NANCY GRACE ROMAN SPACE TELESCOPE

Plus Industry, International, and Academic Partners

Harnessing Large Data with the Nancy Grace Roman Telescope

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Roman Mission Scientist, STScI

Large NASA mission recommended by 2010 Decadal Survey (WFIRST)

Launch readiness date: Oct 31 2026
Launch date no later than: May 2027

Dark Energy

Exoplanet census

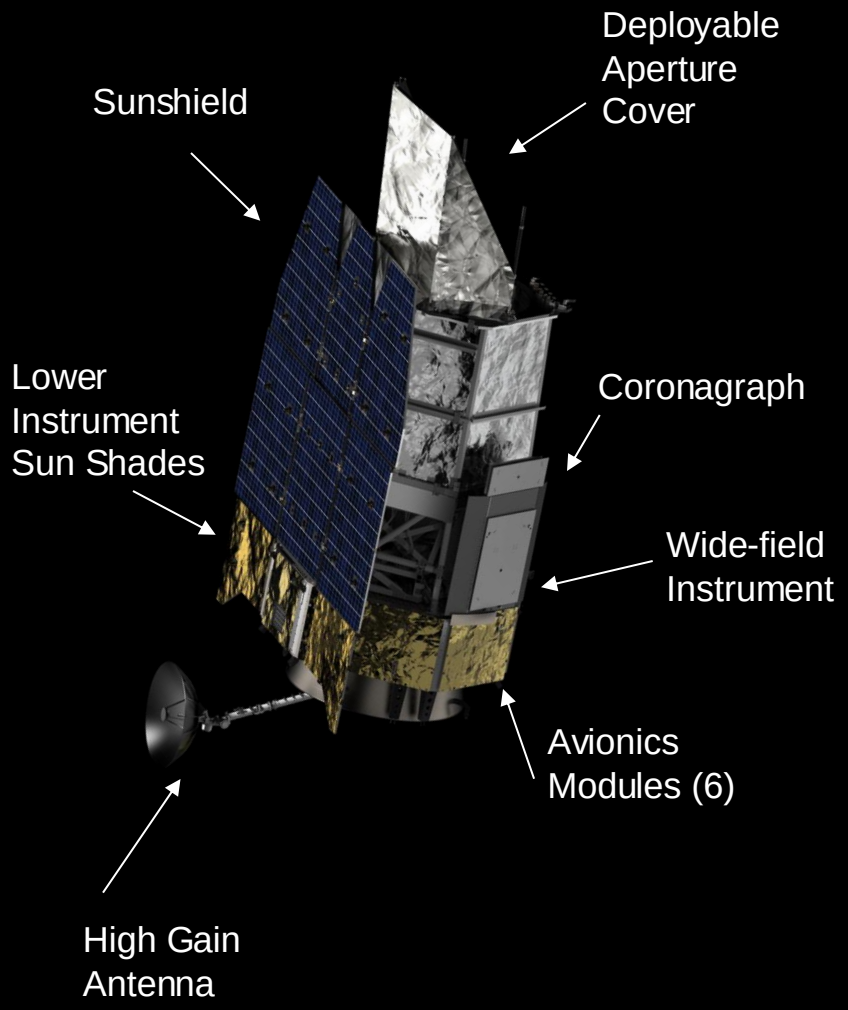
Expansion of the Universe

Transformational Astrophysics

- At least 25% of Prime Mission devoted to PI-led General Astrophysics Surveys
- First call for proposals in Oct 2025

Roman Observatory

Telescope: 2.4 m aperture
Orbit: Sun-Earth L2

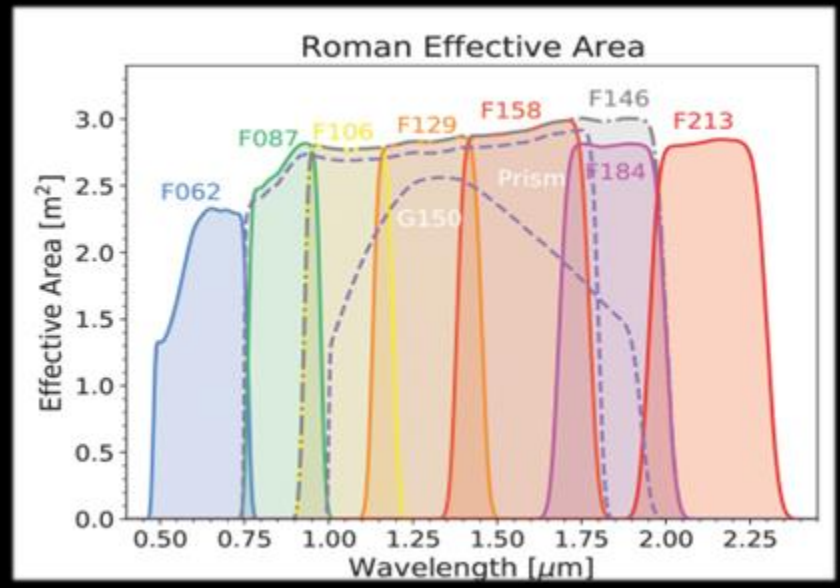


Wide Field Imager (WFI)

- Visible / Near IR (0.48 – 2.3 mm)
- Field of view 0.281 deg^2
- 18 4K x 4K detectors
- Pixel scale: 0.11 arcsec
- Grim (500), Prism (100)

