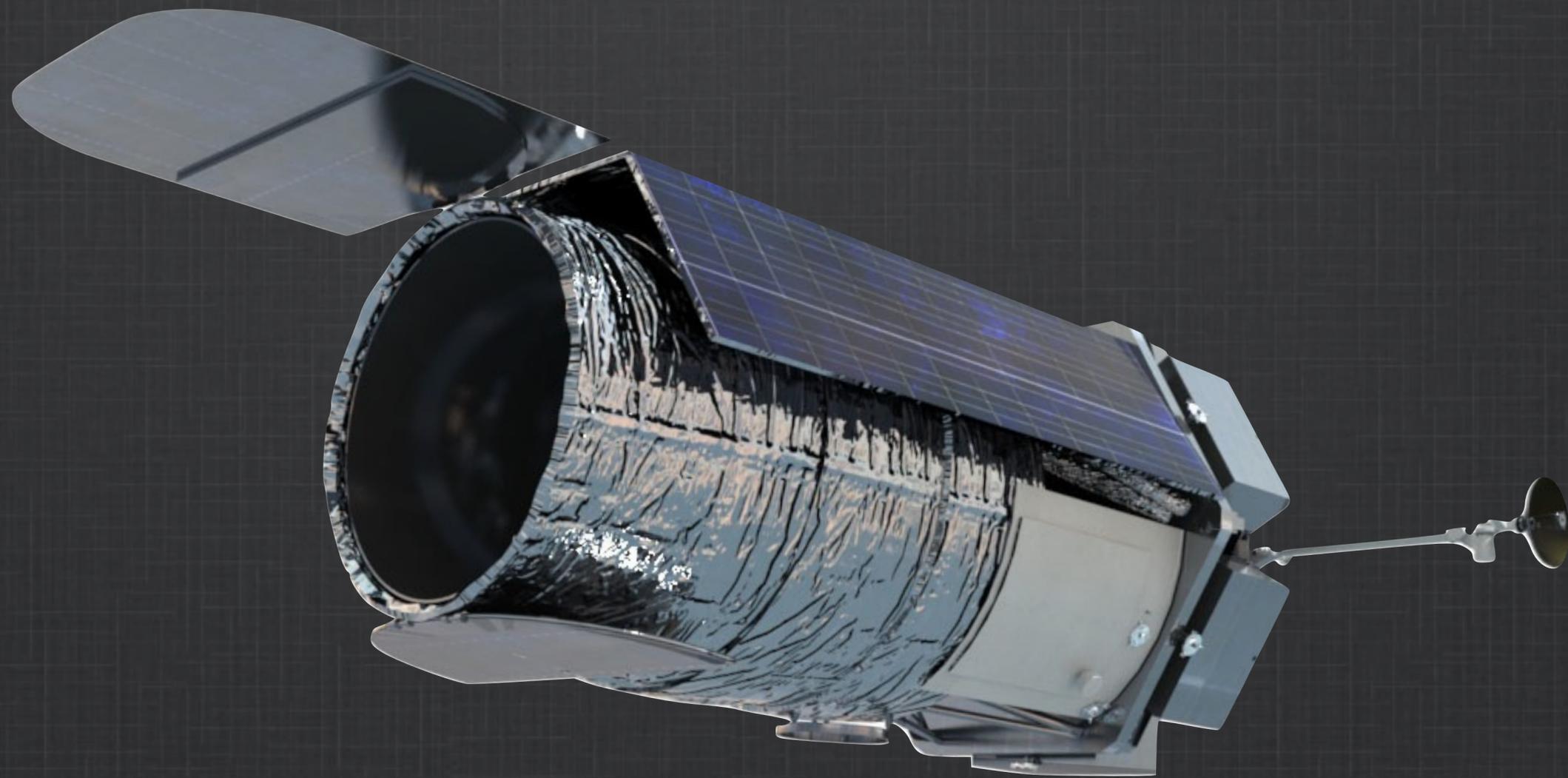


# WFIRST Guest Observer Science



**Jason Kalirai (JHU, STScI)**

SIT Members: C. Conroy (CfA), A. Dressler (OCIW), M. Geha (Yale),  
E. Levesque (UW), J. Lu (IfA), J. Tumlinson (JHU, STScI)

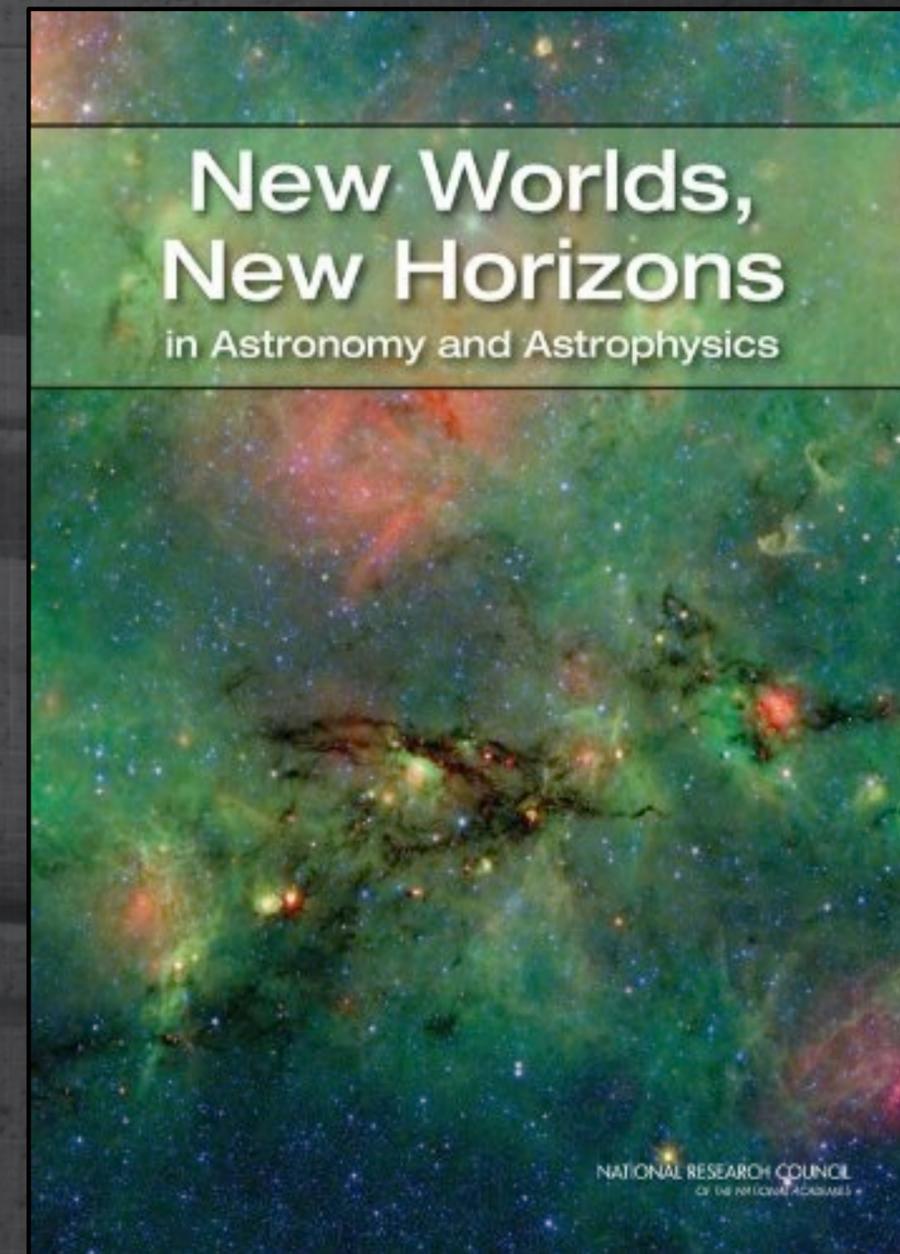
# The Guest Observer Program has Always Been a Part of the WFIRST Foundation

## Panel Reports - New Worlds, New Horizons in Astronomy and Astrophysics

*“A significant fraction of the first 5 years will also be used for surveys and smaller peer-reviewed guest-observer projects that will investigate, for example, galaxy evolution, stellar populations of nearby galaxies, and the plane of the Milky Way galaxy”*

*“The combination of depth, area, and quality of WFIRST data in the infrared will easily surpass that any other ground-based or space-based facility. WFIRST research bears substantially on 10 of the 20 key questions posed in the Astro2010 Science Frontiers Panel reports (see Table 6.2).”*

*“The ability of a single facility to have such broad impact, and its combination of affordability, technical readiness, and low risk, is why the EOS recommends WFIRST as the next large U.S. space mission.”*



