WFIRST and Subaru

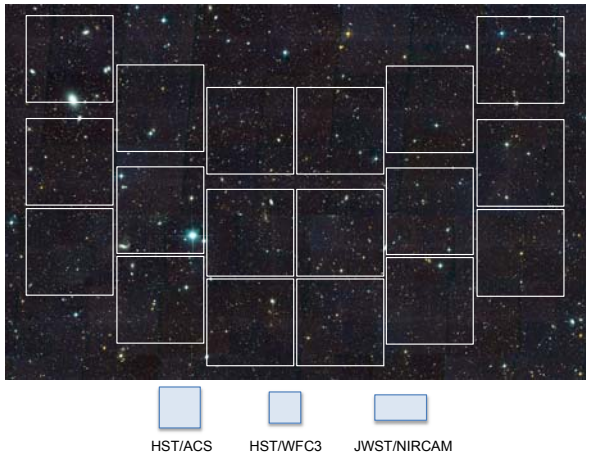
Subaru User's Meeting

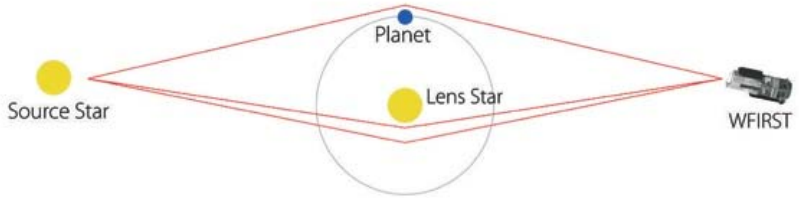
Jason Rhodes (NASA JPL/Caltech/Kavli IPMU)

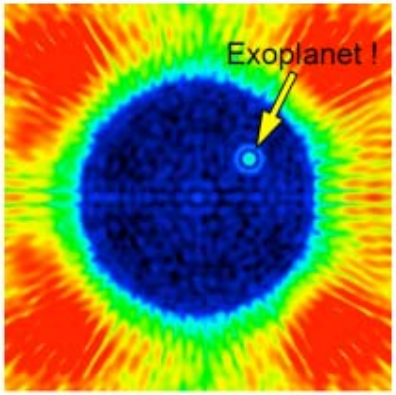
Atami, January 21, 2016

WFIRST-AFTA Summary

- WFIRST is the highest ranked NWNH large space mission.
  - Determine the nature of the dark energy that is driving the current accelerating expansion of the universe
  - Perform statistical census of planetary systems through microlensing survey
  - Survey the NIR sky
  - Provide the community with a wide field telescope for pointed wide observations
- Coronagraph characterizes planets and disks, broadens science program and brings humanity closer to imaging Earths.
- WFIRST gives Hubble-quality and depth imaging over thousands of square degrees
- The WFIRST-AFTA Design Reference Mission has
  - 2.4 m telescope (already exists)
  - NIR instrument with 18 H4RG detectors
  - Baseline exoplanet coronagraph
  - 6 year lifetime





