Cosmology with the WFIRST High Latitude Survey

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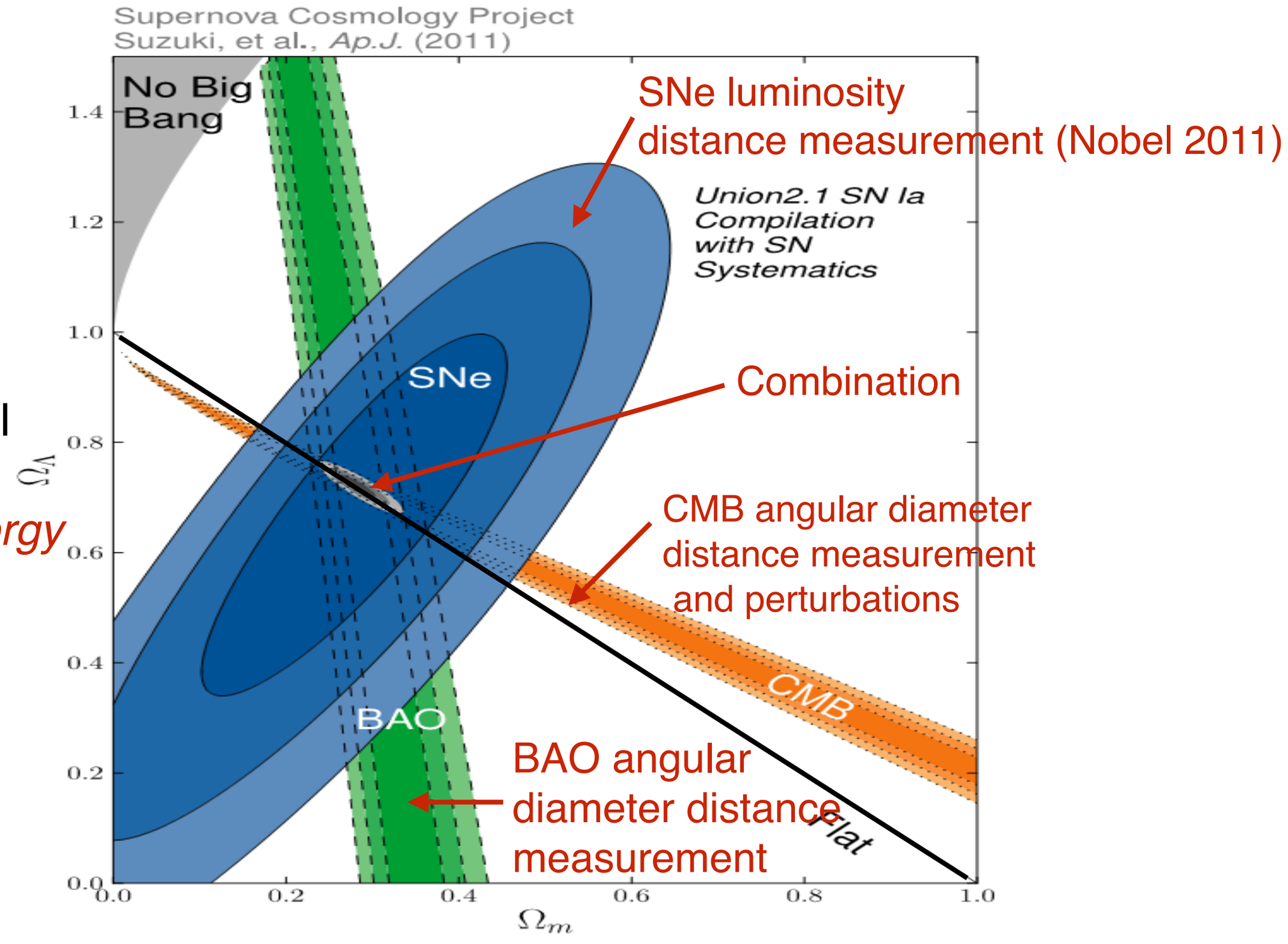
on behalf of the
Weak Lensing & Cluster Growth/Galaxy Redshift Survey
Science Investigation Team

The Observational Foundations of Dark Energy

Cosmological Constant, i.e. *Dark Energy*



- Weak-Lensing not presented is also complementary.

