Habitable Worlds Observatory

Telling the story of Life in the universe

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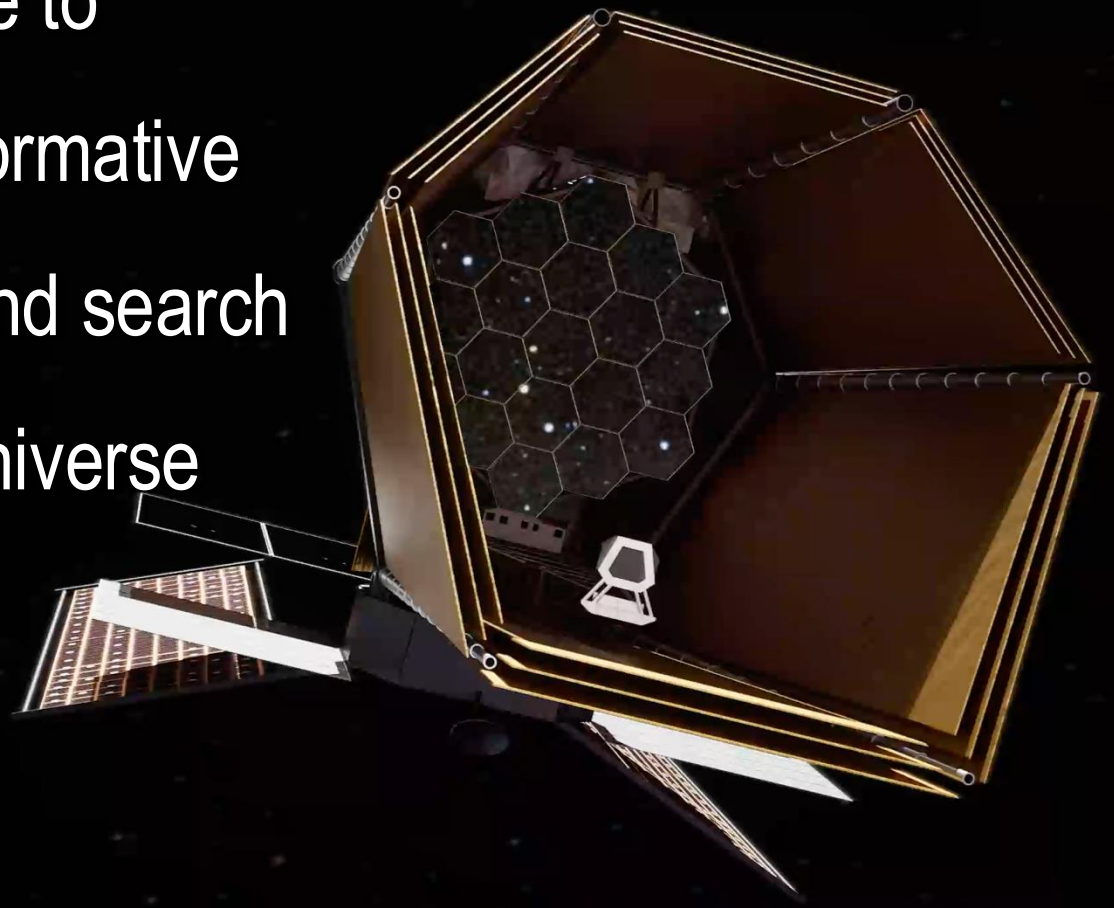
AAS HWO Special Session

HABITABLE WORLDS OBSERVATORY

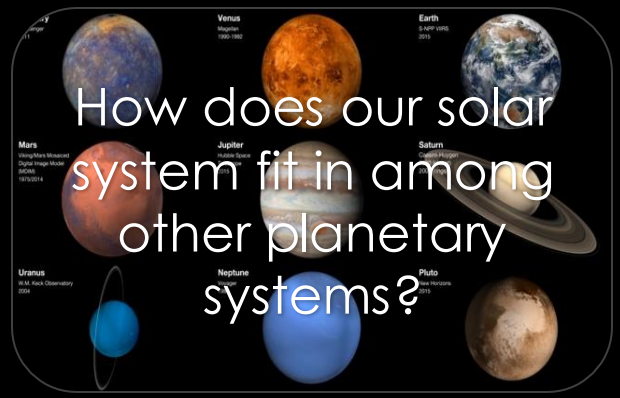
What is Habitable Worlds Observatory?

A super-Hubble to perform transformative astrophysics and search for life in the universe



Preliminary architecture option -- international contributions mission to be considered

What is the mass of the dark matter particle?



How does our solar system fit in among other planetary systems?

