Report of the Hubble Exoplanet Committee

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Space Telescope User's Committee

May 12, 2016

The Committee

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Status of the Report

The committee began work on November 20;
Neill provided statistics on exoplanet proposals from previous cycles

A near-final version was communicated to Neill on April 10

We received final comments from the community on monday May 9; no major issues identified

The final version will be delivered to Neill this week(end)

This presentation serves as an Executive Summary

Charge to the Committee

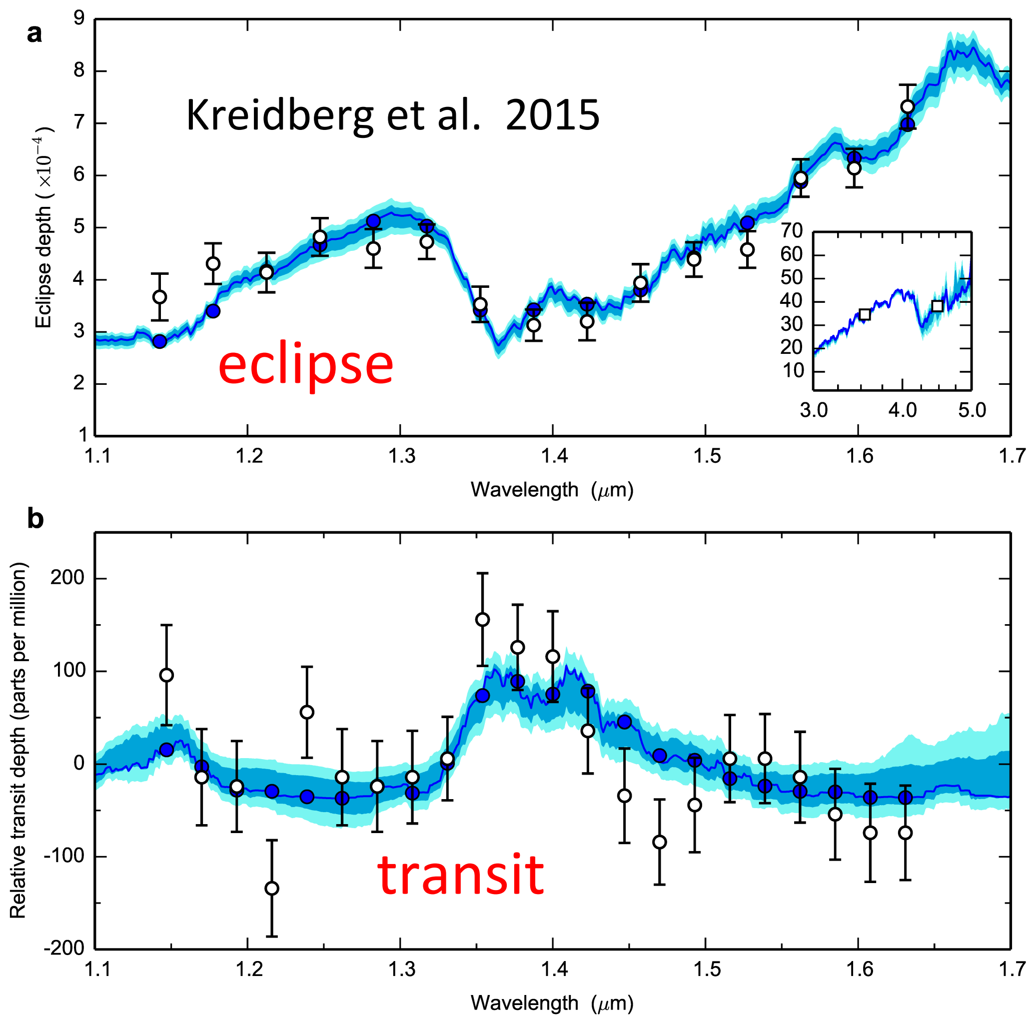
- *Review* the evolution of HST usage by the exoplanetary community and match against factors such as changes in the time allocation process and in instrument capabilities
- *Solicit* input from the community on the role that HST can play in exoplanet science and on methods for allocating observing programs
- *Identify* key exoplanet observations that should be obtained by HST for legacy science and/or in preparation for JWST
- *Investigate* potential mechanisms to coordinate HST observational programs with priorities among the exoplanet science community

Review usage by the exoplanet community....