# The Guest Observer Program has Always Been a Part of the WFIRST Foundation

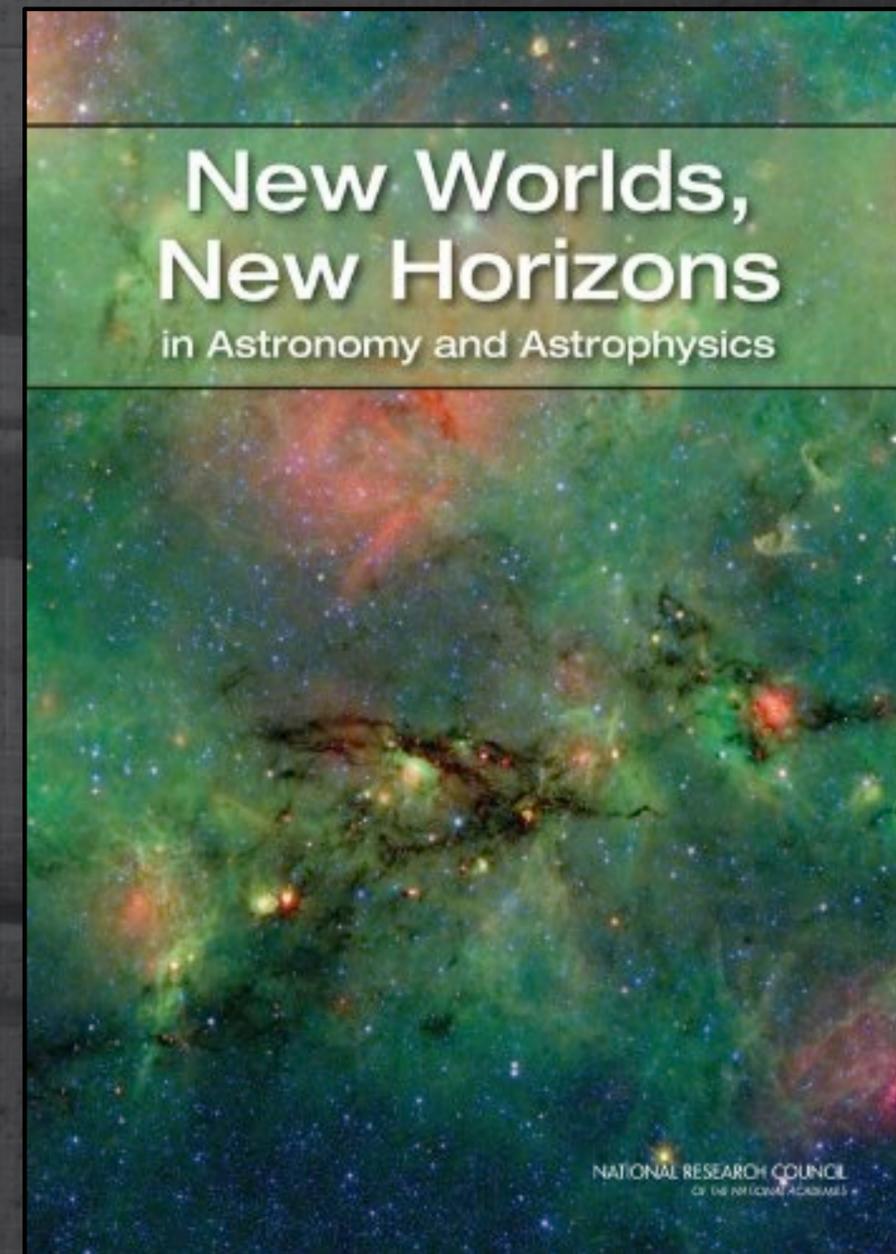
## Panel Reports - New Worlds, New Horizons in Astronomy and Astrophysics

*“A significant fraction of the first 5 years will also be used for surveys and smaller peer-reviewed guest-observer projects that will investigate, for example, galaxy evolution, stellar populations of nearby galaxies, and the plane of the Milky Way galaxy”*

*“The combination of depth, area, and quality of WFIRST data in the infrared will easily surpass that any other ground-based or space-based facility. WFIRST research bears substantially on 10 of the 20 key questions posed in the Astro2010 Science Frontiers Panel reports (see Table 6.2).”*

*“The ability of a single facility to have such broad impact, and its combination of affordability, technical readiness, and low risk, is why the EOS recommends WFIRST as the next large U.S. space mission.”*

...that was for a 1.5m telescope, not a 2.4m

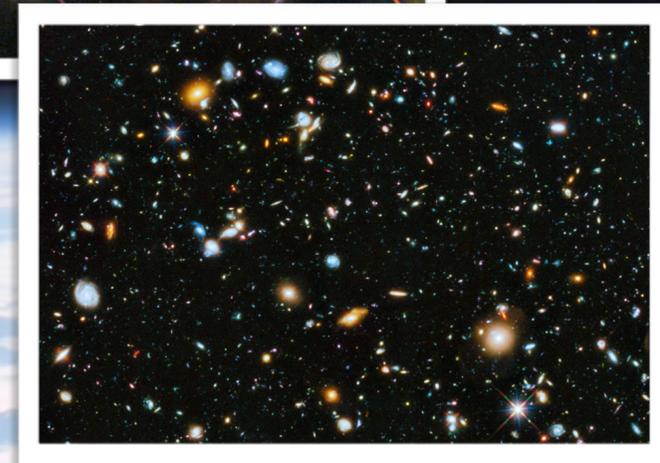
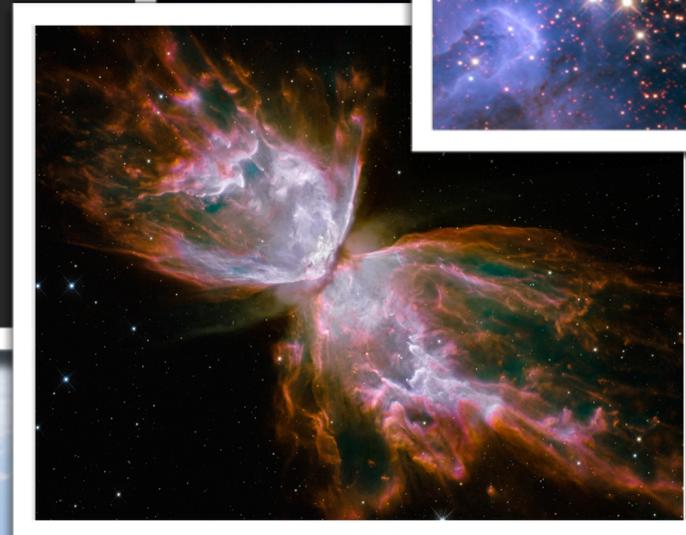
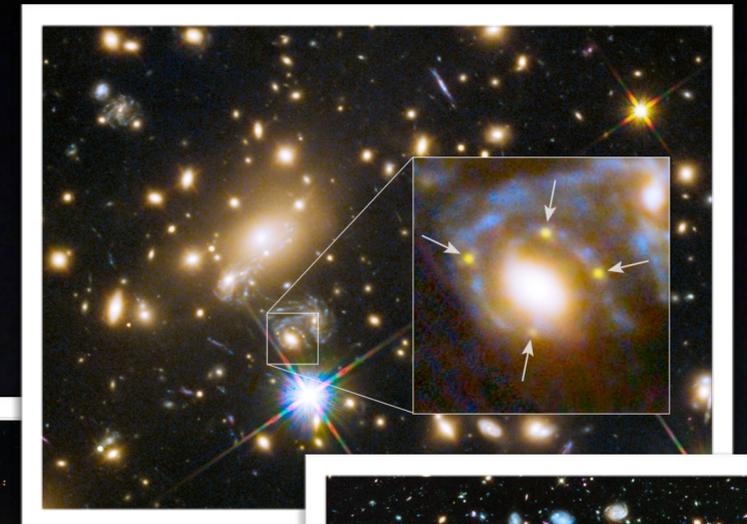
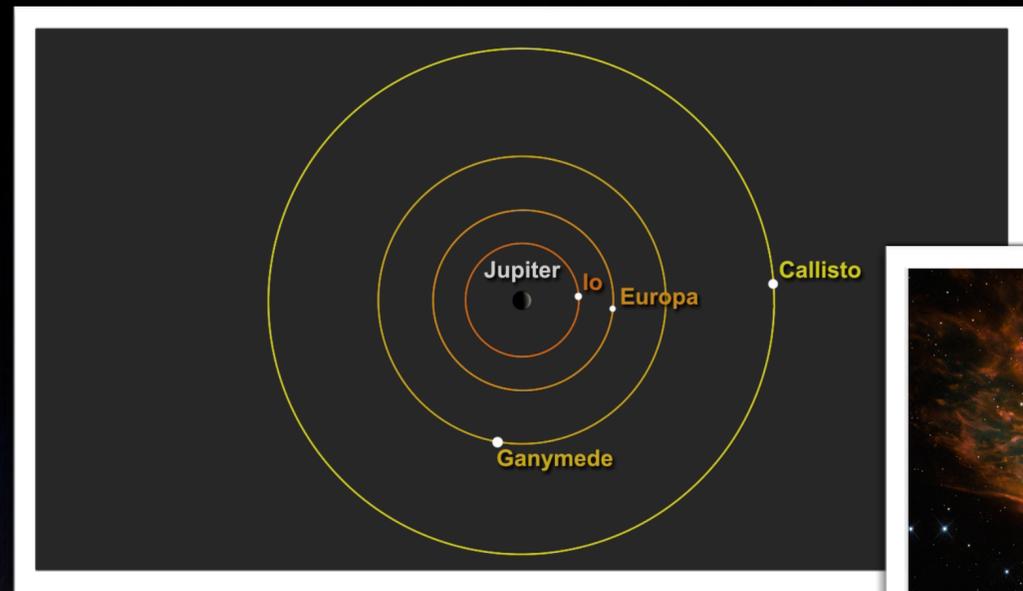


# The Great Observatories

## A Successful Model for the Guest Observer Program

### Our Experience

- ★ Establishes broad **community engagement**
- ★ Tackles **diverse** set of astrophysical **questions** in changing paradigms
- ★ Open **competition** inspires **creativity**
- ★ Ensures long-term scientific **discovery potential**
- ★ For WFIRST, maximizes synergies with **JWST, Euclid, LSST, GSMTs** and other future facilities

