National Aeronautics and Space Administration



EXPLORE SCIENCE

AAAC

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Astrophysics **Decadal Survey** 2021 2010 **Missions** Decadal Decadal Survey Survey 2001 Roman Decadal Survey 1991 Webb Decadal Survey ASTRONOMY AND Spitzer 1982 Astronom Astrophysic Decadal for the 1980 Survey 1972 Chandra Decadal Survey and Astrophysics for the 1970's Hubble Reports of the Pane

Roman Space Telescope

Features

- Determine the **nature of the dark energy** that is driving the current accelerating expansion of the universe
- Perform statistical census of exoplanetary systems through microlensing survey
- Survey the NIR sky with unprecedented sensitivity, scale, and efficiency

Status

- Heritage telescope hardware inherited from another program
- Element Wheel Assembly installed and aligned
- Focal Plane Assembly built, aligned and currently completing TVAC test
- Flight simplified Relative Calibration System assembled and completing environmental testing in January 2023

Important Milestones









Roman Coronagraph Instrument

Features

- Able to directly image gas giant exoplanets; pathfinder for future exo-Earth characterization
- Employs active optics to achieve 1000× better planet-to-host-star flux ratio
- One of the two instruments onboard the Roman Space Telescope (RST)

Status

- All flight subsystems have been completed
- All flight optics integrated onto the Optical Bench
- Deformable mirrors prepared for installation on Optical Bench (Jan 2023)
- Electronic boxes mounted to deck & tested; flight software functional testing ongoing; w/full testing summer 2023









Astro2020 Key Recommendations

Key Mission Recommendations

Near-Infrared/Optical/Ultraviolet 6-m telescope with high-contrast imaging capability

- Image and characterize earth-like exoplanets w/compelling astrophysics program
- Formulate in second half of decade

Great Observatories Mission and Technology Maturation Program (GOMAP)

- IR/O/UV (first half of decade), far-IR and X- ray (second half of decade) missions

Space-based time-domain and multi-messenger counterparts program (TDAMM)

Astrophysics Probe Mission

End SOFIA operations by 2023

Astro2020 Acronyms

GOMAP – Great Observatory technology Maturation Program

TDAMM – Time Domain Astronomy and Multi Messenger counterpart

Astro2020 Primary Recommendation

 Infrared / Optical / UV space telescope with ~ 6-m inscribed diameter to search for life on exoplanets and enable transformative astrophysics

The Habitable Worlds Observatory

- Primary technical requirements for coronagraphic survey are:
 - System-level stability at ~ picometer-level
 - Coronagraphic contrast ≥ 10¹⁰
- Strategic guidance







The Habitable Worlds Observatory

- Working name identifies:
 - Primary science goal survey nearby stars for habitable planets and characterize them for evidence of life (biosignatures)
 - Observatory conducts general astrophysics program.
- Decadal Survey also recommends X-Ray and Far-IR future great observatory with investments to begin towards the end of the decade
 - APD will maintain X-Ray/far-IR technical capabilities this decade via:
 - SAT and APRA program investments
 - Probe and Explorers programs

The Habitable Worlds Observatory: The Big Picture

- Build to schedule: Mission Level 1 Requirement e.g Planetary missions
- **Evolve technology**: Build upon NASA investments i.e.
 - JWST segmented optical system, Roman coronagraph, & Sensors
- Next Generation Rockets: Leverage opportunities offered by large fairings to facilitate mass & volume trades
- **Planned Servicing**: Robotic servicing at L2
- **Robust Margins**: Design with large scientific and technical margins
- Mature technologies first: Reduce risk by fully maturing the technologies prior to development phase.

Astrophysics Technology Investments

System-level picometer stability

Lightweight ULE mirror segment



Credit: L3/Harris

Picometer-scale dynamics measured with high-speed interferometry



Credit: NASA GSFC

High Contrast Imaging

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GOMAP

Stage 1: HQ Preparation *Establish GOMAP plans and policies*

Stage 2: Habitable Worlds Observatory Concept Maturation Study *Analyze architecture options; Mature enabling technologies;*

Stage 3: Evolved Pre-Phase A for Habitable Worlds Observatory *Establish mission architecture; Execute design trades; Mature technologies; Maintain technical capabilities for Future Great Observatories (FGOs)*

Stage 2: HWO Concept Maturation Study

GOMAP HQ Leadership Team

Habitable Worlds Observatory

Selection of Science, Technology, Architecture Review Team (START)

- Members selected from US science and technology communities
- Explore Astro2020 science objectives; break down one or more levels
- Analyze mission architecture options
- International ex-officio representatives included
- Support available for START members in recognition of community service
- Logistical support provided by NASA Program Offices
- Engineering / science analysis support provided by NASA & Science Centers

Community

Independent

Consultants

Decadal Recommendation for Astrophysics Probe

- NASA has issued a draft AO for a PI-led Astrophysics Probe
- The target date for the final Probe AO was revised to July 2023
- Due to European Space Agency (ESA) consideration of whether the Athena mission will be substantially replanned, it was no longer practical to require proposed X-ray probes to "complement ESA's Athena Observatory." This requirement was therefore removed. Astrophysics will now accept proposals for:
 - A far-infrared imaging and/or spectroscopy mission
 - An X-ray probe
- Community announcements and FAQ at https://explorers.larc.nasa.gov/2023APPROBE/

Release of draft AO:	August 2022
Release of final AO:	July 2023 (target)
Proposals due:	NET 90 days after AO release

Time-Domain and Multi-Messenger Astrophysics: I

- Astro2020 Decadal Survey recommended Time-Domain and Multi-Messenger Astrophysics (TDAMM) as highest priority sustaining activity for NASA Astrophysics.
 - TDAMM contributions of current NASA fleet highlight the need to maintain and replace the workhorse missions (capabilities).
 - Recommended strategic approach is to add space-based capabilities based on science priorities and status of complementary facilities.
 - e.g. gravitational-wave, neutrino, international e/m missions)
 - Roman Space Telescope will be a game changer for TDAMM
 - New NASA missions address need for continuous monitoring for transients (X-Ray, γ-ray)
 - Smallsat missions (BurstCube, GlowBug,BlackCat, StarBurst)
 - Explorers: COSI (in development)
 - Star-X, UVEX, LEAP and MoonBeam (in Step-2 competitive downselect)
 - NASA partnership with Israel (ULTRASAT) adds sensitive wide-field UV monitoring
 - Planetary Mission NEO-Surveyor adds IR transient monitoring capability

Time-Domain and Multi-Messenger Astrophysics: II

- Conducting a study of coordinating TDAMM observations among NASA spacecraft using centralized proposal, and ToO initiation to make more efficient use of fleet
- NASA transient alert system
 - Modernizing in preparation for the Rubin era of ~10⁶ alerts per night
 - Funding multi-mission and mission-design software tools for community use
- PhysCOS/COR hosted TDAMM workshop in Annapolis, MD.
 - White Paper recently delivered and posted
 - <u>https://pcos.gsfc.nasa.gov/TDAMM/docs/TDAMM_Report.pdf</u>
 - International agency meeting identified areas of collaboration
 - International working group will be set up in 2023 to discuss standards and coordination.
- Through PhysCOS community groups, supporting new and upcoming Science Analysis Groups in the areas of Gamma-ray Transient Networks and Space Communications
 - <u>https://pcos.gsfc.nasa.gov/TDAMM/</u>