Most common HST exoplanet science themes

Science Theme	*Observational Techniques & Instruments*
Atmospheres of transiting exoplanets	Near-IR transit and secondary eclipse spectroscopy using WFC3 grisms Near-IR phase curves using WFC3 grisms UV transit spectroscopy using STIS and COS
Investigations of protoplanetary and debris disks	Imaging using STIS, ACS Spectroscopy using STIS
Direct imaging of exoplanets at large orbital distances	Spectrophotometry with ACS and STIS UV spectroscopy using STIS and COS
Stellar astrophysics related to exoplanets	Spectrophotometry with ACS and STIS UV spectroscopy using STIS and COS

Atmospheres of transiting exoplanets

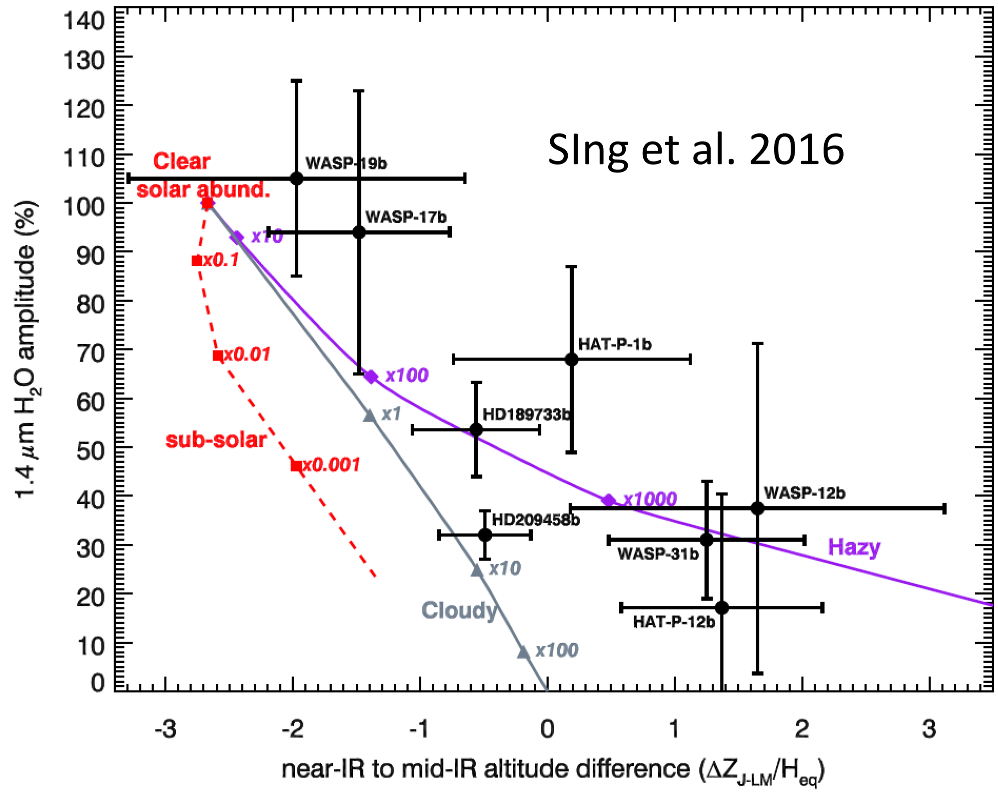


WFC3 probes water vapor in giant planets and Neptunes, yielding a proxy for metallicity

