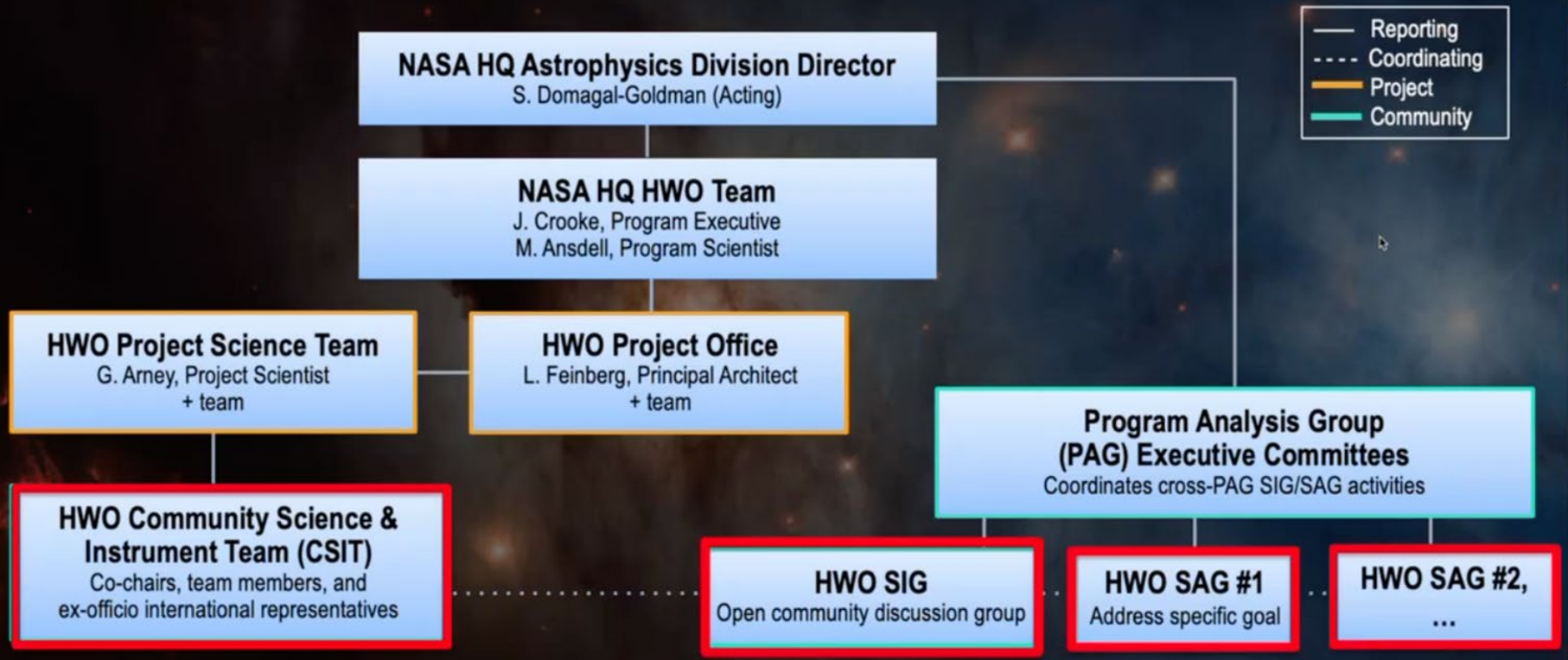

# Science Interest Group

Vivian U

Laura Mayorga, Joe Burchett, Jessie Christiansen, Richard Massey, Fabio Pacucci

# HWO Relations to Community Groups




SIG = Science Interest Group
SAG = Science Analysis Group

# Stay involved in HWO science with the HWO Science Interest Group!

Joint activity of ExoPAG, PhysPAG & COPAG

Community forum for soliciting/coordinating analysis and input in support of HWO

Regular webinars with updates from the HWO project and community SAGs/SIGs

Join the email list at the QR code for updates

Be part of an international community supporting HWO!

**Leadership Team**

ExoPAG

Jessie Christiansen (IPAC/NExScI)

Laura Mayorga (JHU/APL)

COPAG

Joe Burchett (NMSU)

Vivian U (IPAC)

PhysPAG

Fabio Pacucci (CfA)

Richard Massey (Durham)

# We have a website!

Science Interest Group

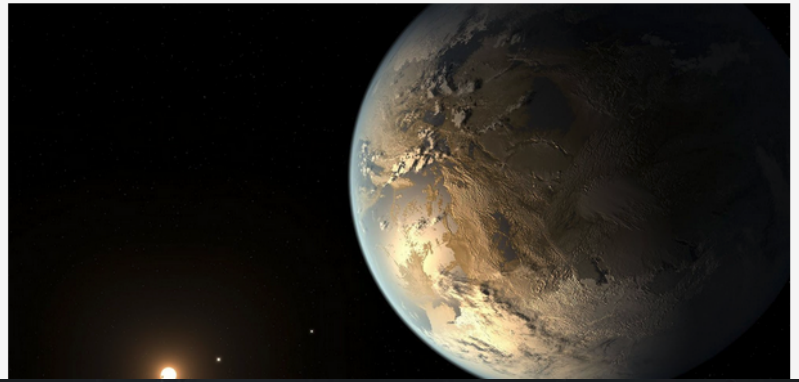
## Habitable Worlds Observatory

The Habitable Worlds Observatory SIG serves as a forum and focal point for the HWO community.

About ↓
Leadership ↓
Documents ↓
Join HWO SIG Email List ↓
News & Events ↓

About HWO SIG

## The Search for Earth-Like Planets in Habitable Zones



HWO is a large infrared/optical/ultraviolet space telescope

# We have a website! (and an unofficial one)

## Habitable Worlds Observatory Science Interest Group (HWO SIG)

The Habitable Worlds Observatory Science Interest Group (HWO SIG) is an interdisciplinary, community-based forum coordinating analysis and communicating input in support of the Habitable Worlds Observatory across the three NASA Astrophysics Program Analysis Groups: Exoplanet Exploration, Cosmic Origins, and Physics of the Cosmos.

This page is unofficial and run by the HWO SIG leadership council. The official HWO SIG page is here.

Terms of Reference

# Recent SIG Activities

- Terms of Reference have been approved:
  - Vivian U is chairperson, Laura Mayorga is chairperson-elect.
- Two seminars (and more to come!)

