

# **HabEx: Notional Mission Properties and Science Applications.**

June 26, 2015

Scott Gaudi

(SIG#1 Chair)

# NASA's Charge to the PAGs.

“I am charging the Astrophysics PAGs to solicit community input for the purpose of commenting on the small set [of large mission concepts to study], including adding or subtracting large mission concepts.”

# Initial list of missions.

Taken from NASA Roadmap (Surveyors)  
and Decadal Survey (HabEx)

- Far IR Surveyor
- Habitable–Exoplanet Imaging Mission
- UV/Optical/IR Surveyor
- X–ray Surveyor

# Timeline/Meetings for Hertz Charge (completed).

- \*January 2014: Initial discussion at ExoPAG 9.
- March 2014: APS approves SIG #1.
- June 2014: Brainstorming session at ExoPAG 10.
- January 2015: Brainstorming session at ExoPAG 11, Paul's charge.
- February 2015: First dedicated SIG #1 Meeting, brainstorming & consensus building.
- March 10 COPAG Virtual Town Hall
- March 19, 2015: Joint PAG EC meeting.
- April 11–14 2015, Am. Phys. Soc. (Baltimore) – PhysPAG
  - SIGs and PCOS mini-symposium
- June 2, 2015 – ExoPAG Virtual Meeting
- June 3–5, Far-IR Workshop (Caltech) – COPAG
- June 13–14, ExoPAG #12 (Chicago) – ExoPAG
  - Half to full day to be spent on charge (2<sup>nd</sup> day)
- June 25–25, UV/Vis SIG Meeting, Greenbelt, MD – COPAG

# Timeline/Meetings for Hertz Charge (future).

- July 1 panel discussion during the HEAD meeting (Chicago) – PhysPAG
- July 14, 2015 – ExoPAG Virtual Meeting
- August 2015 – COPAG Virtual Town Hall
- August 7, Joint PAG Splinter Session at IAU, 1–5pm
- August 18, 2015 – ExoPAG Virtual Meeting
- July–September 2015: writing, circulating, finalizing report(s?).
- October 2015: Deliver report to Hertz (two weeks before the APS)

# Inputs to date.

- Talks, brainstorming, and discussion at ExoPAGs 9, 10, 11, virtual meeting.
- NASA Astrophysics Roadmap.
- Solicited (and unsolicited) input from a several dozen members of the community.
- COPAG White Papers

# Past Meetings Devoted to Paul's Charge.

- SIG #1 Stand-alone Meeting
  - February 10+11, 2015 at JPL.
  - Roughly 45 people attended in person and remotely.
  - Talks, break-out sessions, brainstorming and group discussions.
  - Afternoon of February 11 devoted to Paul's charge.
  - Consensus building.
  - Identified questions and topics for future discussions.
- SIG #1 Virtual Meeting
  - June 2, 2015
  - Roughly 40 people attended.
  - Focused on Paul's charge, mostly discussion and consensus building (no talks)
- SIG #1 Meeting at ExoPAG 12
  - June 14, 2015
  - Roughly 40-50 people attended in person or remotely
  - Talks in the morning, discussions in the afternoon.

# HabEx.

- 4–8m monolith (or segmented with starshade)
- Needs  $\sim 10^{-10}$  contrast
- Coronagraph, wavelength of 0.5–1.0 micron
- and/or starshade, wavelength of 0.25–1.0 (1.5?) micron
- Camera
  - IFU, R=70 spectrum of 30 mag exoplanet
  - 1" FOV
- Optimized for exoplanets, but other uses of instruments possible
- L2 orbit or Earth-trailing



