

NASA Exoplanet Exploration Program Science Update

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ExoPAG 31 - January 11, 2025 – National Harbor MD



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NEW 2025 edition of the ExEP Science Gap List

<https://exoplanets.nasa.gov/exep/science-overview/>

- Description of research areas where additional work would benefit current & future NASA exoplanet missions. *Tactical goals*, flowing from Decadal and NASA *strategic goals*.
- Connects mission needs to work in theory, laboratory measurements, simulations, and supporting observations.
- Its major utility is as a guide for XRP proposers, review panels, and NASA HQ selection officials. Not used proscriptively.
- Updated throughout with 2024 inputs from the ExoPAG EC, community, and HWO scientists
- Now a 55 page document. In June there will be a call for inputs on the 2026 edition.

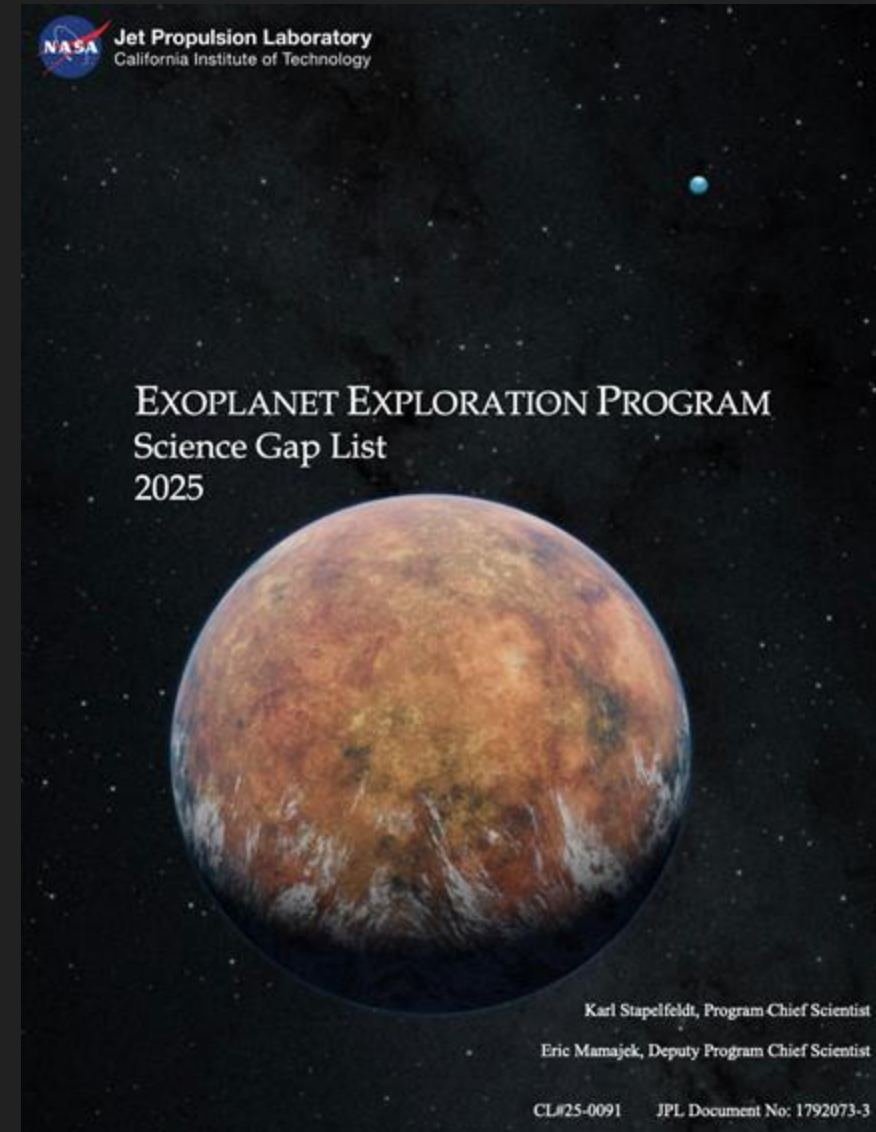


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Each gap is described by:

- **Title**
- **Summary**
- **Capability Needed**
- **Capability Today**
- **Mitigations in Progress**

Mitigations NOT in Progress are what you should be proposing !