**08 October 2025 10PT/1ET**

Recording

HWO SIG Welcome - Vivian U

Update from TMPO - Bertrand Menneson

SAG Process - Karl Stapelfeldt

SAG Highlight #1: UV IFU - Emily Witt

SAG Highlight #2: Exozodi - John Debes

Walk on Discussion - Laura Mayorga

**03 December 2025 10PT/1ET**

Recording

HWO SIG Welcome - Laura Mayorga

Update from CSIT - David Charbonneau

Planetary Defense with HWO - Andy Rivkin

SAG Advertisements - Hartman, Moin

- Multi-star Systems
- ML/AI for HWO

# HWO-related groups

| Group | PAG | Contacts | Group Type |
|---|---|---|---|
| OVI in diffuse media | COPAG | Sanch Borthakur | Working Group |
| Spatially Resolved UV Spectroscopy Science Analysis Group in Support of Habitable Worlds Observatory | COPAG | Emily Witt | SAG |
| Exoplanet demographics | ExoPAG | Rachel Fernandes, Kiersten Boley | SIG |
| Exoplanet/Solar System synergies | ExoPAG | Vikki Meadows, Kathy Mandt | SIG |
| Exoplanet Reflectance Spectroscopy for the Habitable Worlds Observatory | ExoPAG | Renyu Hu, Ty Robinson | SAG |
| Exploring the Complementary Science Value of Starshade Observations | ExoPAG | Sara Seager, Stuart Shaklan | SAG |

# HWO-related groups (cont.)

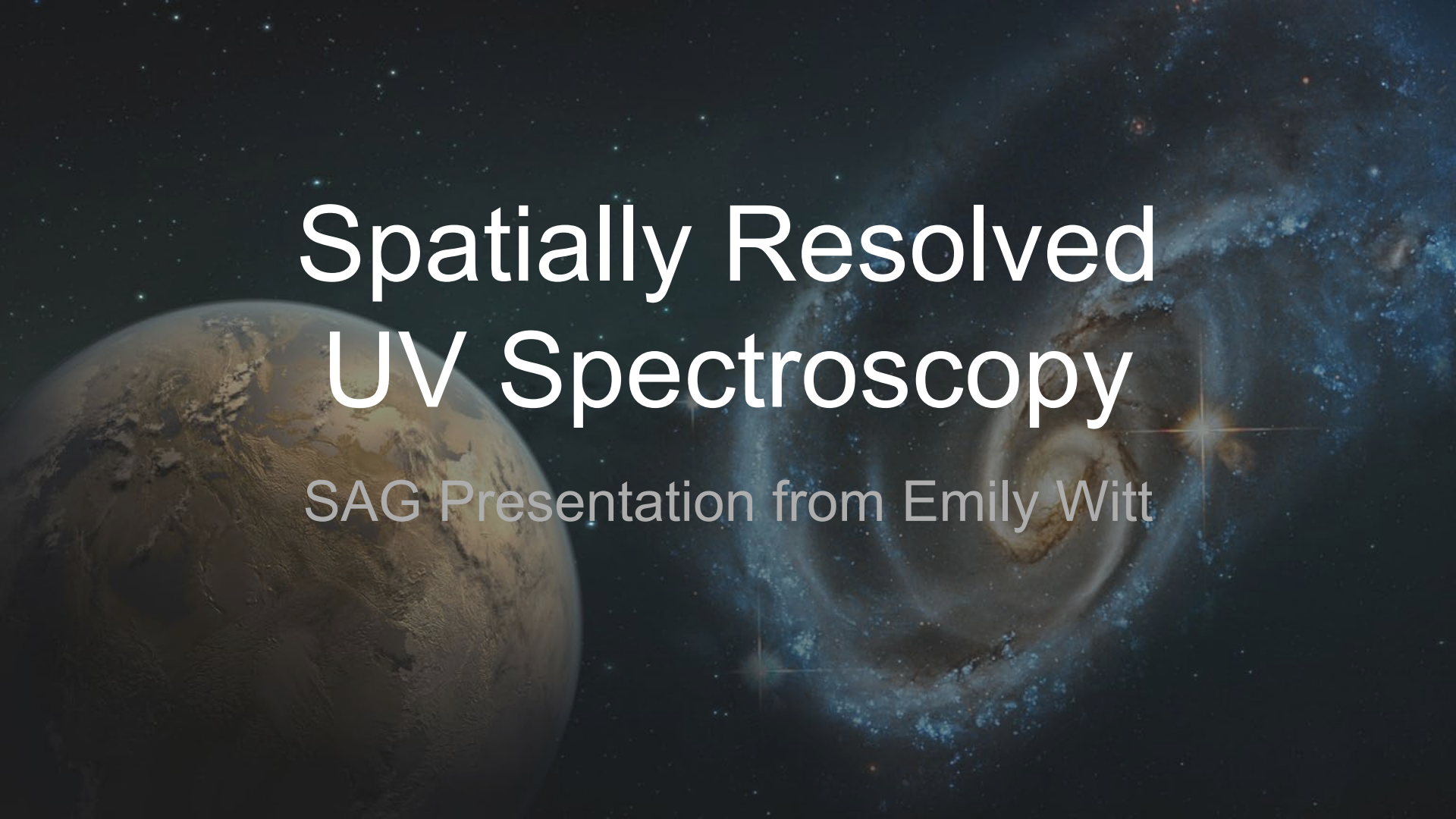
| Group | PAG | Contacts | Group Type |
|---|---|---|---|
| The Impact of Exo-Zodiacal Dust on Exoplanet Direct Imaging Surveys | ExoPAG | John Debes, Yasuhiro Hasegawa | SAG |
| HWO red wavelength limit | COPAG | Roberta Paladini, Kyle Cook, Benne Holwerda | SAG |
| Exploring galaxies throughout the universe | COPAG | Aaron Yung | SIG |
| Astrophysics from the Moon | PhysPAG | Dave Pooley | Other |
| Planetary Defense with HWO | N/A | Andy Rivkin | Other |


Seminar Highlights

# Suggested Cookbook for Starting a new HWO SAG

- Discuss an open HWO  science or technical issue with colleagues, what analyses are needed to work the issue, and where you can find the needed expertise.
- Make sure there is broad interest: most successful SAGs end up accreting at least a couple dozen participants.  You won't be able to do all the analysis & writing yourself.
- Draft a charter for your SAG describing the questions to be investigated, methods to be used, products to produce, a rough schedule of work, the expected impact of the SAG's work, and what success looks like
- Present your SAG charter to the relevant PAG (COPAG, ExoPAG, or PhysPAG) at one of their regular telecons, or their less-frequent face-to-face meetings.  Incorporate their feedback.
- After approval from the PAG Chair and APD Director, start organizing !
- Expect to organize regular telecons, host a webpage or google drive, and to give status updates to the cross-PAG SIG and relevant PAG Chairs
- Most SAGs finish their work within 1-2 years.  Some never finish and fade out
- Good luck !

