Issues for SDT Consideration Arising from Conference

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WFIRST-AFTA SDT

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Ex Officio

Mike Hudson, Univ. Waterloo, CSA rep
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Dominic Benford, NASA HQ
Wes Traub, NASA JPL

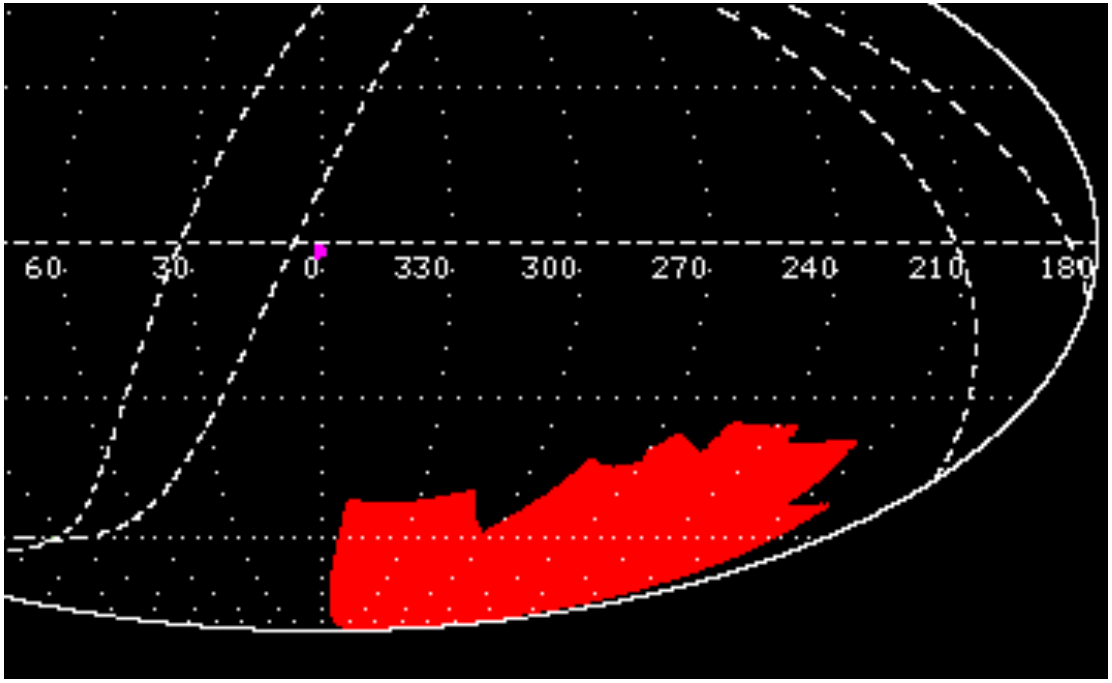
Strategy for Defining WFIRST

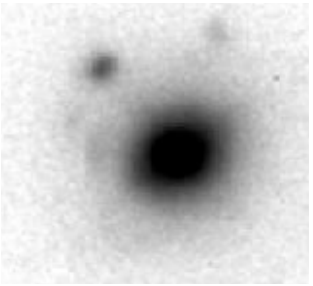
- The SDT is defining an example DRM and observing plan based on the NWNH science goals and the capabilities of the 2.4m telescope. They are being used to refine the observatory requirements.

- The specific hardware configuration of the observatory will be determined by competitively selected team(s) working with the WFIRST project office, as defined by NASA HQ.

- The observing plan will be determined by the WFIRST Science Working Group and the GO program, and refined as the launch date approaches. The GO program will be competitively selected similarly to other NASA astrophysics missions.

