

SPACE BASED ASTRO IN THE 2030S/2040S

Working Group Meeting

July 3, 2024

ACTION ITEMS

1. Let us know if you’re actively participating in another WG and can act as a liaison

2. Fill in any missing missions from our mission list 3. Sign up to lead a mission writeup!

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AGENDA

1. Introduction

2. Space-Based Astro Working Group goals and status 3. Mission list and mission information spreadsheets – sign up!

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WHAT IS HABITABLE WORLDS OBSERVATORY (HWO)?

NASA’s next flagship mission concept 

recommended by Astro2020 Decadal Survey

First telescope designed to search for signs of life

Notional 

architecture option

Large-aperture UV / Optical / NIR observatory performing transformative astrophysics

on planets outside our solar system 

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GREAT OBSERVATORY MATURATION PROGRAM (GOMAP)

A variety of studies point to a consistent set of problems & solutions for flagship projects

*Independent Research Papers Mission Concept Reports GAO Report on Major Projects SMD Internal Studies National Academy Reports *

GOMAP recommended by Astro2020 to “co-develop the science, mission architecture, and technologies” earlier and more thoroughly

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HWO TEAMS DURING GOMAP

**Science, Technology, & Architecture Review Team (START)** 

• Quantify HWO’s science goals using Astro2020’s guidance 

• Outline the needed observatory and instrument capabilities 

• Develop the science goals and objectives portions of a Science Traceability Matrix 

• Develop models & codes needed to assess science returns from mission architectures 

**Technical Assessment Group (TAG)** • Identify mission architecture options • Study architecture options and identify 

technologies needed to enable them • Evaluate risks associated with architecture options 

• Identify technology gaps and create technology maturation roadmaps 

• Develop models & codes needed to execute future trades 

Goal: Have everything ready to make good decisions rapidly in Phase A

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HWO WORKING GROUPS

Likely to evolve in future **Science Joint & Community Technical**

Galaxy Growth 

*Ravindranath & Postman*

Evolution of the 

Elements

*Lee & Scowen*

Ground-Based Astronomy in the 2030s/2040s 

*Lopez-Morales & Miyazaki*

Living Worlds 

*Arney & Parenteau*

Solar System in 

Context

*Robinson & Shkolnik*

Communications 

*Schirner & Straughn*

DEIA & Mentorship *Beaton & Scannapieco* 

GOMAP Synergies for Future Missions *Gaskin & Oschmann* 

Science Case 

Simulation

*Batalha & Osten*

Science Data 

Simulation

*Greene & Tumlinson*

Science-Engineering Interface 

*Morrissey & Sitarski*

Systems 

*Menzel & Shaklan*

Integrated Modeling *Levine & Liu* 

Technology 

*Bolcar & Zhao*

Space-Based Astronomy in the 2030s/2040s *Kataria & Petre* 

Artificial Intelligence & Machine Learning *Ansdell & Dean* 

Past Studies Comparison *Gaudi* 

Servicing 

*Van Campen & Grunsfeld*

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AGENDA

1. Introduction

**2. Space-Based Astro Working Group goals and status** 3. Mission list and mission information spreadsheets – sign up!

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SPACE-BASED ASTRONOMY: GROUP SUMMARY 

● **Primary Goal: Place HWO in the context of contemporaneous space-based observatories**

○ Create a database of potential space-based observatories in the 2030s/2040’s and their capabilities

○ Compare capabilities of other future missions with HWO configurations

○ Provide information to SWGs to enable identification of synergies with HWO

● **Secondary Goals**

○ Identify gaps among future missions–can HWO fill these?

