UV of Science and Technology Interest Group (UVSTIG)

Organizers: Stephan McCandliss (JHU) and Jason Tumlinson (JHU/STScI)

Major activities:

(1) Monthly QUEST Talk series: the Quorum for UV Exploration of Science and Technology

(2) "not the AAS" Splinter Tuesday Jan 11 from 12 noon - 1:30 EST

(3) looking ahead into 2022, we will synthesize tech needs from Astro2020 recommendations and feed these into PAG and COR office activities

to sign up for the email list, send a blank email to UVSTIG-join@lists.nasa.gov
and visit https://cor.gsfc.nasa.gov/stigs/uvstig/QUEST/

also: please attend general COPAG session tomorrow at noon eastern

Context

Pathways to Discovery in Astronomy and Astrophysics for the 2020s

What are the key scientific challenges for astronomy and astrophysics in the next decade? *Pathways to Discovery in Astronomy and Astrophysics for the 2020s*, the National Academies' latest decadal survey, identifies the most compelling science goals and presents an ambitious program of ground- and space-based activities for future investment. The report recommends critical near-term actions to support the foundations of the profession as well as the technologies and tools needed to carry out the science.

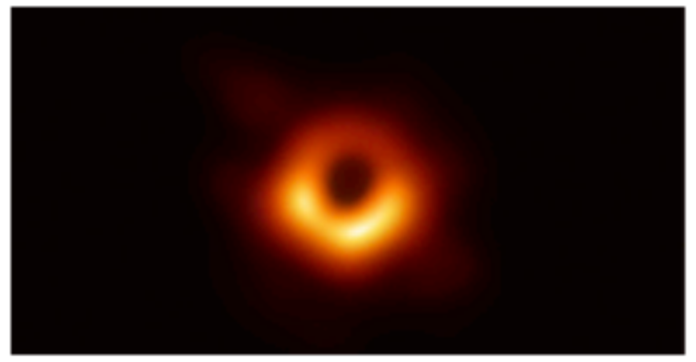
Key Scientific Challenges for the Next Decade

Worlds and Suns in Context

Priority Area: Pathways to Habitable Worlds

Understanding the connections between stars and the worlds that orbit them, from nascent disks of dust and gas through formation and evolution, is an important scientific goal for the next decade. The effort to identify habitable Earth-like worlds in other planetary systems and search for the biochemical signatures of life will play a critical role in determining whether life exists elsewhere in the universe.

KEY RECOMMENDATIONS:



New Messengers and New Physics

Priority Area: New Windows on the Dynamic Universe

Over the next decade, a range of complementary observations—from radio to gamma rays, gravitational waves, neutrinos, and high-energy particles—will enable investigations into the most energetic processes in the universe and address larger questions about the nature of dark matter, dark energy, and cosmological inflation. These growing capabilities will enable closer study of neutron stars, white dwarfs, black hole collisions, stellar explosions, and the birth of our universe.

KEY RECOMMENDATIONS:

Cosmic Ecosystems

Priority Area: Unveiling the Drivers of Galaxy Growth

Research in the coming decade will revolutionize our understanding of the origins and evolution of galaxies, from the cosmic webs of gas that feed them to the formation of stars. New observational capabilities across the electromagnetic spectrum along with computation and theory will help resolve the rich workings of galaxies on all scales.

KEY RECOMMENDATIONS:

Pathways to Discovery (PtD) Mission Recommendations

GOMTMP

The NASA Astrophysics Division should establish a Great Observatories Mission and Technology Maturation Program, the purpose of which is to co-develop the science, mission architecture, and technologies for NASA large strategic missions identified as high priority by decadal surveys. (§7.7.1, page 7-8 to 7-11).

The report specifies a total of $1.2B this decade for the GOMTMP, which breaks down into $800M for the IR/O/UV flagship starting as soon as practical, and then by $40M/year for the other two starting in the second half of the decade.

IR/O/UV
or LUVEx,
or IOUST

After a successful mission and technology maturation program, NASA should embark on a program to realize a mission to search for biosignatures from a robust number of about ~25 habitable zone planets and to be a transformative facility for general astrophysics. If mission and technology maturation are successful, as determined by an independent review, implementation should start in the latter part of the decade, with a target launch in the first half of the 2040s (page 7-17).

Tech Dev
SAT+APRA+

NASA should continue funding for the Strategic Astrophysics Technology Program, and should expand proposal calls to include intermediate level technology maturation targeted in strategic areas identified for the competed Probe class missions (page 6-5).

NASA should increase funding levels for the Detector Development and Supporting Technology components of the Astrophysics Research and Analysis Program. Priority should be placed on increasing grant sizes for larger efforts as well as increasing the overall funding in the technology elements of the program. The total increase needed to ensure a healthy selection rate and appropriate grant sizes is estimated to be about 50 percent above inflation (page 6-4).

Time Domain

NASA should establish a time-domain program to realize and sustain the necessary suite of space-based electromagnetic capabilities required to study transient and time-variable phenomena, and to follow-up multi-messenger events. This program should support the targeted development and launch of competed Explorer-scale or somewhat larger missions and missions of opportunity.