Huge Dynamic Range



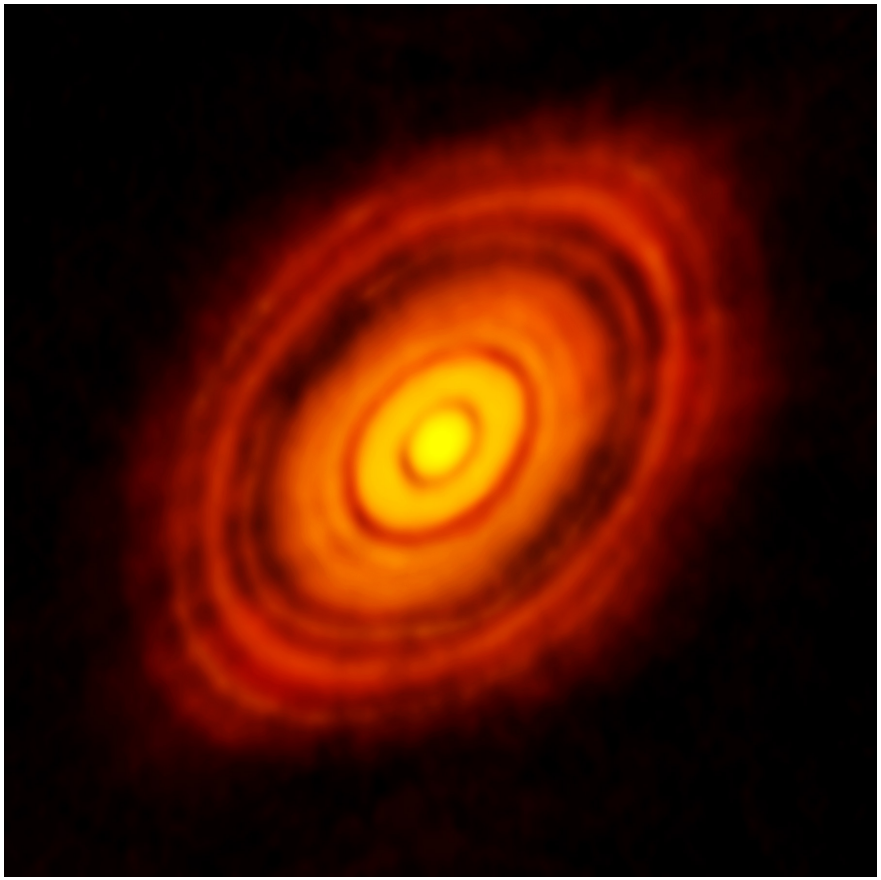


~10^6 dynamic range in size

~2×10^{12} resolution elements in HLS

www.eso.org

ALMA HL Tauri Disk



Beautiful ALMA Disk Image

- Jupiter mass of gas
- ~10^{10} zodis
- Origin of structure unknown
  - instabilities
  - planets
- Very different than WFIRST dust disks but points to interesting structures

DE Survey

The DE world according to J. Frieman:

"Good reason to expect that w is close to -1, but not exactly -1."

"Best approach: control systematics and combine multiple techniques"

“WFIRST will mark return to spectroscopic SN cosmology after a decade”

- SN survey strategy
  - WFI Imager for SN discovery, IFU for spectroscopy
  - Observations every 5 days
  - IFU: 0.6 – 2.0 micron, 3" FoV, R~75
- Foley & Scolnic
  - Independent detailed simulations
  - Larger overall errors than SDT report, insufficient S/N to type SNe
  - Recommend higher resolution in IFU, check of numbers with SDT
- Weak lensing concerns:
  - Galaxy blending
  - Photo-z outliers
  - Recommend combining ground and space WL surveys

Coronagraph

- There can be a tension between exoplanet and disk coronagraphy
  - Masks that give best inner working angle and dark hole, sacrifice outer working angle
  - Solution is to have multiple masks with different designs
- Several ways to observe exoplanets with WFIRST coronagraph
  - Observe known RV planet (current catalog + future extensions)
  - Detect new exoplanets in known RV systems
  - Detect new exoplanets with blind searches
  - Total yield is ~20 for known RVs and 50-100 with all techniques
- Needed future SDT studies
  - Develop more realistic coronagraph model for predictions
  - Study polarization capability and requirements
  - Develop methods for disk observations and predictions
  - Determine calibration needs
  - Survey non-exoplanet science with coronagraph