Context for each gap will be detailed in the ExEP Science Plan Appendix document, currently awaiting revision

Noteworthy changes in the 2025 ExEP Science Gap List

- New **Gap #17** on **planet formation and disk properties**
 - Proposed by ExoPAG EC member Thomas Beatty
 - Appropos now due to surge in JWST work on protoplanetary disks, and upcoming SPHEREx launch on February 27, 2025 (0.75-5 μm all sky-survey – low resolution spectroscopy)
- **Gap #16** on **biosignatures** (new in 2023) has been re-written
- **Gap #10** has a new title "**Observations and analyses of direct imaging targets**"
 - This is to reflect the obvious need for modeling and data analysis, and to leave open the category of the work (precursor or preparatory)
 - The need to identify good coronagraph reference stars for both the Roman Coronagraph and HWO has been added to this gap.

Coordinating community responses to NASA Astrobiology White Paper call

<https://exoplanets.nasa.gov/exep/exopag/NASA-DARES/>
See Rachel Harris' talk tomorrow

Tracking White Paper Responses to NASA Dares RFI

	A	B	C	D	E	F	G	H	I
1	Spreadsheet tracking white papers responding to the NASA Astrobiology RFI (please add your white paper details)							https://go.nasa.gov/ABStrategyRFI	
2	Title	Brief Category/Topic	Lead Author	Affiliation	Email Address	Co-Authors	Deadline for accepting co-signers	Description	Link to whitepaper draft
4									
5	Commensal Observations: An Emerging Opportunity for Astrobiology	remote detection of life	Chenoa Tremblay & Joe Lazio						
6	Technosignatures in the DARES Report: Motivation, Omnibus of Responses, and Resource Hub	remote detection of life	Sofia Sheikh	SETI Institute					
7	Enhancing cross-divisional collaborations in the search for life beyond Earth	topic3=cross-divisional collaborations	Pascucci	UofA	pascucci@arizona.edu	ExoPAG-EC	Jan 20	current PAGs activities and ideas on how to enhance cross-divisional	

ExEP target star list for *Habitable Worlds Observatory*

precursor science: The most accessible nearby habitable zones

Mamajek & Stapelfeldt 2024 arXiv:2402.12414 & <https://exoplanets.nasa.gov/exep/science-overview/> & online tables at the NASA Exoplanet Archive

Selection criteria:

1. HZ Earth analog bright enough for spectroscopy with 6m telescope in <2 months integration time
2. Detection contrast consistent with NASA technology goals
3. Inner Working Angle sufficient to achieve the Astro2020 goal of characterizing ~25 HZ rocky planets

Parameter	Tier A	Tier B	Tier C
IWA constraint	83 mas	72 mas	65 mas
Exoplanet brightness limit (Rc)	30.5 mag	31.0 mag	31.0 mag
Exoplanet-star Brightness ratio limit	4e-11	4e-11	2.5e-11
Disk criterion	No known dust disks of any kind	No disk, or KB disks OK if $L_{\text{disk}}/L^* \leq 10^{-4}$	All disks OK, even if $L_{\text{disk}}/L^* \geq 10^{-4}$ or detected HZ warm dust disk
Treatment of binaries	Single or binary companion > 10" sep	Single or binary companion > 5" sep	Single or binary companion > 3" sep
Number of Stars	47	51	66

Sample	F	G	K	M
Tier A	14	15	17	1
Tier B	15	23	11	2
Tier C	37	17	12	0
Total (A+B+C)	66	55	40	3

Approx. magnitude & distance limits:

F*s: $V < 6.0$, $d < 23.3$ pc

G*s: $V < 6.4$, $d < 20.5$ pc

K*s: $V < 7.0$, $d < 12.8$ pc

M*s: $V < 7.5$, $d < 4.0$ pc



Significant uptake by the community: 3 ROSES programs, 20+ ADS citations, conference talks, posters, etc. There is a clear appetite to work on HWO targets ! (see talk by E. Mamajek on HWO Target Stars & Systems WG)

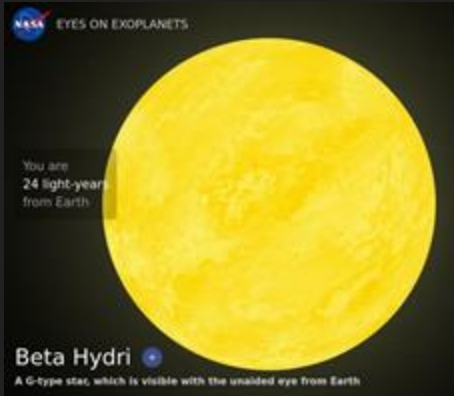
ExEP HWO precursor stars will be available in a public-facing catalog