The results are robust and confirmed by multiple groups

Clouds and haze affect the results, but can be dealt with in most cases

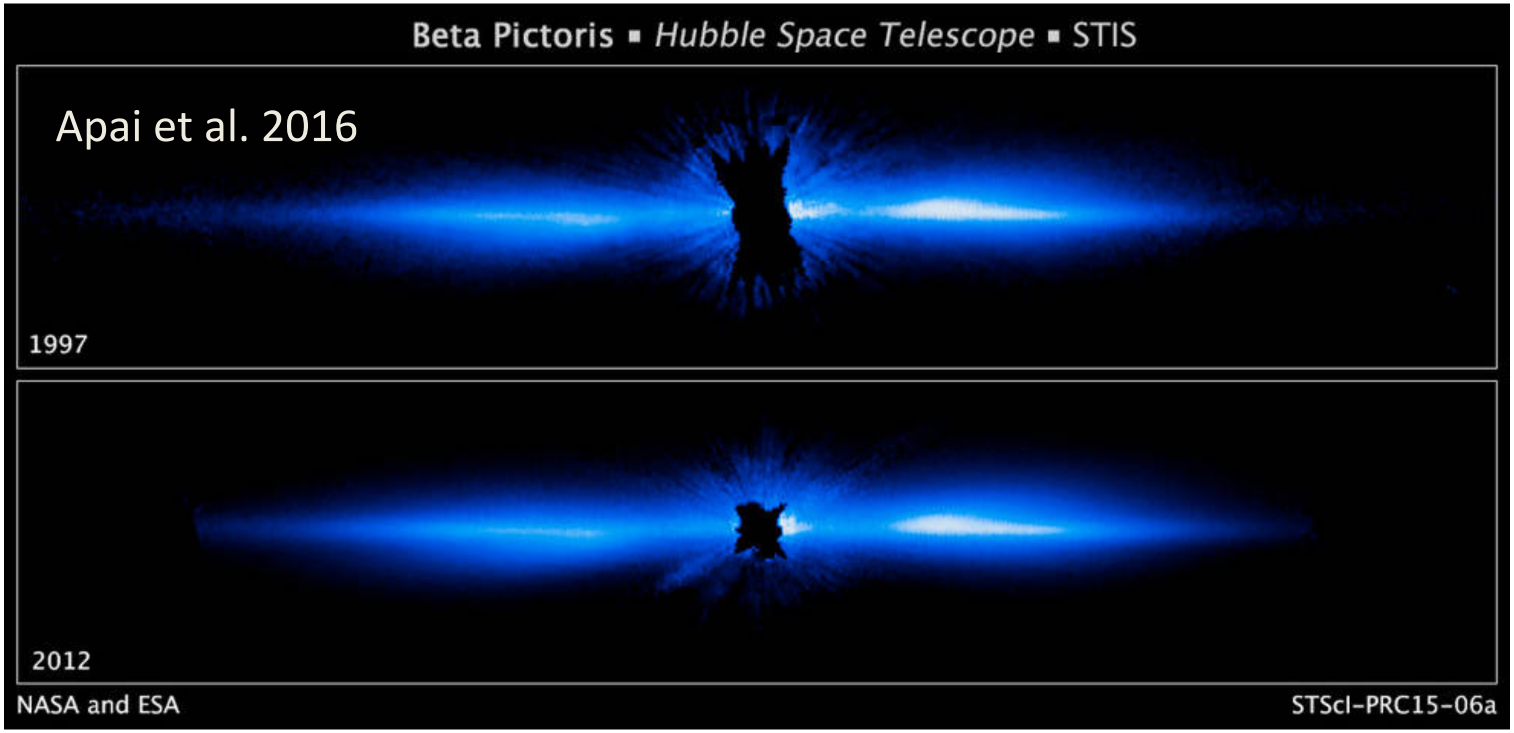
Giant planets have scattering hazes (photochemistry?)



Blue-optical and UV observations during transit are important to characterize clouds and haze prior to JWST

Ongoing and proposed programs will map the prevalence of clouds and haze as a function of temperature and surface gravity

Protoplanetary and Debris disks



HST can image faint structures not possible using ground AO, especially at blue wavelengths