Slide adapted from K. Stapelfeldt

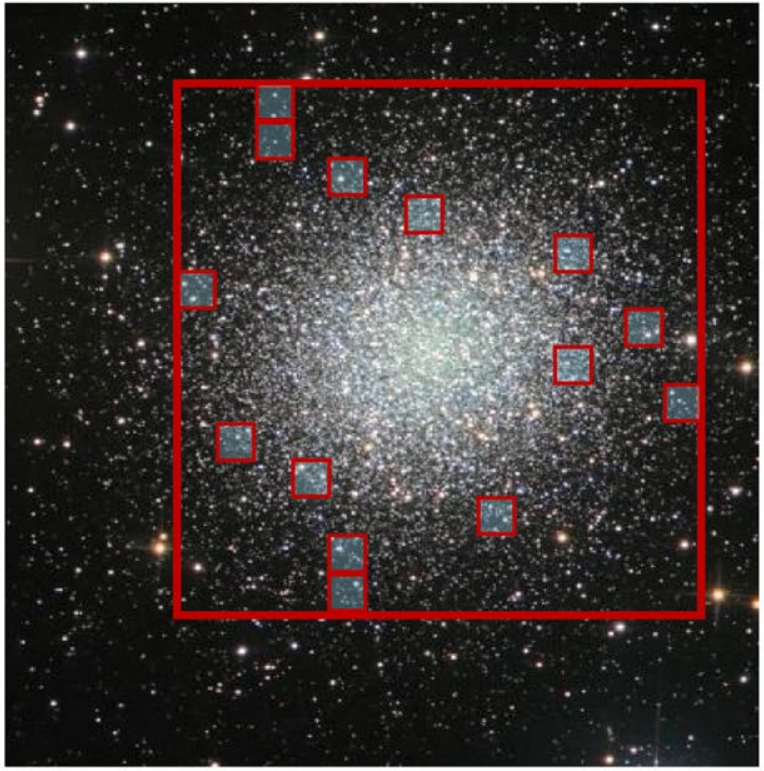


# Spatially Resolved UV Spectroscopy

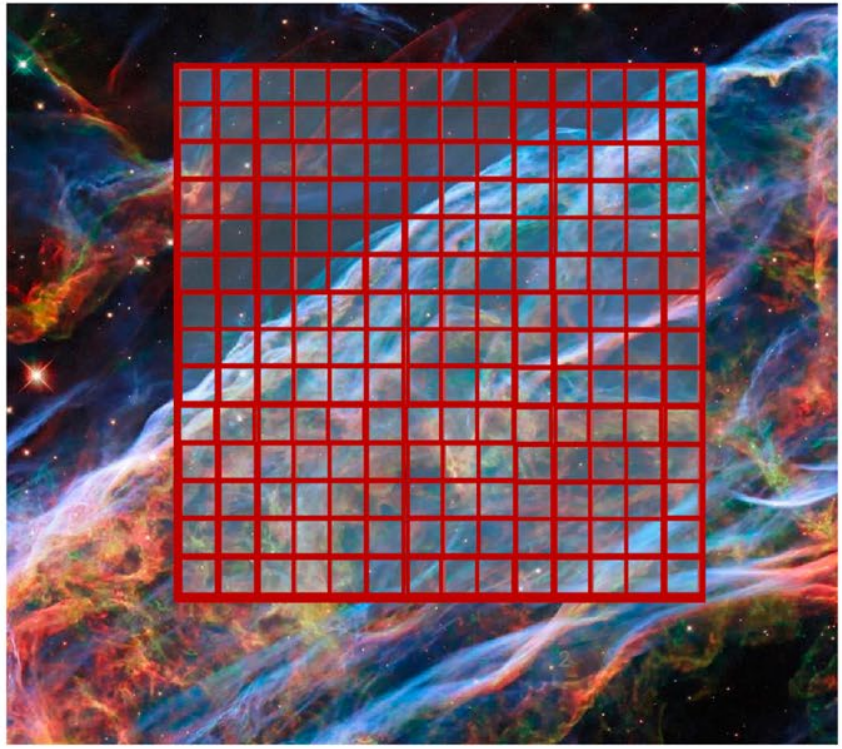
SAG Presentation from Emily Witt

# Spatially Resolved Spectroscopy

**Multi-Object Spectroscopy**



**Integral Field Spectroscopy**



## Objective #1: Review UV spectroscopy requirements for astrophysics and planetary science.

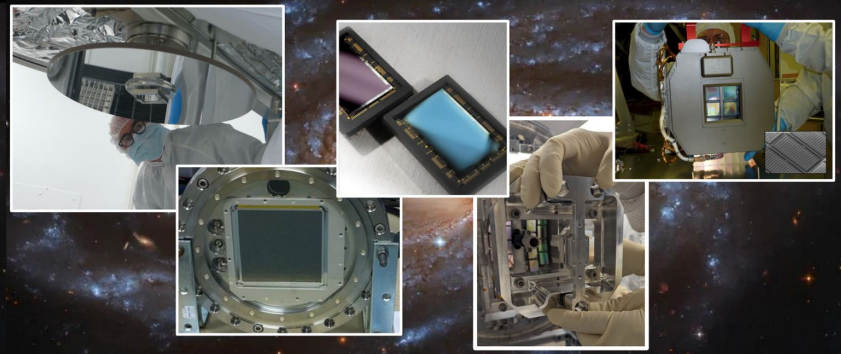
What science cases are enabled by a FUV MOS/IFU?

Are there requirements that would cover the majority of science cases?

What requirements for a MOS and IFU does the community require?

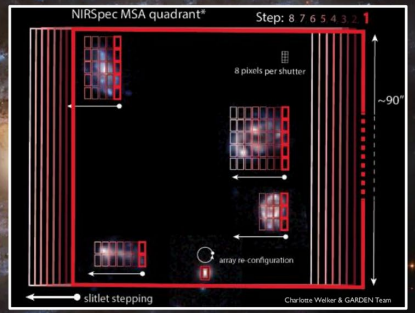
What science cases have requirements that may stretch capabilities?

## Objective #3: Analyze the current status of UV technology development.



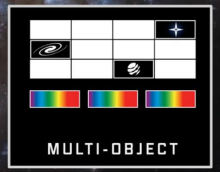
## Objective #2: Identify new science capabilities enabled by an IFS.

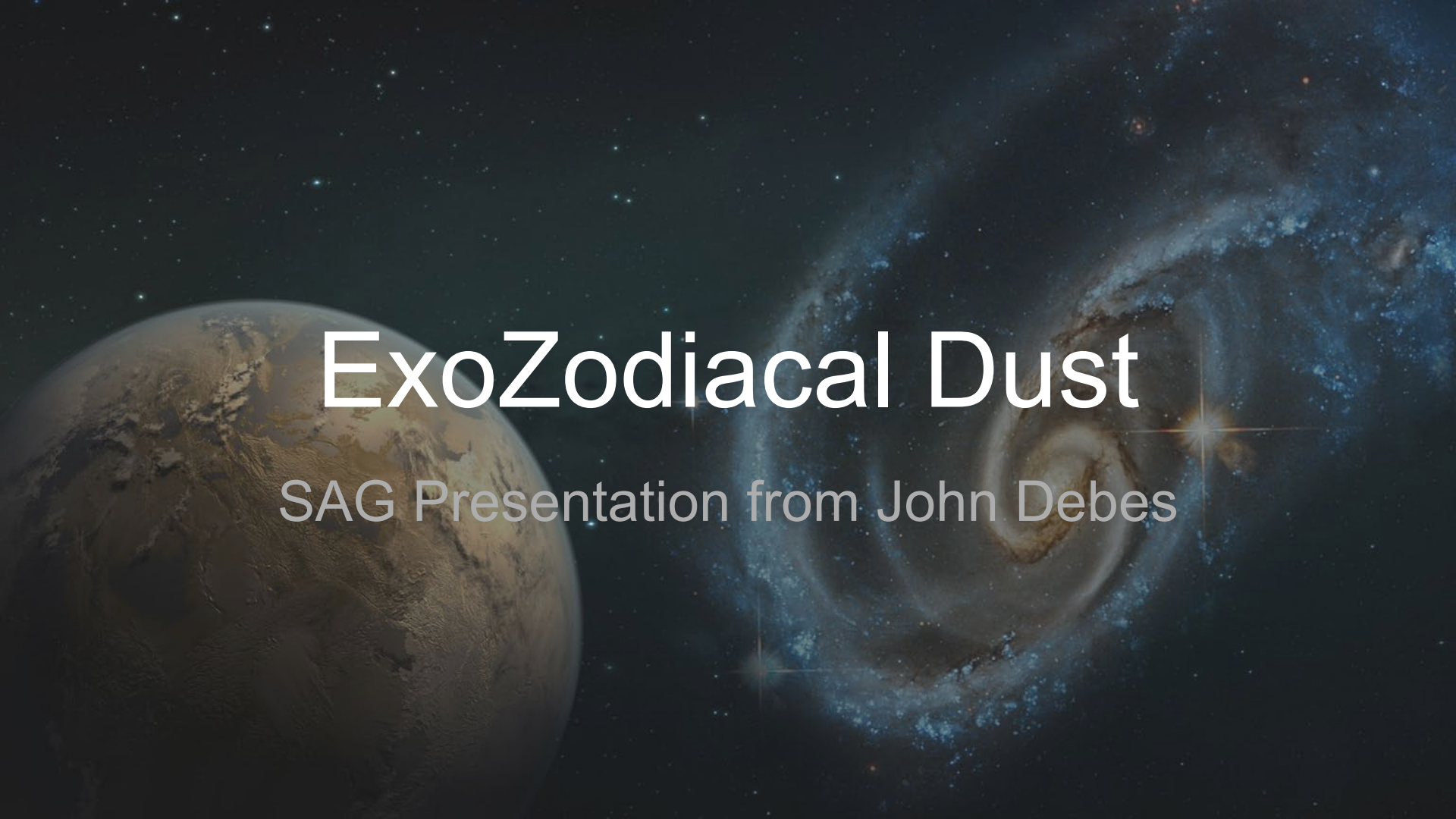
What science cases require an IFU? What sciences cases can be done by either an IFU or a MOS?