Target Star Catalog

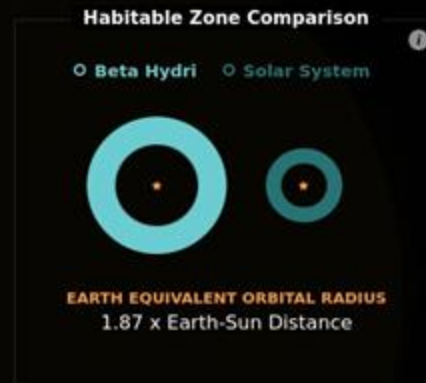
As we search for Earth-like exoplanets, this guide lists the stars we're targeting for future scrutiny — candidates that might be suns shining on their own habitable worlds.

- Goal : Grow public enthusiasm for "Where We Explore" with HWO. Highlight these naked eye targets for amateur astronomers & general public
- Soon to be live at <https://science.nasa.gov/exoplanets/target-star-catalog/>
- 164 stars can be sorted by distance, brightness, constellation, presence of known planets, and stellar type.
- Links to "**Eyes on Exoplanets**" pages depicting the system
- "+" sign link takes you to description of the system including narrative text

Target star catalog preview for beta Hydri



STELLAR POWER OUTPUT 3.48 x Our Sun <small>Sun: 3.8×10^{26} W</small>	STELLAR TEMPERATURE 5806 K <small>Sun: 5772 K</small>	VISUAL MAGNITUDE 2.82 <small>Sun: -26.7</small>
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Beta Hydri

A bright, nearby Sun-like star with good prospects for finding planets with future direct imaging

STAR TYPE G

DISTANCE 24 light-years away

CONFIRMED PLANETS 0

Beta Hydri is a Sun-like star located in the Southern constellation Hydrus, which represents a male water snake. Visible to the naked eye, it is the brightest star in the constellation, and it represents the tail of the water snake. As the closest prominent star to the south celestial pole, it is easily recognizable in the Southern sky. Relative to the Sun, Beta Hydri is older, larger, similar in temperature, and over three times more luminous. It has lower levels of stellar magnetic activity and a lower abundance of elements heavier than helium, compared to the Sun.

Exploration and Planetary Discovery

No confirmed exoplanets have been identified around Beta Hydri, to date. However, its proximity and low levels of stellar magnetic activity make it a good candidate for radial velocity studies. As a bright, nearby star, Beta Hydri is also a good target star for exoplanet searches with direct imaging from future space telescopes. These future high-contrast imaging capabilities will make it possible to detect Earth-sized exoplanets within Beta Hydri's habitable zone, if they exist.

Pop Culture

Beta Hydri's proximity and Sun-like characteristics have captured the imagination of science fiction writers. It has served as a backdrop for interstellar journeys in novels like "Time for the Stars" by Robert Heinlein and "Old Twentieth" by Joe Halderman. In works such as "A Canticle for Leibowitz" by Walter M. Miller and "Daughters of Earth" by Judith Merrill, Beta Hydri hosts exoplanets where human colonies thrive, and in "Calculating God" by Robert J. Sawyer, it serves as an exoplanet host where alien life is discovered.

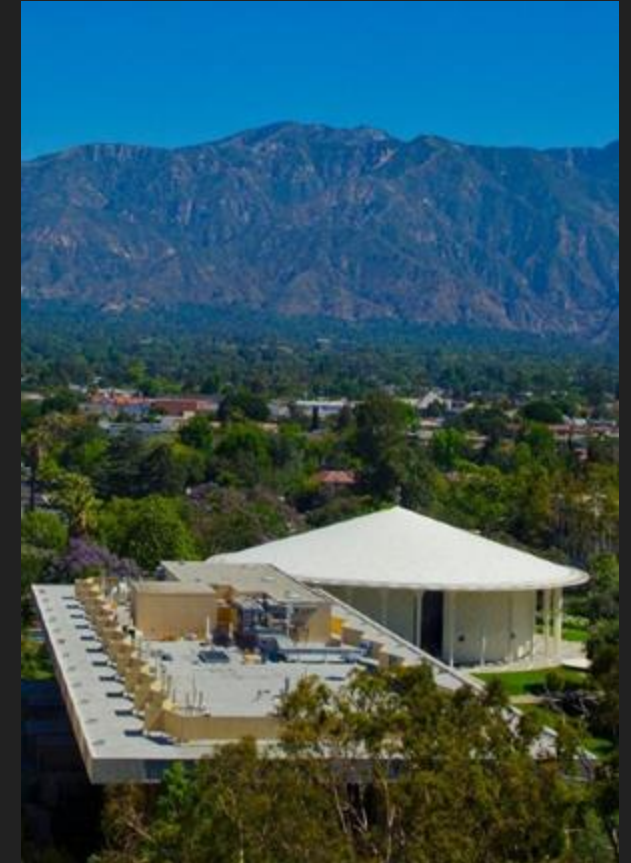
Announcing the 2026 Spirit of Lyot Conference

