeper.
- HSC-MB has filters covering 5000Å-6300Å ($3.2 < z < 4.0$).
- Two options according to results from PFS and DESI-2.
 - Deeper observation at $2.5 < z < 3.2$ than DESI-2.
 - Observe more distant Universe ($3.2 < z < 5.0$)
- It is important to complete the survey before Spec-S5 (6m+4m, ~13000 fibers; seeking funding) starts at ~2035.

Spillover to Fields Other Than Cosmology

- Proto-clusters
 - The spatial distribution of LAE identifies large-scale structures, including protogalactic clusters. Comparing it with the LBG distribution explores the distribution of neutral hydrogen gas and reveals gas accumulation and ionization processes.
 - PFS spectroscopy of LAE will explore the dynamical structure of the galactic gas and reveal gas accretion and outflow processes.
- In the HSC-MB workshop talks, we discussed galaxy evolution, AGN, Milky Way galaxies, and other topics. We will continue discussing connections to PFS-2.

Requests to NAOJ

- Overall budget size of the plan (total or per year)
 - No instrument development is required, only a budget to carry out observations and data analysis is necessary.
- Framework of survey observation similar to SSP is necessary
- Disk or file server for data archive: $\sim < 1.5\text{PB}$ (20M JPY)
- Resources for data analysis, archiving, etc.
 - Manpower equivalent to those currently engaged in HSC/PFS SSP:
Assumer ~ 3 FTE for HSC-MB and PFS-2, and 3 year survey for each -> 180M JPY
 - Computers: Can I use the one I use for HSC and PFS surveys? If not, 50M JPY
- Our group will try to get a Kiban-S class grant to cover computers, storage, and one person for 6 years: in total 130M JPY