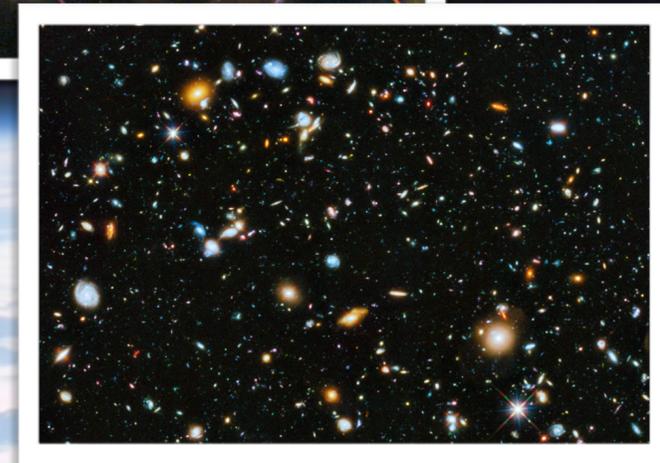
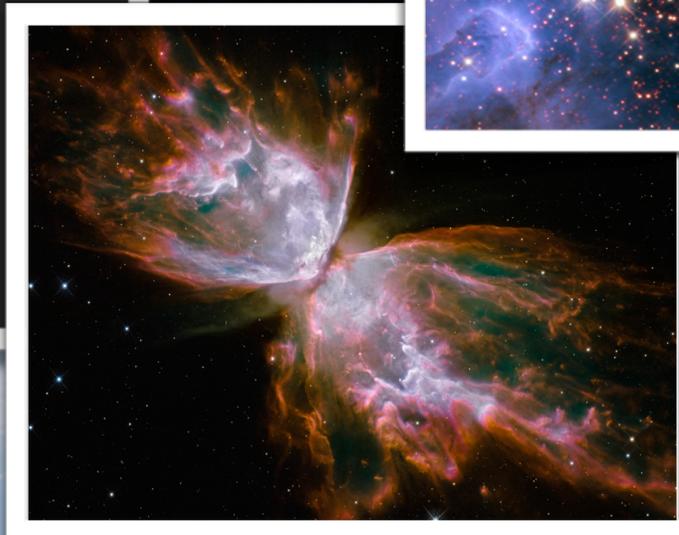
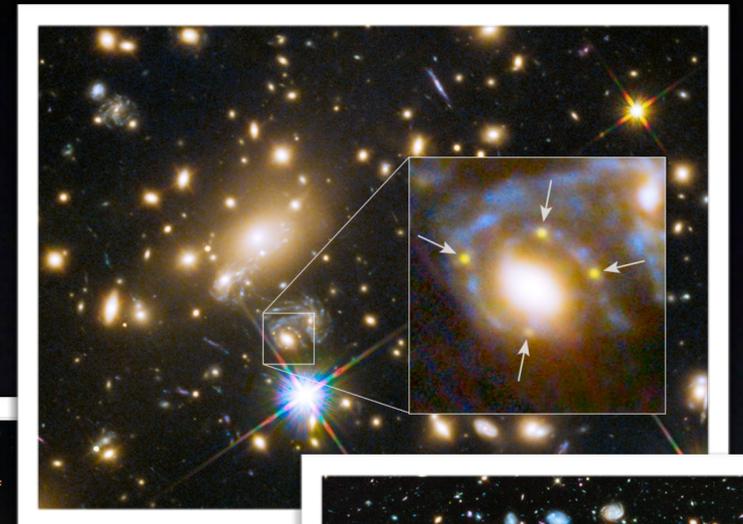
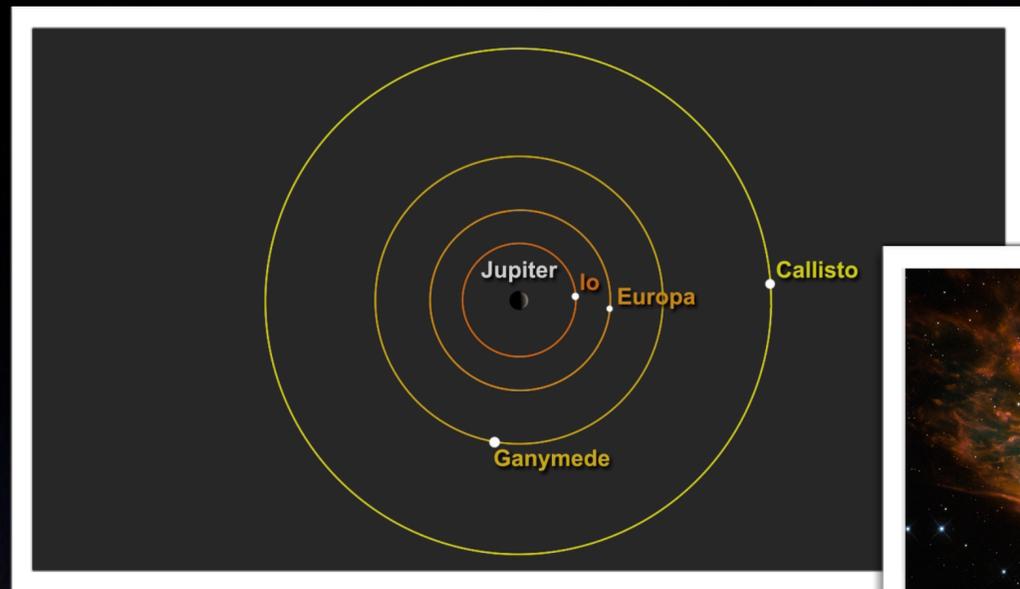
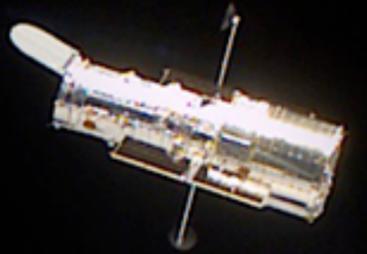


# The Great Observatories

## A Successful Model for the Guest Observer Program

### Our Experience

- ★ Establishes broad **community engagement**
- ★ Tackles **diverse** set of astrophysical **questions** in changing paradigms
- ★ Open **competition** inspires **creativity**
- ★ Ensures long-term scientific **discovery potential**
- ★ For WFIRST, maximizes synergies with **JWST, Euclid, LSST, GSMTs** and other future facilities



# The Great Observatories

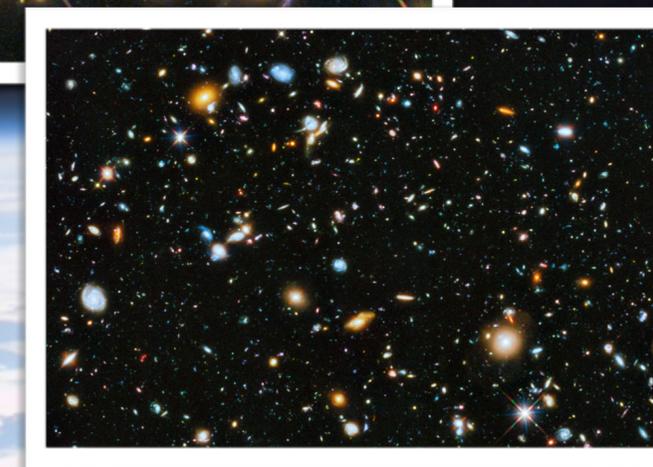
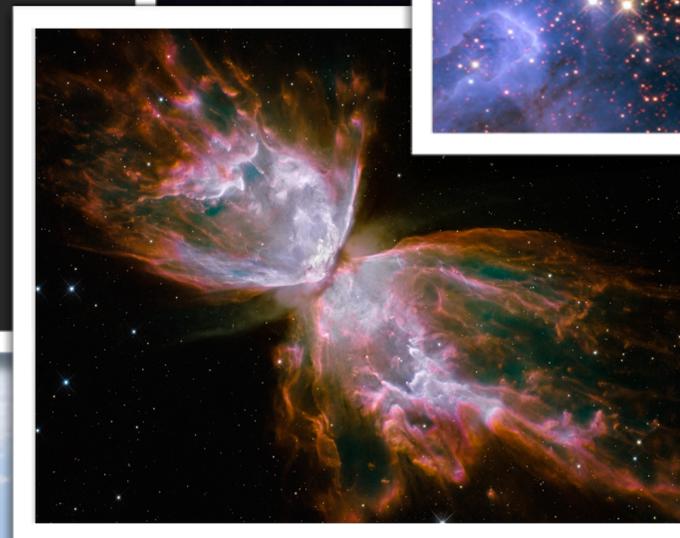
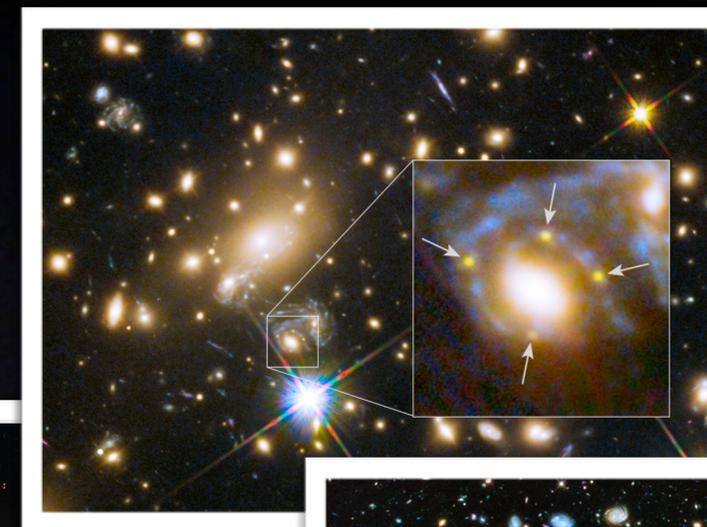
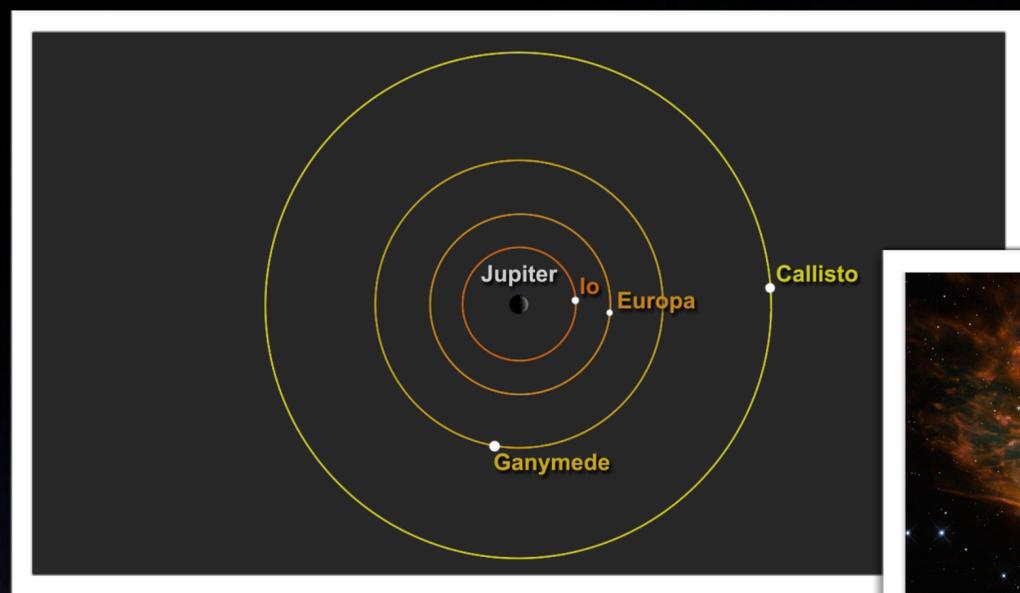
## A Successful Model for the Guest Observer Program