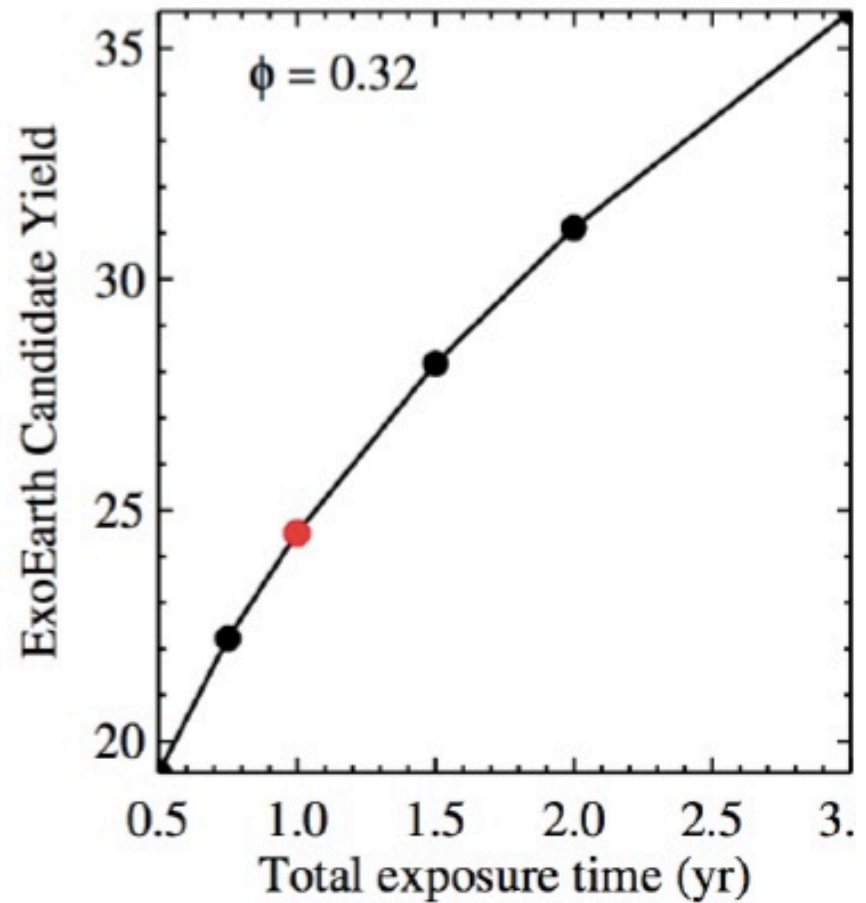
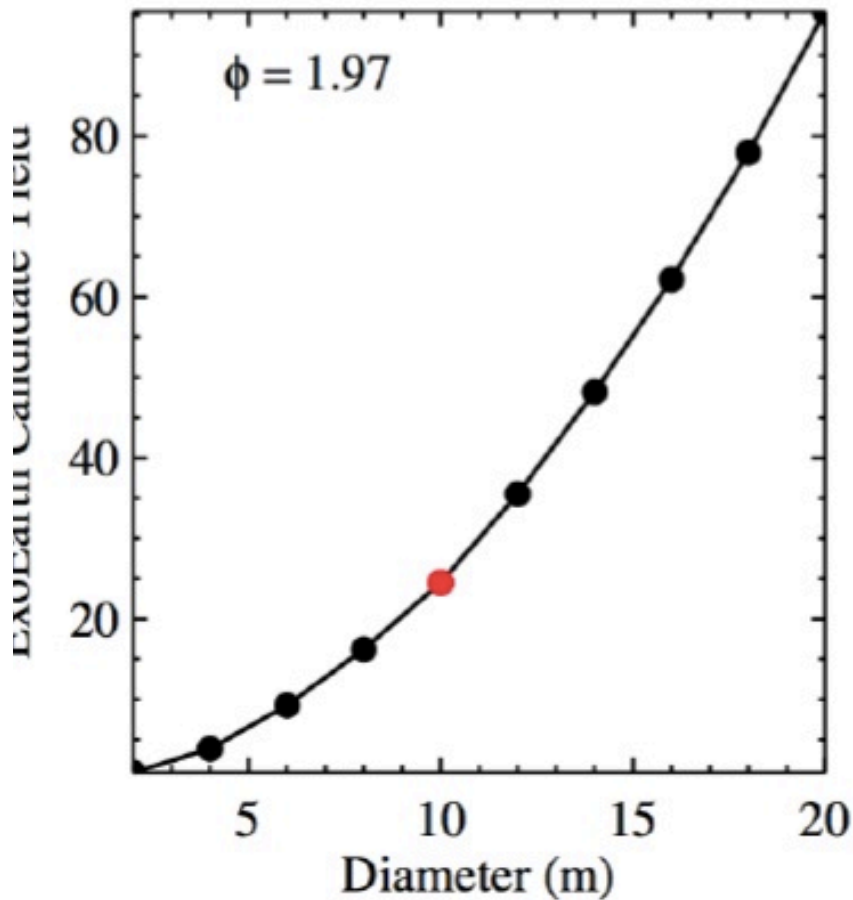
# Large UVOIR Surveyor

- 8–16m (likely segmented, obscured primary)
- HST-like bandpass (91nm - ~2 microns)
- Suite of imagers/spectrographs
- Need  $\sim 10^{-10}$  contrast for planet imaging (coronagraph and/or starshade), less contrast for other studies

# HabEx Tradeoffs.

- 4–8m (off-axis, unobscured) monolith.
- Internal Coronagraph
- Contrast:  $10^{-10} \rightarrow 10^{-11}$
- IWA  $3\lambda/D \sim 60\text{--}150$  mas
- Highly stable.
- UV coatings difficult
  - Not a significant improvement over HST/JWST/WFIRST
- 4–6m segmented or monolithic.
- Starshade
- Contrast:  $10^{-10} \rightarrow 10^{-11}$
- IWA  $1\lambda/D \sim 20\text{--}50$  mas
- Limited search capability (50–100 targets) due to slews and fuel.
- JWST heritage
- UV coatings easier
  - Significant post-HST UV science
  - Larger area, larger detectors

# “ExoEarth” Yields – Coronagraph.



Simulations by Chris Stark.