Coronagraph

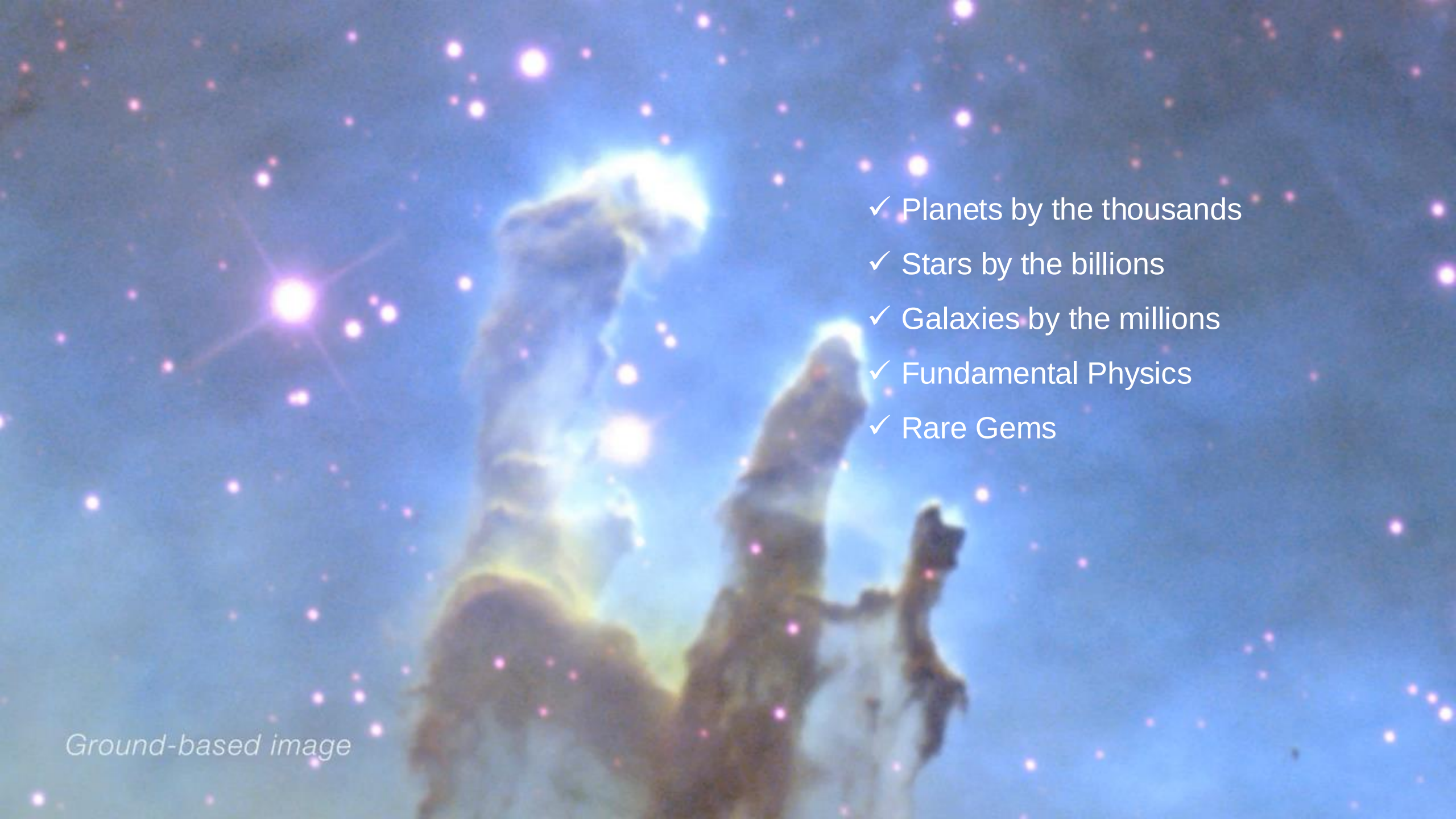
- Visible bandpass
- Contrast 10^{-8} - 10^{-10}



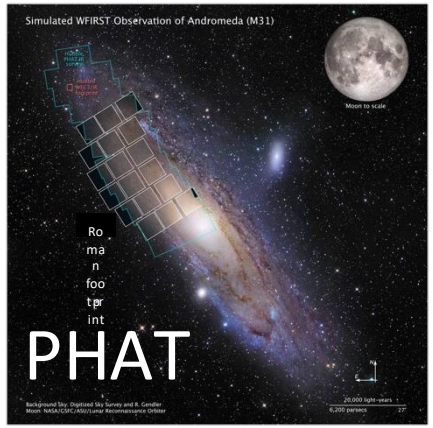
Fast slew and settle times

Data Volume: 11 Tb/day

Mission Duration: 5 years, 10 years goal


✓ Planets by the thousands
✓ Stars by the billions
✓ Galaxies by the millions
✓ Fundamental Physics
✓ Rare Gems
Ground-based image

PI J. Dalcanton



Survey Nearby Galaxies ~1500 Times Faster

Survey PHAT region in Y, J, H equivalent Roman filters to 25.5 mag *in < 30 minutes*

PIs S. Faber, H. Ferguson

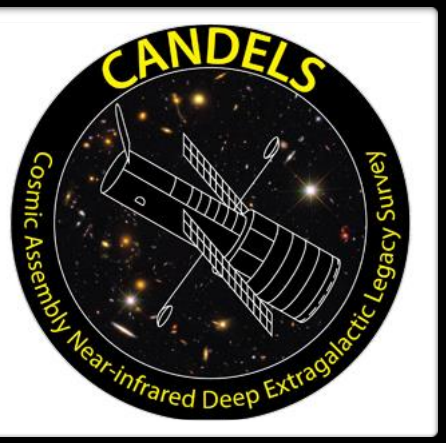
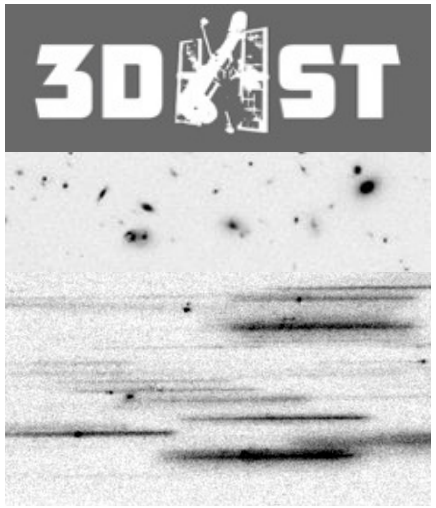


Image Galaxy Fields > 1000 Times Faster

PI P. van Dokkum



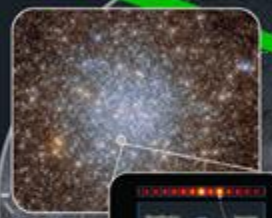
Perform Slitless Spectroscopy Galaxy Surveys > 700 Times Faster

Akeson et al. 2019

Example Implementation of Roman Core Surveys

≲ 15 min cadence over few deg² Galactic bulge

Galactic Bulge Time Domain Survey

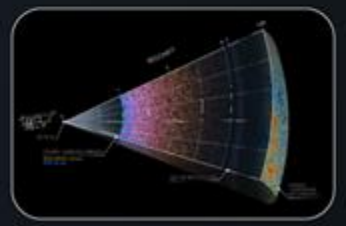


~1000 deg² in three bands (~JHK)