HST can roll +/- 30^{o} for ADI, versus +/- 5^{o} for JWST

In favorable cases, HST can image giant planets in the disk

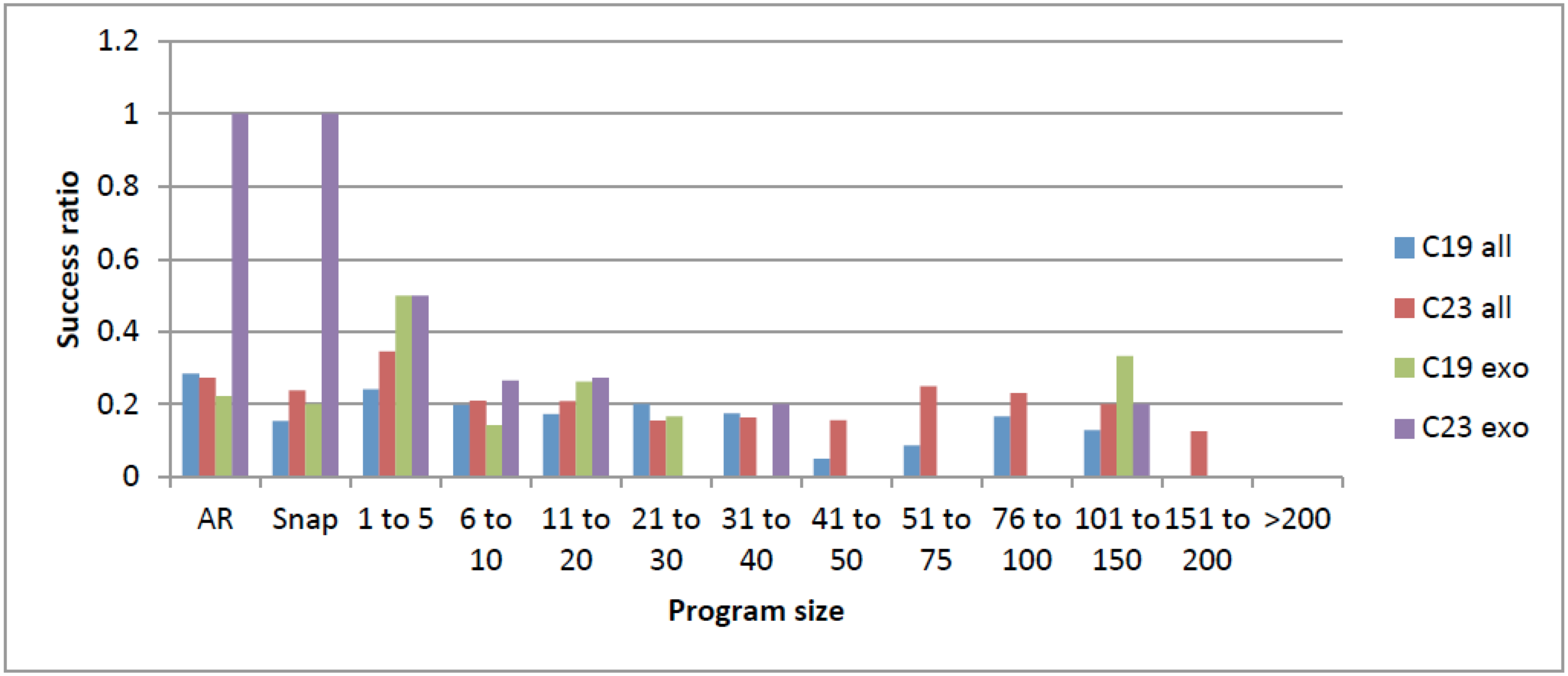
Exoplanet success rate
with gender breakdown

Cycle	*Total exoplanet proposals*	*Male P.I. success rate*	*Female P.I. success rate*	*Exoplanet success rate*	*Average success rate*
18	66	16.0%	0.0%	12.1%	18.7%
19	66	22.6%	15.4%	21.2%	19.6%
20	60	23.5%	22.2%	23.2%	21.3%
21	63	15.7%	8.3%	14.3%	23.1%
22	69	17.5%	8.3%	15.9%	23.2%
23	91	23.9%	30.0%	25.3%	23.4%

Scientific categories of successful exoplanet proposals, since Cycle-18

Topical Category	*Number*
Astrometry	2
Confirmation	3
Direct imaging (disks & planets)	13
Disk composition	1
Microlensing	1
Stellar and host environment	6
Theory	3
Transiting planets - atmospheres	46
Transiting planets - magnetospheres	1
Variability	3
White dwarf spectra	13

Success rate of exoplanet proposals compared to all proposals, since Cycle 19



Solicit input from the community....

Online survey (January 2016) advertised via e-mail, social media, and presentations at ExoPAG, AAS, and other meetings

Questions on the survey asked about:

- Current and future role of HST in exoplanet science
- The proposal review process
- Scientific priorities in the exoplanet community
- Proposal strategies

Professional status	***Number of respondents and percentage***
Faculty	24 (35%)
Research scientists	21 (30%)
Postdocs	15 (22%)
Graduate students	7 (10%)
Other	2 (3%)

Current & future role of HST in exoplanet science

Respondents pointed out that:

- HST is the only telescope with broad wavelength coverage from UV to IR
- Space-based observations are necessary to avoid telluric contamination in the near-IR and to ensure that time critical phenomena (e.g., transits) are not missed
- HST/WFC3 is the only instrument able to achieve the sensitivity required to observe spectra of exoplanetary atmospheres after the demise of cold Spitzer

Community view on legacy science and to prepare for JWST

Observations in the UV:
- Scattering by exoplanet atmospheres in transit
- Escaping atmospheres via strong resonance lines
- Host stars

Characterization of atmospheres:
- Transits & eclipses with WFC3; JWST preparation
- UV transits (as per above)

Imaging of disks:
- FOV and sensitivity surpasses ground AO
- Deep STIS imaging in the visible to complement JWST and ALMA

The proposal and time allocation process

Does the current time allocation process work well?