## Activities

- Meeting every other week
- Presenting at Winter AAS 2026 during the COPAG Splinter Session
- Workshop
- White paper, presented at a AAS splinter session

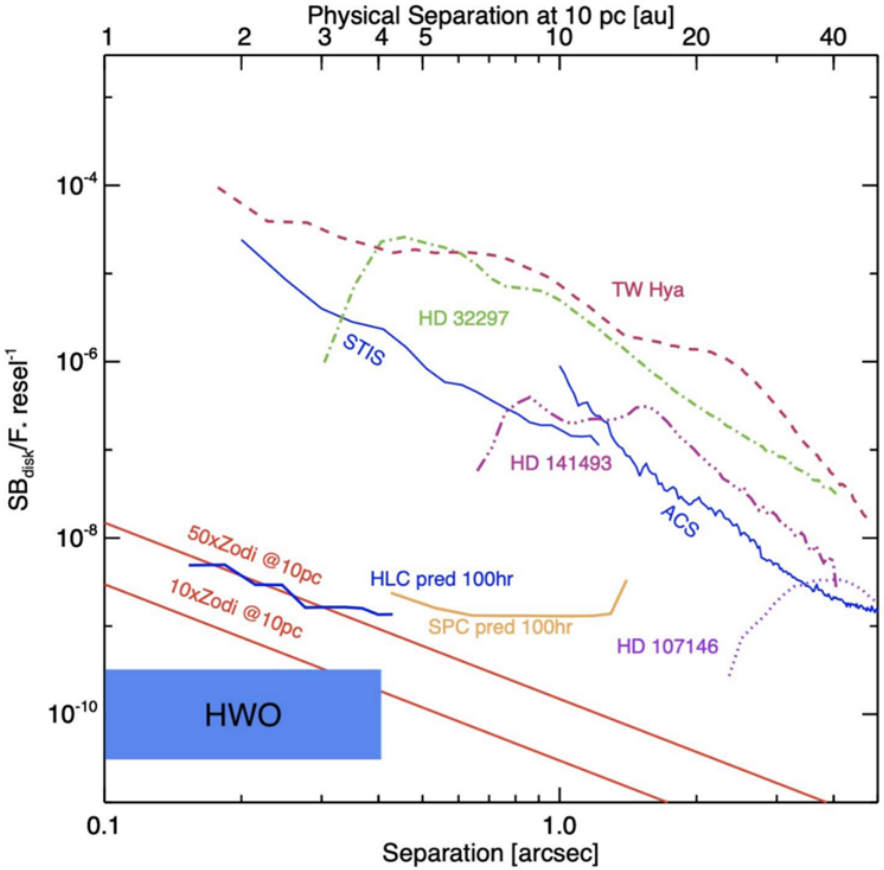





# ExoZodiacal Dust

SAG Presentation from John Debes

# HWO will be an Exozodi finding machine




**Exozodi Characterization**

- Earth finding requirements are excellent for exozodi detection
- Characterization requires:
  - Broad wavelength coverage to constrain composition
  - Polarimetry to constrain grain properties
  - Spatial resolution for morphology
- Well resolved exozodis can be searched for perturbations in density due to low mass planets

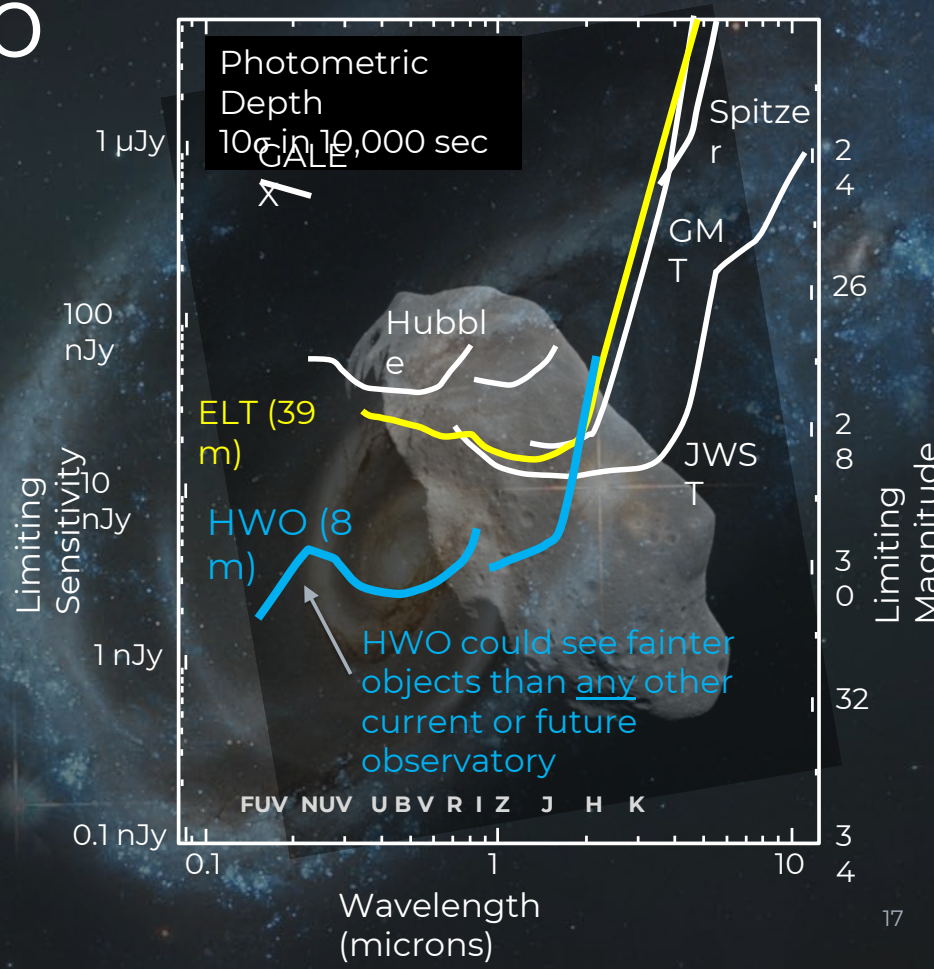

Planetary Defense
With Andy Rivkin

# Planetary Defense with HWO

HWO can characterize asteroids that could pose a threat to humans or human infrastructure in the solar system

