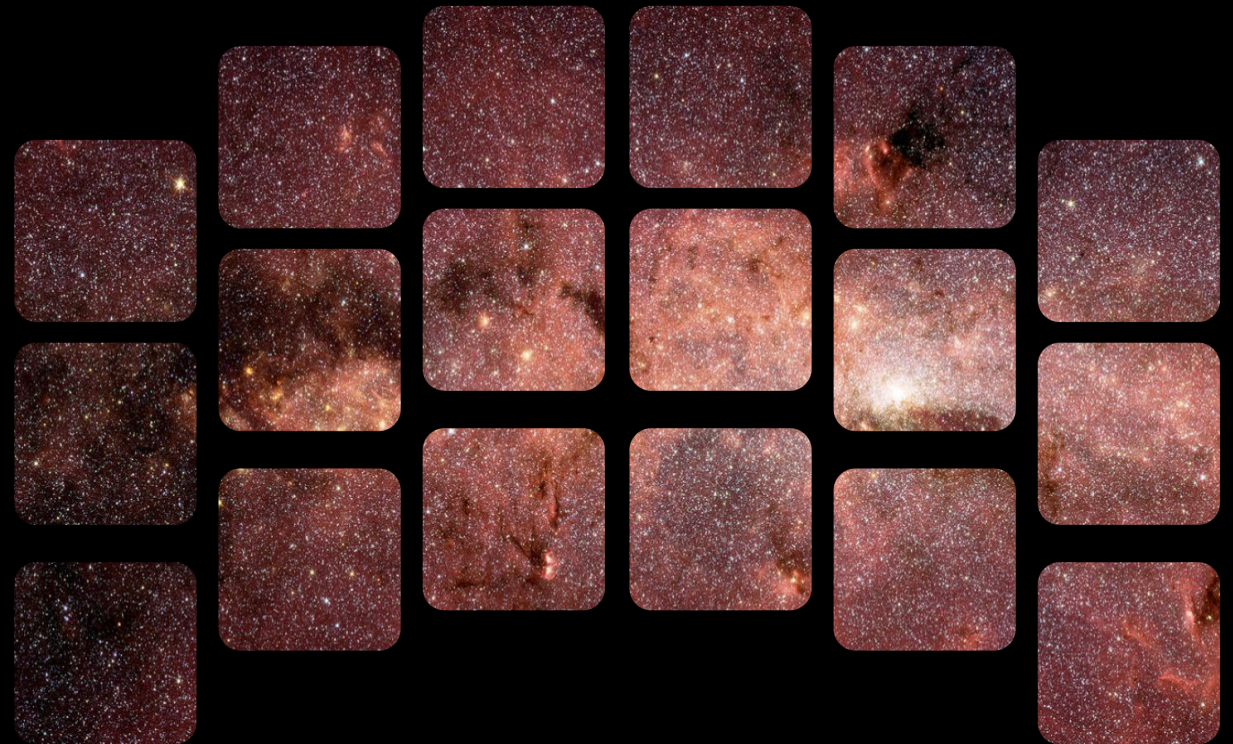


Astrophysics with Core Community Surveys and General Astrophysics Surveys

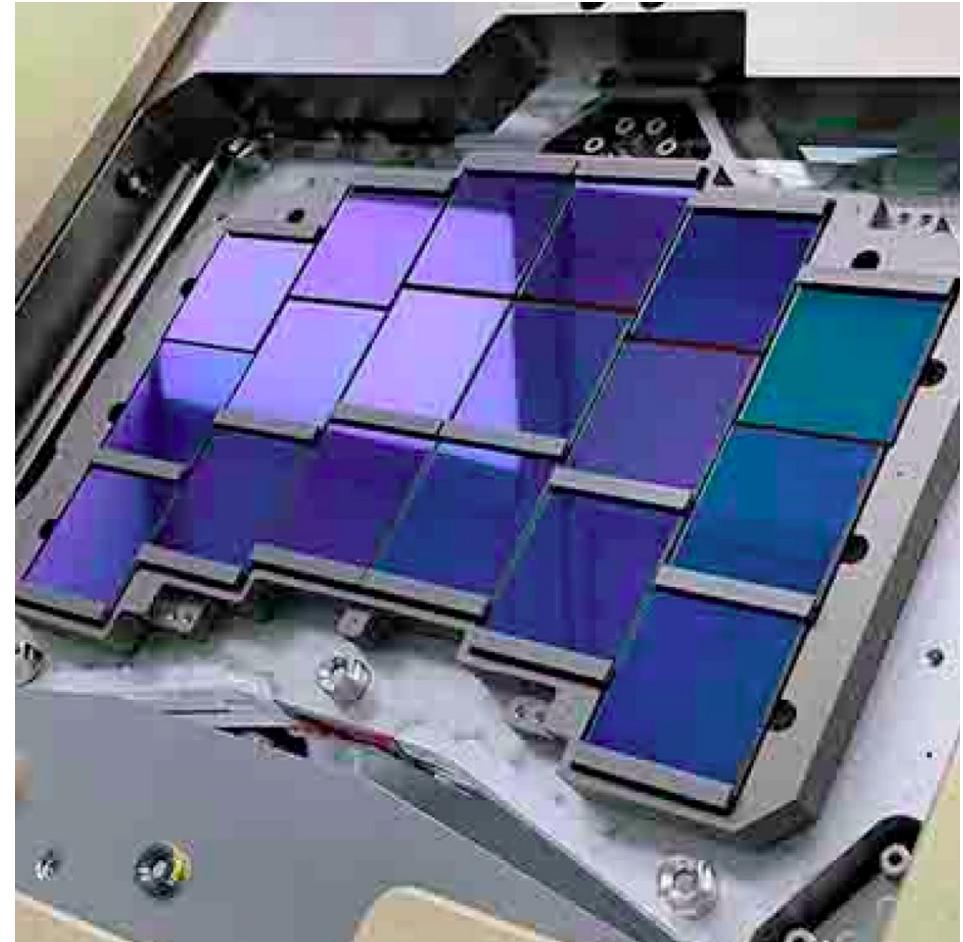
R.ÖMAN



SPACE TELESCOPE

A Roman Hardware Milestone

18 flight detectors installed in the mosaic plate!



- **Worlds and Suns in Context**

- “quest to understand the interconnected systems of stars and the worlds orbiting them, tracing them from the nascent disks of dust and gas from which they form, through the formation and evolution of the vast array of extrasolar planetary systems.”

- **New Messengers and New Physics**

- “The New Messengers and New Physics theme captures the key scientific questions associated with a broad range of inquiries, from astronomical constraints on the