THE SCIENCE AND TECHNOLOGY OF HIGH CONTRAST IMAGING

Feb. 02-06 2026 on the Caltech campus

Topics include

- Coronagraph instrument technology
- Exoplanet imaging and spectroscopy
- Theory & imaging studies of circumstellar disks & exozodi
- Large telescopes and adaptive optics for high contrast imaging
- Modeling of exoplanet atmospheres & biosignatures
- Image processing and spectral retrieval techniques
- High contrast imaging space missions and mission concepts, including dedicated Roman Coronagraph session(s)



<https://conference.ipac.caltech.edu/SpiritofLyot6>

Conference Chair:
Dimitri Mawet (Caltech)

Exoplanet Sessions at AAS 245

Exoplanets @ AAS 245

January 11-16, 2025 – National Harbor MD - Gaylord National Resort & Convention Center (All times = EST)

DATE	TIME	MEETING TITLE	LOCATION	SESSION TYPE
Saturday January 11, 2025				
Sat Jan 11	9:00am - 5:10pm	Exoplanet Exploration Program Analysis Group (ExoPAG 31) (Day 1 presentations) Agenda	National Harbor 12-13	NASA PAG Meeting
Sunday January 12, 2025				
Sun Jan 12	9:00am - 12:30pm	Exoplanet Exploration Program Analysis Group (ExoPAG 31) (Day 2 presentations + business meeting) Agenda	National Harbor 12-13	NASA PAG Meeting
Sun Jan 12	4:00pm - 6:00pm	NASA's Joint Program Analysis Group (PAG) Session incl. presentation & discussion w/NASA Astrophysics Director	Potomac 3-4	NASA PAG Meeting
Monday January 13, 2025				
Mon Jan 13	8:20am - 9:10am	102 - Kavli Lecture: <i>The Terrestrial Worlds of Low-Mass Stars</i> , Dave Charbonneau	Potomac Ballroom AB	Plenary
Mon Jan 13	9:00am - 10:30am	NASA's Astrophysics With Equity: Surmounting Obstacles to Membership (AWESOM, a joint Science Analysis Group of PhysPAG, COPAG, ExoPAG)	Annapolis 1-2	Splinter Session
Mon Jan 13	10:00am - 11:30am	117 - Extrasolar Planets: Transit I	Potomac Ballroom C	Oral Session
Mon Jan 13	10:00am - 11:30am	119 - Exoplanet Emission Spectra and Phase Curves	Potomac Ballroom 3-4	Oral Session
Mon Jan 13	10:00am - 11:30am	131 - SPHERx: The Upcoming All-Sky Infrared Spectroscopic Survey	Chesapeake 4-5	Special Session
Mon Jan 13	10:00am - 11:30am	149 - Exoplanet Transit Spectroscopy: Surveys	Maryland Ballroom B	Oral Session
Mon Jan 13	10:00am - 11:30am	172 - Exoplanet Mass Loss and Space Weather	National Harbor 13	Oral Session
Mon Jan 13	10:00am - 11:30am	ExoCore: An open science curriculum for enhanced reproducibility and equity in exoplanet research	National Harbor 8	Splinter Session
Mon Jan 13	12:45pm - 1:45pm	NASA Town Hall	Potomac Ballroom AB	Town Hall

Flyer prepared by Eric Mamajek to help guide your path through the Washington DC AAS

Mailing list subscribers already received the PDF version; we have hardcopies available here today

By our count there are 72 sessions relevant to exoplanet science

Tuesday and Wednesday there are 5 oral exoplanet sessions running in parallel ! That's a lot of divided attention.

Ask it again: Is it time for a new AAS Division of Exoplanetary Sciences ???