The Roman Science Support Center at IPAC

July 7, 2021
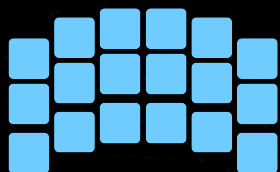
L. Armus (SSC)

IPAC GDPS team: L. Armus (lead), P. Appleton, J. Colbert, G. Duggan, K. Larson, Y. Mei, S. van Dyk, Y. Wang, J. Xie

LAM team: J.-G. Cuby (lead), M. Bethermin, P.-Y. Chabaud, Y. Copin, V. Le Brun, C. Surace, D. Vibert

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The Roman Science Support Center at IPAC

- The SSC at IPAC works with the other Ground System elements to achieve the scientific and operational goals of the Roman mission.
- Primary SSC Responsibilities include:
  - **Science Data pipelines**
    - *Science data processing for the Galactic Bulge Time Domain Survey*
    - *Science data processing for all Wide Field Spectroscopy mode data including the High Latitude Wide Area, Time Domain and General Astrophysics surveys*
  - **Coronagraph Instrument Operations**
    - *CGI Observation scrips and procedures*
    - *Data Analysis Environment for CGI data processing*
    - *High Order Wave Front Sensing and Control (deformable mirror) operations*
    - *CGI health, safety and performance monitoring*
  - **Proposal calls, peer reviews and community grants**
    - *Issue General Observer (GO) /Guest Investigator (GI)/Theory calls for proposals*
    - *Manage the peer review and time allocation process and investigator grants*
  - **Community engagement**

SSC Roman Science Support

- The SSC works with the Roman Project Science Office and the Science Investigation Teams to:
  - Understand science requirements of the mission
  - Define operational and data processing scenarios
  - Discuss potential roles and contributions of future Science Teams

- IPAC and SSC scientists are directly involved in current Roman Galactic Bulge Time Domain, High Latitude Wide Area and High Latitude Time Domain Survey Science Investigation Teams.

- The SSC participates in Roman working groups focusing on WFI calibration, wide field spectroscopy data processing, data formats, simulations, etc.

- The SSC participates in the Formulation Science Working Group and The Roman Science Interest Group.