Microlensing

WFIRST is uniquely capable of performing precise NIR space microlensing

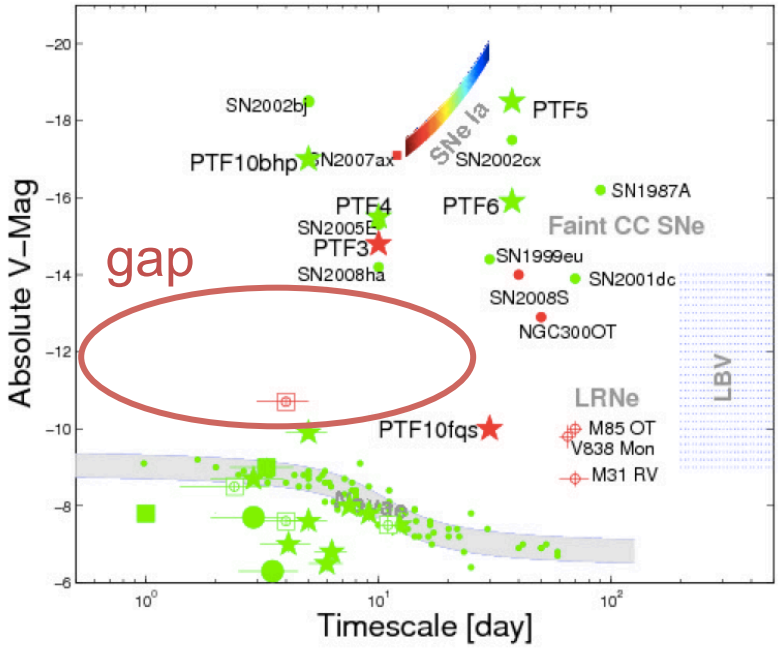
- Microlensing and supernova time requirements could limit GO time in that region of the sky. Difficult scheduling job.
- Precursor WFC3 data can simulate observing cadence to give parallaxes and proper motions
- Ground data can give parallax information, even with less sensitive observations. Need 4m time.

- Needed future SDT studies and activities
  - Develop more accurate predictions of microlensing yields
  - Study needed precursor data
  - Grow the microlensing community

Time Domain Science

High sensitivity, large sky coverage and NIR bandpass give WFIRST a powerful time domain capability

- Large sky coverage will capture rare events in the nova – supernova gap. Increase population by order of magnitude
- WFIRST will be prime mission for studying rare SNe to high z
- WFIRST will capture several tidal disruption events per year
- WFIRST will provided sensitive GRB follow-up in NIR
- Needed further SDT studies
  - Determine needed response times
  - Study operational impacts



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Filter Choices

- Current filter set: 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), F149 (0.93-2.00)
- Grism 1.35 – 1.89
- **Desire** to move longer wavelength limit redward for higher redshift, lower extinction, sensitivity to dust, lower background.
  - "Zero redshift people want longest wavelengths" David Soderblom
  - Depends on telescope temperature and thermal background
  - WFIRST project studying lower telescope temp from 282K to 250K
  - K-short filter may be desirable even if temp is higher than 250K
- **Desire** to move lower limit blueward for better overlap with ground
- **Desire** to change grism blue limit to ~ 1 micron for better coverage of Ly-α and Ly break at z~7 (reionization and high-z quasars; Malhotra)
- Plan forward: SDT will study several possible filter set options and give to PAGs and community for comment.