Dark Energy Requires a Modification to Einstein's Equation

$$G_{\mu\nu} = 8\pi T_{\mu\nu}$$

?

- A cosmological constant Λ?
- Deviation from general relativity on cosmological scales?

?

- New matter interaction?
- New matter component?
- Inhomogeneous Universe?

- Each of these modifications will lead to different observational signatures either in the expansion history of the Universe or in the growth of large scale structures:
  - ➡ To observationally and unambiguously solve this puzzle will require multiple probes (also critical for cross-checks)

WFIRST-AFTA Dark Energy/Cosmology Roadmap

Supernova Survey

wide, medium, & deep imaging
+
IFU spectroscopy

2700 type Ia supernovae
z = 0.1–1.7

See Saul Perlmutter's talk

standard candle distances
z < 1 to 0.20% and z > 1 to 0.34%

High Latitude Survey

spectroscopic: galaxy redshifts

16 million Hα galaxies, z = 1–2
1.4 million [OIII] galaxies, z = 2–3

imaging: weak lensing shapes

380 million lensed galaxies
40,000 massive clusters

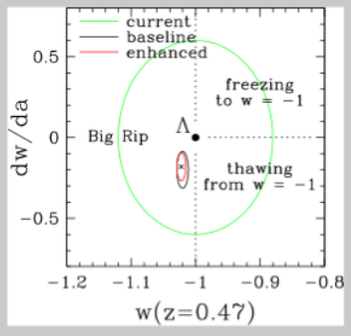
standard ruler

distances	expansion rate
z = 1–2 to 0.5%	z = 1–2 to 0.9%
z = 2–3 to 1.3%	z = 2–3 to 2.1%

dark matter clustering
z < 1 to 0.21% (WL); 0.24% (CL)
z > 1 to 0.78% (WL); 0.88% (CL)
1.1% (RSD)

history of dark energy
+
deviations from GR

$w(z)$, $\Delta G(z)$, Φ_{REL}/Φ_{NREL}



From WFIRST-AFTA SDT Final Report

WFIRST-AFTA Dark Energy Surveys

Weak Lensing (2200 deg^2)

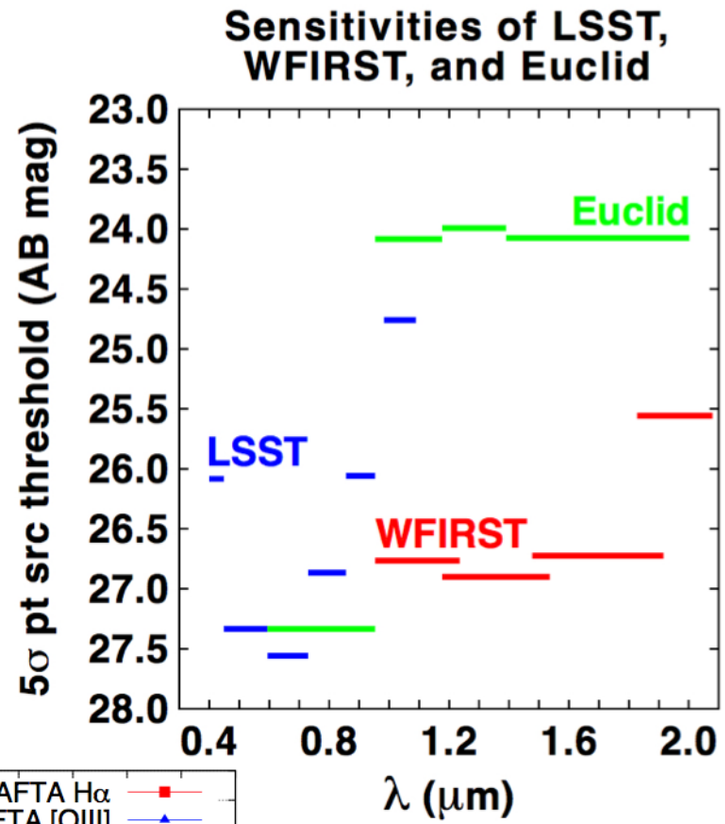
- High angular resolution
- Galaxy shapes in IR
- 380 million galaxies
- Photo-z redshifts
- 4 imaging filters