- The SSC team includes scientists with expertise in:
  - Microlensing data reduction and analysis
  - Direct exoplanet imaging and coronagraphy
  - Wide field Infrared spectroscopic data reduction, analysis and simulations
  - Cosmology, supernovae, MW and galaxy evolution (theory and observation)
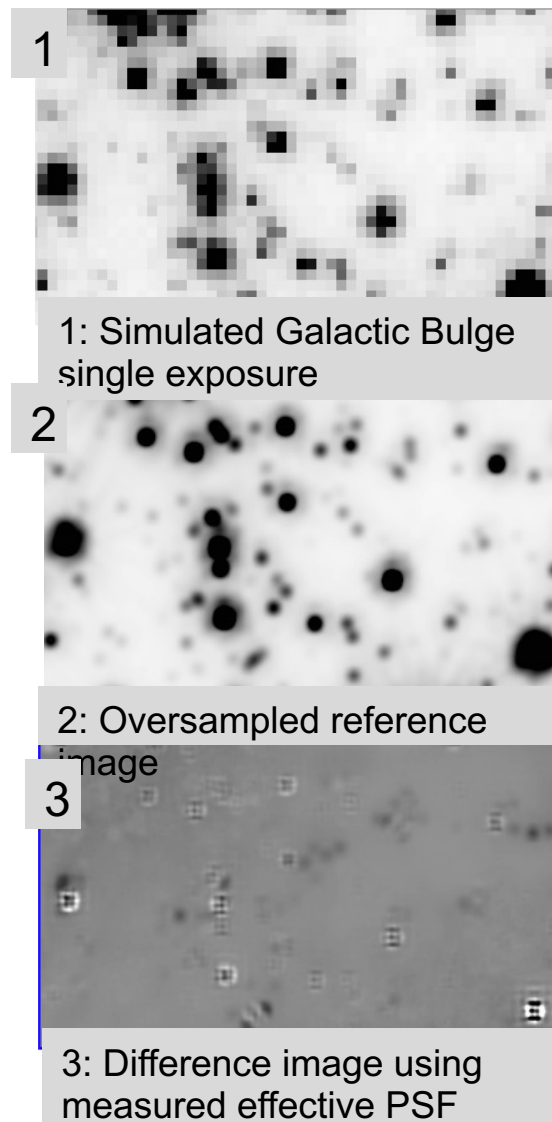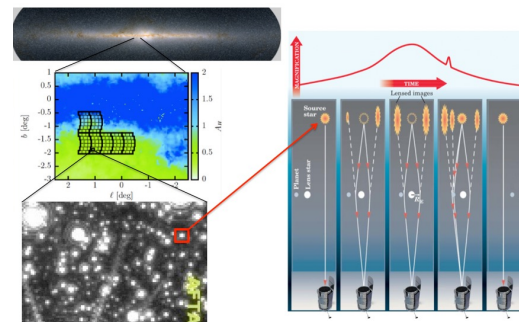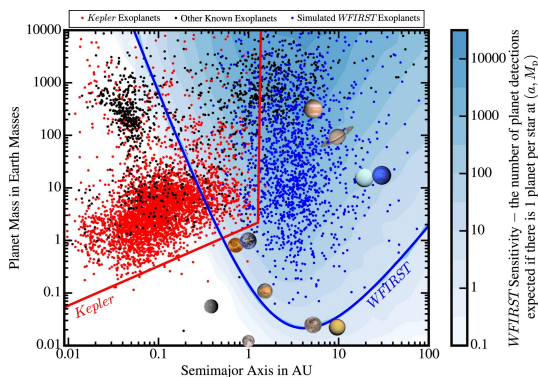
Main SSC Systems
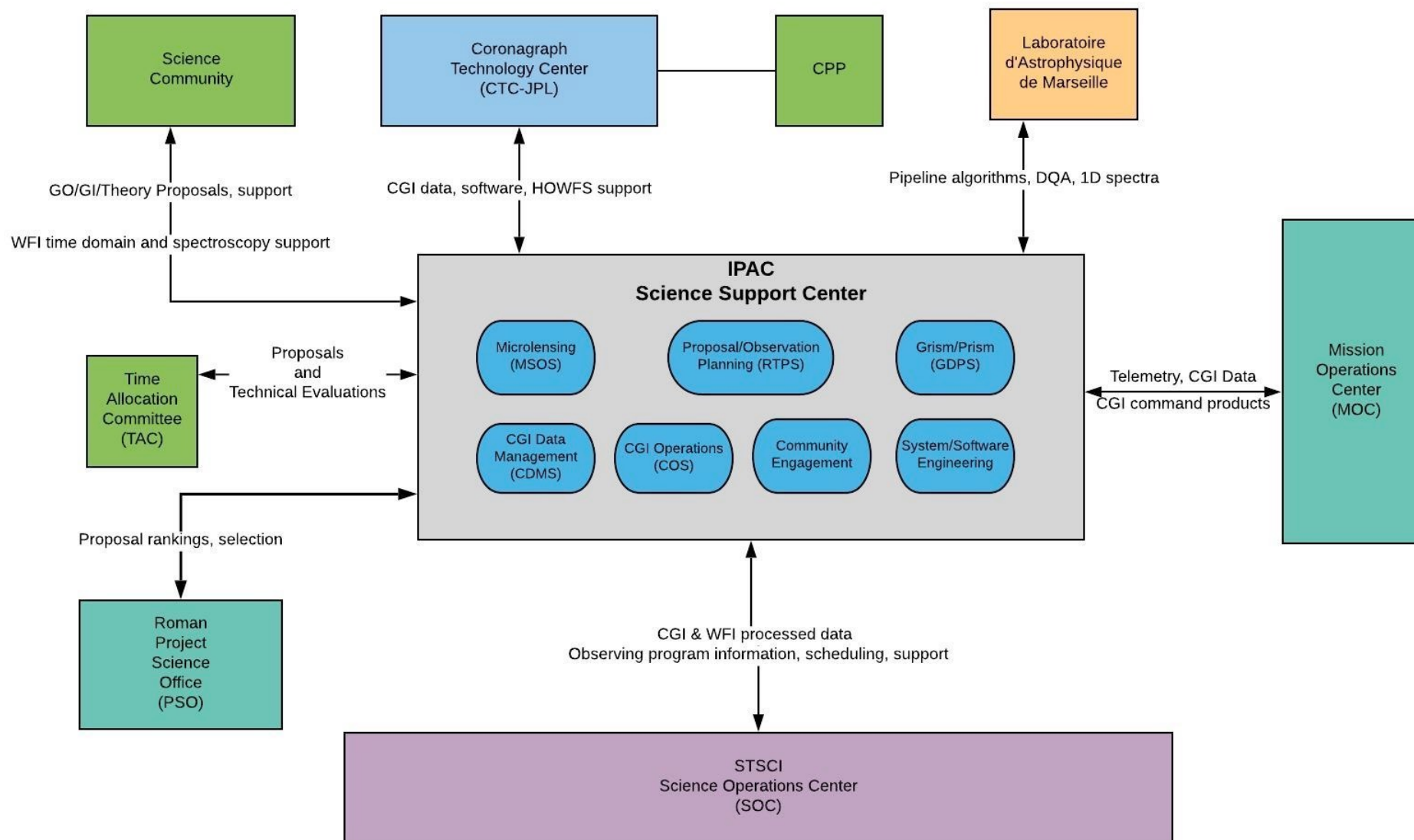
- <u>Microlensing Science Operations System</u> (**MSOS**): WFI microlensing data processing for the Roman Galactic Bulge Time Domain Survey, which will produce high-level science data products and deliver these to the Roman archive.

