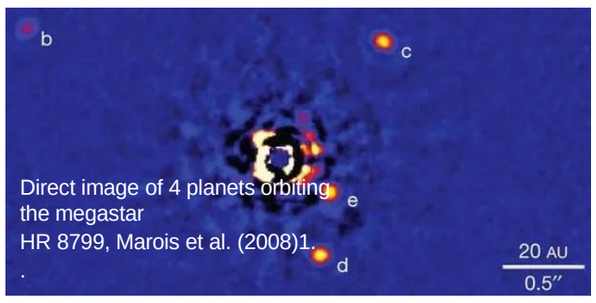
Study of Different Exoplanet Atmospheres with the Nancy Grace Roman Telescope Coronagraph tool

Direct Imaging

Direct imaging captures a 2d photo of light emitted through objects in space, together with exoplanets. The predominant undertaking of direct imaging is taking pictures faint planets adjacent to their intensely luminous host stars. cutting-edge direct imaging efforts are constrained in the goals they can study, focusing on planets which might be less complicated to detect and are:

- **large (outstanding-Jupiters)**
- **some distance from their host stars (extensive Orbits)**
- **younger (much less than one hundred million years antique). those planets glow brightly in infrared (IR) because of their residual warmth of formation, a wavelength range wherein the stellar accomplice is not as brilliant**



Direct image of 4 planets orbiting the megastar HR 8799, Marois et al. (2008)1.

The Nancy Grace Roman Space Telescope

The Nancy Grace Roman space Telescope represents a considerable development in space statement, constructing upon the achievements of both the Hubble and JWST missions. originally unique as WFIRST (wide-discipline Infrared space Telescope), it become renamed in 2020 to honor Nancy Grace Roman, NASA's first girl executive and a key parent within the development of the Hubble area Telescope. Scheduled for launch by way of 2027, the telescope will orbit the Earth's L2 factor, boasting a number one mirror 2.4 meters wide, comparable to that of the Hubble.
The telescope functions two fore most units:

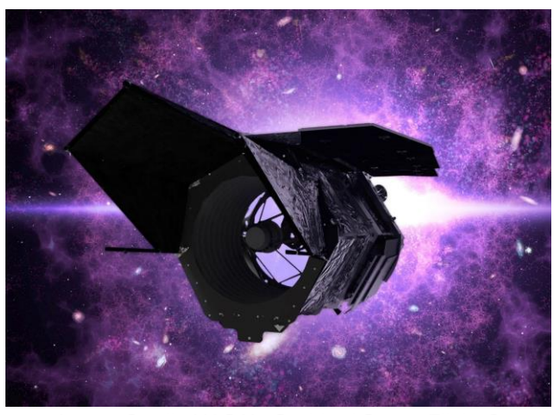


Image Credit: NASA's Goddard Space Flight Center

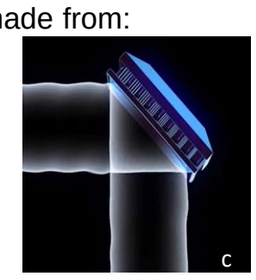
The extensive-area instrument (subject of

- **view a hundred instances that of Hubble)**
- **• Coronagraph instrument (narrower**
- **subject of view for high-resolution**
- **targets)**

The Roman Coronagraph Instrument (RCI) Design

The Roman Coronagraph device (RCI) is a generation demonstration that showcases novel starlight suppression with a purpose to enhance functionality over previous coronographs like the ones flown on Hubble and JWST with the resource of a element of 100 to one thousand. the novel era inherent to the RCI is made from:

extremely-unique wavefront sensing and control
big-layout deformable mirrors
high-evaluation coronagraph mask



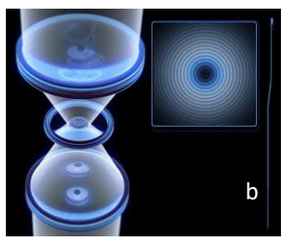
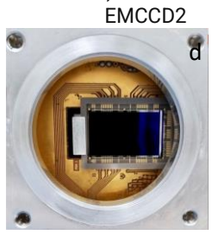


figure 3. a) Coronagraph mask b) impact of overlaying: blocked primary star and deconstructive interference c) Deformable mirror d) EMCCD2



ultra-low noise photon counting Electron Multiplying fee-Couple tool detectors
advanced algorithms for facts submit-processing

The RCI will serve as a essential precursor for obligations which include the remarkable Observatories assignment and era Maturation software program and the habitable Worlds Observatory (HWO), that permits you to finally allow for the direct imaging of small, rocky planets.

RCI Capabilities

The Roman Coronagraph instrument is designed to study targets with an absolute visual value ≤ five boasts a predicted seen-mild planet/megastar flux ratio detection restriction of 10-8 or better at angular separation of about zero.1 to one arcsecond. With three awesome looking at modes—Direct Imaging, Polarimetry, and Spectroscopy. RCI makes use of 4 bandpass filters in visible wavelength degrees. Bands 2 and three are used for spectroscopy, permitting CGI to seize spectra of orbiting planets through dispersing the light from the planet's area through a prism, with sign from the reference star subtracted at some stage in post-processing to generate flux ratios (Fp/Fs) for evaluation

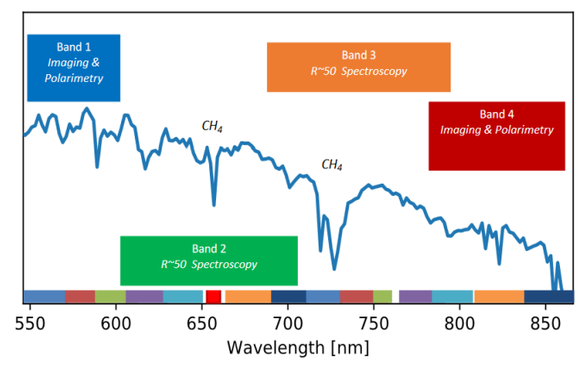


Fig 4. Roman space Telescope observing bands as compared to an atmospheric spectrum 2.