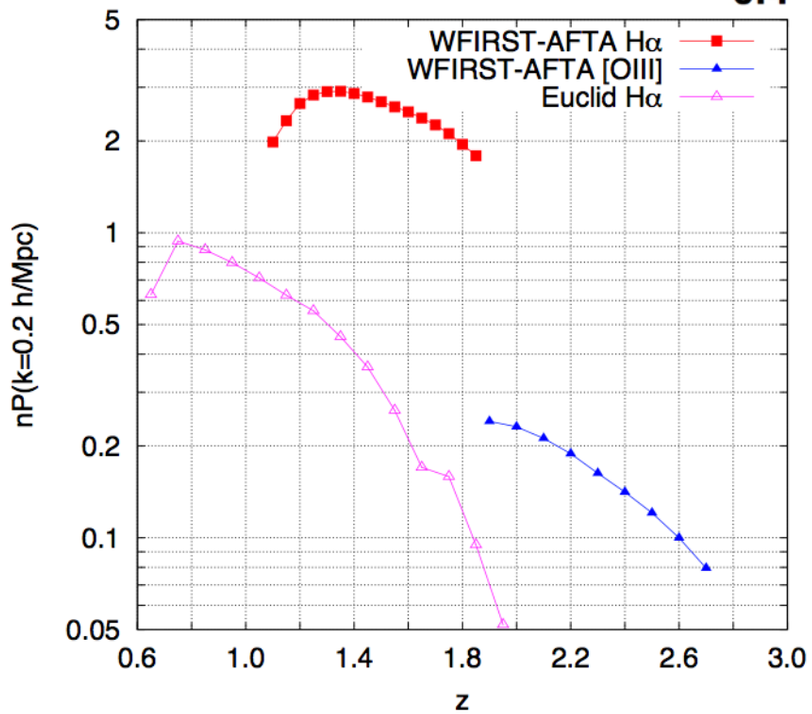
Supernovae

- High quality IFU spectra
- 5 day sampling of light curves
- 2700 SNe

Redshift survey (2200 deg^2)