Foundations

PtD also made a number of recommendations about strengthening and diversifying the PI base and proposing teams that will be the subject of Erika Hamden's presentation.

Our goals for today

(1) Assess and discuss the Pathways to Discovery recommendations that bear on our work

(2) hear about the latest tech developments

(3) kick off 2022 UVSTIG analysis of “gaps” in UV/optical technological readiness in light of the Astro2020/PtD recommendations.

Agenda

Topic / Time / Candidate Speakers

Intro & Context / 10 min / Tumlinson

Science

- Time Domain Science / 10 min / Cenko
- **Exoplanet Science** / 10 min / Shkolnik
- **SMEX concepts** / 5 min / Heap

Tech

- Coatings / 10 min / Quijada
- Gratings / 10 min / Fleming

Broadening the PI base / 10 / Hamden

Panel / 20 min / McCandliss, Siegmund, Nikzad, Hamden

LUVOIR UV/Optical Technologies

Based on Table 11-3 of LUVOIR Report

Black font = current status as of 2018, from Table 11-3 of LUVOIR Final Report

Orange font = Expected TRL from SAT Quad Charts

TRL	Description	Far-UV Broadband Coatings: Al+eLiF+MgF2	Far-UV Broadband Coatings: Al+eLiF+AlF3	Far-UV Broadband Coatings: Al+eLiF	Configurable Shutters: Microshutters	Configurable Shutters: Micromirrors	High Efficiency Gratings: e-beam lithography	UV Microchannel Plate Detectors: CsI	UV Microchannel Plate Detectors: GaN	UV Microchannel Plate Detectors: Bi-alkali	UV Microchannel Plate Detectors: Funnel micro	Visible Detectors: 8K x 8K CMOS	Visible Detectors: 4K x 4K CCDs
7	System prototype demonstration in an operational environment.	SPRITE Cubesat Prime Mission			FORTIS Rocket for 128x64 format								
LUVOIR Preliminary Design Review													
6	System / sub-system model or prototype demonstration in an operational environment.	SPRITE Cubesat I&T					CHESS echelle grating Fleming SAT	meets requirements for 100-150 nm					
5	Component and/or breadboard validation in relevant environment.	ALD on >20 cm optics; aging tests **Hennessy SAT; Quad**	SISTINE rocket telescope; small shaped optic meets requirements France APRA	Meets performance requirements, but is environmentally unstable	2021 Greenhouse SAT Goal	UV performance measurements on re-windowed XGAs **Ninkov SAT ; Quad**			Vallerga SAT			Figer SAT	8K x 8K devices exist with 18 micron pixels, lacks high speed subarray readout for guiding
4	Component and/or breadboard validation in lab environment					>5000:1 contrast achieved on re-windowed XGA format (1024x768) **Ninkov SAT ; Quad**			meets requirements for 100-150 nm; requires devel for large tile size and integration with cross-strip readout. GaN has better Solar-blind performance		Demonstrated 50% improved QE with CsI photocathode	4K x 4K devices exist, require development for 8K x 8K and readout optimization	
3	Analytical and experimental critical function and/or characteristic proof of concept	Meets performance requirements, but requires demonstration on meter-class optics, validation of uniformity, repeatability, and env. stability **PVD; Quijada SAT; Quad**			840x420 prototype demonstrated, but requires devel. to survive launch **Greenhouse SAT ; Quad**		curved grating substrates (KF) Fleming SAT						
		> 50% over 100-115 nm, > 80% over 115-200 nm > 88% over 200 - 850 nm, > 96% over > 850 nm, < 1% reflectance non-uniformity over primary mirror in coronagraph bandpass (200-2000 nm)			840x420 format, two-side buttable, high contrast			200 mm x 200 mm tile size > 30% QE between 100-200 nm				8K x 9K format, < 7 µm pixels, three-side buttable, ~1 e- read noise, 10^{-4} e-/pix/s dark at 170K	
		$Al+eLiF+MgF_2$ **Baseline**	$Al+eLiF+AlF_3$	Al+eLiF	Microshutters **Baseline**	Micromirrors	e-beam lithography	CsI **Baseline**	GaN **Baseline**	Bi-alkali	Funnel micro	8K x 8K CMOS **Baseline**	4K x 4K CCDs
		Far-UV Broadband Coatings LUVOIR pg. 11-25			Configurable Shutters LUVOIR pg. 11-26		High Efficiency Gratings	UV Microchannel Plate Detectors LUVOIR pg. 11-26				Visible Detectors LUVOIR pg. 11-27	

LUVOIR UV/Optical Technologies

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WHAT HAPPENS HERE?

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	Technology	Far-UV Broadband Coatings LUVOIR pg. 11-25			Configurable Shutters LUVOIR pg. 11-26		High Efficiency Gratings	UV Microchannel Plate Detectors LUVOIR pg. 11-26				Visible Detectors LUVOIR pg. 11-27	

for discussion:
what will it take to be ready,
to go to mission implementation in ~2026?

what combination of lab, small mission, and/or
prototypes will get us there?

what additional analysis can we do to inform COPAG
and NASA efforts towards the GOMTMP?