- <u>Grism and Prism Data Processing System</u> (**GDPS**): WFI wide-field spectroscopy data processing for the High Latitude Wide Area, High Latitude Time Domain and Guest Observer surveys, which will produce high-level science data products and deliver these to the Roman archive.

- <u>CGI Operations System</u> (**COS**): CGI operations support including validation of commanding products and instrument health, safety and performance trending, and support of the High Order Wavefront Sensing and Control (HOWFSC) Ground in the Loop (GITL) operations.

- <u>CGI Data Management System</u> (**CDMS**): CGI instrument support including low-level data processing, user support, providing a Data Analysis Environment (DAE) which will be used to produce high-level data products, validate and deliver these products to the Roman archive.

- <u>Roman Telescope Proposal System</u> (**RTPS**): Roman Telescope proposal ingest, time allocation committee review process, and grants management.

- <u>Community Engagement</u>: Interface with the scientific user community for Roman exoplanet science, proposal preparation and submission, and spectroscopic science.

Roman Data Levels

Level 0	Science telemetry: Packetized data as it arrives from the spacecraft
Level 1	Uncalibrated exposures: include metadata, engineering data
Level 2	Calibrated exposures: remove detector signature, map to scene flux
Level 3	Resampled data: use rectified grid, coadd multiple exposures as appropriate
Level 4	High-level data: mostly source-oriented, include catalogs, extracted spectra, postage stamps, high fidelity flux, shape, morphology measurements
Level 5	Community-contributed products: may include any of the above types

The SSC will manage the **Microlensing Science Operations System** (MSOS). The primary responsibilities of the MSOS are to:

- Implement and operate the microlensing pipeline, including light curve generation, starting from Level-2 images, identifying microlensing events, deriving stellar and planetary parameters, and measuring the pipeline detection efficiency.

- Produce Level-3 & 4 data products, including images, light curves, catalogs, detection efficiency, completeness and reliability and DQA products.

- Deliver Level-3 & 4 data products to the Roman archive.

- Support the community in analyzing Roman microlensing data.

- Release pipeline modules and associated documentation to the community.