### Our Experience

- ★ Establishes broad **community engagement**
- ★ Tackles **diverse** set of astrophysical **questions** in changing paradigms
- ★ Open **competition** inspires **creativity**
- ★ Ensures long-term scientific **discovery potential**
- ★ For WFIRST, maximizes synergies with **JWST, Euclid, LSST, GSMTs** and other future facilities



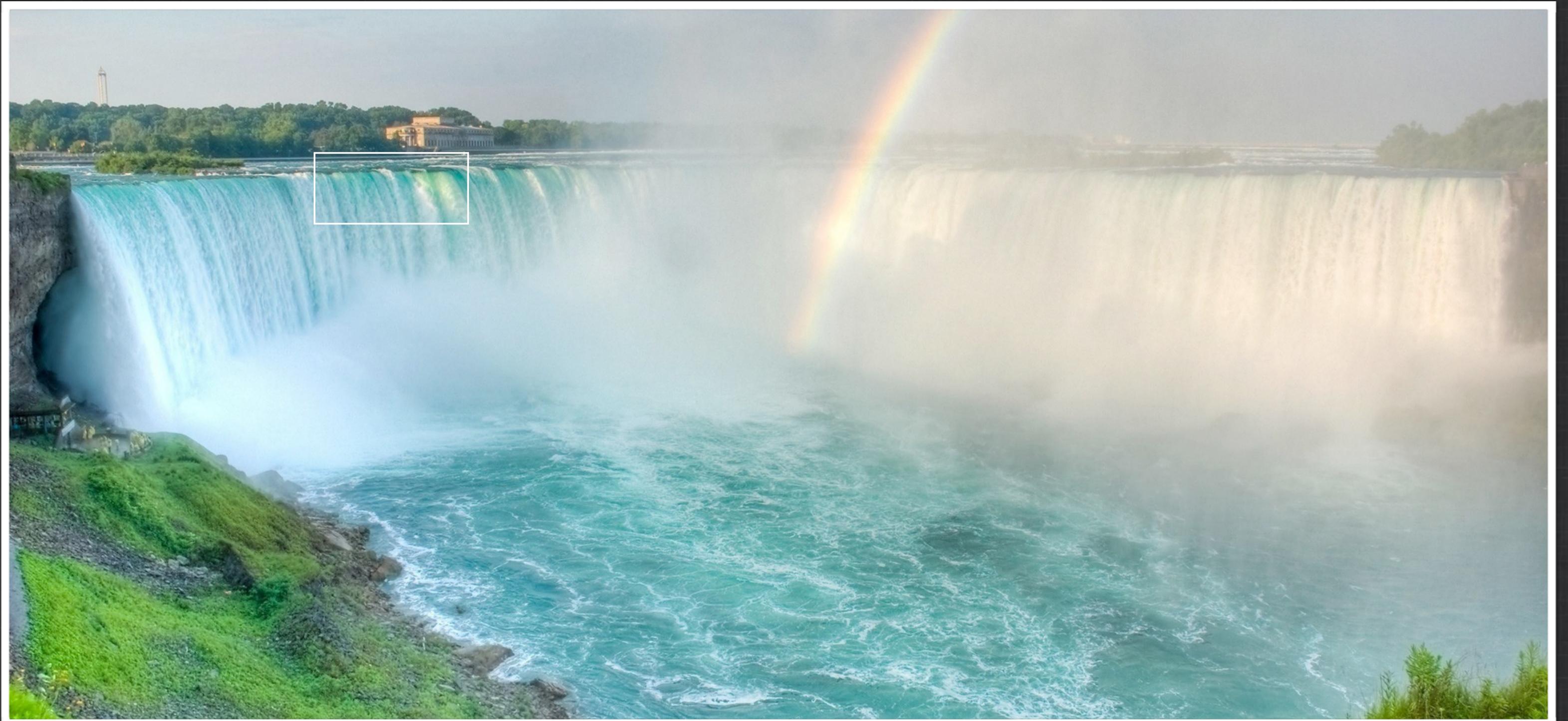
**25% of WFIRST is budgeted for GO science**