Goal: RCI Exoplanet Target Planning

Our research will aid the investigation of self-luminous young jovians in emitted mild jovians in contemplated light, to be imaged with the aid of the Roman area Telescope. target choice is important because of restricted looking at time, however decoding atmospheric spectra poses demanding situations because it's an inverse problem that may cause degenerate solutions.
To aid in target selection and records interpretation, we will utilize the subsequent equipment:

1. PICASO: This Python Planetary depth Code for Atmospheric Scattering Observations3 simulates the 1D structure of exoplanetary atmospheres, such as temperature-pressure profiles and chemical composition. It incorporates a excessive-constancy radiative switch model to generate excessive-decision, phase-based spectra.
   rfast: This inverse modeling tool, designed to support destiny missions like HabEx and LUVOIR, enables discover the information encoded inside exoplanetary spectra. It identifies regions of parameter space steady with observed spectra, facilitating facts interpretation

Goal: Incorporating Hazes

Clouds and hazes can difficult to understand spectral signatures, mask surface features, and appreciably effect temperature and climate, hence posing demanding situations to appropriately characteriz ing planetary atmospheres. Laboratory experiments have highlighted the connection among haze residences a nd the thermochemical environments wherein they form4, making them of particular hobby.

While PICASO currently incorporates cloud modeling, we are working on integrating hazes into the code. This involves prescribing mode particle sizes and aerosol mass densities to determine haze number densities to include in the radiative transfer calculations.

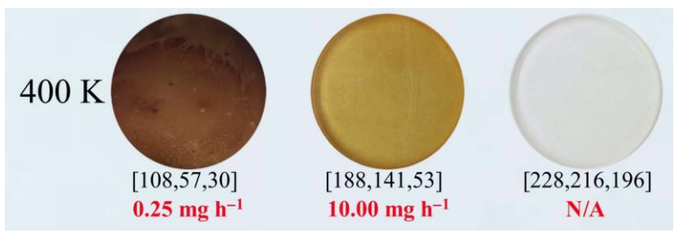


Fig 5 Hazes produced in a laboratory at conditions applicable to capability target atmospheres for the RCI from He et al. (2018)four. The metallicities from left to right are a hundred X, 1,000 X and 10,000 X leading to differing formation prices proven at backside in pink.

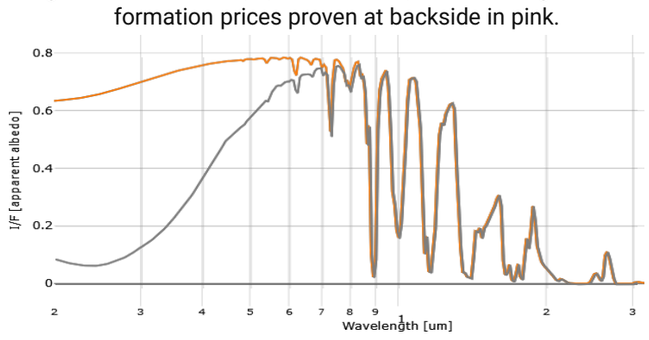


Fig 6. Jupiter in meditated light as modeled by the Planetary Spectrum Generator5 to simulate viewing with the Hubble area Telescope (orange). The addition of haze (gray) based totally on Titan tholins produces huge absorption capabilities at shorter wavelengths

Synopsis. The Nancy Grace Roman area Telescope Coronagraph instrument guarantees exceptional abilities in direct imaging. we will use the PICASO climate modeling and radiative transfer code to create version grids of cool and heat jovian planets, facilitating the selection of promising objectives with a higher chance of yielding discernible atmospheric residences from their spectra. through incorporating hazes into the PICASO model, we will higher understand their potential impact on observations with the Roman Telescope

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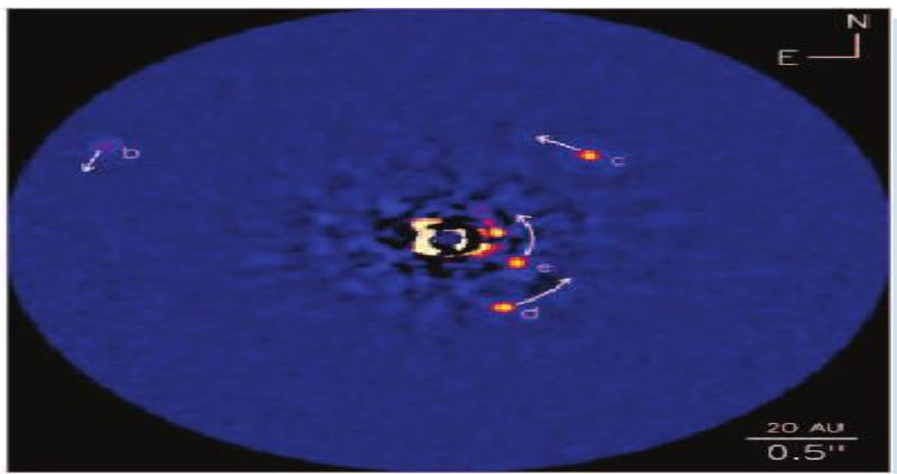

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