○ Identify precursor science by space observatories prior to HWO’s launch

● **Key First-Year Products**

○ Database of 2030s/2040s missions and capabilities

○ Quantitative comparison with HWO using figures of merit

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CURRENT ACTIVITIES 

● Steering Committee (SC) appointed and began regular tag-ups (see next slide for SC members)

● Co-chairs met with Ground-Based WG co-chairs to discuss synergies ● SC developed mission information template and defined figures of merit for mission comparisons

TO-DOS BY OCT FACE-TO-FACE MEETING 

● Identify liaisons to key Science and Community WGs

● Complete provisional list of missions to consider with assignments of WG members to collect information

● Collect relevant information for each mission with help from the entire Working Group ● Possible face-to-face meeting with WG members (possibly joint with Ground-Based WG)

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SPACE-BASED ASTRO STEERING COMMITTEE MEMBERS 

Tiffany Kataria (Co-Chair, JPL)

Rob Petre

(Co-Chair, GSFC)

Emma Louden

(deputy chair, Yale Univ)

Eleonora Alei (GSFC)



Lia Corrales

(Univ. of Michigan)

Erika Hamden (Univ. of Arizona)

Ana Inés Gómez de Castro

(Universidad Complutense de Madrid)

Takahiro Sumi (Osaka Univ)

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AGENDA

1. Introduction

2. Space-Based Astro Working Group goals and status **3. Mission list and mission information spreadsheets – sign up!**

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SIGN UP TO LEAD MISSION INFORMATION WORKSHEETS! • The SC has devised a list of space-based missions here:

https://docs.google.com/spreadsheets/d/1deeCR70KdV32WoImTdhOfym5RCr1spSSkrxZ\_eA 3teY/edit#gid=0

• **Action #1: Please fill in any mission you think is missing from this list!** • We need **you** to help lead writeups on each mission! See template here: https://docs.google.com/document/d/19wg4r69n2F9S\_XmfHO9GC9dd

agWnNaPtwOyOY9Qt5g/edit

• **Action #2: Please sign up to lead mission writeups!**

• **Due date for writeups: ~Aug 31, 2024**

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SPACE-BASED ASTRONOMY: EXAMPLE PRODUCTS 

● From Lynx Synergies WG

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MISSION INFORMATION WORKSHEET

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ACTION ITEMS

1. Let us know if you’re actively participating in another WG and can act as a liaison

2. Fill in any missing missions from our mission list 3. Sign up to lead a mission writeup!

**Questions?**

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GOMAP-HWO Code of Conduct & Reporting Protocol

**NASA Astrophysics Division Statement of Principles**

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*All participants in GOMAP-HWO activities must adhere to the APD Statement of Principles*

**American Astronomical Society (AAS) Code of Ethics** 

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*The AAS Code of Ethics is required to be followed under the APD Statement of Principles*

**Reporting Protocol**

*Follow the procedures in the APD Statement of Principles and contact the HWO GIG*

*Use institutional reporting channels, as appropriate*

*NASA-funded individuals have access to NASA programs (Ombuds, Anti Harassment, ODEO) and a facilitator to help navigate the various options*

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ADDITIONAL SLIDES

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SPACE-BASED ASTRONOMY IN THE 2030S/2040S 

• The 2030’s are almost here. We have a good idea what to expect for 2030: • The current fleet (minus missions that die or are shut off – more later)

• Roman Space Telescope

• Euclid

• SPHEREx

• UltraSat

• Xuntian?

• ESA M-class missions – Ariel and Plato

• CASTOR

• By 2040 the landscape changes dramatically and presents uncertainty: • Few if any of the current fleet will be operating (JWST will be 17 years old; Roman 13)

• Astrophysics Probe will be the only major NASA addition; in extended ops in 2040

• Major ESA missions (LISA and Athena), maybe

• UVEX (2032) is only planned NASA UV mission (if it lasts that long)