1: Simulated Galactic Bulge single exposure

2: Oversampled reference image

3: Difference image using measured effective PSF

The Grism-Prism Data Processing System

The SSC and the Laboratoire d'Astrophysique de Marseille (LAM) are collaborating to create the Roman **Grism-Prism Data Processing System** (GDPS). The primary responsibilities of the GDPS are to:

- Implement and operate the Roman Wide Field Spectroscopy Mode (WSM) pipelines that will operate on all WFI spectroscopy data (High Latitude Wide Area, Time Domain and General Astrophysics surveys).

- Produce Level-4 WSM grism and prism science and calibration data products, including decontaminated 2D and 1D spectra, catalogs, redshifts and spectral fitting results, and DQA products.

- Deliver Level-4 science data products to the Roman archive.

- Support the community in analyzing Roman WSM data.

- Release pipeline modules and associated documentation to the community.
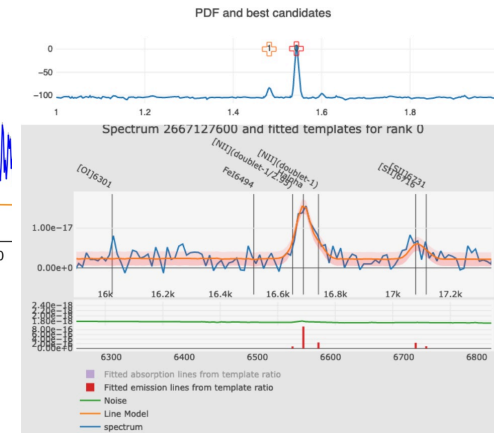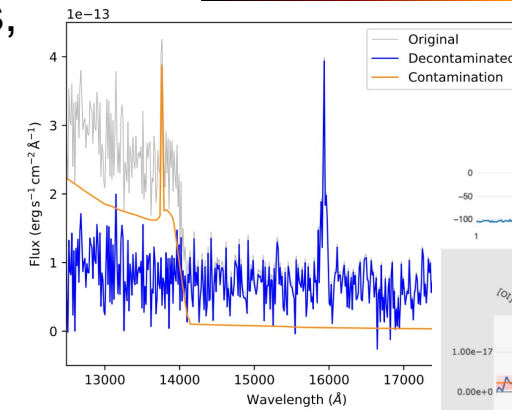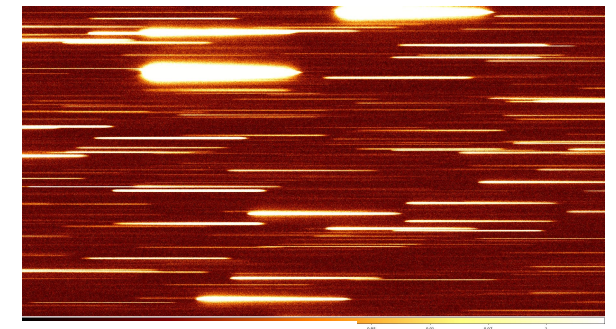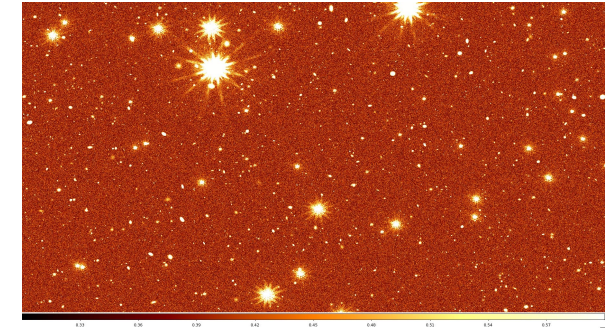
- There are two core survey concepts being planned for the Roman Space Telescope which have significant spectroscopic components:

  - **High Latitude Wide Area Survey**
    - Combined four NIR band imaging and **grism** survey using WFI over >1700 sq. deg. in 4 passes, including dedicated time for deep field observations (20 sq. deg.). Notional estimate of 200 total days over the 5 year baseline science mission.
    - Expect ~10^7 redshifts determined by two emission lines over $1 < z < 2$.
  - **High Latitude Time Domain Survey**
    - A two tier imaging (six-bands over 16 and 5 sq. deg.), and **prism** (3.4 and 1.1 sq. deg.) survey for SNe. A total of 146, 30hr visits every 5 days over 2 years of the mission.
    - Expect more than 100 Type-Ia SNe per 0.1 redshift bin over $0.2 < z < 1.7$.