*...the forest for the trees*



*...the forest for the trees*

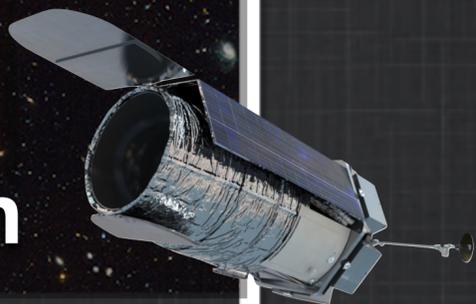


*...the forest for the trees*



**The Hubble Ultra Deep Field**

**A GO Program WFIRST Deep Field will measure  
1,000,000 galaxies (100+ at  $z > 10$ ) at Hubble-resolution**



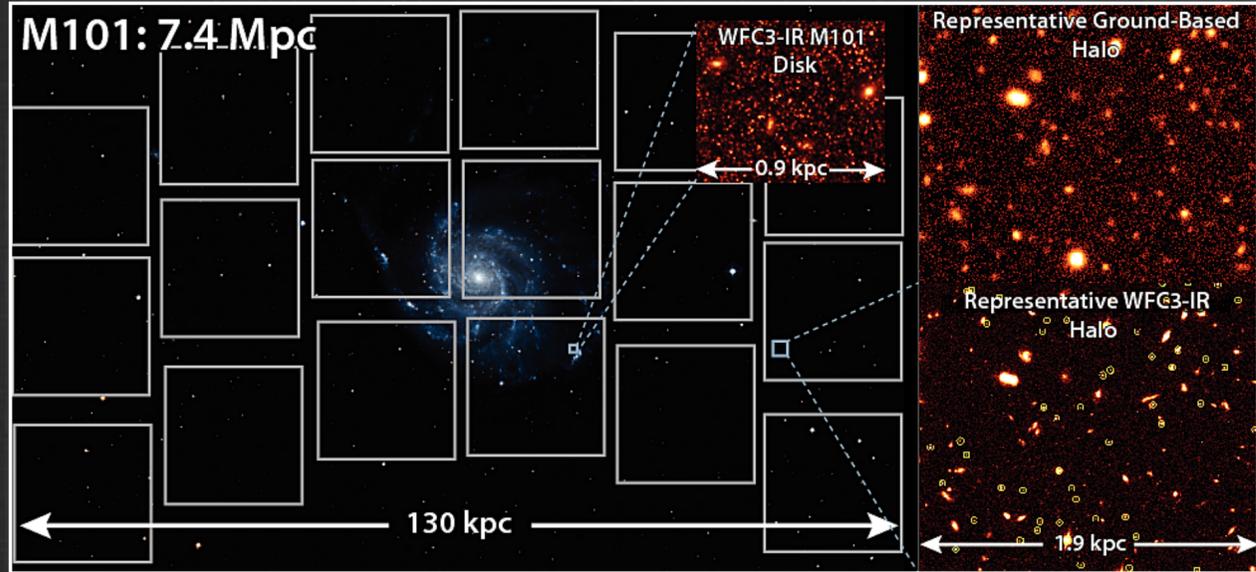
PHAT Movie Here

PHAT Movie Tiling Here

# WFIRST GO and GI Science Investigation Teams

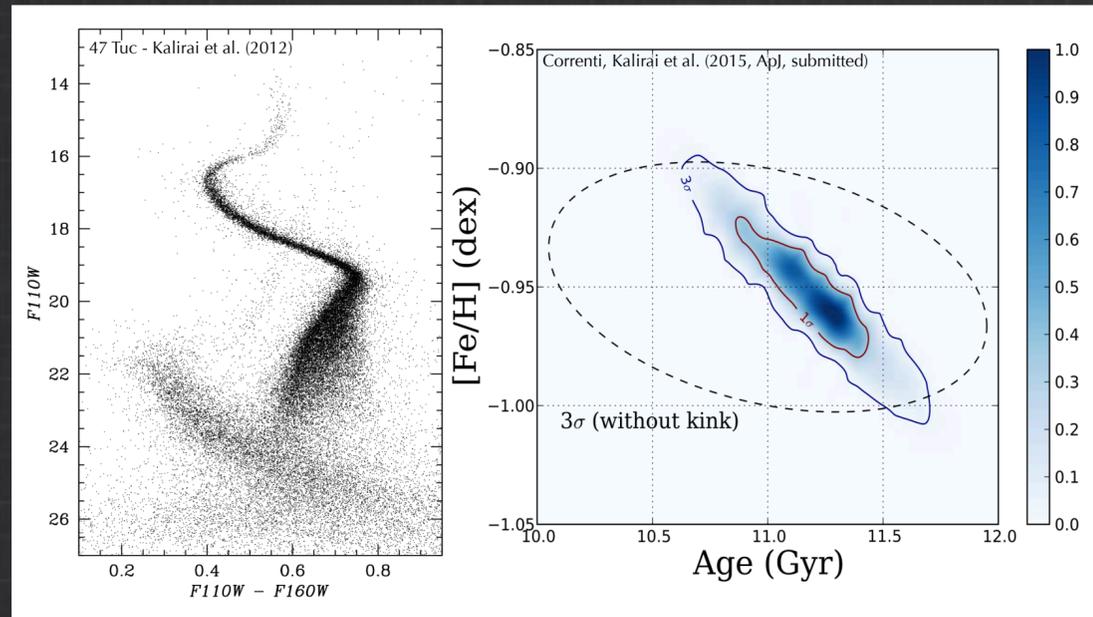
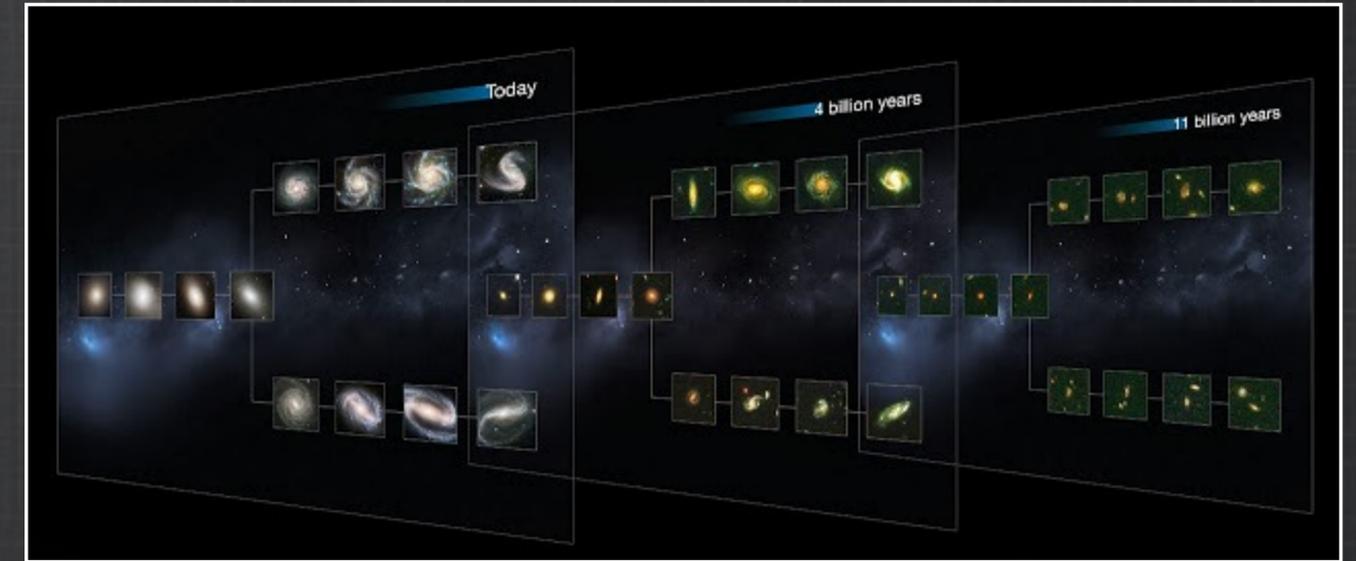
**Ben Williams et al.**

WINGS: WFIRST Infrared Nearby Galaxy Survey



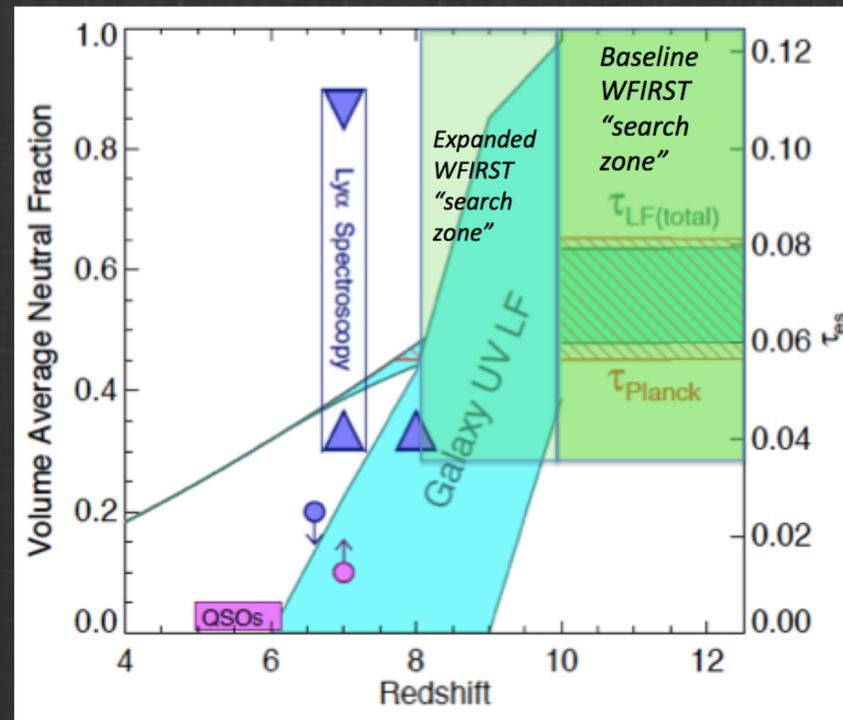
**Brant Robertson et al.**

WFIRST Extragalactic Potential Observations (EXPO)