Mixed responses, one third positive, one third neutral, one third negative

Separating exoplanet and solar system panels

Multiple respondents viewed this favorably

Proprietary periods

Frequent suggestion to modify the proprietary process for Large programs – data for each planet would become public only after all visits

Mid-cycle proposals

Welcomed, but complaints about the 5 orbit limit

Identify key observations...for legacy and/or preparation for JWST

Committee view on legacy science

- Atmospheres of transiting exoplanets
  - Escaping atmospheres via strong UV lines
    - Close-in rocky planets may be remnants
    - Intrinsically strong UV lines probe outflow
  - Clouds and hazes
    - Have been probed successfully in visible & IR, but blue-optical and UV give leverage
  - Infrared spectroscopy and phase curves
    - Successful, and setting up JWST
    - Complementary to UV spectroscopy

Committee view on legacy science, con't

Direct imaging and spectroscopy of disks and planets

- Morphology from HST in blue-optical; ground-AO in IR
- Strong atomic lines in the UV probe the gas component

Accretion onto white dwarfs

- Orbital decay of asteroidal bodies – probes the small-body component of exoplanetary systems
- Strongest lines are in the UV

Stellar physics with exoplanet implications

- Stellar UV spectra are crucial for exoplanet photochemistry

Ten years into the future – next slide

Ten years in the future...we expect to:

Have characterized a large sample of exoplanets using transmission spectroscopy, and (for the hottest planets) spectroscopy at secondary eclipse

Understand the occurrence of haze and clouds as a function of temperature, surface gravity, and type of planet, enabling efficient use of JWST

Have identified many cloud-free planets whose gaseous abundances can be measured with high sensitivity and accuracy

Have measured escaping atmospheres for a wide range and type of planets

Extend wavelength coverage of the best JWST exoplanetary spectra to HST's FUV-UV-near-UV-blue optical wavelengths

Ten years in the future...we expect to (con't):

Have measured spectroscopic phase curves for the highest S/N exoplanet targets, laying the groundwork for potential phase-resolved spectroscopy by JWST

Have made optical scattering measurements for debris disks to be targeted by JWST

Have measured rotational modulation for directly imaged planets, revealing the nature and longitudinal distribution of their clouds

Understand many new aspects of debris disk evolution, e.g., how planet formation remnants accrete onto white dwarfs, and what that tells us about planet formation

Understand the UV spectra of planet-hosting stars - no longer a source of uncertainty for photochemical modeling

Mechanisms to coordinate HST observational programs with priorities

(we take that to mean recommendations)

Recommendations

Emphasize HST's unique capabilities

In addition to the obvious (UV), HST has *other* unique capabilities, e.g., high spectrophotometric precision for transits at $\lambda < 600$ nm, and high contrast imaging over large FOVs - also at blue wavelengths

Gather legacy observations to prepare for JWST

Context observations at short wavelength, e.g., debris disk morphology to complement JWST & ALMA, UV spectroscopy of polluted white dwarfs with JWST-observable disks, NUV/blue optical observations to probe haze and clouds during transit

(Do not discourage red and near-IR observations)

For transits, deep multi-visit spectroscopy with WFC3 can sharpen the questions to be addressed by JWST

Recommendations, continued

Enable ambitious programs without sacrificing modest ones

Transit observations are often very single-purpose, so a Treasury program won't cover all possible transit science

Very Large Treasury proposals should not (and do not) compete directly with small proposals

Monitor the success of proposals in the medium size range

Clarify policies for data and code sharing

Large program observations for a given planet should become public only when all visits are observed – promotes better science

Encourage exoplanet teams to share their data analysis codes

Respond rapidly to new planets

Mid-cycle capability almost achieves this, but the 5-orbit limit can be inconsistent with science

Allow large ToO programs (e.g., TESS follow-up)

Recommendations, continued

Preserve and refine the allocation process

- Community view: it's generally working
- Need more specialized reviewers per panel
- Separate exoplanet and solar system panels should allow the above
- Associated funding is extremely helpful
- Preserve archival and theory grants

Develop a transit noise calculator to support proposers and panelists

- It can help to clarify the credibility of S/N estimates

Preserve coordinated observing capabilities

- NOAO, NRAO, Spitzer, Chandra, XMM-Newton
- (panchromatic is good)

Continue to host HST & JWST exoplanet Workshops

Thank you for listening..!