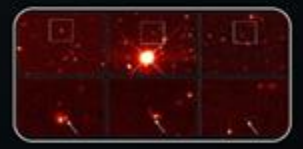
Galactic Plane Survey

Wide area multiband survey with spectroscopy

High Latitude Wide Area Survey



Tiered multiband time domain ~10s of deg² with spectroscopy



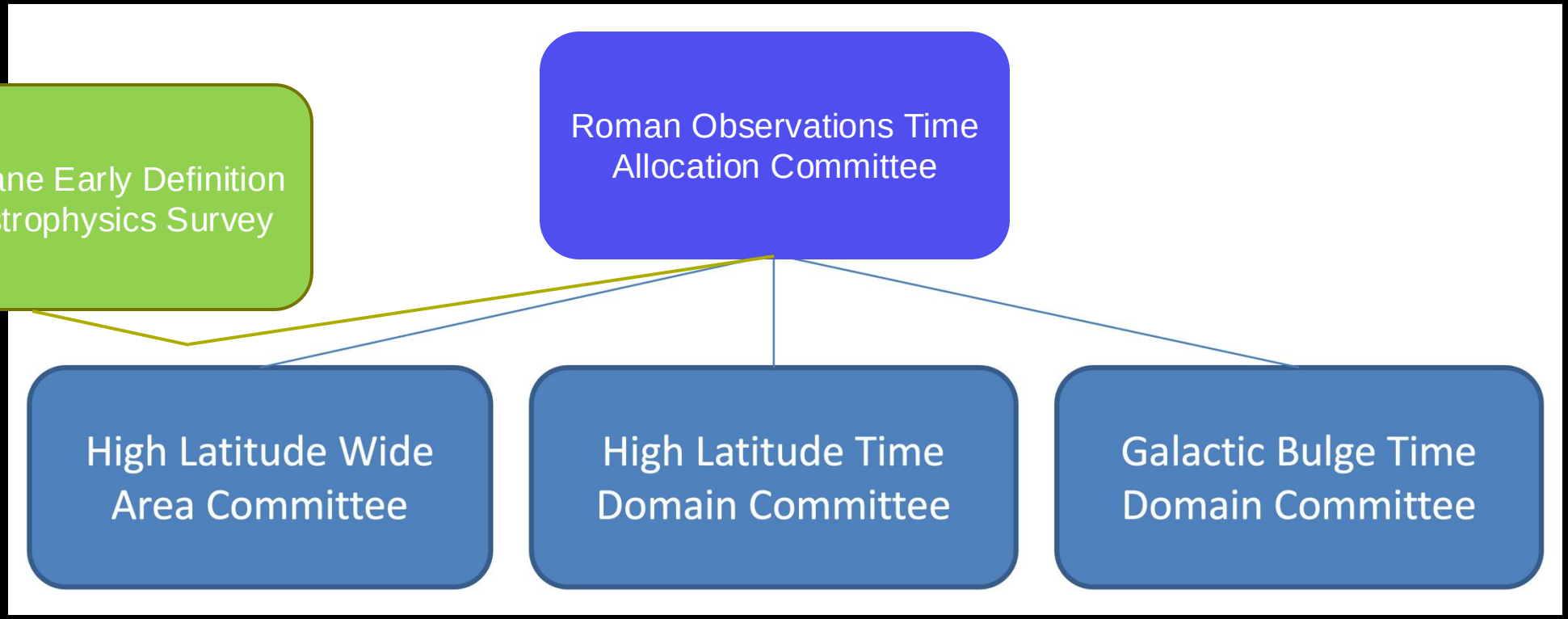
High Latitude Time Domain Survey

ROMAN SPACE TELESCOPE

Core Surveys

Roman Space Telescope's larger view and fast survey speeds will unveil the evolving universe in ways that have never been possible before.

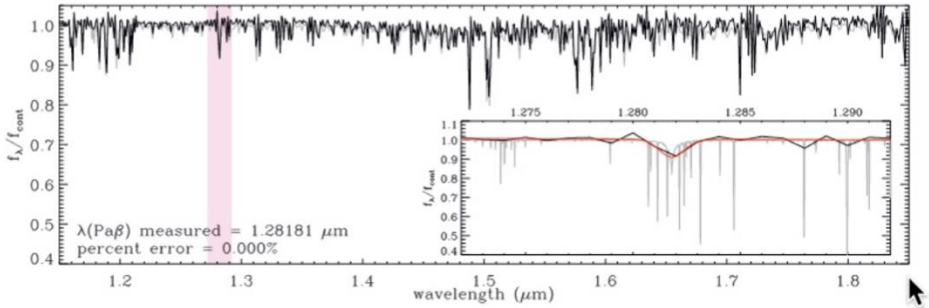
Community definition of the Core Survey and Community Contributed Survey



Evaluate initial community input; solicit additional, targeted community input through a variety of channels; evaluate survey options against science metrics; produce recommendations for survey implementations with options for enhancements/descopes

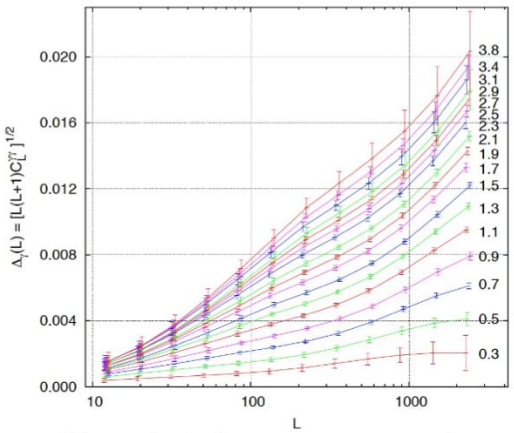
Stringent Mission Calibration Requirements

0.1% wavelength accuracy (for BAO; maps to source redshift)



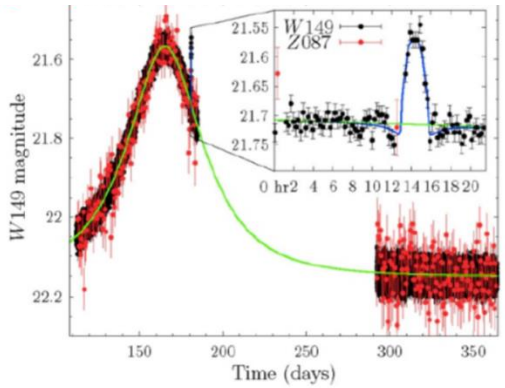
Paβ in simulated stellar spectrum (Ryan+ 2019); 0.027% error

0.05% PSF shape (cosmic shear measurements)