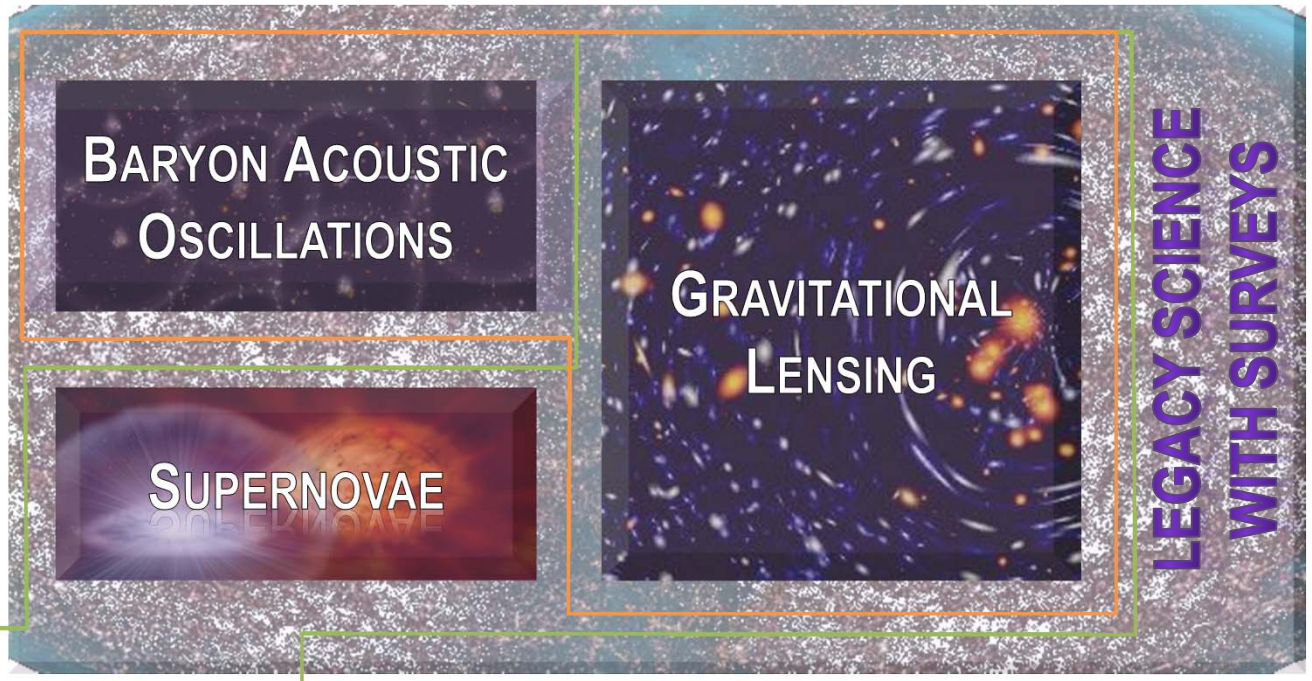


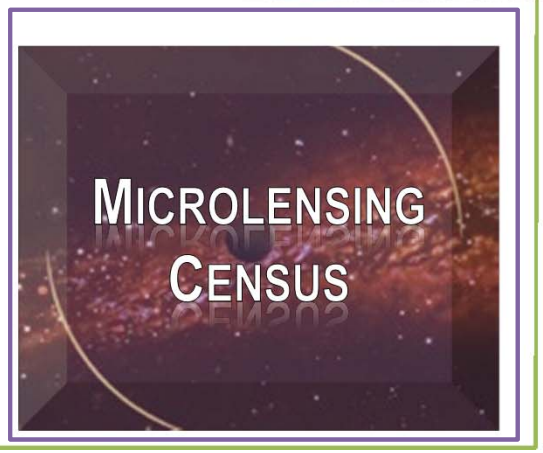
WFIRST Science

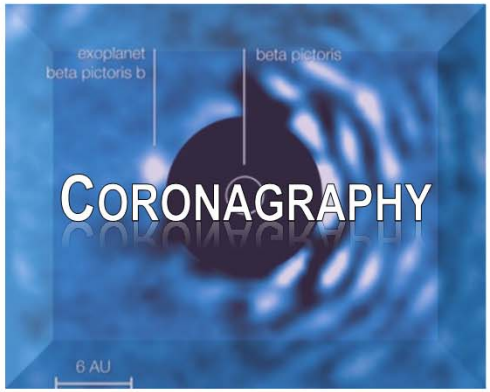
complements Euclid

complements LSST

complements Kepler







continues Great Observatory legacy

WFIRST Status

- Significant WFIRST-AFTA funding added to the NASA budget by Congress for FY14 and FY15 for a total of $106.5M. FY16 budget is $90M. Expected entry into Phase A is **next month** for a 2024 launch
- Foreign contributions being actively pursued for hardware, science, and telescope time
  - Need to be decided during Phase A, in the next ~ year, with 'Acquisition Strategy Meeting' in August, 2016
- Formulation Science Working Group selected last month to assist Project in requirements, methods, algorithm, simulations development through ~2021
  - Made up of 11 Science investigation Teams and 2 Adjutant Scientists
- Operation science team selected in ~2021
- Foreign co-Is not selected for FSWG or SITs so that foreign partners can make their own selections
  - When foreign FSWG members are selected, they will participate in all discussions about WFIRST science

WIRST FSWG

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David Spergel Princeton U. WFI Adjutant Scientist, Co-Chair

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Nominal Capabilities (To be discussed by FSWG)

WFI:

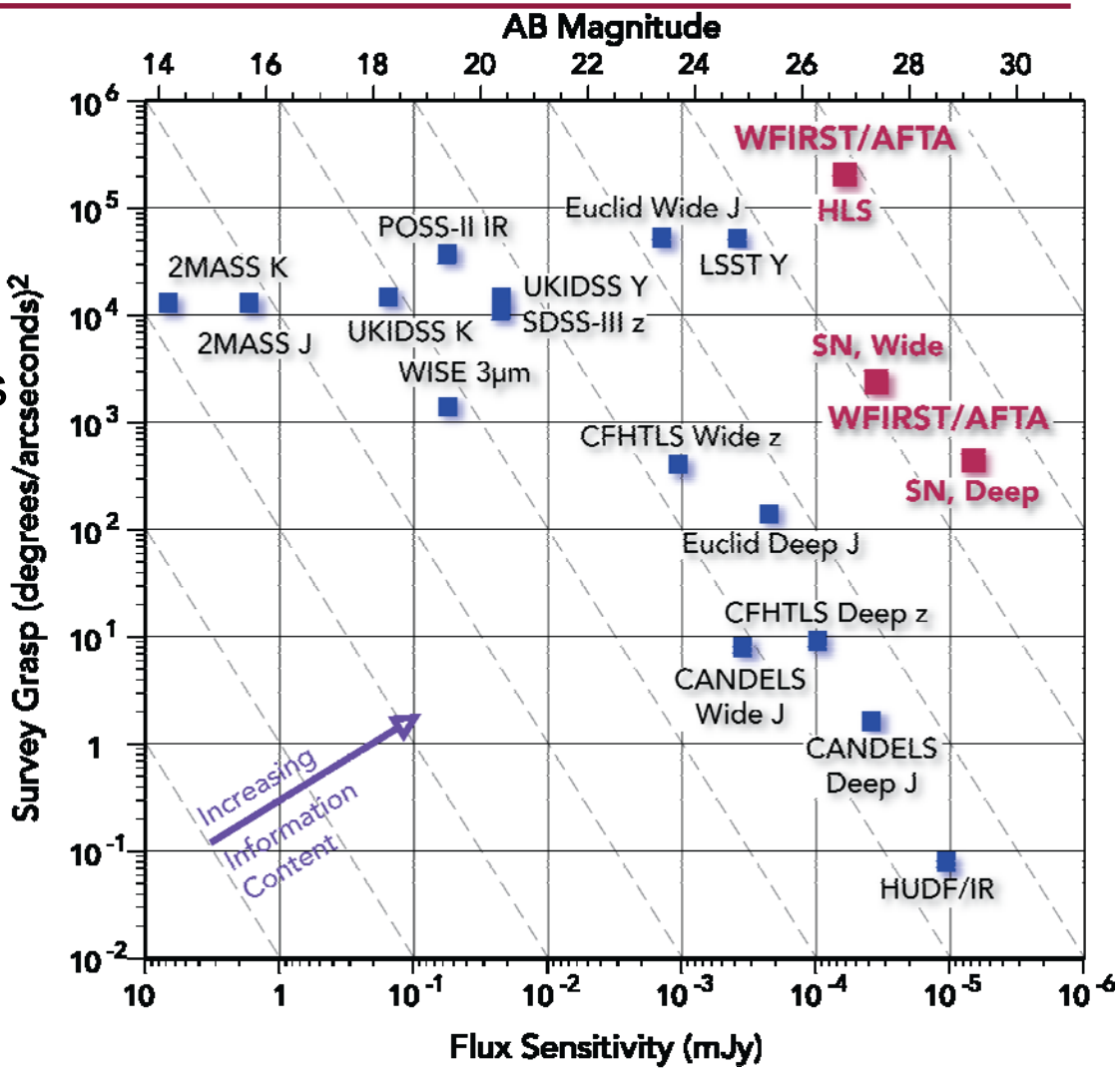
Imager	**0.76-2.0 microns** 0.28˚ FoV, 0.11" pixel scale, 18 4k by 4k H4RG
Filters:	z (0.76 - 0.98), Y (0.93-1.19), J (1.13-1.45), H(1.38-1.77),
	F184 (1.68-2.0), W149 (0.93-2.00)
Grism:	**1.35-1.89 microns** 0.28˚ FoV, R=461λ, 0.11" pixel scale
IFU:	**0.6-2.0 microns** 3" & 6" FoV, R~100, 0.075" pixel scale