With its unprecedented sensitivity – better than any other assets on ground or space – it will observe smaller bodies at greater distances than ever before possible

The result is greater advance notice to refine orbits and determine the likelihood of a collision with Earth or human assets off Earth



# Hazard mitigation depends on asteroid size & orbit

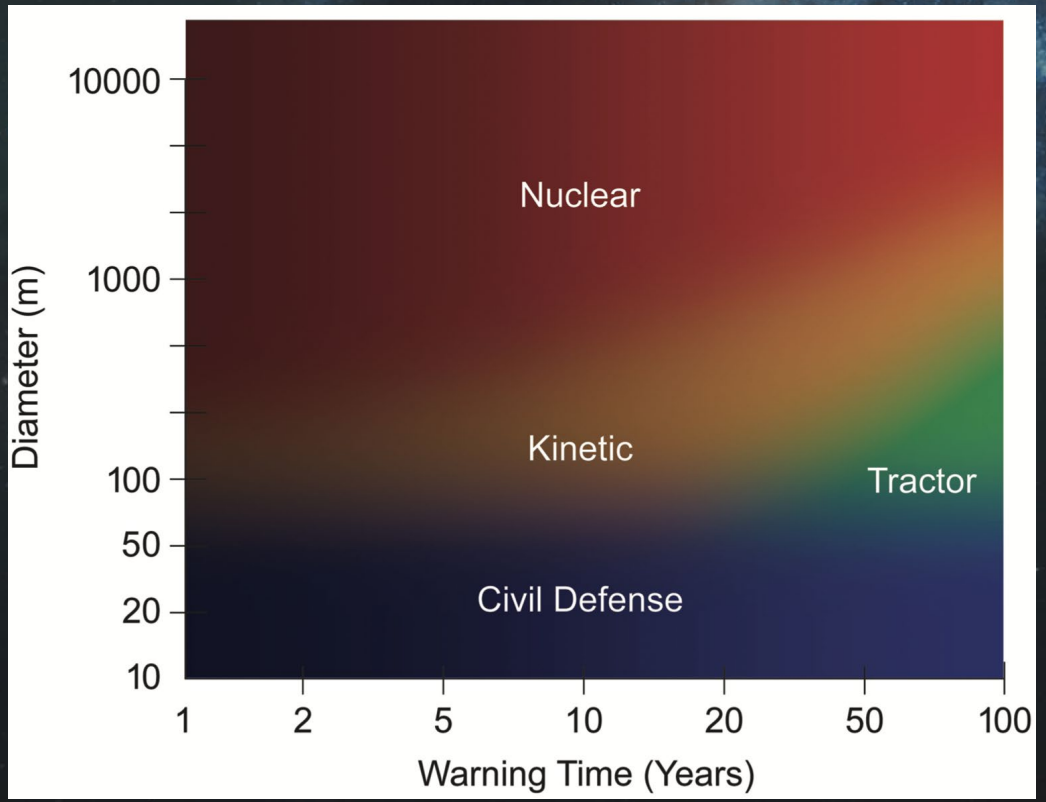
For a future asteroid impact, all planning depends on having as much warning time as possible and knowing the size of the object

A potential impactor can be unobservable for years after discovery!

HWO's sensitivity will provide orbit refinement earlier & faster than ever previously possible

HWO will also constrain the surface composition of a given asteroid, enabling improved models of its diameter and mass – critical for hazard mitigation strategies for Earth and for assets off Earth

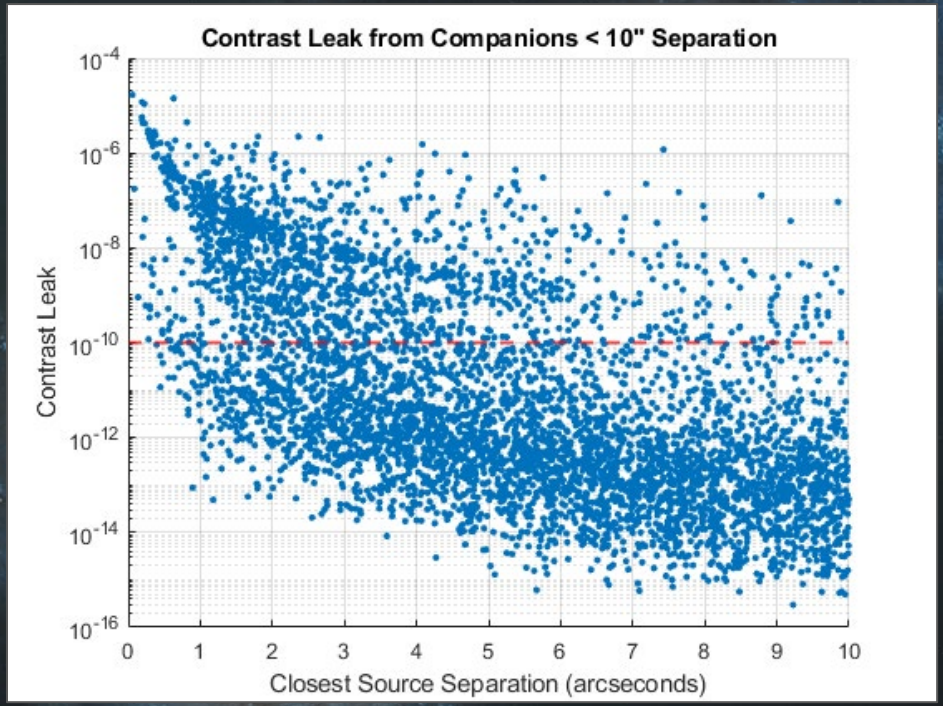
"Defending Planet Earth: Near-Earth-Object Surveys and Hazard Mitigation Strategies" (2010), National Academies Press




SAG advertisements

# *HWO, Multi-star Systems, and Exoplanets Oh My!*

- **Originally a task team of the Target Stars and Systems Working Group**
  - Could be part of a continuation of Target Stars
- **Goals:**
  - Understand which potential HWO targets are part multi-star systems
  - Understand the potential impacts of stellar companions on direct imaging observations (scientific requirements, realistic planet yields)
- **Expansions?**
  - Identify multi-star systems in support of SCDDs (e.g. Newton et al. 2025)
- **Interested?**
  - Email zachary.d.hartman@nasa.gov