**Jason Kalirai et al.**

Resolving the Milky Way with WFIRST



**James Rhoads et al.**

Cosmic Dawn with WFIRST



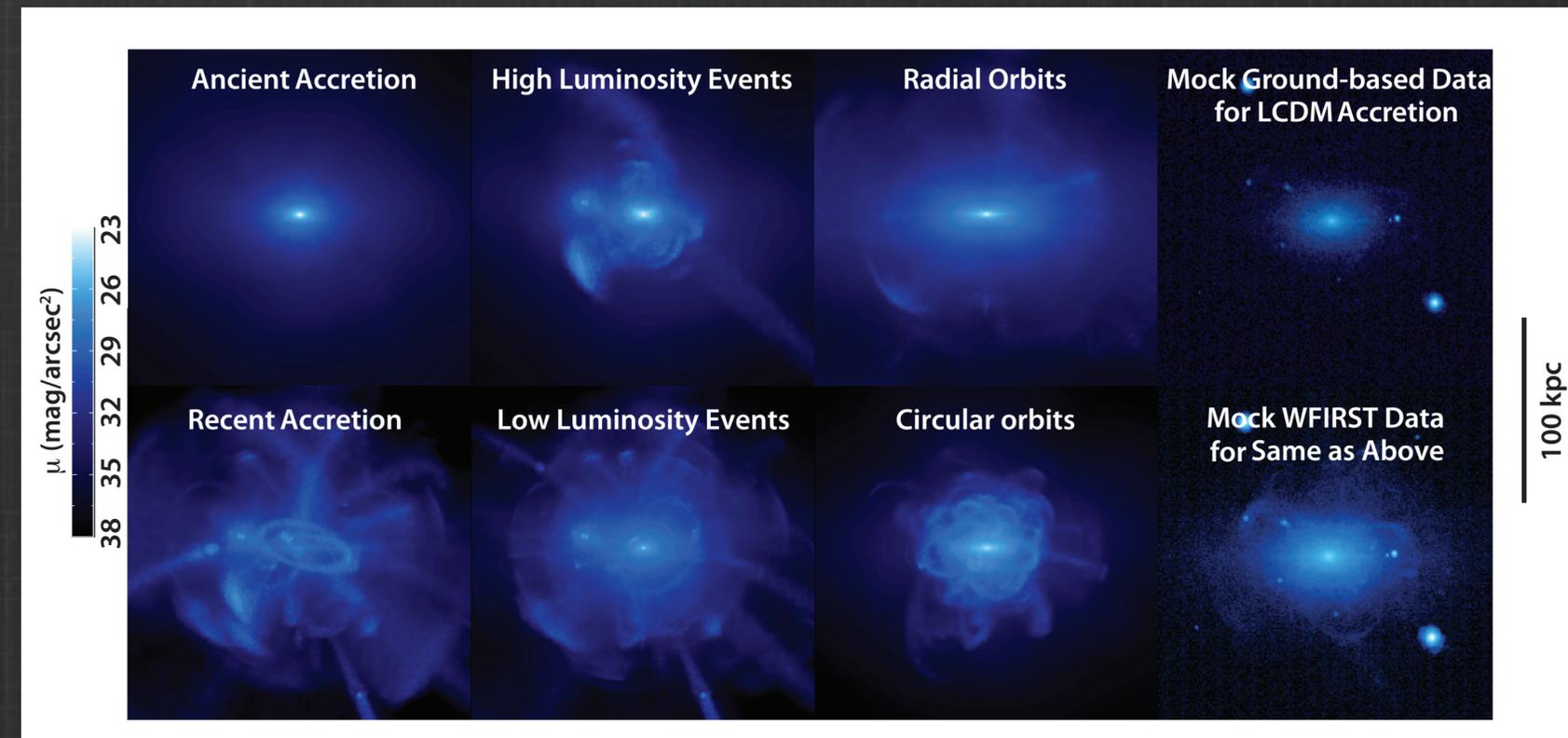
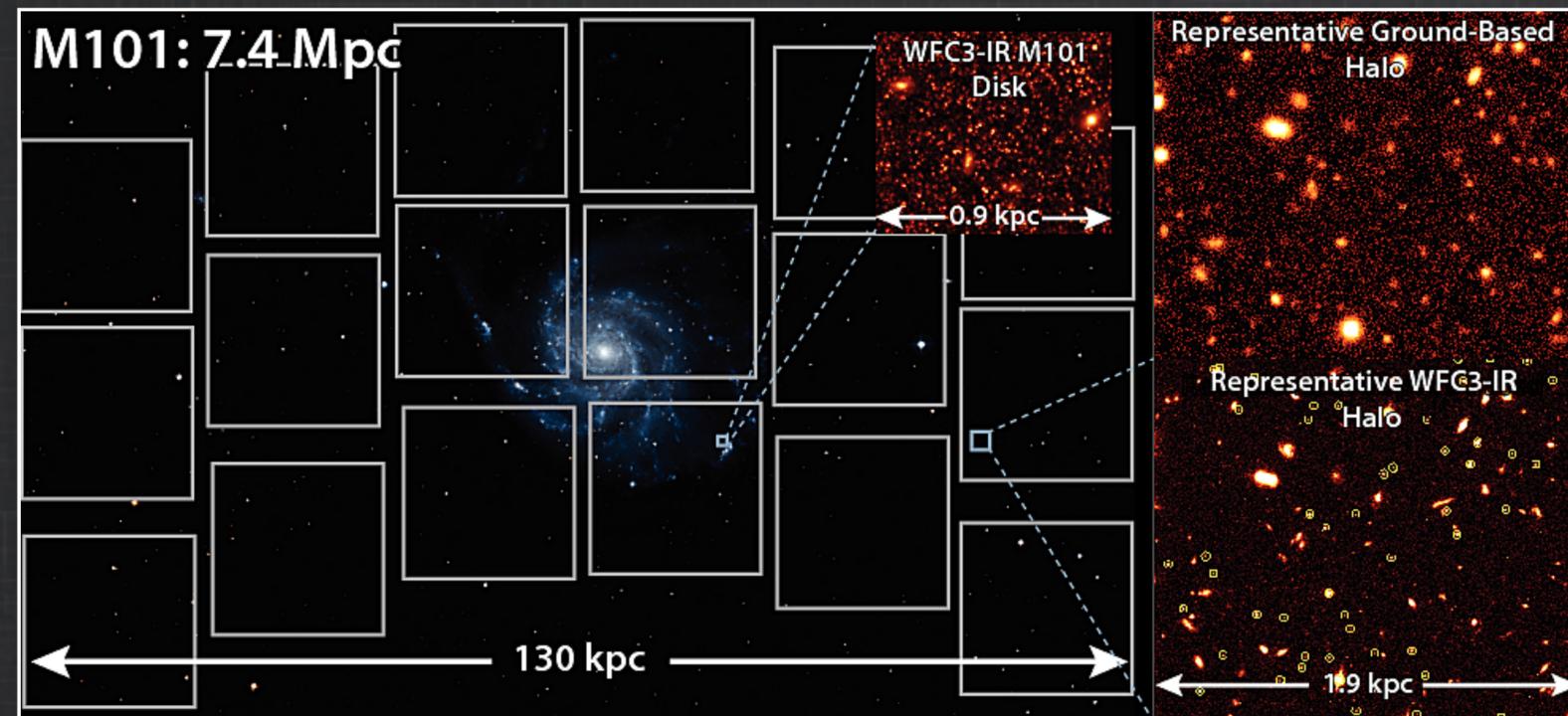
**Alex Szalay et al.**

Archival Research Capabilities of the WFIRST Data Set

# WFIRST GO Science Investigation Teams

## PI Ben Williams - WINGS: WFIRST Infrared Nearby Galaxy Survey

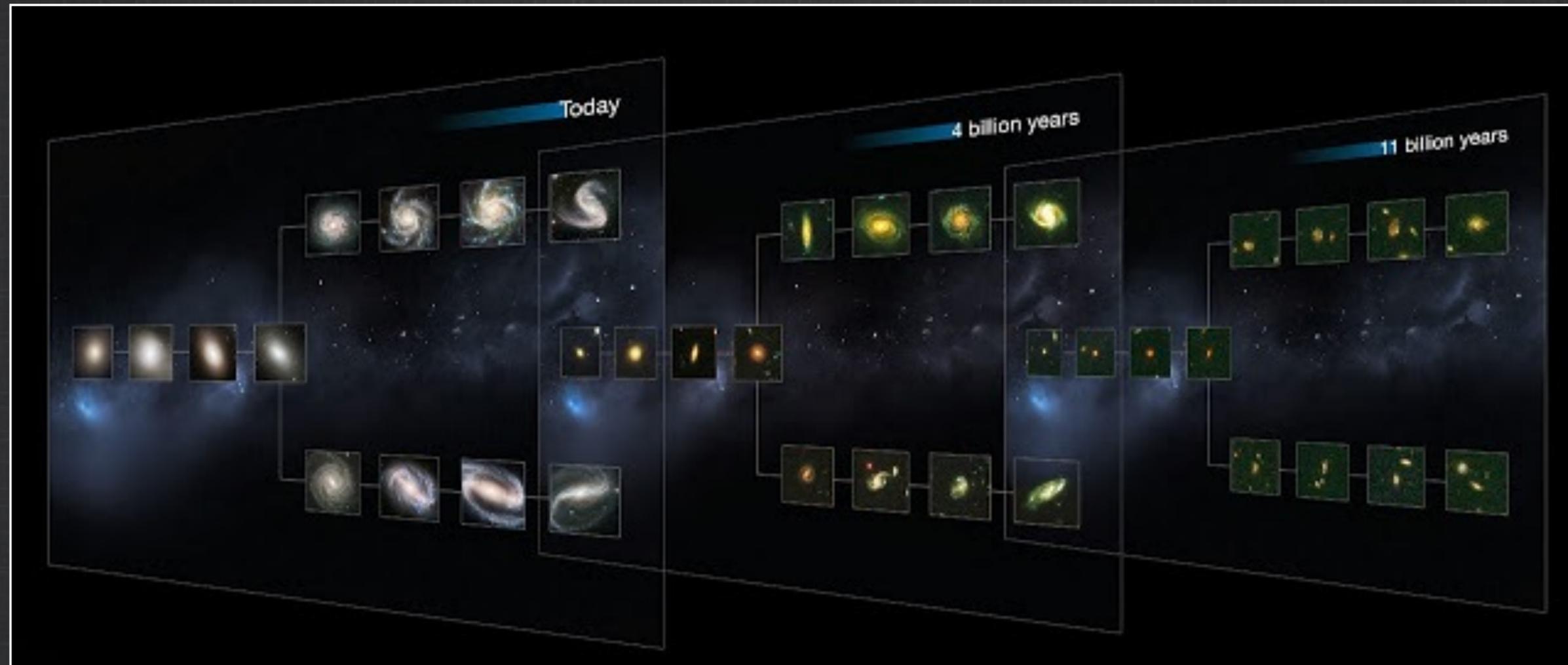
- Measure star count maps and define galaxy structure to  $\sim 35$  mag/sq arcsec (billions of stars within 10 Mpc)
- Test galaxy formation and dark matter models on galactic (and even sub-galactic) scales
- Measure the detailed evolution of nearby galaxies from resolved stellar photometry
  - reconstruct the history of star formation in the nearby Universe
  - put constraints on theoretical models to interpret near infrared extragalactic observations
- Program will model the halo structure and resolved stellar populations to optimize WFIRST constraints on both dark matter halo structure and galaxy formation models in the local Universe