How does galactic star formation propagate and why do massive galaxies stop forming stars?

How are heavy elements recycled by galaxies?

How many black holes are in the Milky Way?

HABITABLE WORLDS OBSERVATORY

Are there habitable icy worlds in the outer solar system?

Where are the smallest galaxies?

How do the most chemically primitive stars live and die?

Is there life on exoplanets?

How do the most massive black holes form?

“If planets like Earth are rare, our own world becomes even more precious.

If we do discover the signature of life in another planetary system, it will change our place in the universe in a way not seen since the days of Copernicus.”

National Academies of Sciences, Engineering, and Medicine Astro2020 Decadal Survey Report (Nov 2021)

HWO Community Working Groups

SCIENCE

- Galaxy Growth
  Ravindranath & Postman
- Solar Systems in Context
  Robinson & Shkolnik
- Living Worlds
  Arney & Parenteau
- Evolution of the Elements
  Lee & Scowen

COMMUNITY

- Ground-Based Astro in the 2030s/2040s
  Lopez-Morales & Miyazaki
- Mentoring & Internships
  Scannapieco & Beaton
- Space-Based Astro in the 2030s/2040s
  Petre & Kataria
- Synergies for Future Missions
  Gaskin & Oschmann

JOINT

- Science-Engineering Interface
  Morrissey & Sitarski
- Science Case Simulation
  Batalha & Osten
- Science Data Simulation
  Greene & Tumlinson
- Machine Learning
  Ansdell & Dean

TECHNOLOGY

- Post-Processing & ConOps
  McElwain & Mawet
- Integrated Modeling Standards & New Methods
  Levine & Liu
- Servicing
  Van Campen & Grunsfeld

Working groups include international participants

Evolution of the Elements Working Group

Trace the rise of the periodic table via studies of the formation, distribution, evolution, and deaths of stars

Co-Chairs

Janice Lee (STScI)

Paul Scowen (NASA GSFC)

Star Formation

Roberta Paladini (IPAC-Caltech)

Samir Salim (Indiana U)

Cosmic Explosions

Eric Burns (Louisiana State U)

Jennifer Andrews (Gamini-NOIRLab)

Stellar Populations

Peter Senchyna (Carnegie Observatories)

Martin Barstow (U Leicester)

Evolution of Elements Science Case Development Documents

Title	Lead Author(s)
Massive Stars in Extremely Metal-Poor Environments	Miriam Garcia, Peter Senchyna et al
Dust extinction curves in the Milky Way and Local Group galaxies	Roberta Paladini et al
Flash Spectroscopy of CCSNe	Jen Andrews, Eric Burns
r-Process Elements	Eric Burns, Jen Andrews
Very massive stars (VMS)	Fabrice Martins, Aida Wofford
Resolved Stellar Populations in Large Nearby Galaxies	Adam Smercina, Tara Fetherolf
White Dwarfs as Probes of Fundamental Astrophysics	Siyi Xu, Martin Barstow et al
The first stars	Ian Roederer, Rana Ezzeddine
The nature of the astrophysical r-process	Ian Roederer, Rana Ezzeddine
Distance Ladder 3.0	Gagandeep Anand, Adam Reiss
Interstellar dust abundance and properties within and between galaxies in the Local Volume	Julia Roman-Duval
Probing the Full Depth of ISM Properties with a UV-IFU	Bethan James, Danielle Berg
Formation and Evolution of Star Clusters	Janice Lee

Galaxy Growth Working Group

Study how galaxies, constituents, and their environments evolve over the history of the HWO-observable universe

Co-Chairs

Swara Ravindranath (NASA GSFC)

Marc Postman (STScI)

AGN Over Cosmic Time

Vivian U (UC Irvine)

Chris Packham (UT San Antonio)

Ionizing Photons & their History

Stephan McCandliss (JHU)

Alison Strom (Northwestern)

IGM & CGM

Sanchayeeta Borthakur (ASU)

Joe Burchett (New Mexico State)

The Dark Sector

Jason Rhodes (JPL)

Richard Massey (Durham U)