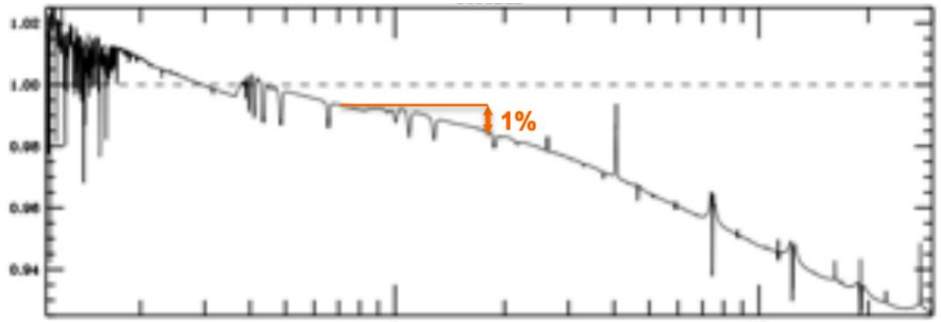
Expected shear power spectrum
(SDT report, Spergel+ 2015)

0.1% Photometric stability (for microlensing; maps to planet mass uncertainty)



Simulated microlensing event (S. Carey)

0.5% Absolute color calibration (for SNe; maps to luminosity distance vs. redshift)



Ratio between white dwarf spectral models (Bohlin+ 2014)

Requirements significantly exceed what we've achieved on Hubble and the requirements for Webb

BIG DATA

172

Terabytes

Hubble’s data archive

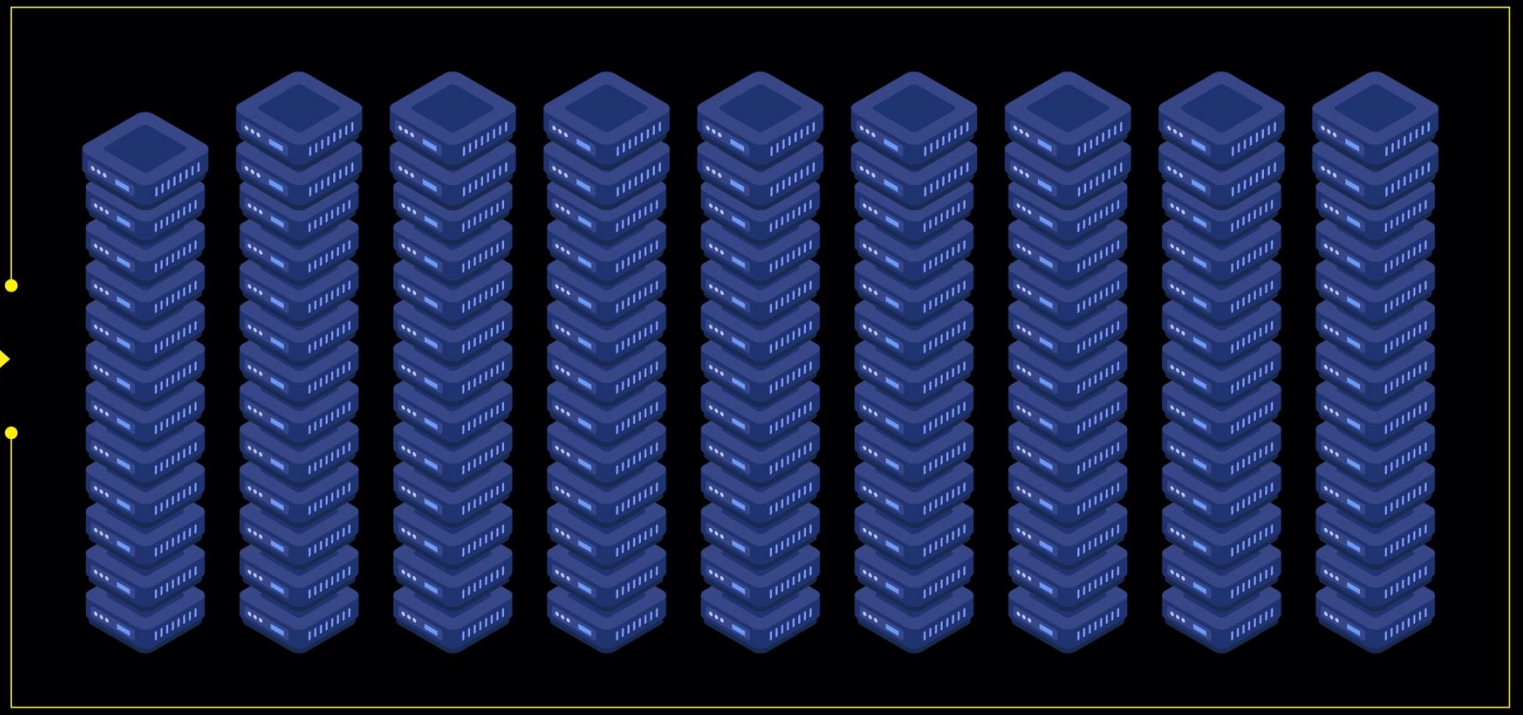
30 years (1990–2020)

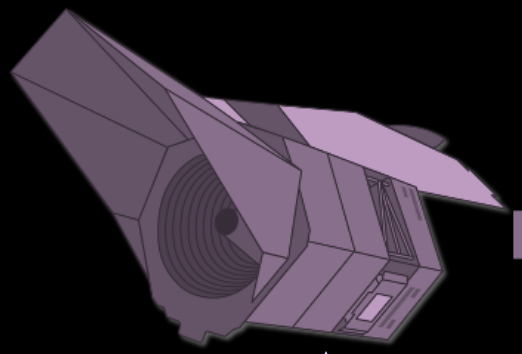
30,000

Terabytes

Roman’s data archive

5 year primary mission
(projected)