Coronagraph:

Imager:	**0.43-0.97 microns** 1.63" FoV (radius), 0.01" pixel scale, 1k x 1k EMCCD, 10^{-9} final contrast, 100-200 mas inner working angle,
IFS:	**0.60-0.97 microns** 0.82" FoV (radius), R~70
Field of Regard:	54˚ - 126˚ 60% of sky instantaneous

WFIRST-AFTA Surveys

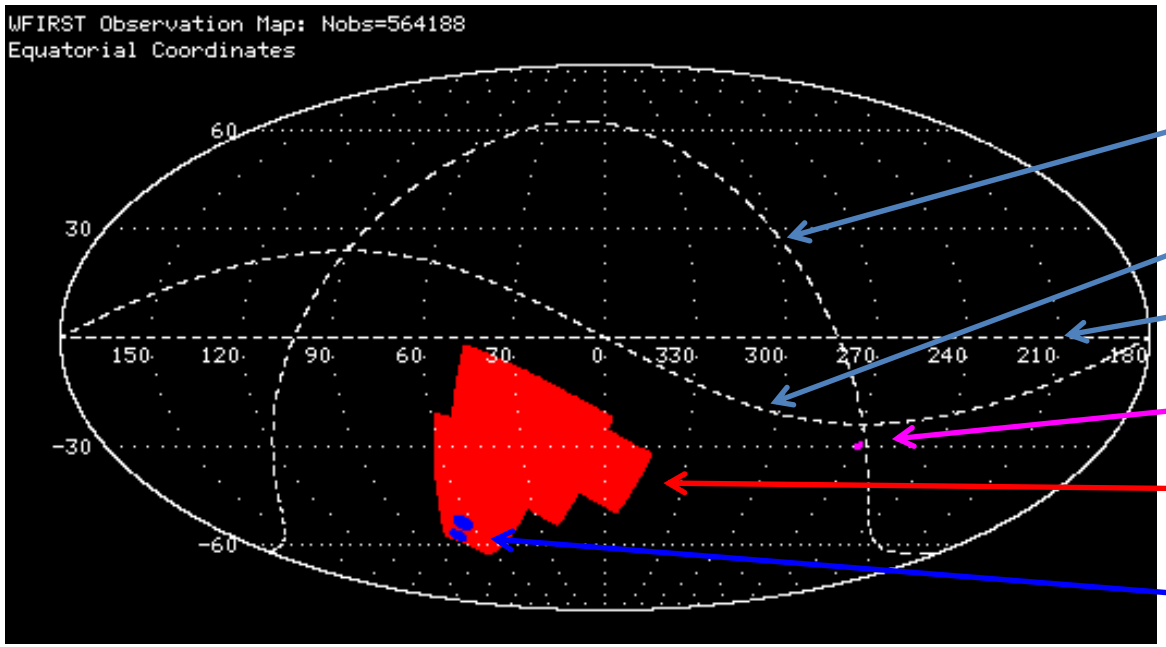
- Multiple surveys:
  - High-Latitude Survey
    - Imaging, spectroscopy, supernova monitoring
  - Repeated Observations of Bulge Fields for microlensing
  - 25% Guest Observer Program
  - Coronagraph Observations
- Flexibility to choose optimal approach



Near Infrared Surveys

Example Observing Schedule (to be revised by future science team)

- High-latitude survey (HLS: imaging + spectroscopy): 2.01 years
  - 2227 deg^2 @ ≥3 exposures in all filters (2279 deg^2 bounding box)
- 6 microlensing seasons (0.98 years, after lunar cutouts)
- SN survey in 0.63 years, field embedded in HLS footprint
- 1 year for the coronagraph, interspersed throughout the mission
- Unallocated time is 1.33 years (includes GO program)



Galactic Plane

Ecliptic Plane

Celestial Equator

Microlensing Fields

High-Latitude Survey Area

SN Fields

Imaging on Subaru For WFIRST

- To match High Latitude Survey depth (LSST Depth g=27.4,r=27.5,i=26.8,z=26.1)
  - ~1 night per square degree
- To match supernova survey one would need:
  - 2.5 nights per sq deg for wide (+0.5 mag deeper)
  - 6 nights per sq deg for medium (+1 mag deeper)
  - 100 nights per sq deg for deep (+2.5 mag deeper)
    - ~1.5 square degrees is smallest field so would require 150 nights