- These surveys will be interspersed with peer-reviewed community surveys and dedicated calibration observations throughout the Roman prime mission.
- The GDPS will process all WFI spectroscopic data (beyond Level-2) for the Roman archive.

- A CNES-NASA MOU that describes the intent to collaborate on WSM science data processing.
- An SSC-LAM Operational Interface Agreement (OIA) that describes the exchange of software, data, and documentation between SSC and LAM.
- The GDPS leverages Euclid development and experience:
  - LAM contributes OU-SPE expertise
  - IPAC hosts the Euclid NASA Science Center (ENSCI) and Euclid SDC-US, and it participates in Euclid SGS and software development. A number of GDPS members are also part of ENSCI, actively working on the science and calibration pipelines.
- The GDPS team is also actively consulting with the Euclid OU SIR co-leads.

The Coronagraph Instrument Data and Operations System

The SSC will manage the **CGI Operations System** (COS) and the **CGI Data Management System** (CDMS).
The primary responsibilities of the COS and CDMS are to:

- **COS**
  - Command and operate the CGI during commissioning and nominal operations.
  - Develop tools to create, format and validate CGI programs and observing scripts,
    based on designs and goals of the Coronagraph technology demonstration team.
  - Perform High Order Wavefront Sensing and Control/Ground In The Loop
    (HOWFSC/GITL) operations, processing and uplink.
- **CDMS**
  - Produce Level-1 CGI data and deliver to the archive.
  - Develop and operate a Data Analysis Environment (DAE) for the process of CGI data.
 - Validate and deliver Level-2-4 CGI data produced by Coronagraph technology team to the Roman archive.
- Asses and trend CGI Health & Safety, performance.
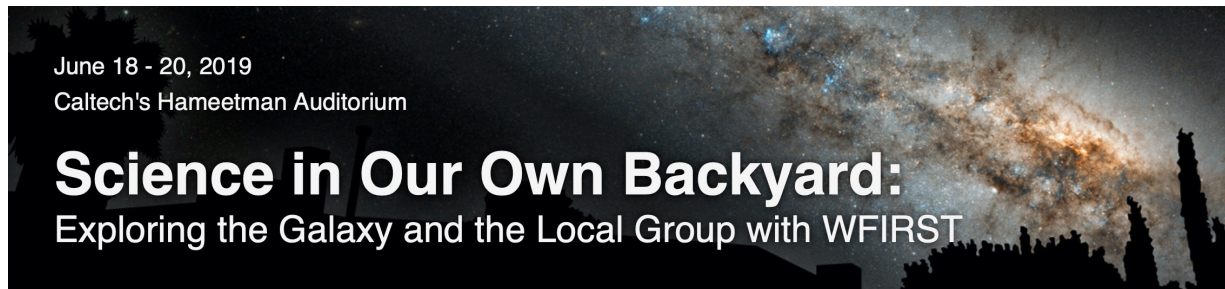- Support CGI I&T and Observatory I&T.
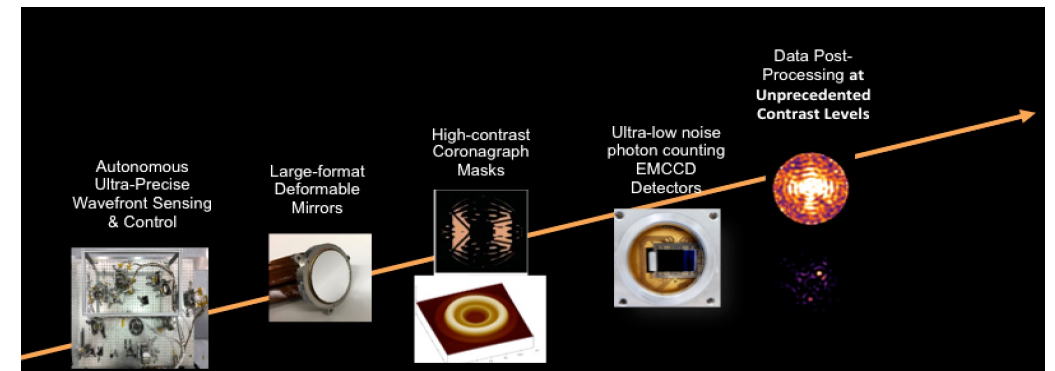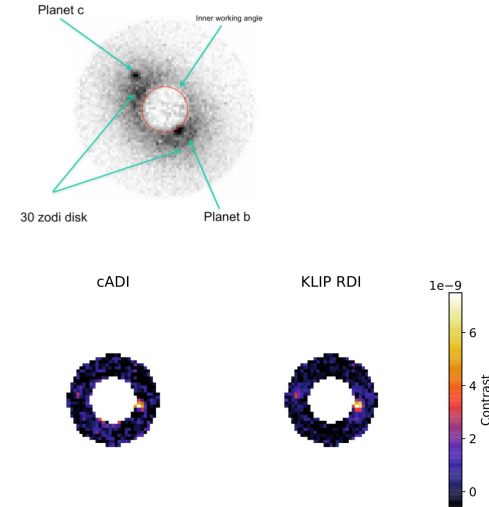
The Roman Telescope Proposal System

