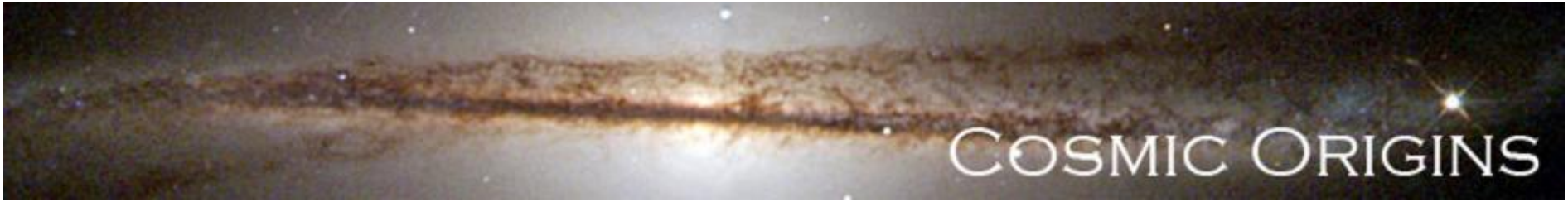


Science Analysis Group #6

Cosmic Origins Science Enabled by the Coronagraph Instrument on NASA's WFIRST- AFTA Mission

Dennis Ebbets, Ken Sembach, Susan Neff

AAS Boston

June 05, 2014

SAG 6 Charter

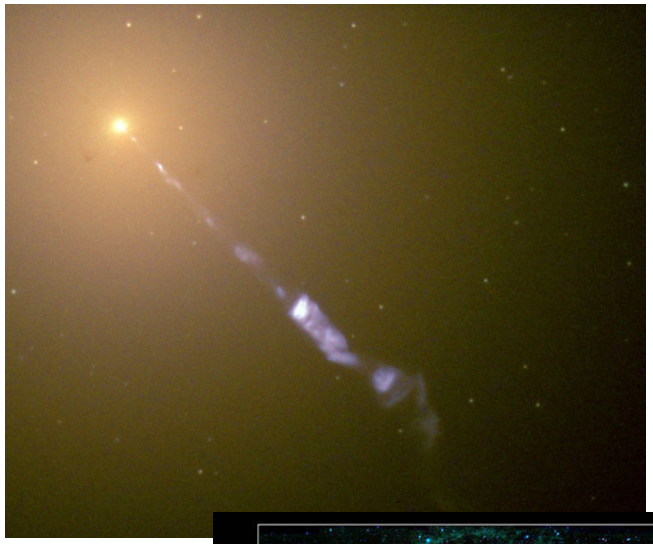
The Wide-Field Infrared Survey Telescope (WFIRST) is the highest priority large space mission recommended by the recent decadal survey in astronomy and astrophysics. It is designed to perform wide-field imaging and slitless spectroscopic surveys of the visible to near-infrared sky. The Astrophysics Focused Telescope Assets (AFTA) study design of the mission makes use of an existing 2.4m telescope to enhance light collecting and imaging performance. The main instrument is a wide-field multi-filter imager with infrared grism spectroscopy. It also features a small-field low-resolution integral field spectrograph. A coronagraph instrument was part of the study and has a primary science focus of direct imaging of gas-giant exoplanets and debris disks.

The WFIRST-AFTA Science Definition Team has solicited community input for potential WFIRST-AFTA coronagraphic science investigations related to NASA's Cosmic Origins (COR) theme or Physics of the Cosmos (PCOS) theme. Such science investigations may further enhance the science case for the AFTA-study design that includes the coronagraph. While not a primary driver for coronagraph design, science investigations other than exoplanet and debris disk studies may provide helpful insight for future design choices.

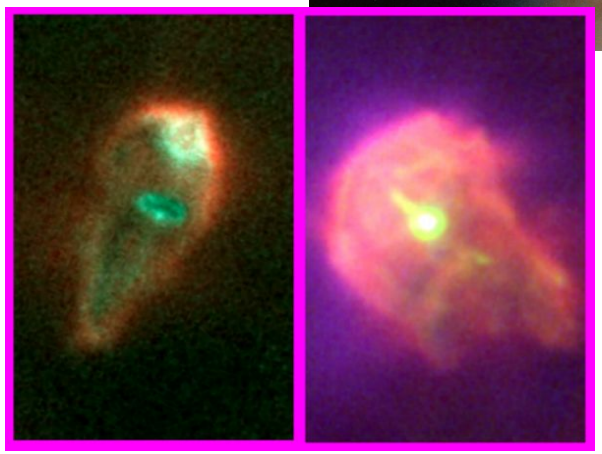
Reasons for doing this

- WFIRST was the highest ranked recommendation for a large space mission made by the 2010 Astrophysics Decadal Survey NWNH
- WFIRST-AFTA is NASA's priority for the next large mission following JWST
- A coronagraph designed to enable exoplanet studies is included in the baseline instrument suite
- **Exploring additional science that this instrument can enable will increase the scientific return and broaden the community of future users**

COR maps directly into the science objectives of: 2010 Astrophysics Decadal Survey and 2013 30 Year Roadmap



Supermassive Black Holes
Galaxy formation and evolution
Starbirth
Protoplanetary systems
Stellar evolution



SAG 6 Schedule and Products

Schedule:

- Initial meeting January 2014 (AAS)
- Having discussions & soliciting inputs now
- **Public Splinter at June AAS (Monday)**
- Briefing to Astrophysics Subcommittee late summer 2014
- Written report fall 2014