Capabilities

WFI Imaging:	**0.8-2.0 microns** 0.28˚ FoV, 0.11" pixel scale
WFI grism:	**1.35-1.87 microns** 0.28˚ FoV, R=450, 0.11" pixel scale
WFI Filters:	z (0.76 - 0.98), Y (0.93-1.19), J (1.13-1.45), H(1.38-1.77), KS (1.68-2.0), Wide (0.93-2.00)
IFU:	**0.6-2.0 microns** 3" FoV, R~75, 0.075" pixel scale
Coronagraph:	**0.4-1.0 microns** 2.5" FoV, 0.017" pixel scale 1k x 1k e2V detector 10^{-9} effective contrast, 100-200 mas inner working angle
IFS:	**0.6-1.0 microns** 1.5" FoV, 0.017" pixel scale, R~70
Field of Regard:	54˚ - 126˚ 60% of sky

Capabilities

Attributes	WFIRST capability
Imaging survey	J ~ 27 AB over 2200 sq deg
	J ~ 29 AB over 3 sq deg deep fields
Multi-filter photometry	Filters: z, Y, J, H, F184 (Ks), W (wide)
Slitless spectroscopy	R~600 over 2200 sq deg
Slit multi-field spectroscopy	IFU, R~70
Number of SN Ia SNe	2×10^3 to z~1.7
Number galaxies with spectra	2×10^7
Number galaxies with shapes	4×10^8
Number of galaxies detected	few x 10^9
Number of massive clusters	4×10^4
Number of microlensed exoplanets	3000
Number of imaged exoplanets	10's

SDT Considerations of Science Team Selection Process

Background

- NASA will have an NRA or AO for participation in WFIRST-AFTA at the start of Phase A (~ 2016 or 17)
- Coronagraph and/or wide-field IR imager may be selected competitively or may be provided by NASA. If competitive, those teams would also include scientific investigations.
- Other scientific investigations may be selected competitively
  - Large teams with PI, Co-I's and collaborators
  - Interdisciplinary Scientists
  - EPO Scientist

Science Working Group

Typically 15-20 members

- Project Science team (from NASA Centers)
  - Project, Instrument, Telescope, and Detector Scientists
- Science center leads
- PIs of selected investigations / instruments
- Interdisciplinary scientists (IDSs)
- EPO scientist
- Program Scientist (from HQ, ex-officio)
- Foreign representatives

WFIRST-AFTA Options

- Scientific investigations and interdisciplinary scientists may be selected as follows. If instruments are competed, those teams would also have science investigations
- Assume 8 investigations and 3 IDSs
- Option A:
  - 4 investigations for IR survey
  - 4 investigations for exoplanets
- Option B:
  - 1 investigation **each** for WL, BAO, SNe
  - 1 investigation for non-DE survey science
  - 1 or 2 investigations for microlensing
  - 1 or 2 investigations for exoplanet coronagraph
  - 1or 2 investigations for debris disks

SDT Consideration of Data Rights

Background

- Rules for data rights will be determined by NASA HQ prior to science team selections
- Important for observatory builders, science teams and GIs
- Different missions have different rules, dependent on field of view, era, and advocacy of particular groups when the mission was formulated
- Trend is strongly toward "open data" policies

WFIRST-AFTA Considerations

- Standard of 1 year proprietary time for all data is probably no longer acceptable to NASA or the community
- WFIRST-AFTA wide field imager has wide FoV that makes proprietary data difficult
- Different science areas for WFIRST-AFTA have different data needs, making any proprietary rules complex and likely unworkable.
- An open data policy such as that of LSST and Fermi LAT may be the natural fit for most or all of the WFIRST-AFTA data
- Rapid public access to broad-use survey data has been demonstrated to maximize scientific output.

Summary

- Plenty of work ahead for SDT and future science team
- WFIRST DE survey better than NWNH. Finer imaging and larger mirror increase complementarity with Euclid & LSST. Microlensing survey also better due to decreased confusion.
- WFIRST coronagraph is powerful step forward for direct exoplanet imaging
- Issues remain to be resolved
  - SN typing
  - WL shape blending and photo-z errors
  - Microlensing predictions
  - Microlensing community size
  - Coronagraph models
  - Coronagraph calibration needs