Galaxy Growth Science Case Development Documents

Title	Lead Author(s)
Probing the extraction of energy from black holes with the Habitable Worlds Observatory	Mainak Singha, Peter Senchyna
The formation and evolution of SMBHs: IMBH Mass and Spin Functions	Jenna Cann, Krista Lynne Smith, Francesca Civano, et al
Imaging the Dusty Torus around Supermassive Black Holes	Varoujan Gorjian et al
Exploring the Quiescent Black Hole Population of Nearby Dwarf Galaxies with the Habitable World Observatory	Fabio Pacucci
Deciphering the launching of multi-phase AGN-driven outflows and their (spatially resolved) multiscale impact	Lulu Zhang et al
Spatially Resolving the Fundamental Elements of Reionization in Galaxies with HWO	Xinfeng Xu, Annalisa Citro, et al
Modeling Lyman Continuum Escape with HWO	Cody Carr et al
Tracking Cosmic Reionization via Green Pea Galaxies with HWO	Mainak Singha, Kristen Garofali, Annalisa Citro et al
Calibrating Lyman Continuum Indirect Estimators with HWO	Annalisa Citro et al
Revealing the shape of the SED of Ionizing Radiation with HWO	Allison Strom
HWO Measurements of The Evolution of the Ionizing Photon Luminosity Function	Stephan McCandliss
Counting Extremely Faint Galaxies with HWO to Measure the Dark Matter Power Spectrum	Jess Doppel
Observing the Small-scale Power Spectrum of Dark Matter with Perturbed Einstein Rings Using HWO	Qiuhan He
Measuring SMBH Merger Timescales with HWO	James Nightingale
A High Spatial and Spectral Resolution Absorption Map of the Inner CGM Enabled by HWO	Joe Burchett et al
Characterizing the Disk - CGM Interface with HWO	Sanch Borthakur et al
Characterizing the Morphology and Spatial Distribution of the CGM via Emission Line Mapping with HWO	Deb Lokhorst, Joe Burchett et al
AGN Feedback effects on the IGM	Megan Tillman et al

Living Worlds Working Group

Explore finding & characterizing potentially habitable exoplanets and searching them for the possibility of life with HWO

Co-Chairs

Giada Arney (GSFC)

Niki Parenteau (Ames)

Biosignature Possibilities

Eddie Schwieterman (UC Riverside)

Sara Walker (ASU)

Biosignature Interpretation

Stephanie Olson (Purdue)

Josh Krissansen-Totton (U of Washington

Steering Committee

Kevin Fogarty

Ravi Kopparapu

Jake Lustig-Yaeger

Mark Moussa

Garima Singh

Sukrit Ranjan

Clara Sousa-Silva

Target Stars & Systems

Eric Mamajek (JPL)

Natalie Hinkel (Lousiana State)

Living Worlds Science Case Development Documents

Title	Lead Author(s)
The Search for Life	Living Worlds WG
Surface Biosignatures	Mary N. Parenteau, Giulia Roccetti, Eleonora Alei, et al
Testing Origin of Life Theories with HWO	Sukrit Ranjan, Danica Adams et al
Pre-biosignatures with HWO	Sukrit Ranjan et al
Characterizing Technosignatures	Ravi Kopparapu, Svetlana Berdyugina et al
Life as we Don’t Know it (LAWDKI)	Sara Walker, Evgenya Shkolnik
Linear and Circular Polarization Spectral Biosignatures	Svetlana Berdyugina, Giulia Roccetti et al
Seasonality as a Biosignature	Stephanie Olson, Emelie Lafleche, Edward Schwieterman
Biologically influenced mineralization as a biosignature	Taro Matsuo
Geochemical Habitability	Kara Brugman

Solar Systems in Context Working Group

Explore UVOIR imaging and spectroscopy of Solar System objects at all scales, along with exoplanet observations to understand the full range of planet possibilities and histories

Co-Chairs

Evgenya Shkolnik (Arizona State)

Tyler Robinson (U of Arizona)

Characterizing Exoplanets
Renyu Hu (JPL)
Michiel Min (SRON)

Solar System Observations
Lynnae Quick (GSFC)
Richard Cartwright (JHU-APL)

Birth & Evolution
Meredith MacGregor (JHU)
Yasuhiro Hasegawa (JPL)

Demographics & Architectures
Jessie Christiansen (NExScI)
Malena Rice (Yale)