• Tianlin?? 18

MAJOR GROUND & SPACE FACILITIES IN 2040 

**Facilities in Anticipated to be Active in 2040 (Ground & Space)**

| **Facility** | **Band** | **Sensitivity**  **improvement** | **Start of**  **operations** |  |
| --- | --- | --- | --- | --- |
| **Ground:** |  |  |  |  |
| SKA | 50 MHz – 14 GHz | 5 over JVLA | 2028? |  |
| NgVLA | 1.2 – 116 GHz | 10 over JVLA & ALMA | 2030? |  |
| CMB S4 | 30-300 GHz | 10 over current | 2021 |  |
| ALMA | 110 GHz – 950 GHz |  | 2013 | Already in  operation |
| CTA | 25 GeV – 200 GeV | 5-10 over  HESS/MAGIC/VE RITAS | 2025 |  |
| IceCube Gen 2 |  | 10 over IceCube | 2028 |  |
| TMT, EELT,  GMT | 0.3 µm – 2.4 µm | 4-5 over current | EELT – 2024 GMT - 2025 TMT - 2027 |  |
| LSST | 320-1050 nm | r~24.5 over 18,000 sq. deg; 24 h.  cadence | 2021 | Extended lifetime? |
| Ground GW | 1 Hz – 103 Hz |  |  |  |
| **Space:** |  |  |  |  |
| JWST | 0.6µm – 28.5 µm | 10x Hubble | 2023 | Near end of life |
| Roman Space  Telescope | 0.7µm – 2.0 µm | 10 in information content (Ω x AB magnitude) | 2027 | Extended mission |
| LISA | 10-4 Hz – 1 Hz |  | 2035 |  |
| Athena | 0.2 – 12 keV |  | 2037 |  |
| Astro Probe | FIR or X-ray | ~ x10 | 2032 |  |

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**UV Workshop 2024**

****HUBBLE / JWST / HWO IN CONTEXT 

**Lynx**

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**UV Workshop 2024**

CAPABILITIES OF RADIO / OPTICAL FACILITIES 

HWO

**UV Workshop 2024** 21

SPACE OBSERVATORIES 2030-2045 

Darker colors: prime mission 

Lighter colors: extended mission

Lots of uncertainty

Most missions in extended operations

Three UV survey / TDAMM missions in late 2020’s / early 2030’s

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MAJOR FACILITIES IN THE 2030’S 



Hubble

Mind the gap!

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**UV Workshop 2024**

GW FACILITY CAPABILITIES 



**UV Workshop 2024** 24

XUNTIAN: LAUNCH 2025?

• Survey to cover ~ half the sky over 10 years 

• Science goals similar to

Roman, Euclid

• Off axis, 2 m telescope • Survey camera, IFS, coronagraph, terahertz

receiver, multichannel

imager

• Bandpass 2.55 nm – 1 µm • Designed to be serviceable from Chinese space station

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UPCOMING UV MISSIONS



All three missions are all sky surveys with TDAMM capability, but have very different capabilities

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CASTOR 



1 m primary mirror 

Wide field (30’) blue / UV imaging Photometry

Spectroscopy (R ~ 2000)

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UVEX

Synoptic all-sky survey in two bands 

Large field of view (3.5°x3.5°) with

high resolution (<2.25”) imaging

Time domain probed over multiple

cadences

3 hour TOO access over 70% of sky

Long slit spectroscopy (R > 1000) 

over 1.15-2.65 nm

Kulkarni et al. 2023

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**Lynx UV Workshop 2024**

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TIANLIN VS. HWO 

**Comparison between Tianlin and the Habitable Worlds Observatory (HWO)**

Tianlin HWO Key Differences

Tianlin coronagraph contrast requirement

**Primary Science Objective**

Discover and characterize rocky planets in the habitable zones of nearby Sun-like GK stars and search them for signs of life.

Discover and characterize at least 25 rocky planets in the habitable zones of nearby Sun-like FGK stars and search them for signs of life.

Number of potentially habitable exoplanets that can be studied with Tianlin is unknown. Ability of Tianlin to confirm presence or absence of biosignatures is unknown.

is 10-9 (10-10 for HWO)

Tianlin has more emphasis on

exoplanets than general astrophysics

**Telescope** 4 – 6 meter diameter monolith primary mirror.

~6 meter diameter segmented primary mirror.

HWO telescope more technologically mature, drawing on heritage from the NASA / ESA James Webb Space Telescope.

**Wavelength Range**

Ultraviolet / Optical / Near-Infrared Ultraviolet / Optical / Near-Infrared Exact UV coverage of Tianlin is unknown.

**Additional Science Objectives**

**Operational**

**Timeline**

Studies of dark matter, dark energy, and the formation and evolution of the cosmic web and galaxies.

Launch in 10 – 15 years, operational lifetime of 5+ years.

To be determined, but likely include studies of the cycles of matter into and out of galaxies, galaxy formation and evolution, dark matter, and Solar System bodies.

Launch in 2040s, with operational lifetime of 5+ years. In-space servicing baselined.