nature of dark matter and dark energy, to the new astrophysics enabled by combined observations with particles, neutrinos, gravitational waves, and light.”

- **Cosmic Ecosystems**

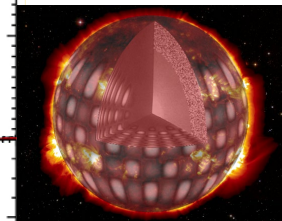
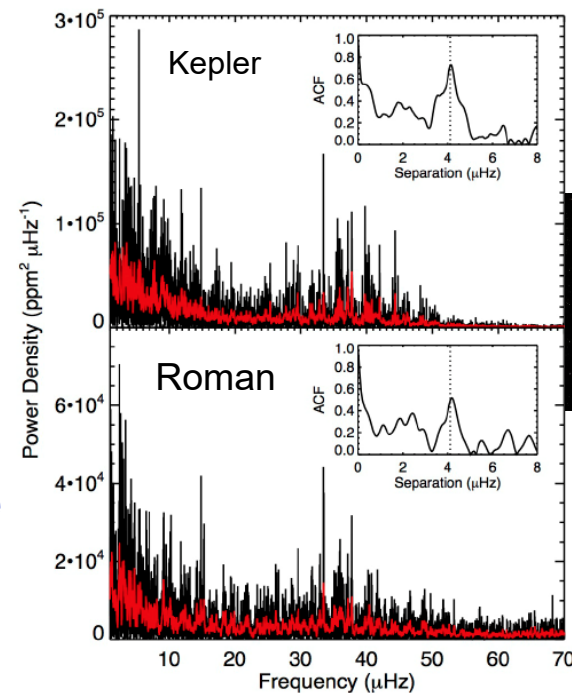
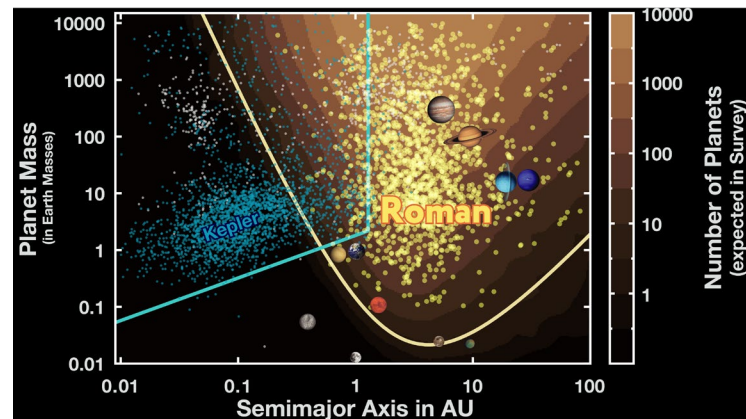
- “The universe is characterized by an enormous range of physical scales and hierarchy in structure, from stars and planetary systems to galaxies and a cosmological web of complex filaments connecting them. A major advance in recent years has been the realization that the physical processes taking place on all scales are intimately interconnected, and that the universe and all its constituent systems are part of a constantly evolving ecosystem.”