1

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3

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6

Misson Operation Center

Goddard SPACE FLIGHT CENTER

Roman Science Operations Center

STScI

WFI Exposure-Level Processing

WFI High-Level Processing

Roman Archive @ MAST

Roman Science Platform

Roman Science Operations Center

STScI

Planning & Scheduling

WFI Spectroscopic Pipeline

Galactic Bulge Microlensing Science Pipeline

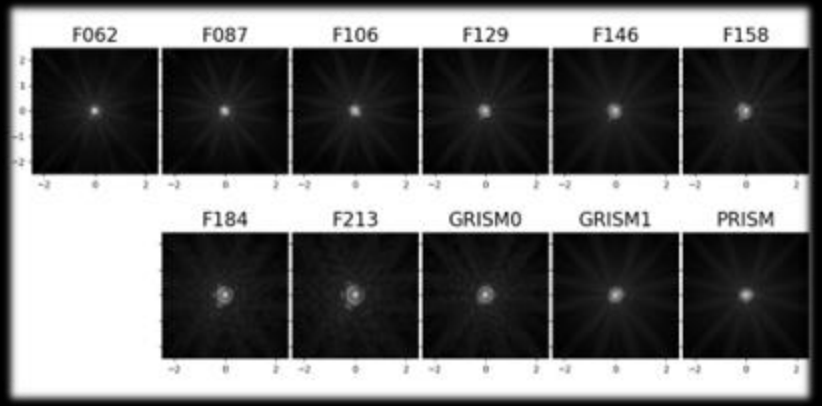
ipac

Roman Science Support Center

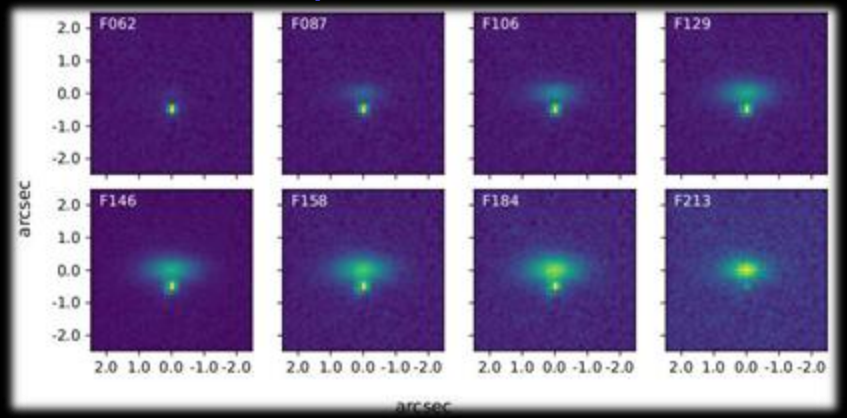
Science Community

Planning Observations – Simulation tools & utilities

WebbPSF

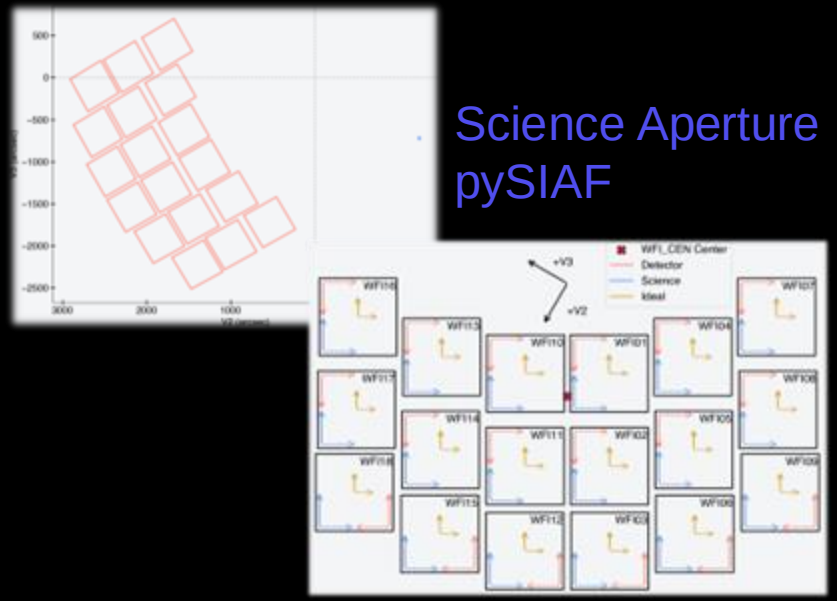


