Hubble-Like Resolution ~0.1'' **Near-Infrared Imaging and Spectroscopy** 0.48–2.3 µm **Expansive Field of View** 0.281 deg^2 **All Data Nonproprietary** ~4 Pb/yr
Complementing Other Observatories HST, JWST, Rubin, Gaia, Euclid, TESS, and more **Propelling Future Discoveries** All of Astrophysics

Stellar Populations of the Milky Way Bulge and Disk

The Roman Space Telescope's unique combination of Hubble-like resolution, near-infrared sensitivity, and wide field of view will provide key insights into star formation processes in the Milky Way bulge, bar, and disk. Roman will provide:

- Funding opportunities to mine data collected during planned microlensing surveys of the MW bulge, including
  - ◊ Photometric measurements of ~240 million stars brighter than 25th magnitude in W146
  - ◊ Repeated observations over 6 seasons (72 days/season) at cadences of 15 min in W146, 12 h in F062 or F087, and 12 h in F106 or F129, covering a total field of ~2 deg^2
  - ◊ One of the deepest views of the Milky Way bulge ever captured, in multiple filters (e.g., ~2 × 10^6 s in W146 and ~3 × 10^5 s in F087)
  - ◊ High-precision astrometry (3-10 µas) providing parallaxes and proper motions for more than 100 million stars
  - ◊ Near-infrared sensitivity and high resolution required to study stellar populations otherwise hidden from view due to dust extinction, intrinsic faintness, and confusion
  - ◊ The ability to study multiple stellar population properties, including luminosity and mass functions down to the hydrogen-burning limit
- Funding for new observations, affording access to the wide field, high resolution, and IR sensitivity needed to
  - ◊ Observe entire stellar environments, such as the central molecular zone and star-forming regions, in one pointing
  - ◊ Investigate multiple stellar properties, including T_{eff}, [M/H], age, luminosity, and A_H
  - ◊ Map the structure and history of the MW bulge, bar, and disk
- Immediate open access to all data from core community surveys and general observations, including those of the MW bulge or disk

Probing stellar populations of the Milky Way: Simulated Roman image of a Milky Way bulge field covering 1/140th of Roman's field of view in three filters: F087, W146, F184. (M. Penny 2019, ApJS, 241, 3).

Stellar Populations of the Milky Way Halo

Roman's ability to resolve faint stars over vast swaths of the sky will play a crucial role in our understanding of multiple stellar populations in globular clusters (GCs) of the Milky Way halo. In addition, Roman will be able to detect and resolve faint halo stars and structures such as stellar streams, filling key gaps in our understanding of the composition, structure, formation, and evolution of the galaxy as a whole. Roman will provide:

- Field of view wide enough to cover the entire tidal radius of a typical GC in a single pointing
- Near-infrared sensitivity needed to optimally probe faint, low-mass stars that typically populate the mostly uncharted outskirts of GCs
- Resolution required for high-precision astrometry and deblending of stars in GC cores and outskirts
- Extension of time baselines for relative proper motion studies with precision ≤25 µas/yr, and improved to ~10 µas/yr when anchored by Gaia reference stars
- Ability to differentiate the various kinematics within a GC, as well as more accurate determinations of GC orbital motion
- Immediate open access to imaging and spectroscopic data of low-density portions of the halo collected during proposed Type IA Supernovae and High-Latitude surveys
- Opportunities to propose specific individual observations and time-domain surveys for composition, demographic, kinematic studies of the halo, with the potential for discoveries of new stellar streams

Charting the faint outskirts of globular clusters: Roman's footprint superimposed on the globular cluster NGC 1851, with the nominal tidal radius of the cluster outlined in red. (A. Bellini, et al. 2019, arXiv:1903.05085 [astro-ph.GA])

Resolved Stellar Populations in Neighboring Galaxies

Roman's high resolution and rapid survey speed will enable comprehensive population studies of stars in the main bodies, extended halos, and satellites of neighboring galaxies. Roman will provide:

- Hubble-quality resolution needed to resolve and characterize billions of individual stars in galaxies as far as ~10 Mpc
- Near-infrared sensitivity (H_{AB}~28 in 1-hr exposure) needed to image faint halo stars, as well as stars in the spiral arms and inner region that are otherwise obscured by dust
- Field of view large enough to survey the entire disk of Andromeda in a few pointings; and the ability to survey the halo and satellites as well as the main body of smaller and more distant targets like M33, providing a holistic view of both a galaxy and its immediate environment
- Survey speed 1475 times faster than Hubble for coverage similar in depth and area to the Panchromatic Hubble Andromeda Treasury (PHAT) program
- Ability to differentiate faint, large-scale structures like tidal streams to better understand the physical and evolutionary relationships between various stellar populations within the galaxy
- Opportunities to propose comprehensive surveys of interacting galaxies
- Immediate open access to imaging and spectroscopic data of halo stars of neighboring galaxies in fields covered by other proposed surveys

Mapping nearby galaxies: Roman's footprint overlaid on Andromeda (M31), with the apparent size of the Moon for scale. (Background: Digitized Sky Survey and R. Gendler; Moon: NASA, GSFC, and Arizona State University)

Stellar Oddities

Roman is capable of detecting and characterizing transient events and variable phenomena with milli-magnitude changes on time scales of minutes to years. Roman will provide:

- Funding opportunities to mine large photometric datasets with varying time cadences for characterization of stellar phenomena such as pulsating variable stars, stellar flares, and star spots, with immediate open access to:
  - ◊ Data collected via potential microlensing survey of the MW bulge (2 deg^2 with 15-min cadence over 6 seasons with 72 days/season)
  - ◊ Potential medium- and deep-sky surveys (~8 – 18 deg^2 with a 5-day cadence) that are expected to discover ~8,800 supernovae (SNe) Ia out to z~1.7
- Resolution and sensitivity needed to detect SNe in dusty environments, including light echoes in the Milky Way and neighboring galaxies
- Precision astrometry (3 – 10 μas) in the planned microlensing surveys, enabling detection of hundreds to thousands of isolated black holes in the MW bulge via photometric and astrometric microlensing
- Monitoring of stars in the MW bulge via the microlensing survey, with the ability to conduct asteroseismology of ~10^6 $H_{AB} < 14$ red giant stars with known distances
- Near-IR observations supporting multi-wavelength and multi-messenger studies of phenomena such as binary neutron star mergers and Pop III explosions, to propel our understanding of unique events and discover new classes of transients
- Opportunities to propose targeted observations and follow-up studies of specific stellar oddities

Capturing transient phenomena: Infrared Hubble image of variable star V838 Mon and its light echo: HST ACS/WFC, F606W (V) and F814W (I). (NASA, ESA, and H. Bond, STScI)

Learn more about the Roman Space Telescope

STScI

STScI website: **www.stsci.edu/roman**

Mission/partner websites: **www.stsci.edu/roman/about.html#Partners**

For more about how Roman will explore the universe, see **www.stsci.edu/roman/documentation**

Previously known as the Wide Field Infrared Survey Telescope (WFIRST), the Nancy Grace Roman Space Telescope was named in May 2020 in honor of NASA's first Chief of Astronomy.

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