Solar Systems in Context Science Case Development Documents

Title	Lead Author(s)
Ocean World Habitability	Richard Cartwrightet et al
Habitability in Planetary System Context	Yasuhiro Hasegawa et al
Rocky Worlds vs Sub-Neptunes	Renyu Hu, Mario Damiano et al
How common are oceans on habitable zone rocky planets?	Nicolas Cowan et al
Case for Venus	Noam Izenberg
Occurrence Rates in Binary Systems	Elisabeth Newton
Solar System Origins	Kathy Mandt
Protoplanets and Protoplanetary Disks	Bin Ren
Debris Disks and their Properties	Isabel Rebollido
Disk Winds and Dispersal of Protoplanetary Disks	Keri Hoadley, Yasuhiro Haswgawa
Earth-Like Atmosphere Demographics	Sarah Blunt, Eric Nielsen, Elisabeth Newton
Giant Exoplanet Orbital Evolution	Sabina Sagynbayeva, Stephen Kane
Occurrence Rates of Small Exoplanets	Tansu Daylan, Romy Rodriguez
Atmospheric escape of small exoplanets	Leonardo Dos Santos, Eric Lopez, Luca Fossati et al
Reflected light spectroscopy of gas giant exoplanets	Michiel Min et al
Transiting exoplanets	Hannah Wakeford et al
Identifying cold ocean worlds	Lynnae Quick
Identifying Venus-like exoplanets	Stephen Kane
Exozodi as a probe of the dynamical history of planetary systems	John Debbs
Survivability of liquid surface ocean on rocky planets	Ludmila Carone
Retention of volatiles on rocky planets	Ludmila Carone
Mars Origins & Small Bodies	Ramses Ramirez

What comes next for science cases?

Signatories & comments to be collected – call will open to full research community

Science case authors may opt out of opening their science case to signatories & public comment. Authors own their respective science cases.

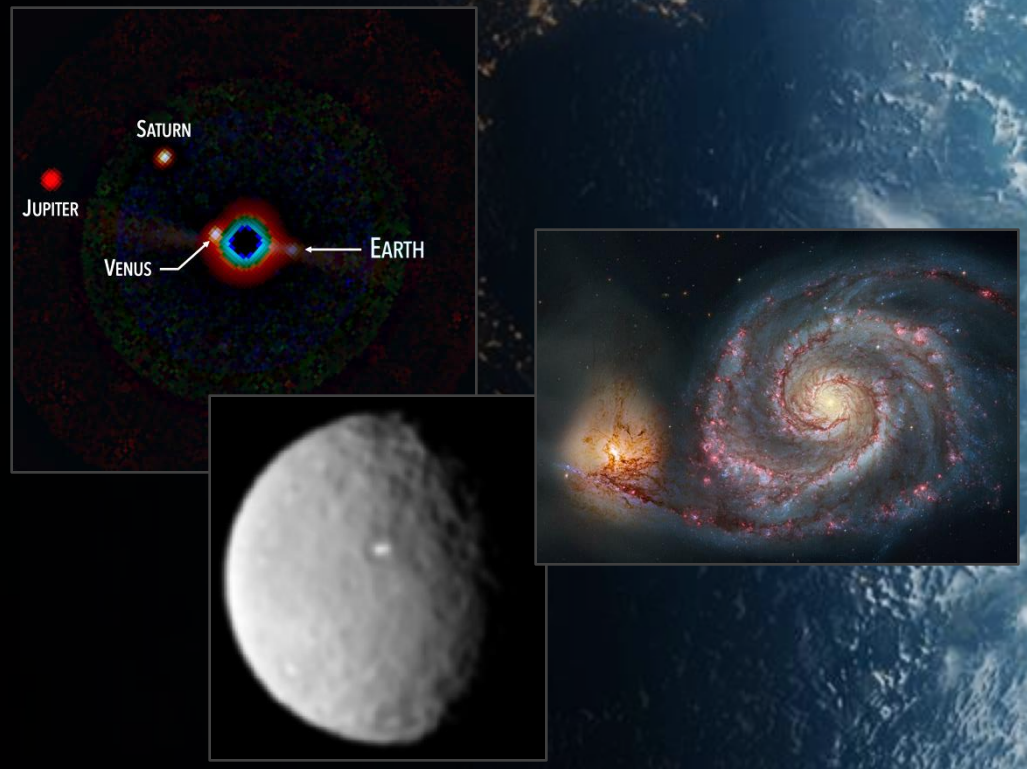
Notional Timeline:

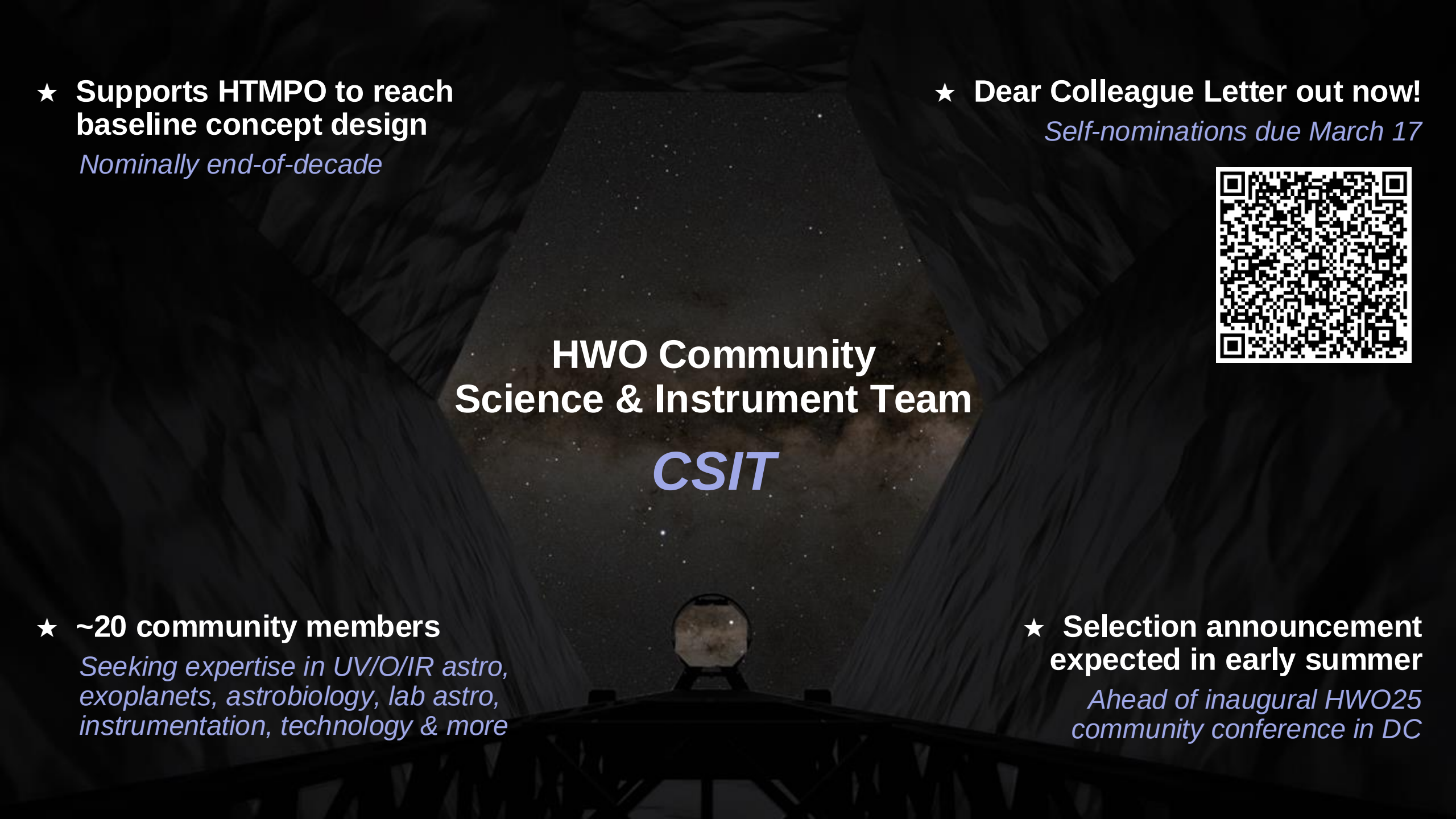
March: Release of science cases & call for signatories

May 1: Signatory & comment deadline

June: Group posting of science cases to arxiv

July: HWO summer meeting





★ **Supports HTMPO to reach baseline concept design**

Nominally end-of-decade

★ **Dear Colleague Letter out now!**

Self-nominations due March 17

HWO Community Science & Instrument Team

CSIT

★ **~20 community members**

Seeking expertise in UV/O/IR astro, exoplanets, astrobiology, lab astro, instrumentation, technology & more

★ **Selection announcement expected in early summer**

Ahead of inaugural HWO25 community conference in DC

Continuing community engagement

Over 1000 participants in the HWO Community Slack and growing!

HWO Monthly Seminar Series

- Intended for broad audiences

HWO News email updates

HWO Working Groups transitioning to the NASA Astrophysics Program Analysis Groups (PAGs)

- Long-term support for volunteer efforts

Request invitation to join HWO_Community Slack

Subscribe to HWO-News

Instructions on NASA HWO website

HWO25 | JULY 28 – 31, 2025

Towards the HABITABLE WORLDS OBSERVATORY

VISIONARY SCIENCE AND TRANSFORMATIONAL TECHNOLOGY

JOHNS HOPKINS BLOOMBERG CENTER, WASHINGTON DC

ABTRACTS DUE MONDAY, FEBRUARY 10

PRELIMINARY PROGRAM
ANNOUNCED MARCH-APRIL

STScI | SPACE TELESCOPE SCIENCE INSTITUTE

JOHNS HOPKINS UNIVERSITY

NExScI

IT WILL TAKE A GLOBAL VILLAGE TO MAKE HWO A REALITY