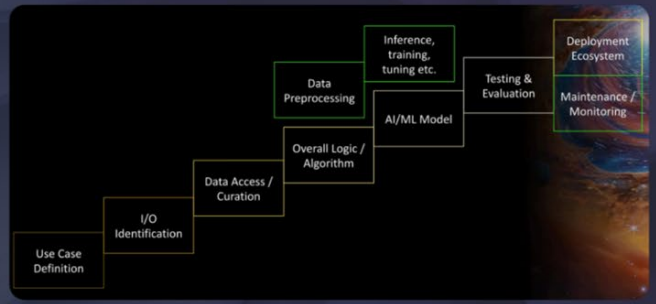



Dan Sirbu

## HWO AI Solutions & Ecosystems Lab [HAZEL]

# {AI/ML Solutions for HWO Research Workflows}

- A cross-functional working group to explore, design, develop and deploy AI/ML-powered tools and utilities for accelerated HWO research workflows.
- Operating across multiple groups, SIGs, SAGs.
- **LLM/RAG-assisted Knowledge Synthesis**: requirements-to-science / science idea-to-requirements, science idea-to-document generation [proposals, science cases, reports, reviews and more].
- **AI-assisted Technical Description**: instrument configurations, technical parameters, observation schemes, traceability, science return, cross-referencing, validation.
- **AI-powered Multi-Source Information Consolidation**: Information retrieval, management, consolidation from multiple sources [ADS/SciX, NASA documents, ArXiv].
- **ML-driven data analytics workflows**: pattern recognition, classification, anomaly detection, data processing, analytics, predictions [across HWO Science Cases: Exoplanets / Planetary Science / Astrophysics].




### AI/ML Deployment Ladder

**Contemporary AI models, ML frameworks, techniques and support tools are widely available, but they become practically and operationally useful only when they are systematically orchestrated, integrated, and deployed as unified AI-assisted solutions for accelerated science research workflows saving time, minimizing manual effort.**

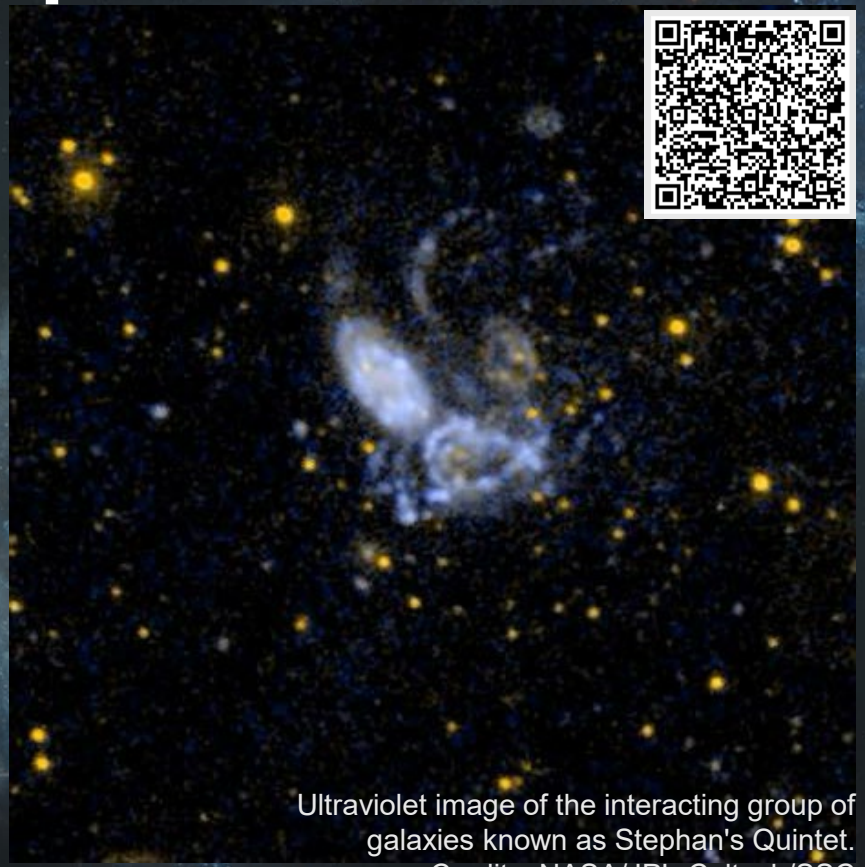
Interested?

**Contact:** aakib moin [aquibmoin@gmail.com]

[HWO AI/ML WG]

# Science Analysis Group
# O VI

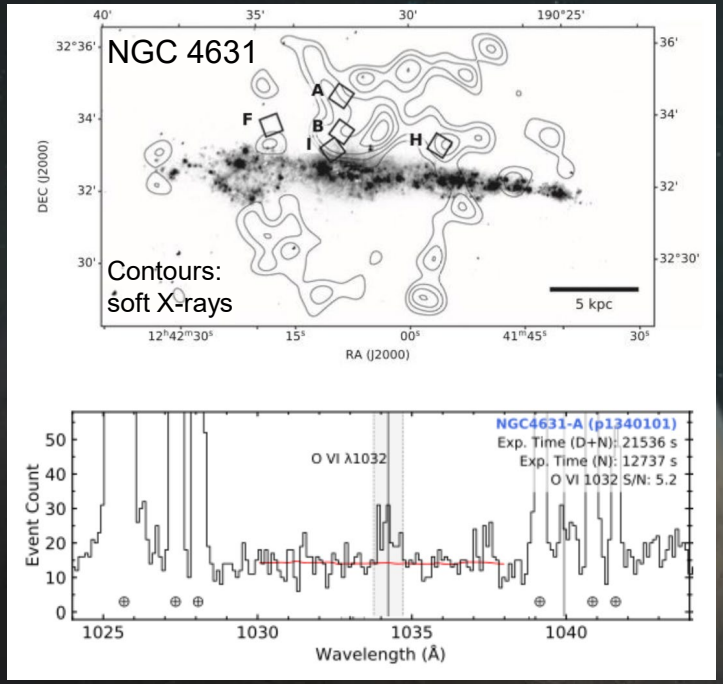
- O VI ($\lambda_{rest}$= 103 nm) is a key high used to study diffuse tenuous media.
- To better understand the science using the UV O VI doublet, the Cosmic Origins Program Office formed the O VI Science Analysis Group (SAG).
- The O VI SAG will produce a white paper by mid-2026.
- SAG lead: Sanch Borthakur (ASU)
  - Feel free to reach out!