Calculations from Peter Capak (IPAC)

Subaru for WFIRST

- NASA HQ and WFIRST project interested in a **partnership with Japan** that includes hardware for coronagraph, science involvement, ground stations, and Subaru time or data
- Envision and allotment of Subaru time that would enhance and enable WFIRST science and provide benefit to the WFIRST and Subaru communities
- **Details of the use of this time would be left to future WFIRST Science Team which would have Japanese involvement**
- Japanese involvement could span the range of WFIRST science
- Talked to all 11 SIT leads about what Subaru data is of interest
  - All areas of WFIRST science may benefit from (or even require) Subaru data
  - 3 time scales: near term (through ~2020); medium term (2020-2024); concurrent with WFIRST (2024-2030+)
  - The bulk of the time could be best used after ~2023, allowing for currently planned large surveys to be completed.
  - PFS and HSC are primary instruments of interest, but some AO desired

Cosmology

Weak Lensing and Galaxy Redshift Survey

- 2200 square degree High Latitude Survey (HLS) will mostly or completely overlap LSST because of required photo-z depth (full LSST 10 year depth required)
- Some portion might be visible to Subaru, which would also allow TMT follow up
- Deep and Calibration fields in the north will be important, especially for TMT follow up
  - — Subaru data will be needed for photo-z
  - — Tens of nights

Supernova Survey

- 3 tiered survey, with some of the fields in the North, would require Subaru and allow TMT follow up
- Subaru could enhance WFIRST SN program by widening the search field and giving more SN for IFU to follow up (improves DE FoM)
- Precursor work would require covering several 5-10 square degree fields w/ HSC and PFS at a cost of a few nights before 2024
- SN search fields will give ~175 SN over 2 years, requiring 12 nights
  - — For 2000 SN, want 12 fields at a cost of 72 nights over 2 years

Examples of Guest Observer Science

- Nearby galaxies: Subaru HSC data could be valuable for simulations
  - 10 nights on 10 nearby galaxies in the near term
  - ~10-20 nights of concurrent deep imaging with WFIRST in wide and narrow band filters
  - Would benefit from HSC-wide survey data for planning, especially in understanding Milky Way stars
- Stellar populations in Milky Way
  - Few nights of near term observations on HST-WFC3 IR fields for panchromatic simulations/planning
  - Single deep pointing in galactic bulge and one in a globular cluster, ~10 nights
  - Would benefit from HSC-wide survey data for planning, especially in understanding Milky Way stars
- High Z Galaxies
  - Subaru z band observations over a part of the HLS field (deeper than LSST) would enable more z=7 galaxies to be identified; 1 night per square degree or ~50-100 nights concurrent with WFIRST
  - Ultra-deep grism survey woud be complemented by Subaru deep optical imaging; tens of nights
  - Deep Fields with HSC and PFS are key to some extragalactic science ; ~50 nights
- Setting aside ~10 nights per year (60 nights total) to be warded to appropriate WFIRST/Subaru joint GO programs would benefit the WFIRST and Subaru communities

Microlensing

- Deep HSC precursor observations of WFIRST microlensing fields (10 square degrees), 5 nights
- Follow up of ~40 Spitzer/K2 microlensing events using Subaru AO in order to verify methodology ahead of WFIRST, 7 nights
- Concurrent observations of microlensing fields, 8 nights per year, 48 nights

Coronagraph

- Because of limited WFIRST field of view, WFIRST CGI and Subaru could complement each other nicely in imaging disks, with CGI imaging the inner region and Subaru the outer; time TBD concurrent with WFIRST

- Subaru precursor observations of debris disks could provide WFIRST target list; time TBD in 2020-2024

Summary

- **WFIRST is happening!!**
  - —Japan is a valued potential partner, and Subaru data/access is a key aspect of that partnership
  - —The timescale for partnership agreements is the next few months
- Access to HSC and PFS data will be useful for WFIRST planning and joint science exploitation
- Hundreds of nights of Subaru data will greatly enhance, and in some cases, enable, all areas of WFIRST science
- Subaru access/data will push some WFIRST science to the North, allowing for TMT follow up
- Would like to see ~15 nights per year in precursor observations starting in ~2018 and ~60 nights per year during mission (staring 2024)

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