- **Exoplanet demographics**

- Roman's microlensing program with the **Galactic Bulge Time Domain (GBTD) Survey** will fill out the census of exoplanets by finding exoplanets in the outer reaches of planetary systems that are inaccessible by other detection techniques

- **Stellar Astrophysics**

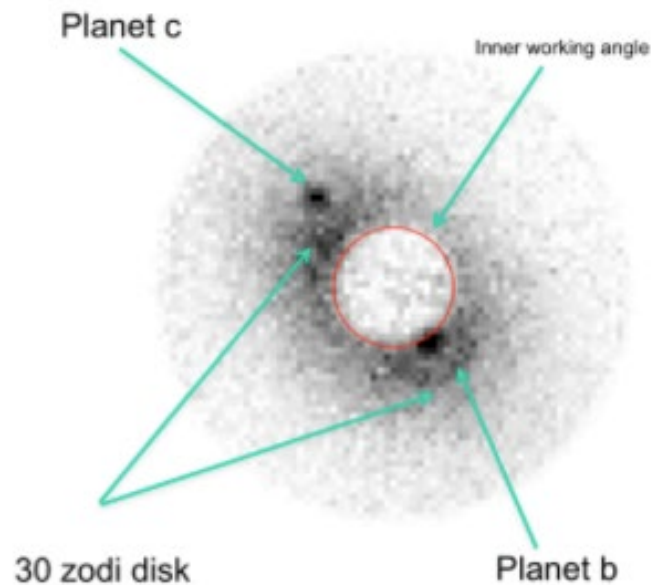
- **GBTD Survey** will monitor >200 million stars
 - Microlensing studies will reveal the population of neutron stars and stellar mass black holes in the galactic bulge
 - Astroseismology – use stellar oscillations to measure mass and radius of stars in the galactic bulge
 - and lots more – stellar flares, pulsating variable stars etc
- **GBTD Survey** will provide a deep image of 2 deg² region of the bulge
 - Identify unusual stellar populations down to very faint levels
 - measure positions, distances precisely
- **Roman General Astrophysics Surveys of nearby galaxies and the Milkyway** open new windows in extragalactic stellar astrophysics



- **Priority Area: Pathways to Habitable Worlds**

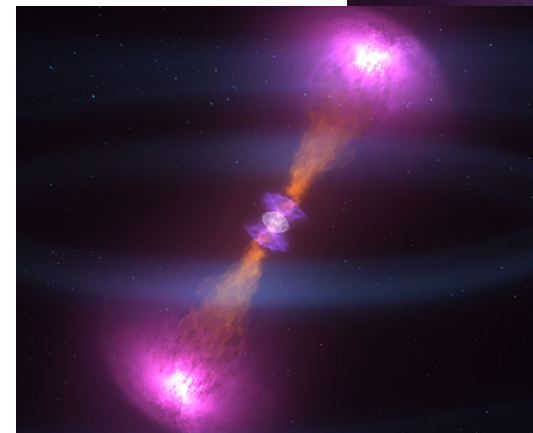
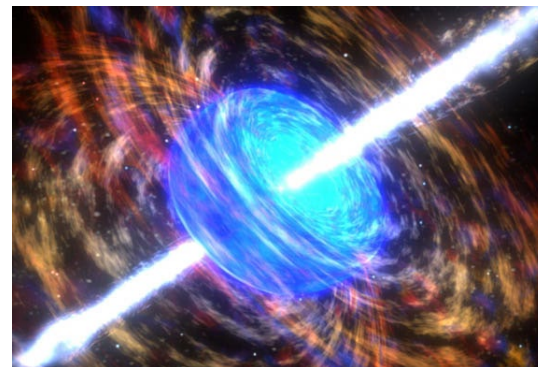
- How to answer the question “Are we alone?”
- The planets around Sun-like stars are only accessible via an ultra-stable, space-based telescope equipped to block the star’s light and directly image the planet
 - The **Roman coronagraph instrument tech demo** is an important part of the path

Simulated Roman Space Telescope coronagraph image of the star 47 Ursa Majoris



- The unknown physical natures of dark matter and dark energy remain outstanding Grand challenges in physics and astronomy
 - Exploring these on large scales by measuring galaxy shapes, distributions of galaxies on large scales and by detecting distant supernova was a prime motivation for the Roman mission with the **High Latitude Wide Area and Time Domain Surveys**
 - Roman can also map dark matter more locally, by measuring astrometric motions and populations of stars in our Milkyway and nearby galaxies. (using **GBTD survey** and **General Astrophysics surveys of the Milkyway and local galaxies**)