# WFIRST GO Science Investigation Teams

## PI Brant Robertson - WFIRST Extragalactic Potential Observations (EXPO)

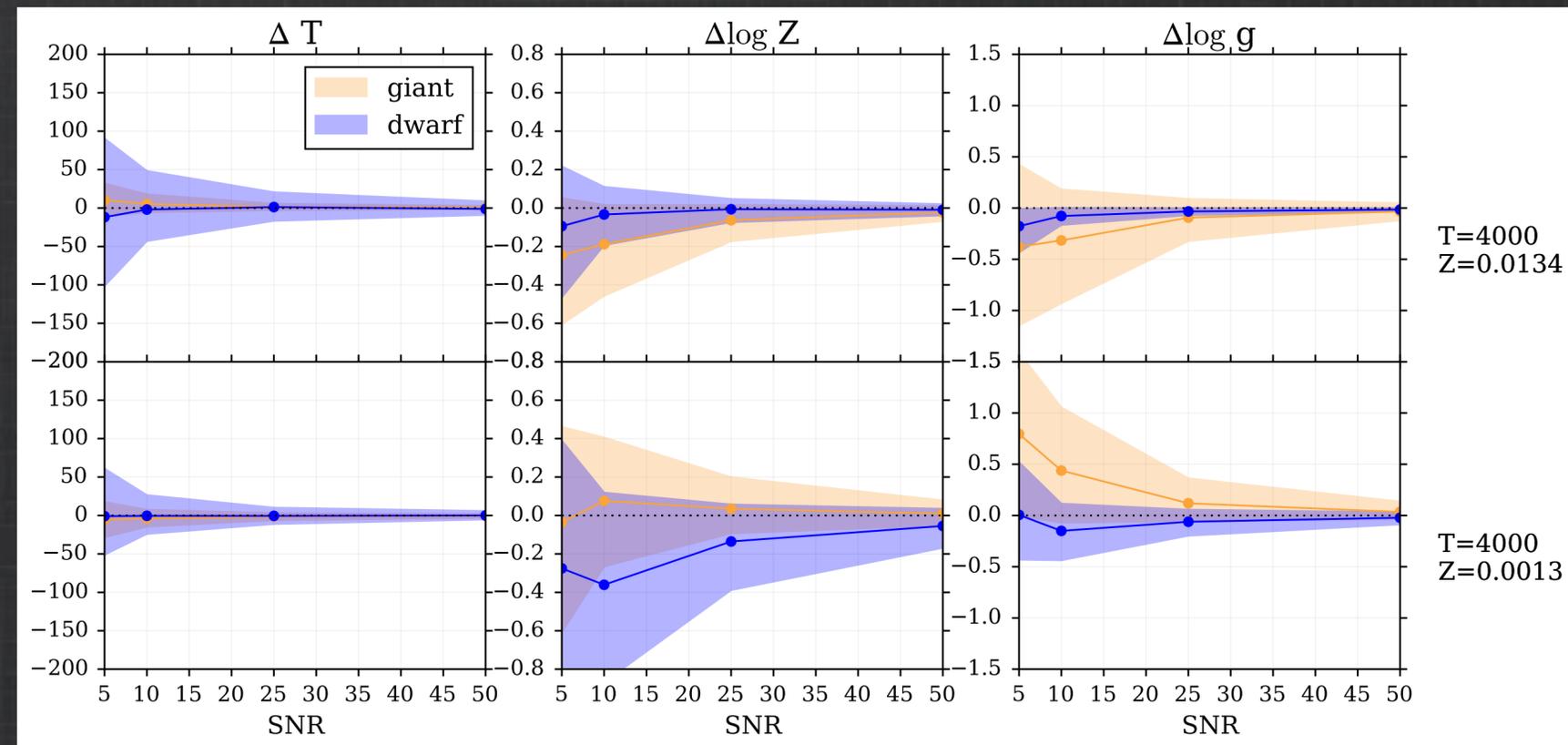
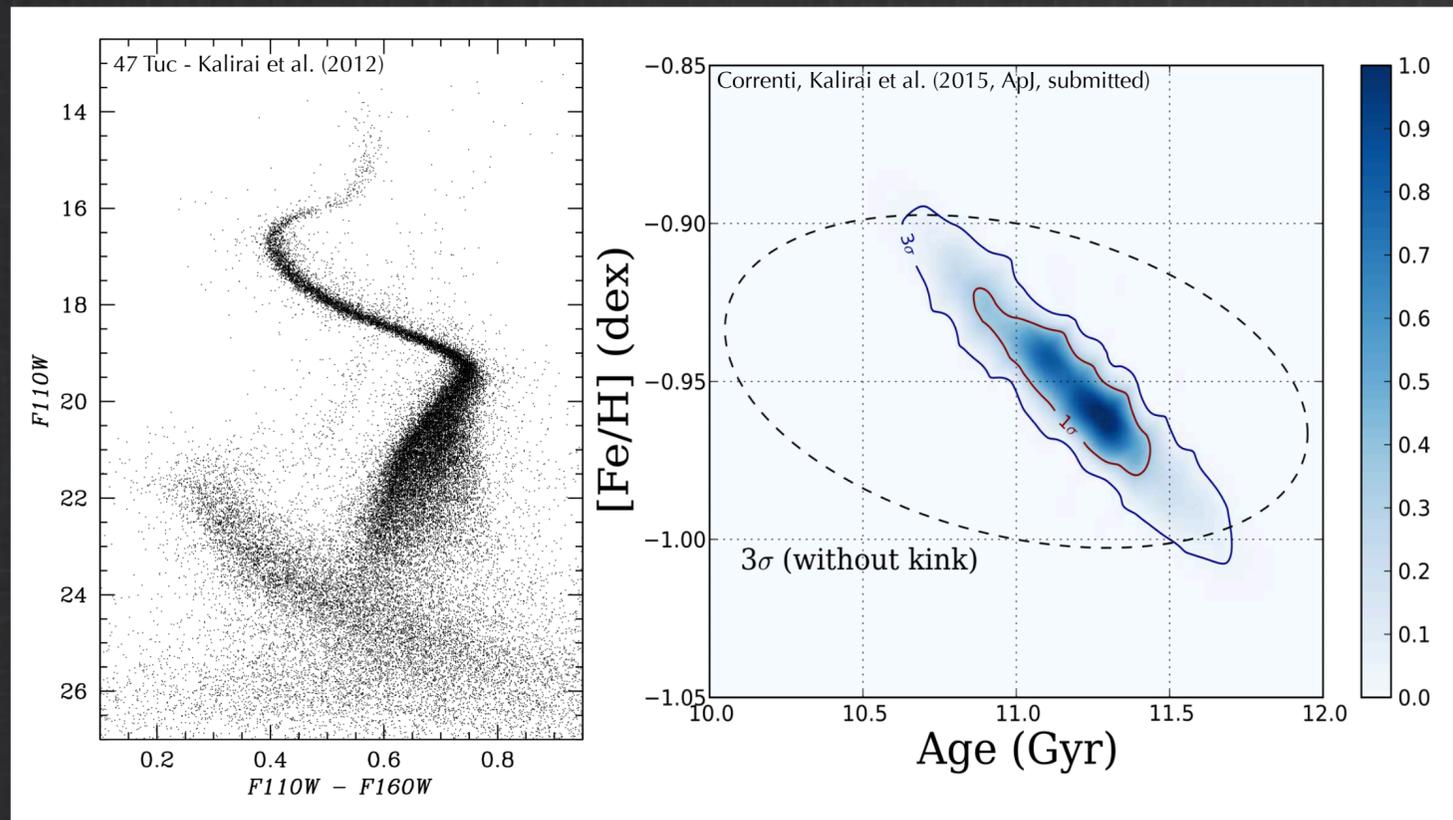
- Understanding the relation between galaxies and their environments over cosmic time
- Galaxy formation through the evolving population of rest frame optical line emission
- Discover and characterize rare AGN and quasars
- Informing properties of dark matter through gravitational lenses
- The importance of galaxies and quasars for reionization
- Exotic, distant supernovae and the fates of early stellar populations



# WFIRST GO Science Investigation Teams

## PI Jason Kalirai - Resolving the Milky Way with WFIRST

- Includes star forming regions, young clusters, globular clusters, inner disk, central region, halo, dwarf galaxies
- Characterize the IR color-magnitude relation over all ages and metallicity
- High precision measurements of the age-metallicity relation and hydrogen burning limit
- The Milky Way mass budget and the variability of the IMF
- Bringing IR diagnostics to bear on the “multiple populations” problem
- Structure of the inner galaxy, dynamics, and star formation history (proper motions)
- Cosmologically interesting ages for fossil streams, major substructure, and ultra faint dwarf galaxies