Pandeia - Exposure Time Calculator

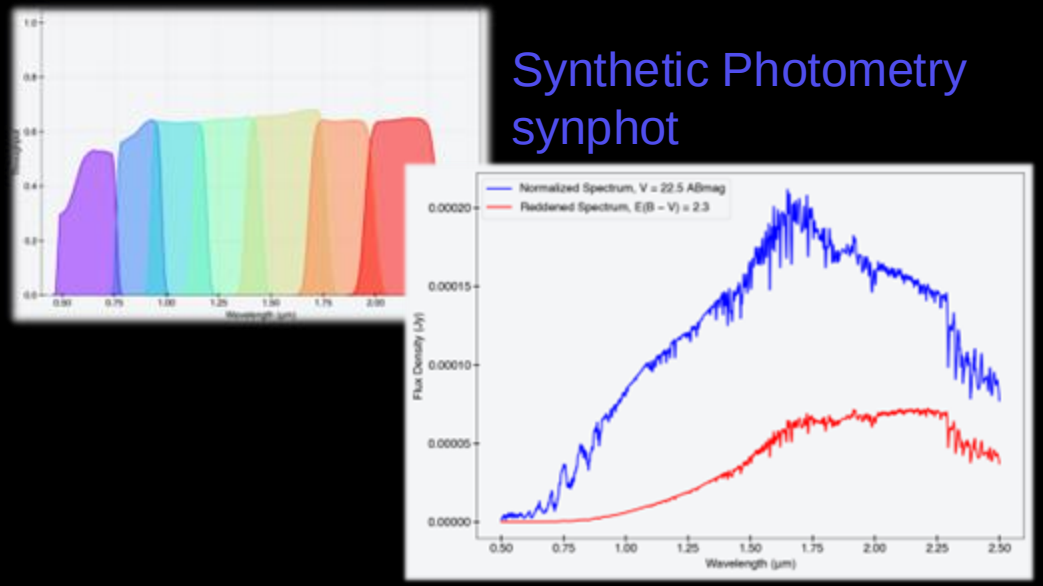


STIPS

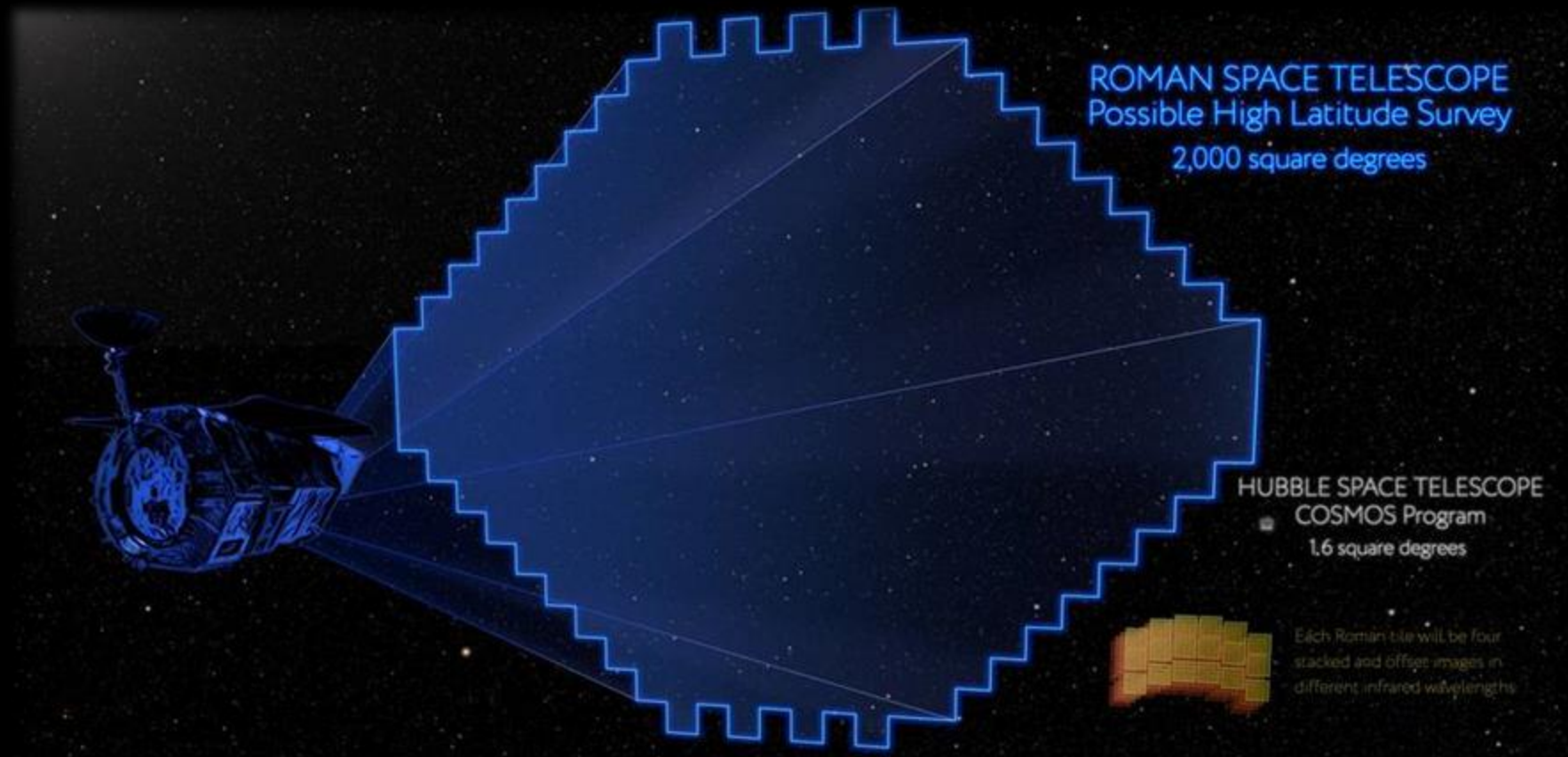
Science Aperture pySIAF

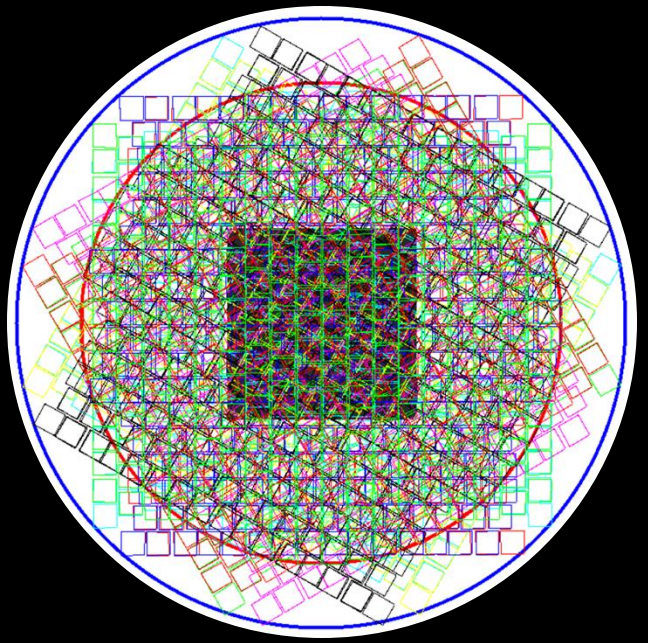


Synthetic Photometry synphot



Planning Observations – Roman APT





Roman Science Platform Vision

- Cloud-compute environments – Jupyterlab
- Brings users to the data – easy and efficient access, decreased need for downloads
- Cloud-based computing resource
  - Resources for exploratory work will be available with no need to write grant proposal
- Offers flexible and scalable architecture
- Includes pre-installed software and tools for simulations, calibration, visualization, analysis, and training