- **Priority area: New windows on the Dynamic Universe**
 - Exploring the Universe in the time domain is a discovery machine
 - Gamma-ray bursts, tidal disruption events, supernovae, fast radio bursts, etc were all discovered, and can only be studied by observatories monitoring large areas of the sky on a variety of timescales.
 - Roman will study all these, and almost certainly make new discoveries of our own
 - The **Galactic Bulge and High Latitude Time Domain Surveys** will be the engine of these discoveries
 - Also significant discovery space in a **General Astrophysics Survey of the Milkyway plane** with a time domain component
 - Observing/identifying the counterparts to gravitational wave and neutrino events
 - Connecting the whole new world revealed by GW and neutrinos to things we know from the rest of astronomy
 - Using the **High Latitude Time Domain Survey and TOO observations** to identify/follow up interesting events

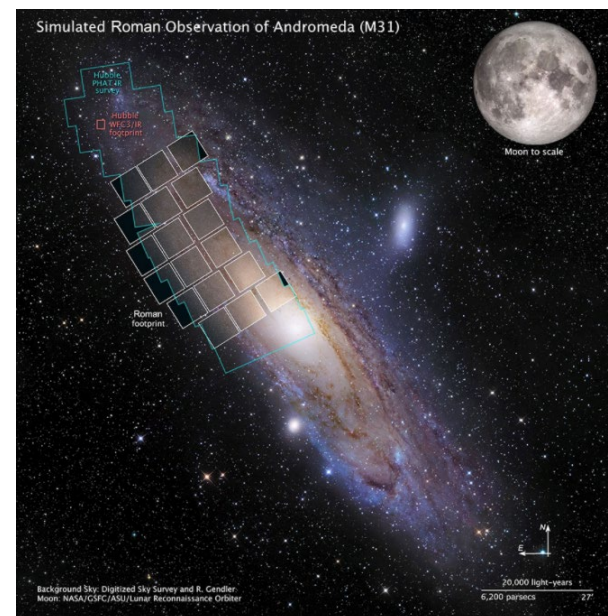
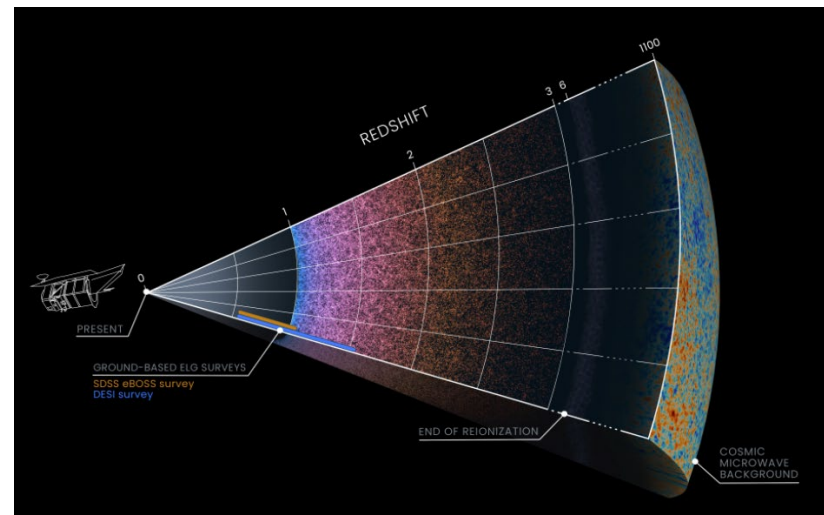


- **Cosmic structure**

- How the seeds of galaxies planted during the first moments of the big bang become the structures and galaxies seen today
- Roman's galaxy redshift survey (from the **High Latitude Wide Area Survey**) has a major role to play

- **Galaxies are ecosystems of their own**

- Balance between formation of stars and planets and feedback from stellar winds, outflows and supernovae
- What is the role of the supermassive black holes that reside at the center of most galaxies
- **General Astrophysics surveys of Milkyway and nearby galaxies** will provide insight into this



- **Priority Area: Unveiling the Drivers of Galaxy Growth**
 - Roman's **High Latitude Wide Area and High Latitude Time Domain** will greatly expand our sampling of the structure, colors and spectra of galaxies over a significant fraction of cosmic time
 - **General Astrophysics Survey of an Ultra Deep Field** would provide additional depth
 - Track the growth of normal galaxies as a function of environment
 - Enable discoveries of rare galactic objects
 - Measure/infering dark matter mass **and** stellar mass at all scales via both lensing and spectroscopic constraints on clustering



All three of our Core Community Surveys and the CGI Tech Demo have central roles to play in the science priority areas identified by Astro2020

General Astrophysics Surveys will also have key contributions