Ultraviolet image of the interacting group of galaxies known as Stephan's Quintet.
Credits: NASA/JPL-Caltech/SSC

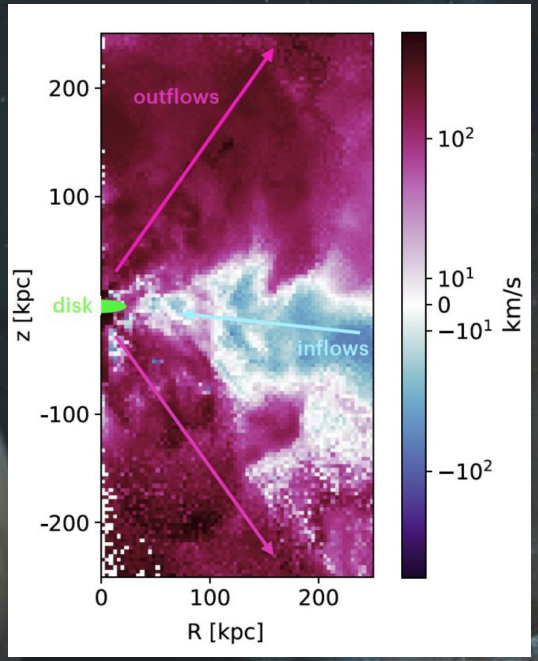
# Need for OVI measurements

## Currently, we cannot access O VI in the nearby Universe (z < 0.1)



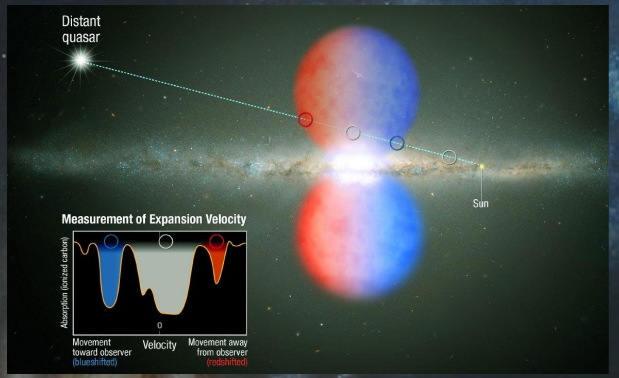

Emission detected from the regions marked A-I with FUSE.

Chung et al. 2021




Simulations predict signatures of gas flows in OVI

Silich et al. 2025




Schematic showing the power of absorption spectroscopy tracing energetic processes in the Milky Way. O VI uniquely traces the highly ionized phase that is inaccessible otherwise

Fox et al. 2015


Updates from CSIT and TMPO

# HWO's Community Science & Instrument Team (CSIT)

**David Charbonneau**
**Co-chair**
Harvard

**Evgenya Shkolnik**
**Co-chair**
Arizona State

**Michael Bottom**
UC Berkeley

**Eric Burns**
LSU

**Richard Cartwright**
JHU - APL

**Ewan Douglas**
U. Arizona

**Kevin France**
CU Boulder

**Scott Gaudi**
Ohio State

**Rebecca Jensen-Clem**
UCSC

**Janice Lee**
STScI

**Victoria Meadows**
UW/SETI

**Chris Packham**
UT San Antonio

**Laurent Pueyo**
STScI

**Tyler Robinson**
U. Arizona

**Jason Tumlinson**
STScI

+ New international ex-officio members

# What the CSIT Does

**Community Science → Mission requirements**
Translate community science priorities into Driving Science Cases that inform HWO mission-level requirements.

**Capability Trades → Instructments**
Help evaluate instrument concepts and technology maturity to define a scientifically optimized core instrument suite for MCR.

**Community Alignment → HWO design**
Coordinate across PAGs, SIGs, and partners to ensure broad community science priorities are reflected in HWO design.

**Science Advocacy → Stakeholders**
Serve as ambassadors for the community, articulating the scientific value of HWO across stakeholder groups.

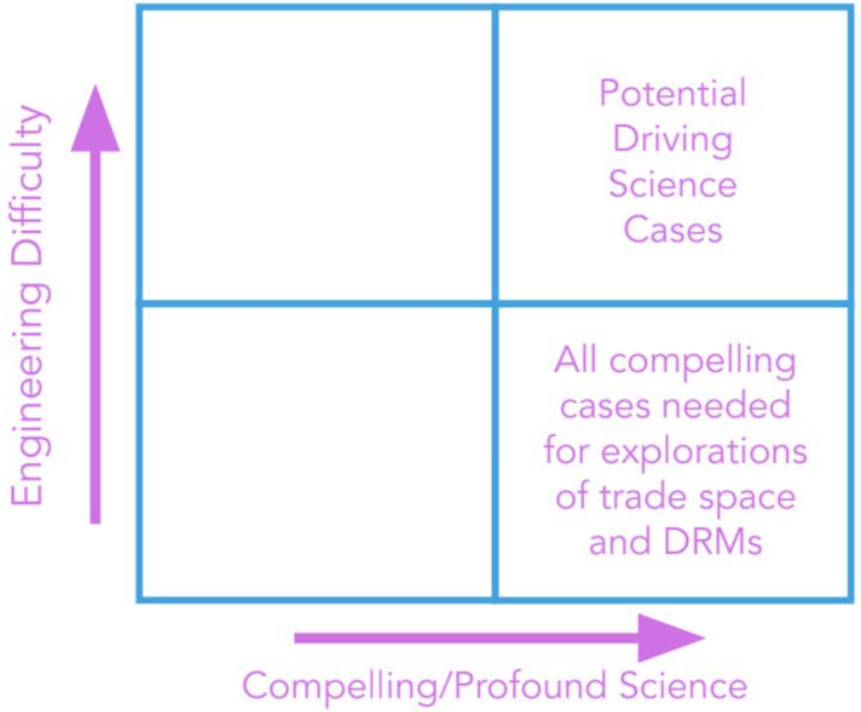
# CSIT: SCIENCE-DRIVING WORK

Reviewed all community SCDDs to identify potential Driving Science Cases (DSCs) guiding HWO and enabled compelling science.

Using DSCs to shape draft Level 1 science requirements (baseline and threshold).

Helping to develop Design Reference Missions (DRMs).

Developing a Science Traceability Matrix (STM) to map science objectives to capabilities.



# CSIT: INSTRUMENTS, TECHNOLOGY, AND COMMUNITY

Assessing HTMPO-provided instrument concepts with simulations and analysis to help define the core instrument suite for MCR.

Providing scientific perspectives on HTMPO's technology maturation plans.

Acting as ambassadors and advocates for the broader science community and other stakeholders.

Coordinating with the science and technology efforts of the new HWO Cross-PAG SIG.