The Roman Science Platform will democratize data/computer access

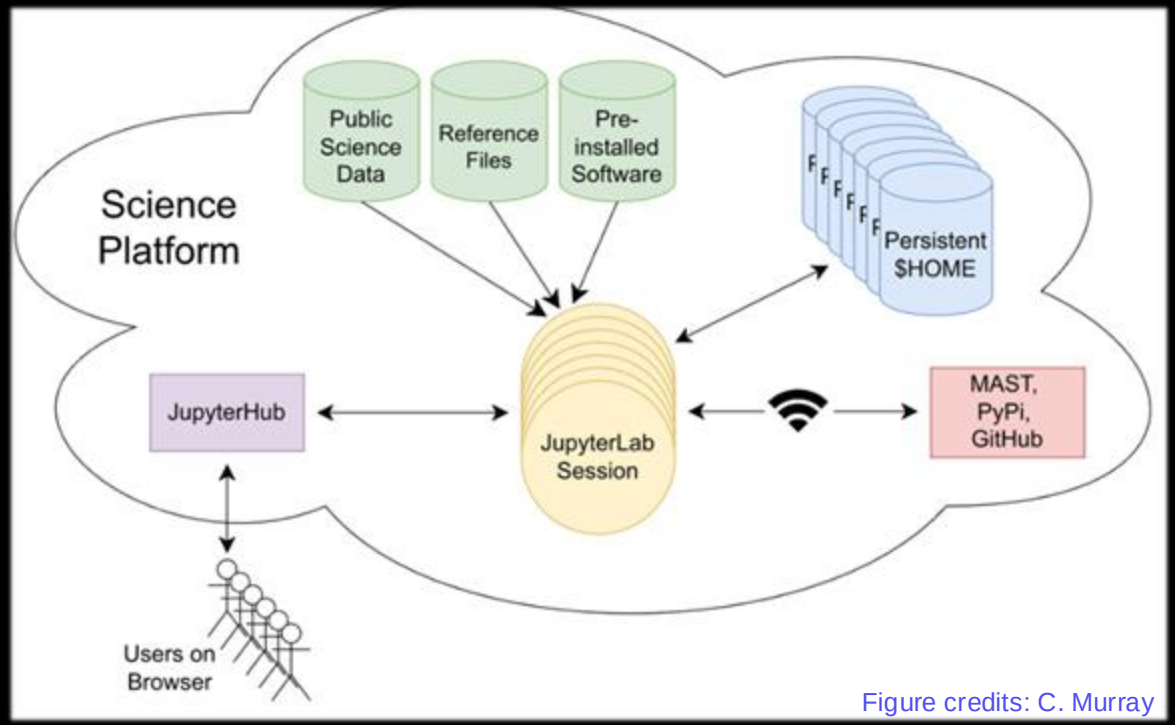


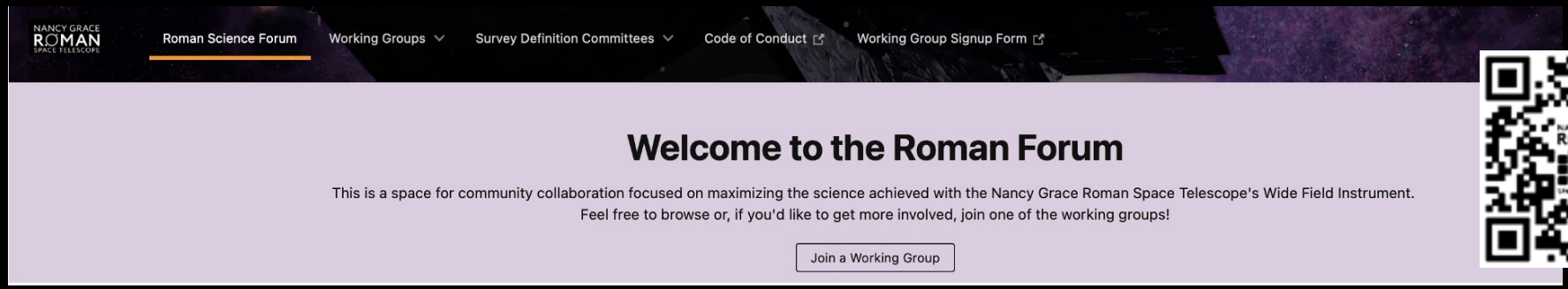
Figure credits: C. Murray

Rare Gems in Roman Surveys
Expect the unexpected

- Dwarf galaxies
- Stellar streams
- Galaxy environments
- Superluminous supernovae
- Tidal Disruption Events
- Pair-instability supernovae
- High-z transients
- Very highly lensed stars and supernovae