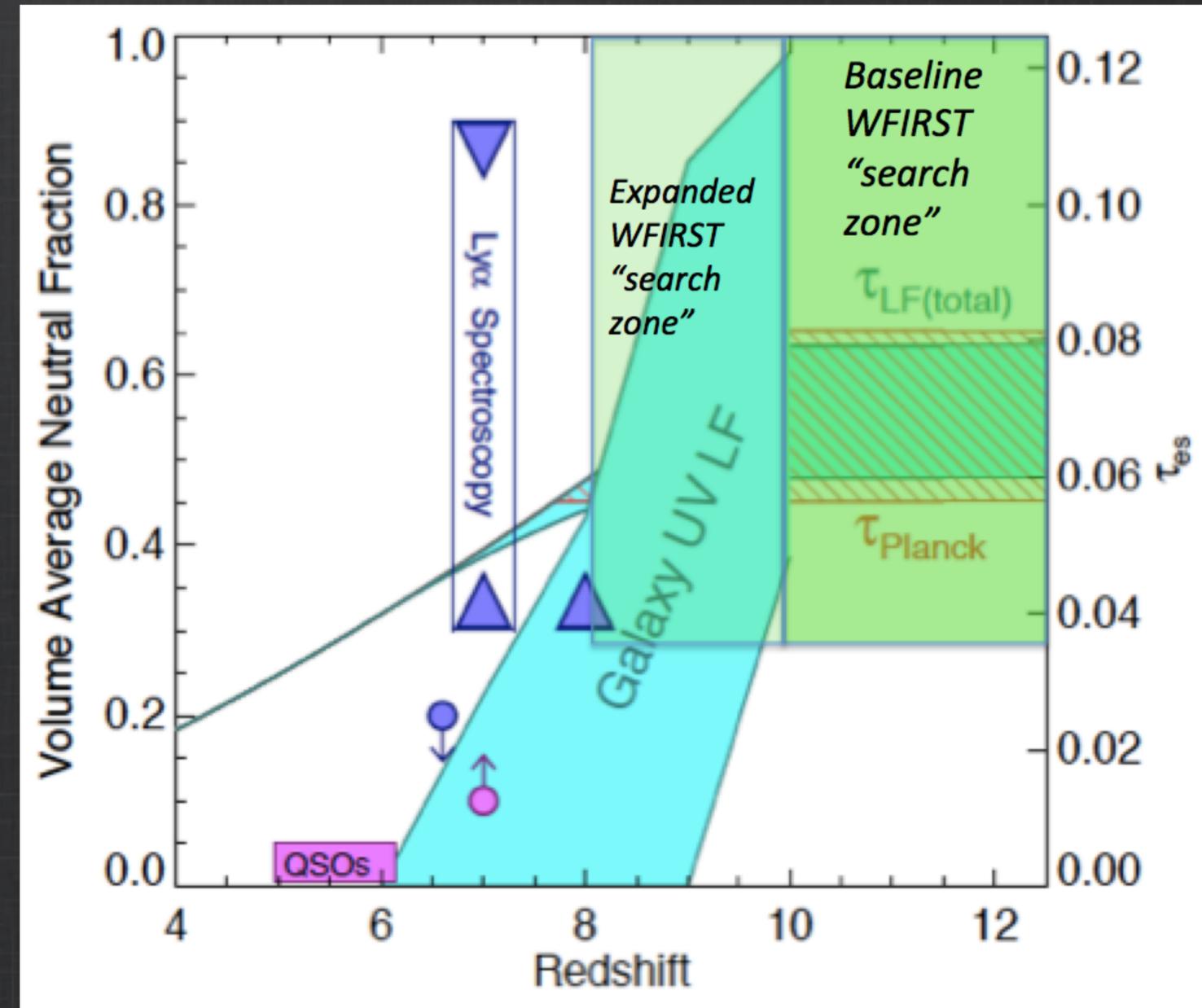


# WFIRST GO Science Investigation Teams

## PI James Rhoads - Cosmic Dawn with WFIRST

Epoch-of-reionization science with samples of millions of galaxies and thousands of quasars at  $z > 7$

- Measures of ionizing photon budget from  $z=6$  to 10, from both galaxies and AGN
- Dependence of galaxy properties on environment
- Direct constraints of the intergalactic neutral fraction
  - Grism searches for Lyman alpha galaxies, on scales larger than reionization bubbles
  - Follow up spectra of WFIRST quasars



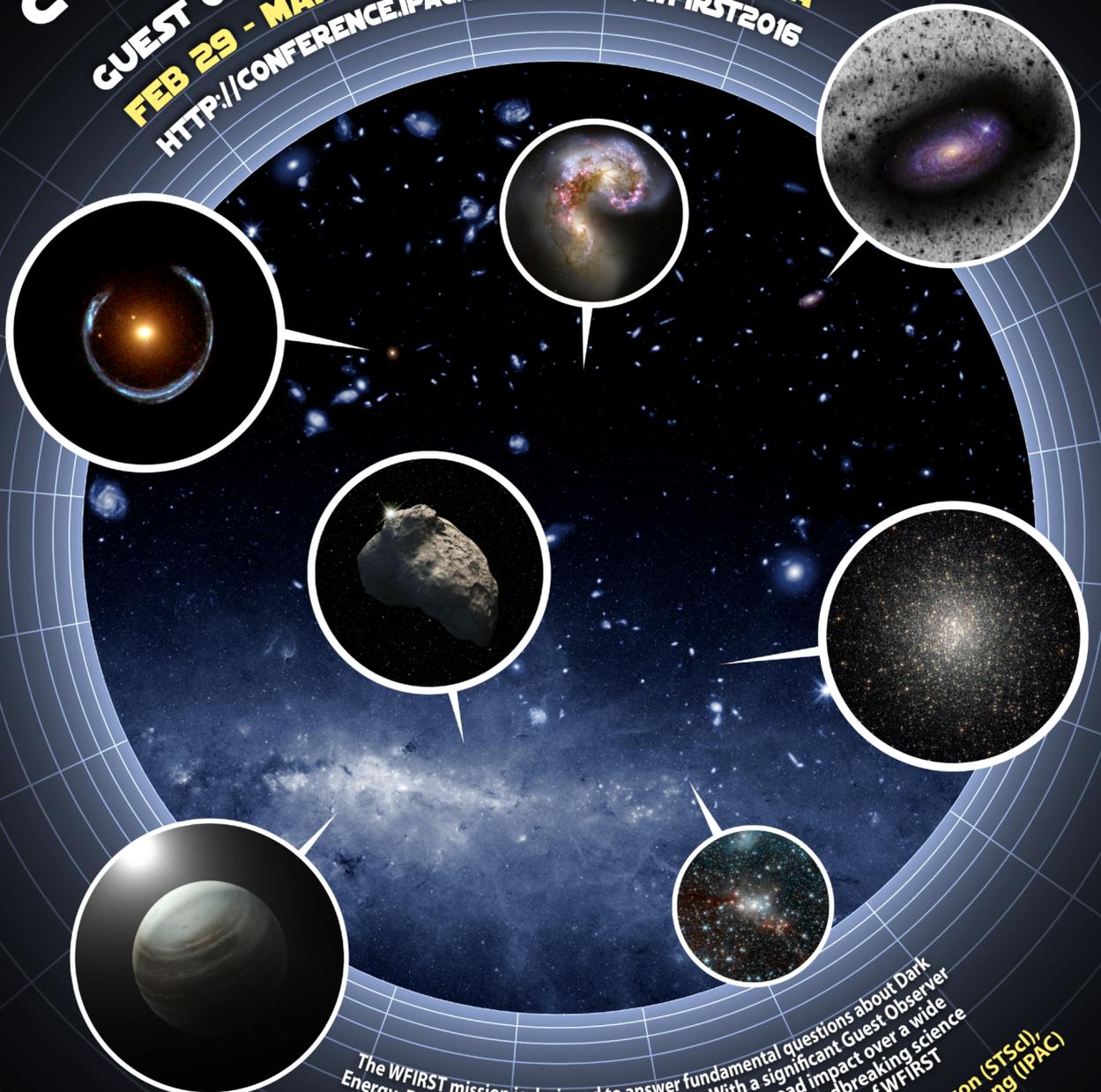
# WFIRST GI Science Investigation Teams

## PI Alex Szalay - Archival Research Capabilities of the WFIRST Data Set

- Evaluate best archival practices from across all of astronomy
- Design and build simple end-to-end simulations and incorporate into databases
- Establish a common platform for the science teams
- Design and prototype a unified object catalog using a simulated catalog, with xmatches to external surveys
- Identify new forward-looking technologies that don't exist today (e.g., scripting, fast parallel analysis tools)
- Develop algorithms for science use cases and build prototypes of highly scalable parallel tools (e.g. angular and spatial cross-correlations inside the DB)
- Implement novel object classification techniques based on machine learning principles



**COMMUNITY ASTROPHYSICS WITH WFIRST:**  
**GUEST OBSERVER AND ARCHIVAL SCIENCE**  
**FEB 29 - MARCH 2, 2016 IN PASADENA, CA**  
[HTTP://CONFERENCE.IPAC.CALTECH.EDU/WFIRST2016](http://conference.ipac.caltech.edu/wfirst2016)



The WFIRST mission is designed to answer fundamental questions about Dark Energy, Exoplanets and infrared astrophysics. With a significant Guest Observer and archival science program, WFIRST will have a broad impact over a wide range of astrophysics. This meeting will focus on the groundbreaking science that can be done with the GO and archival opportunities of WFIRST

Science Organizing Committee: N. Gehrels (GSFC), L. Armus (IPAC), H. Ferguson (STScI), S. Gaudi (OSU), J. Kalirai (STScI), D. Kirkpatrick (IPAC), H. Schlichting (MIT), Y. Wang (IPAC)

**IPAC · STSCI**

**WFIRST Science Conference**  
**Community Astrophysics with WFIRST**  
 Feb 29-Mar 2, 2016 (Pasadena CA)

**WFIRST**