# TMPO update from Bertrand Mennesson

## ITERATING ON POSSIBLE HWO ARCHITECTURES USING "EACs"

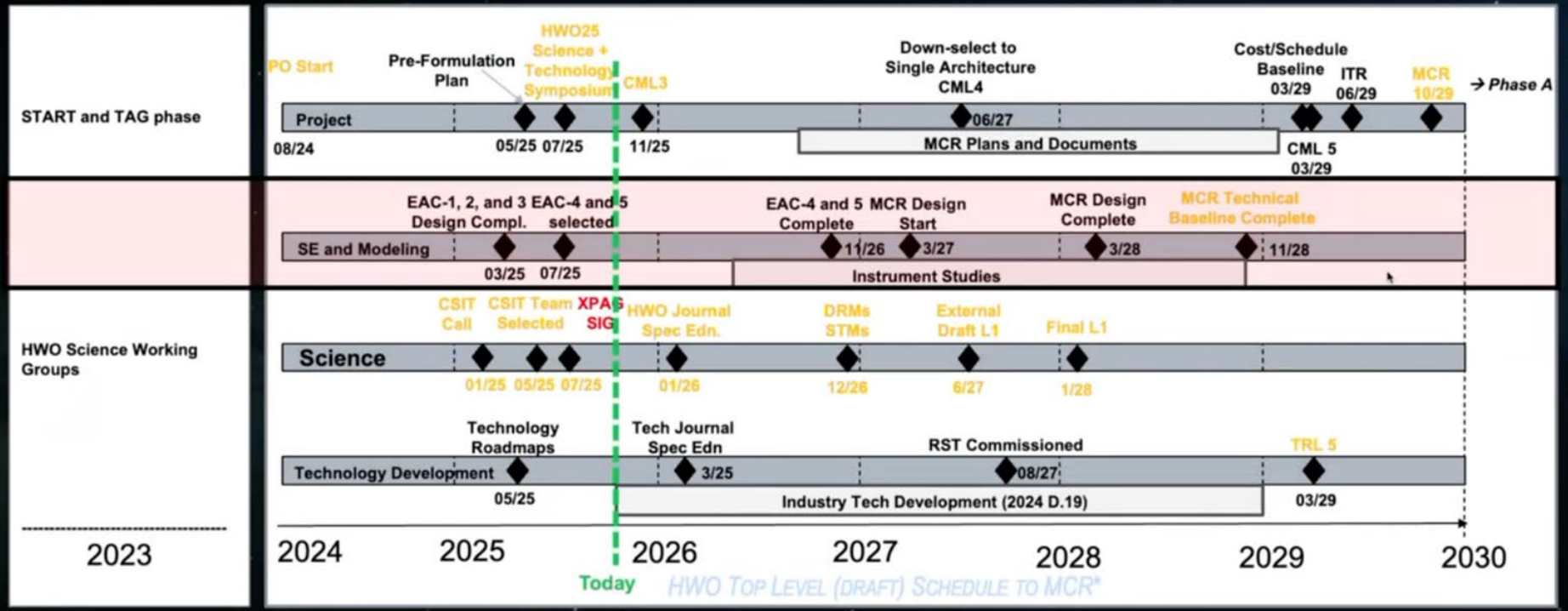
### EACs 1-3 Top Lessons Applied to EACs 4-5

1. **Launch vehicles are driving constraints on mass and volume**
   - Continue to seek compatibility for at least two launch vehicles
2. **Deployment complexity remains an important design challenge**
   - Trade PM/SM/Barrel deployment complexity with primary mirror size
3. **Passive detector cooling drives instrument placement**
   - Passive cooling of NIR detector is difficult but achievable
4. **Off-axis systems are most favorable for coronagraphy**
   - On-axis systems have mirror tower stiffness and obscuration issues
5. **Telescope polarization effects impact high-contrast science**
   - Un-polarized observations require longer PM-SM distance, complicating launch packaging


*EAC4 preliminary design*
*off-axis ~6.5m ID*
*non-deployed PM*

*EAC5 preliminary design*
*off-axis ~8.3m ID*
*deployed PM*

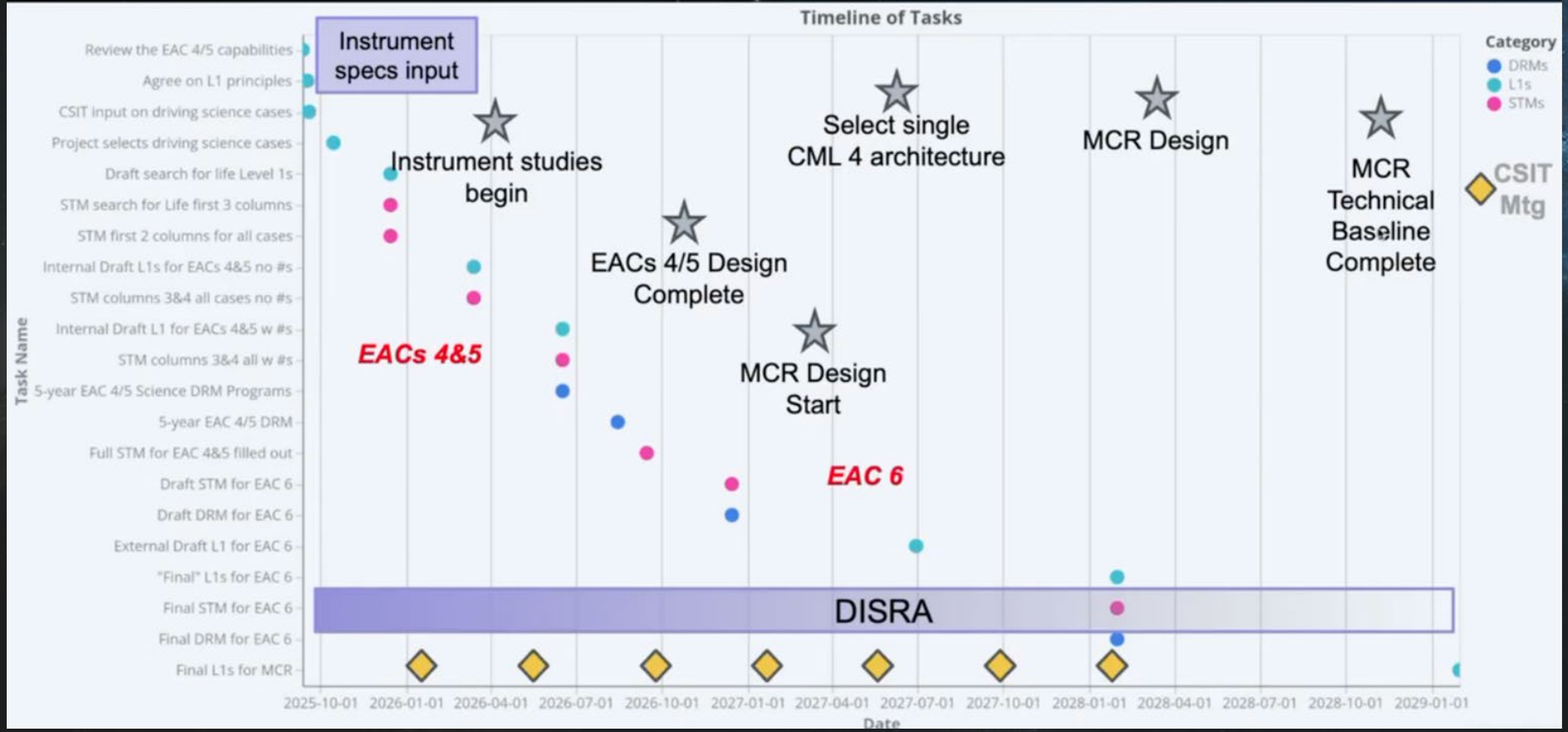
# HWO IS IN PRE-FORMULATION




- Pre-phase A: exploring the overall trade space of science vs instrument complexity
- Still gathering the full breadth of HWO's science objectives,
- Aiming for phase A start by the end of the decade

*Contingent on Funding

# SCIENCE TIMELINE (CONTINGENT ON FUNDING)



# Ways to Support HWO TMPO

- Tell TMPO what is interesting and exciting and explore!
  - More detailed analyses following from SCDDs. Focus on “enabling” science cases.
  - Advocacy for science cases
  - Identifying important science not covered by SCDDs (Please make sure to check SCDDs first!)
  - Are there important details you need know that are missing from the slide packages? Nothing is locked down, but guard rails exist.
- SAG reminder: Technology is a valid SAG topic! As is hardware and programmatic topics, not just science!
- Synergistic activities in the meantime until launch
  - Supporting observations, e.g. large time baselines
  - Big computations that will take time to complete
  - Laboratory astrophysics


Questions?
We’d love feedback!