Roman Documentation

SOC Roman Helpdesk



Nancy Grace Roman

NASA’s First Chief of Astronomy

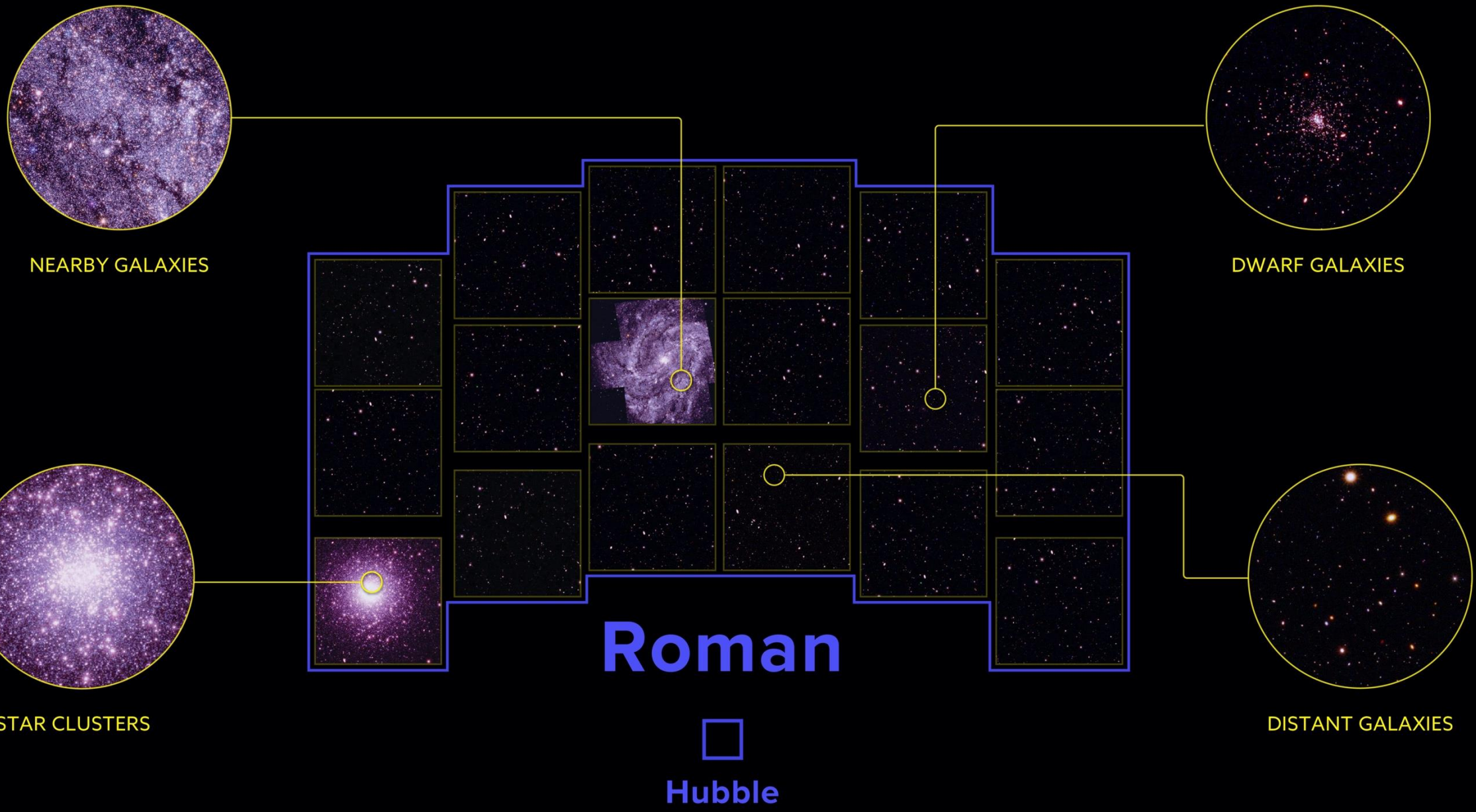
1925–2018

Roman's Instrument Capabilities

Roman Space Telescope Imaging Capabilities								
Telescope Aperture (2.4 meter)		**Field of View** (45′x23′; 0.28 sq deg)		**Pixel Scale** (0.11 arcsec)		**Wavelength Range** (0.5-2.3 μm)		
Filters	**F062**	**F087**	**F106**	**F129**	**F158**	**F184**	**F213**	**W146**
Wavelength (μm)	0.48-0.76	0.76-0.98	0.93-1.19	1.13-1.45	1.38-1.77	1.68-2.00	1.95-2.30	0.93-2.00
Sensitivity (5σ AB mag in 1 hr)	28.5	28.2	28.1	28.0	28.0	27.5	26.2	28.3

Roman Space Telescope Spectroscopic Capabilities				
	Field of View (sq deg)	**Wavelength (μm)**	**Resolution**	**Sensitivity (AB mag) (10σ per pixel in 1hr)**
Grism	0.28 sq deg	1.00-1.93	461	20.5 at 1.5 μm
Prism	0.28 sq deg	0.75-1.80	80-180	23.5 at 1.5 μm

Roman Space Telescope Coronagraphic Capabilities					
	Wavelength (μm)	**Inner Working Angle (arcsec)**	**Outer Working Angle (arcsec)**	**Detection Limit***	**Spectral Resolution**
Imaging	0.5-0.8	0.15 (exoplanets) 0.48 (disks)	0.66 (exoplanets) 1.46 (disks)	10^{-9} contrast (after post-processing)	47-75
Spectroscopy	0.675-0.785				

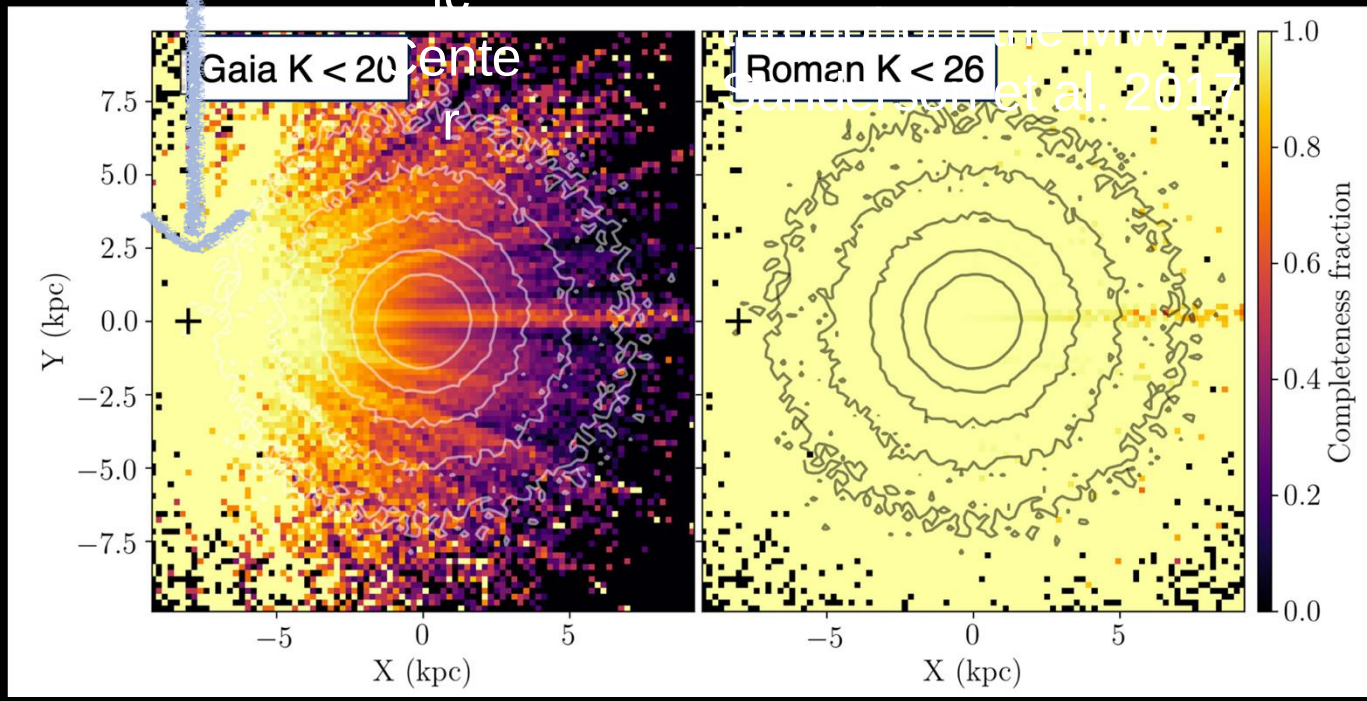

NEARBY GALAXIES
DWARF GALAXIES
STAR CLUSTERS
DISTANT GALAXIES
Roman
Hubble

Galactic Plane Survey

Roman's high angular resolution, sensitivity, NIR wavelengths, and survey speed will minimize confusion and extinction in the plane of the Galaxy, enabling surveys that can

- Resolve previously unresolved stellar populations, e.g., stellar clusters in star-forming regions, globular clusters
- Place new constraints on Galactic structure, by surveying red clump stars and YSOs over a greater volume of the disk
- Measure the stellar Initial Mass Function to lower mass limits; resolve low mass stars in extincted regions
- Observe more "background" sources for the construction of 3D dust maps
- Obtain a complete census of evolved massive stars in the disk: measure physical properties, constrain their binary fraction, and enable multi-messenger stellar astronomy

Roman will be capable of detecting a complete sample of red-clump stars



Slide content: Palladini et al., Levesque et al., Sanderson et al.