Tianlin’s ability to perform

transformative astrophysics studies

will depend on its exact wavelength

coverage and telescope size.

More aggressive development

schedule for Tianlin.

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SURVEY RESULTS

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INTRO TO HWO AND START/TAG 35

ASTRO2020 SCIENCE THEMES **Worlds and Suns in Context:** 

**Pathways to Habitable Planets**

**New Messengers & New Physics: New Windows on the Dynamic Universe** 

**Cosmic Ecosystems: Unveiling the Drivers of Galaxy Growth **

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ASTRO2020 SCIENCE THEMES **Worlds and Suns in Context:** 

**Pathways to Habitable Planets **

HABITABLE WORLDS OBSERVATORY

**Cosmic Ecosystems: Unveiling the Drivers of Galaxy Growth **

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ASTRO2020 SCIENCE THEMES **Worlds and Suns in Context:** 

**Pathways to Habitable Planets **

**New Messengers & New Physics:** 

**New Windows on the Dynamic Universe**Dark Matter? 

HABITABLE WORLDS OBSERVATORY 

**Cosmic Ecosystems: Unveiling the Drivers of Galaxy Growth **

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START MEMBERSHIP

**Name Institution** Giada Arney GSFC

Natasha Batalha Ames

Eric Burns Louisiana State University Jessie Christiansen NExScI

**Courtney Dressing (Co-Chair) UC Berkeley** Kevin France CU Boulder Scott Gaudi Ohio State University Renyu Hu JPL

Alina Kiessling JPL

Janice Lee STScI

Bruce Macintosh UC Observatories

**Name Institution John O’Meara (Co-Chair) W. M. Keck Observatory** Jim Oschmann Marinus Consulting Rachel Osten STScI

Chris Packham UT San Antonio Lynnae Quick GSFC

Jason Rhodes JPL

Jane Rigby GSFC

Ty Robinson University of Arizona Dmitry Savransky Cornell University Evan Scannapieco Arizona State University Evgenya Shkolnik Arizona State University

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START EX-OFFICIO MEMBERSHIP

**Industry**

**Name Institution** Charlie Atkinson Northrop Grumman Matthew East L3Harris Alison Nordt Lockheed Martin Erik Wilkinson Ball Aerospace

**NASA Program Offices**

**Name Institution** Eric Mamajek ExEP

Swara Ravindranath COR

**International**

**Name Institution** Miyazaki Satoshi JAXA / NAOJ Takahiro Sumi JAXA / Osaka Ana Gomez de Castro ESA / Madrid Michiel Min ESA / Amsterdam

David Mouillet ESA / Grenoble Christian Marois CSA / NRC-Herzberg

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TAG MEMBERSHIP 

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Michael Menzel GSFC

Patrick Morrissey JPL

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**Aki Roberge (Sci. Co-Chair) GSFC**

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Breann Sitarski GSFC

Philip Stahl MSFC

Christopher Stark GSFC

Julie van Campen GSFC

Feng Zhao JPL

**John Ziemer (Eng. Co-Chair) JPL**

TBA member - deferred start date JPL

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ORGANIZATION & RELATIONSHIPS

**GOMAP Integration Group (GIG)** 

PE: J. Crooke PS: M. Ansdell DPS: J. Pepper

Reporting

START Leads C. Dressing J. O’Meara 

TAG Leads 

L. Feinberg, B. Mennesson, A. Roberge, J. Ziemer

Coordinating

**HWO START HWO TAG**

**Ex-officio members representing Program Offices, industry partners, international partners**

**START Working Groups** Sub-Groups 

**Joint Working Groups**

**TAG Working Groups** Sub-Groups 

**START, TAG, & Community Co-Chairs**

**START, TAG, & Community**

** members** Sub-Groups Program Analysis Groups (PAGs) PAG SIGs PAG SAGs **Volunteer Community Efforts** 

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GET INVOLVED Info and updates on NASA HWO Website 

*Subscribe to*

*HWO-News email list*

Volunteer for Working Groups & sub-Working Groups

*Info on HWO Working Groups presented in Splinter Meeting at Jan 2024 AAS meeting (recording available on website)*

Join HWO\_Community Slack workspace

NASA HWO Website Slack Join Link Working Groups Sign-Up Info 

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