Products:

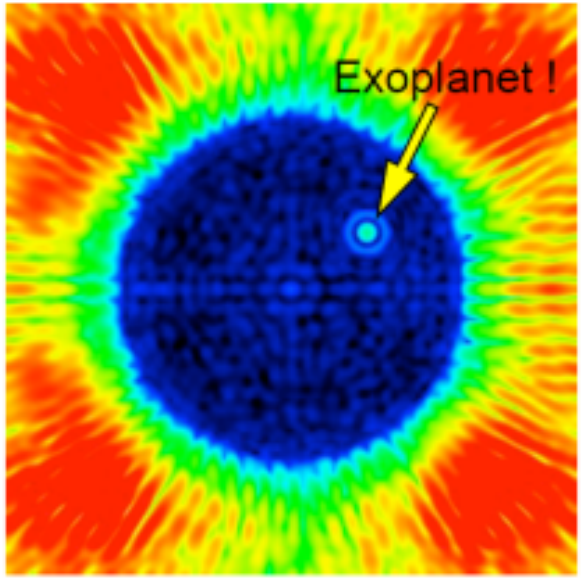
1. Oral briefing to Astrophysics Subcommittee
2. Written report to APS and WFIRST-AFTA SDT
3. Posting of briefing on COPAG web site

SAG 6 Participants

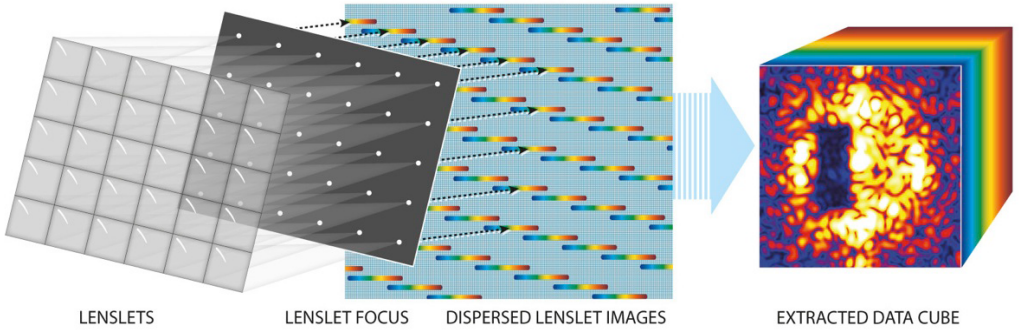
- COPAG EC connection – Dennis Ebbets, Ken Sembach, Susan Neff
- Interviews and discussions
  - CU CASA colloquium (15 participants)
  - Mike Shara
  - Wes Traub
  - Steve Unwin
  - Dominic Benford
  - Karl Stapelfeldt

The AFTA Coronagraph

Occulting Mask Coronagraph = Shaped Pupil + Hybrid Lyot (primary)
Phase-Induced Amplitude Apodization (backup)



- 400 – 1000nm spectral coverage
- Central 100 – 250 mas radius occulted
- Contrast ~ 10^{-9}
- Outer FOV about 2 arc sec



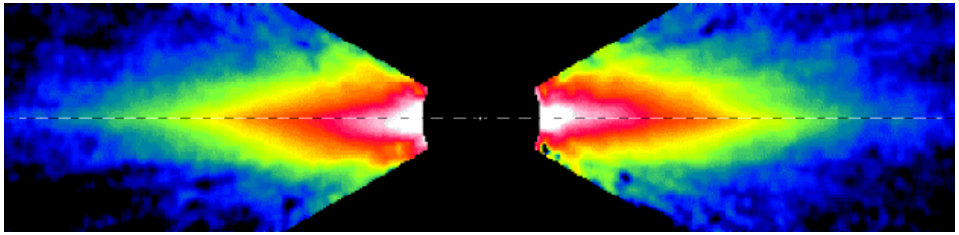
Direct imaging
5 bands 10% width each

Integral Field Spectrograph
17 mas / spatial sample
R ~70

Examples of Science Investigations

- Quasars & AGN
  - Host galaxies
  - Central black holes
  - Accretion disks
  - Jets
- Young stars
  - Accretion disks
  - Outflows
  - Protoplanetary disks
- Evolved Stars
  - Debris disks
  - Ejecta
  - LBVs - η Carinae
  - WR stars

We are hoping that you will help articulate some specific examples



Suggestions from previous audiences

- Quasars and AGN
  - Hosts of IGM absorbers (block light of quasar)
  - Inner regions of jets from AGN, SMBH etc.
  - Bulges of quasar host galaxies
  - Scattering of Ly a in environs of z ~ 6 quasars
  - Are high-z SNe lensed with multiple images or magnification?
  - Faint tidal tails of galaxy mergers (point sources?)
- Young stars
  - Collimation of jets from YSOs
  - Inner regions of zodis of nearby stars
  - Disk morphology affected by planets
- Evolved stars
  - Interactions of stellar winds with circumstellar media
  - RG, AGB mass loss
  - Multiple shells of WR, LBV and P Cygni stars
  - Shell structures, causes of symmetry

Summary of planned SAG 6 activities

- Review of AFTA coronagraph designs to understand expected performance
- Ongoing discussions with community on potential observations relevant to SAG charter
- Solicitation of written summaries
- **Discussions with intended recipients to identify content & level of detail that would be valuable**
- Written report will consolidating suggestions
- Presentations to ApS, community