The SSC will manage the **Roman Telescope Proposal System** (RTPS). The primary responsibilities of the RTPS are to:

- Issue the call(s) for General Astrophysics (GO), Archival (GI) and Theory proposals
- Support the community in proposal submission, and accept and ingest proposals
- Design and maintain proposal submission software
- Maintain proposer/proposal database
- Manage the peer review process for all proposals
- Notify proposers of results and support post-selection process
- Manage GO, Archival, and Theory grants
- Support the proposal preparation and submission process via regular workshops, on-line documentation, and a helpdesk
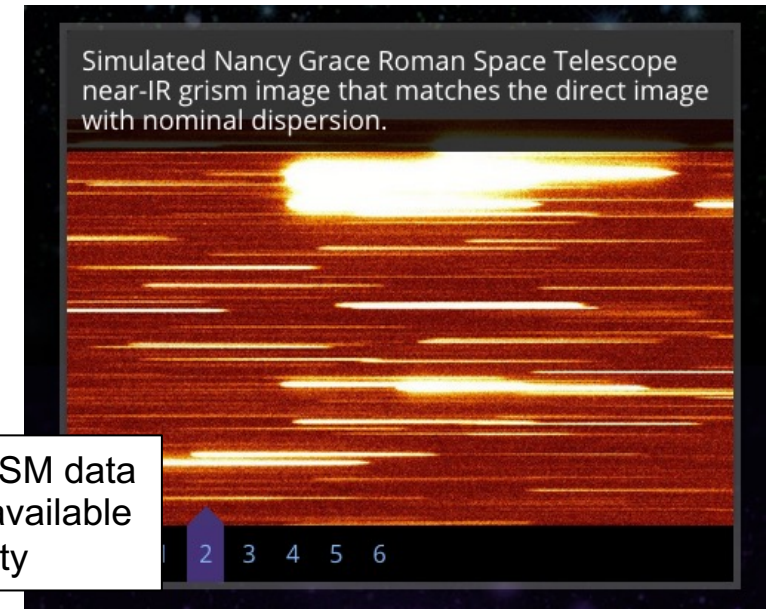
SSC Community Engagement and Outreach
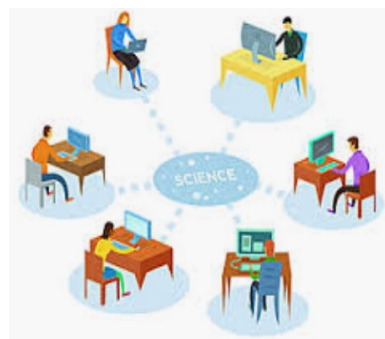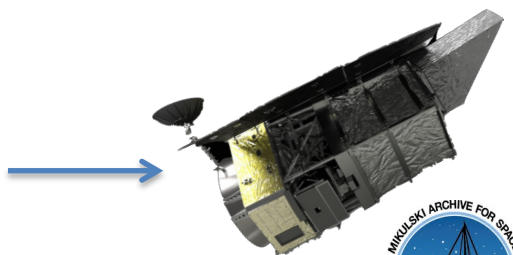
- The SSC will Interface with the scientific user community for Roman exoplanet science, WFI spectroscopy, CGI operations and observations, and proposal submission