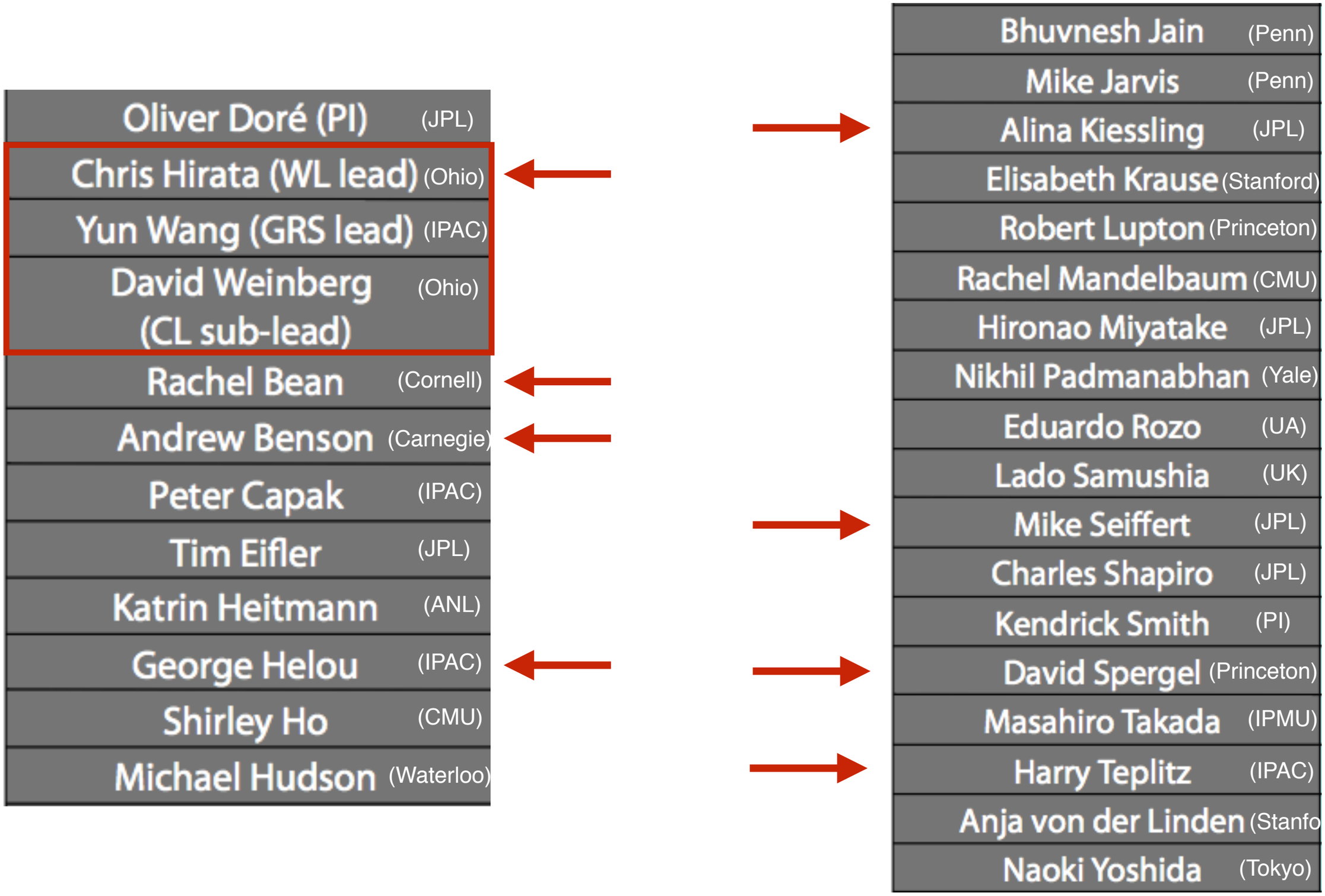
- BAO & Redshift Space Distortions
- High number density of galaxies
- 16 million galaxies