# “ExoEarth” Yields – Starshade.

- Less well explored.
- Better sensitivity at a given aperture, but limited by number of slews
- Preliminary simulations yield ~30 ExoEarths for 6m apertures, but requires ~500 visits.
- Mitigation:
  - Refueling, multiple starshades, find planets first (RV or astrometry)

# COR Science.

- Presentation by Paul Scowen at ExoPAG 12.
- Stellar, IGM, Galaxy Evolution, other.
- 2–4m, 90–1000nm, R~100 – 100,000,
- FOV 10' to ~0.7 sq degrees.
- Polarimetry

# Conclusions

- Early days for these discussions – expect clarification at the SIG2 workshop
- Clear that there is a strong initial portfolio for 4m-class astrophysics in the UV-visible
- Similarly strong portfolios exist from Explorer-class up through Probe- and Flagship-class missions sizes – what are the budgetary and political realities?
- The opportunities exist for real collaboration between the Exoplanet and Astrophysics communities - whether it is at the 4m-class or the 10m-class

(From Paul Scowen's ExoPAG 12 presentation)

# Points of Consensus.

1. There was a general support for WFIRST with a coronagraph **and** a starshade.
2. There was a general consensus that a broad range of apertures and architectures for direct imaging missions should be studied, encompassing both the nominal concepts of the HabEx and LUVOIR missions.
3. There was a general consensus that there should be a common executive summary with the other PAG reports. It was agreed that the executive summary should include: a statement that we support these four missions being studied, a recommendation for probe studies, and suggestions for how STDTs should be organized (provided that the other PAGs are in agreement on these points).
4. There was a general consensus that a common table describing the nominal parameters of the four missions should be included in the PAG reports. These parameters are to be determined in future discussions with the ExoPAG and other PAGs.
5. There was a general consensus that we should neither add nor subtract from the four proposed mission concepts (HabEx, LUVOIR, X-ray Surveyor, and Far-IR Surveyor).

# Points of Consensus, cont.

6. With regards to organization of the HabEx and LUVOIR STDTs, there was a general consensus on the following points:
  - There should be two separate science teams and two separate engineering and technology teams.
  - The science teams should have significant overlap (common members), and should include significant representation from the planetary science community.
  - We should express the following concerns in the report:
    - Exoplanets may get marginalized in the LUVOIR STDT if their representation is too small.
    - The general astronomical community may get fractured if the representation of disciplines is very different between the two STDTs.
  - Thus the members of the science teams should be carefully chosen to ameliorate these concerns.
  - The teams should meet periodically, including the kickoff meeting.
  - There should be a small, independent and unbiased team that is tasked to evaluate the science yield and technical readiness of both mission designs in a consistent and transparent manner.



# Points of Consensus, cont.

7. There was a general consensus that probe-class (<~\$1B) missions should be studied in advance of the next decadal survey, and that the following missions should be presented in the report as examples of possibly compelling probe-class missions.
  - A starshade for WFIRST-AFTA.
  - A transit characterization mission.
  - An astrometry mission.



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## ExoPAG Input into the 2020 Decadal Survey and Large Mission Studies

[Virtual Meetings](#) | [Face-to-Face Meetings](#) | [Science Division Documents](#) | [Supporting Documents](#) | [Links](#)

Paul Hertz (NASA Astrophysics Division Director) has charged the three Astrophysics Program Analysis Groups (PAGs) with reviewing a small set of candidate large mission concepts, and suggesting addition, subtraction, and other useful summary. The results of this review will be reported at the NASA Advisory Council Subcommittee meeting in October in the form of a report. This page provides information on the charge and the ExoPAG's plans for responding to this charge and creating this report.

The ExoPAG will respond to this charge in the context of its Science Interest Group #1 activities, as described in the following charter:

SIG #1: [Toward a Near-Term Exoplanet Community Plan](#).

The ExoPAG is soliciting input from the community through three primary methods:

- Direct input to the SIG #1 chair Scott Gaudi: [gaudi.1@osu.edu](mailto:gaudi.1@osu.edu).
- [Virtual Meetings](#)
- [Face-to-Face Meetings](#)

The COPAG is also soliciting white papers and are happy to receive white papers from the ExoPAG community: <http://cor.gsfc.nasa.gov/copag/rfi/>

# Reference Material.

- <http://cor.gsfc.nasa.gov/copag/rfi/>
- <https://exep.jpl.nasa.gov/exopag/decadal/>
- <http://pcos.gsfc.nasa.gov/physpag/>