- Develop and maintain a Roman website (WFI and CGI simulations, meeting information, parameter updates, links to partner websites and other Roman resources, etc.) and a helpdesk system

- Support and organize Roman science conferences and workshops for the astronomical community, including splinter/special sessions at the AAS.

- Support the general public and provide educational and public outreach products in these areas, in coordination with, and following the procedures of the Roman Communications Board.
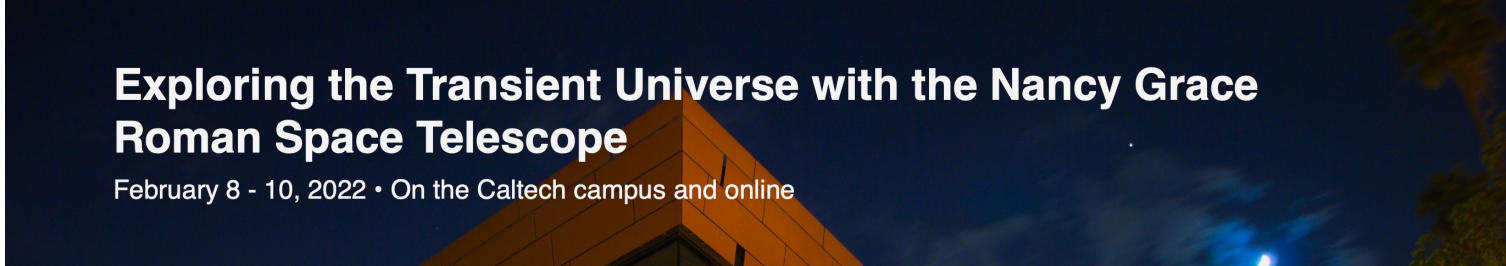

June 18 - 20, 2019
Caltech's Hameetman Auditorium

Science in Our Own Backyard:
Exploring the Galaxy and the Local Group with WFIRST

Previous meetings on GO science, microlensing, exoplanets, etc.

SSC website: *https://roman.ipac.caltech.edu*
SSC Helpdesk: *roman-help@ipac.caltech.edu*

Simulated Nancy Grace Roman Space Telescope near-IR grism image that matches the direct image with nominal dispersion.

Example WSM data simulation available to community

Exploring the Transient Universe with Roman

Exploring the Transient Universe with the Nancy Grace Roman Space Telescope
February 8 - 10, 2022 • On the Caltech campus and online

Home

Pre-registration

Invited Speakers

Venue & Local Information

Important dates

**Agenda**

Posters

Instructions for Presenters

**Code of conduct**

Join Mailing List

Time-domain astrophysics comprises a vast array of phenomena, that span the range from our own Solar System to high-redshift galaxies, from asteroids and comets to novae, supernovae, active galactic nuclei, and gamma-ray bursts. We are now at the dawn of multi-messenger astrophysics, with the electromagnetic signatures of gravitational-wave sources within our observational grasp, most recently illustrated by the binary neutron-star merger GW170817. The Nancy Grace Roman Space Telescope will be a powerful observatory for exploring the time-varying Universe. Via its core surveys, it will search for supernova explosions at cosmological distances, as well as for the microlensing signatures of planets orbiting stars in our Galaxy. Roman will naturally enable serendipitous discoveries and analyses of many other time-variable phenomena during the course of its mission, through new surveys and a vigorous archival research program. This 3-day conference will bring together inclusively members of the community to discuss the exciting time-domain astrophysics that will be investigated with the Roman Space Telescope.