From WFIRST-AFTA SDT Final Report

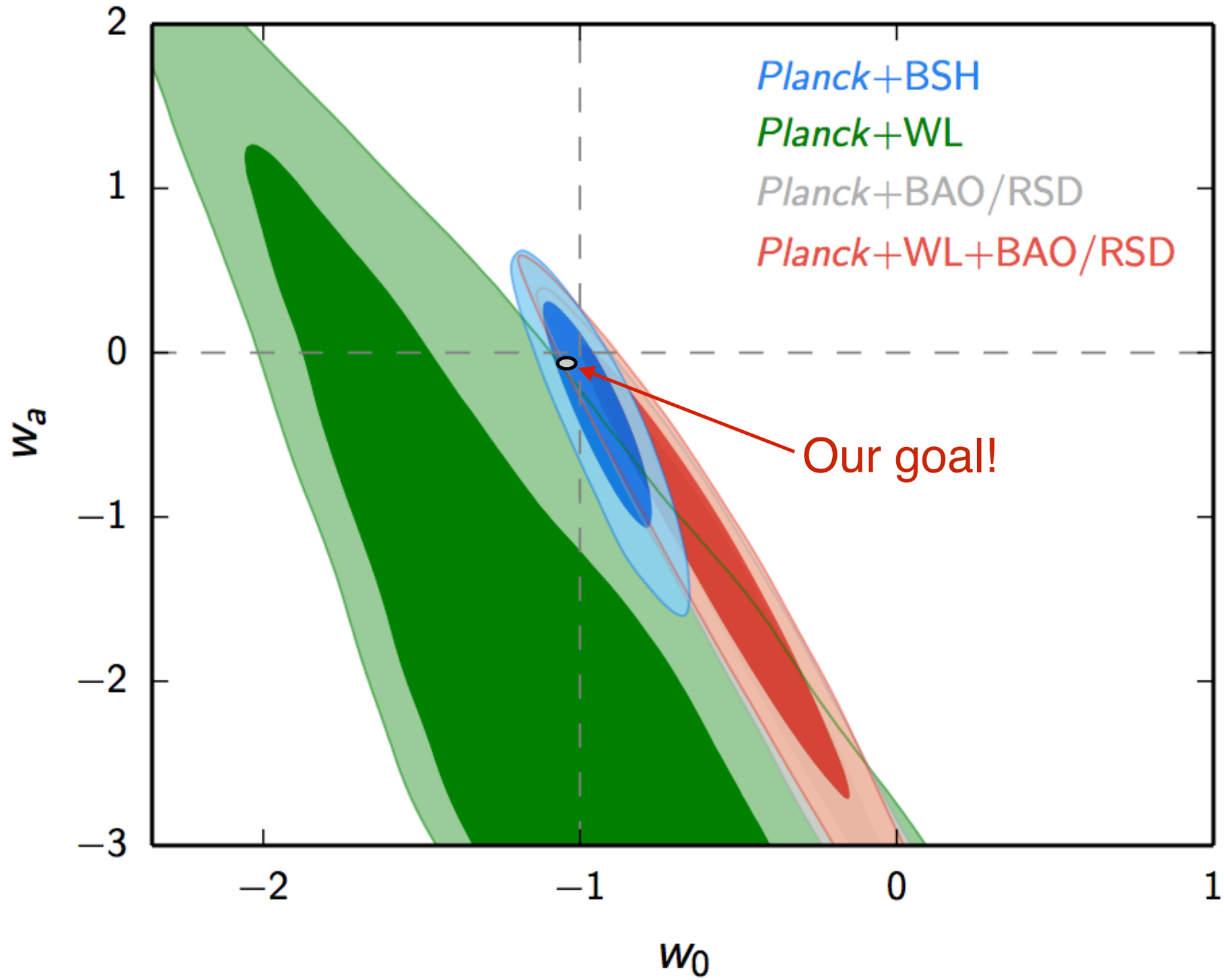
Cosmology with the High Latitude Survey: SIT Team



Cosmology with the High Latitude Survey: SIT Deliverables

- Full requirement flow-down.
- Forecasts of the cosmological performances of the HLS.
- Simulated imaging and spectroscopic data sets.
- Proto-type imaging and spectroscopic pipeline.
- Calibration strategies.
- A strategy for the determination and calibration of photometric redshifts.
- A detailed operations concept for the HLS Imaging and Spectroscopy program.
- Development of methods for modeling and interpreting the cosmological measurement anticipated from WFIRST.
- Simulated light cone observations.
- Pilot survey proposals with associated figures of merits.
- A prioritized program of observations from other facilities.
- Broad engagement with the cosmological community.

Dark Energy Equation of State Status and Prospects



Planck 2015 XIV

Summary

- The existence of Dark Energy is robust and will require new fundamental physics.

- Dark Energy/cosmological studies are done statistically, and require great precision and attention to systematics.

- The answer to the Dark Energy puzzle will come from multiple observational signatures:
  - ➡ A strong and robust portfolio of Dark Energy probes is being developed for WFIRST-AFTA .

- A SIT team to define the cosmological studies with the High Latitude Survey has been selected.

- WFIRST-AFTA is very complementary to other space or ground based efforts, e.g., DES, Subaru HSC, DESI, Subaru PFS, LSST, Euclid… (*see Rachel Bean's talk*)
  - ➡ A broad community engagement is a goal of this SIT.

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