Themes will include:

- Multi-messenger astrophysics
- Tidal disruption events
- Supernovae
- Cepheids, Miras, and other periodic variables
- Novae and related phenomena
- Massive-star eruptions and outbursts
- Gamma-ray bursts
- Fast radio burst counterparts and hosts
- Active Galactic Nuclei
- Microlensing
- Solar System objects
- Time-domain data mining software and tools
- Alerts and brokers
- Synergies with other missions and facilities (Rubin, ELTs, Euclid, JWST, etc.)
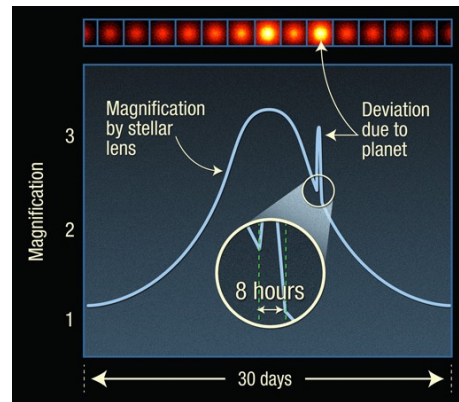
Credit: NASA and ESA.
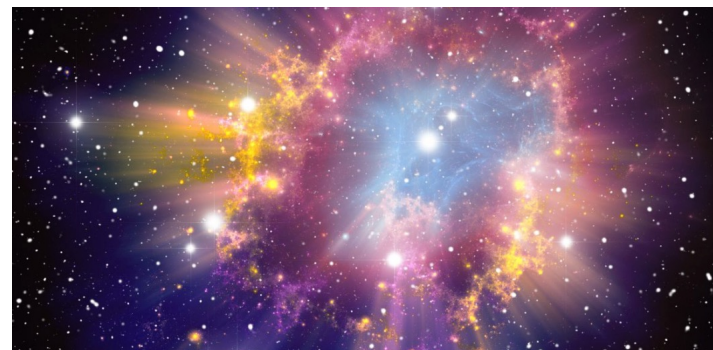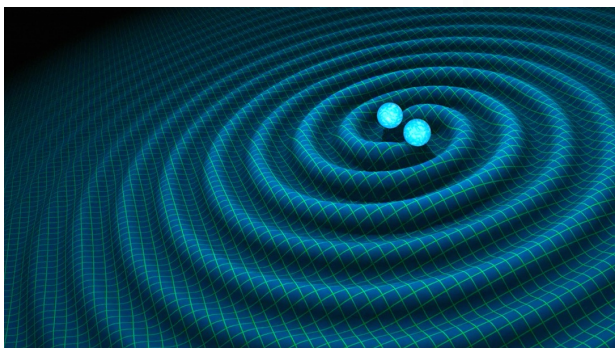
- The Roman science pipelines and data products for microlensing and wide field spectroscopy, and related user support, will be made available to the worldwide scientific community.

    - The WSM pipelines leverage the development work and testing for Euclid on the OU SIR and SPE, and they will take advantage of in-orbit lessons once Euclid is launched and commissioned.
    - Close collaboration with LAM and consultation with OU-SIR co-leads ensures Euclid wide field grism spectroscopy algorithms are carefully adapted to the Roman surveys and science requirements, and that lessons-learned from Euclid get applied in a timely fashion.

- Participation on the Roman FSWG, core science survey teams, and the CCPP

- Roman proposals for observing time and general investigations are open to the worldwide scientific community, following standard NASA policies.
    - ISO, Spitzer, Hubble, Planck, Herschel and Webb have demonstrated the great value of cross-Atlantic science community collaborations.

- Roman science meetings and workshops welcome and encourage participation by the worldwide science community. This has been true for past meetings, and for meetings being planned for 2022 and beyond – e.g., **Exploring the Transient Universe with Roman**

- IPAC advances the exploration of our Universe through science operations, data archiving, and community support with a special focus on:

  - *Cosmology*
  - *Galaxy evolution*
  - *Exoplanets*
  - *Asteroids and the Solar System*
  - *IR/Sub-mm Astrophysics*

- IPAC has a long-standing, strong connection to the European community through joint development and research on ESA and NASA led missions.

- We look forward to building on this legacy and working together on Roman.

THE NANCY GRACE ROMAN SPACE TELESCOPE