



ASTRA · COPAG

Mission-Concept Binning

Shouleh Nikzad (COPAG-EC Chair) and Sabrina Stierwalt (COPAG-EC Vice Chair)

On Behalf of

Cosmic Origins Program Analysis Group (COPAG)

and associated

Science Interest Groups (SIGs), Science and Technology Interest Groups (STIGs), and Science Analysis Groups (SAGs)

And in collaboration with

Cosmic Origins Program Office

Ad ASTRA Workshop

September 1, 2026

Pasadena, CA

Cosmic Origins Program Analysis Group (COPAG)



Get involved to represent your communities:

NASA PAGs are community-based interdisciplinary forums for coordinating community input in support of NASA SMD Science Program objectives and their implications for activity prioritization for future exploration. PAGs provide their analysis findings to the NASA Astrophysics Division Director.

COPAG Executive Committee (EC) lead analysis and coordinate COPAG activities; members should span breadth of COR science, technology
COPAG EC created a strategic plan to make efficient and effective use of volunteers to serve the community and NASA

Current activities:

Quarterly Town Halls, AAS Splinters, Science Gap Analysis, Cosmic Pathfinders, SIGs, SAGs, STIGs

Science Interest Groups: Galaxies, Stars, Cosmic Ecosystems, HWO, ML/AI, UV, IR

Science Analysis Groups: Red Limit, Spat. Resolved UV Spectroscopy, OVI

Stephanie Clark

Program Support Manager

Peter Kurczynski

COR Chief Scientist:

Swara Ravindranath

COR Deputy Chief Scientist

Dori Daou

COR Program Scientist

Mia Bovill

COR Deputy Program Scientist

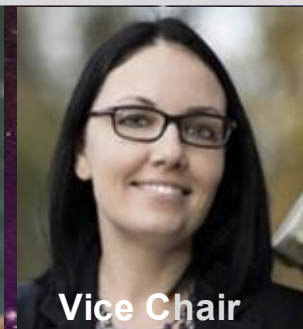
Ronald Gamble

COR Scientist



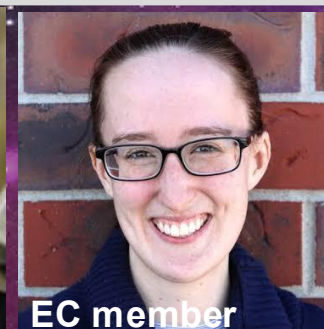
EC Chair

**Shouleh
Nikzad**



Vice Chair

**Sabrina
Stierwalt**



EC member

**Emily
Witt**



EC member

**Hsaio-Wen
Chen**



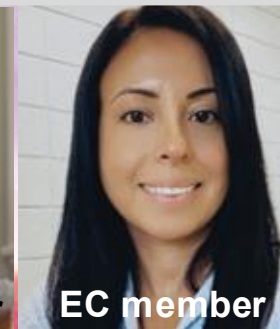
EC member

**Rachael
Beaton**



EC member

**Sanchayeeta
Borthakur**



EC member

**Rana
Ezzeddine**



EC member

**Varsha
Kulkarni**



EC member

**Joaquin
Vieira**

COPAG SIGs, STIGs, and SAGs



NGO SAG

HWO Red Limit

AGN SIG

IR STIG

TDAMM SIG

Galaxies SIG

UV/Visible STIG

OVI SAG

HWO SIG

AI/ML STIG

Sanch Borthakur

Joe Burchett

Cosmic Ecosystem SIG

Stars SIG

Spatially Resolved UV Spectroscopy SAG

Estelle Janin

Vivian U

Hsiao-Wen Chen

Rachael Beaton

Derek Buzasi

Yuan-Sen Ting

Jay Wadekar





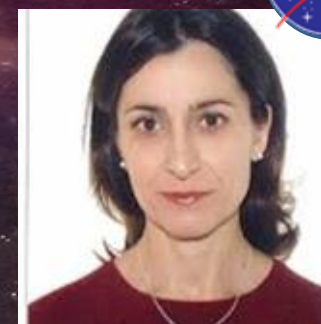


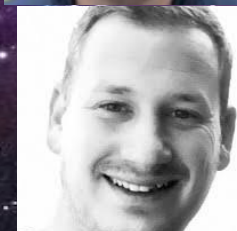




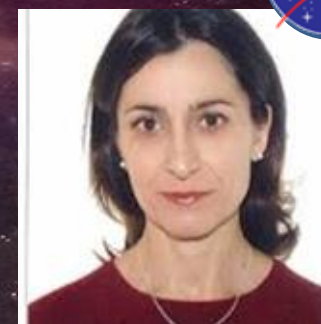


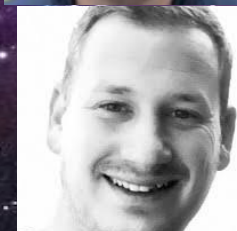


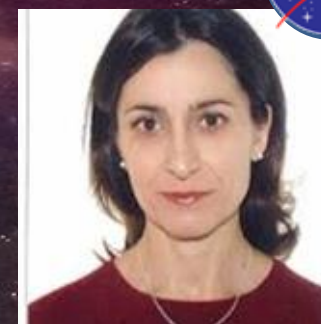


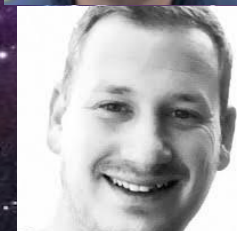


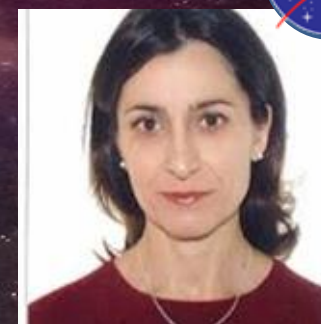


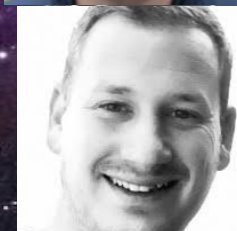


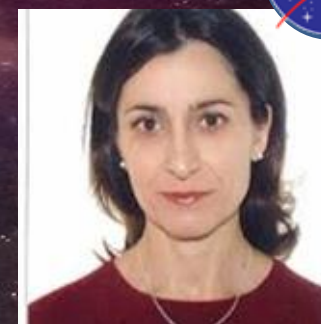


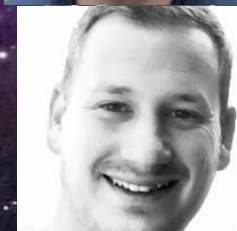


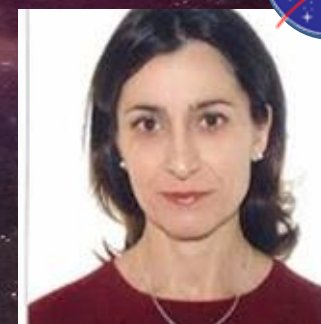


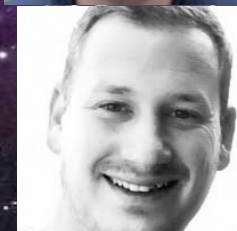


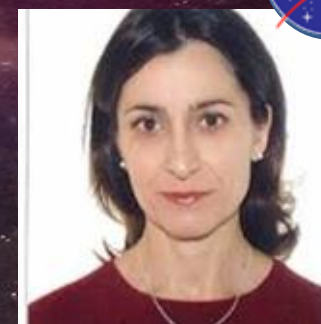


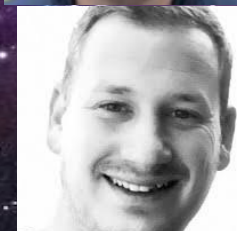


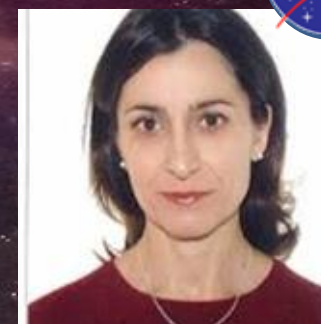


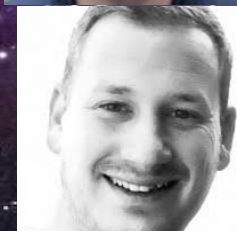


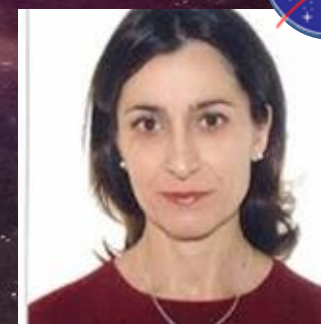


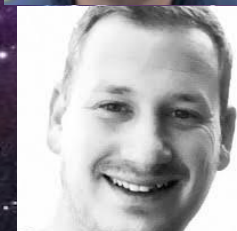


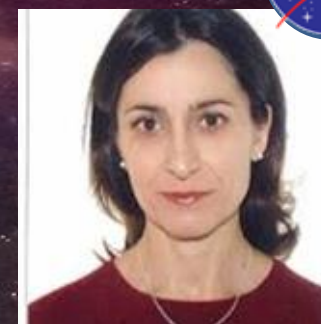


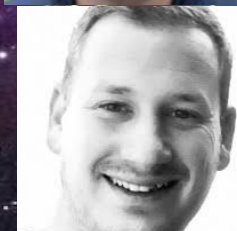


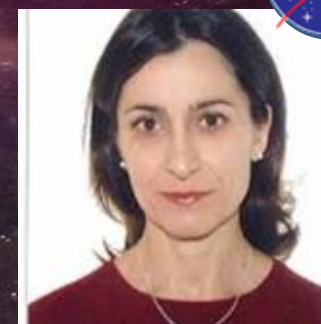


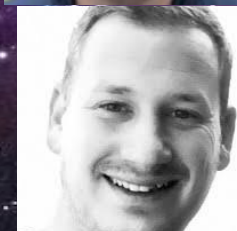


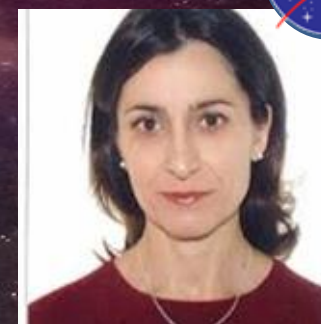


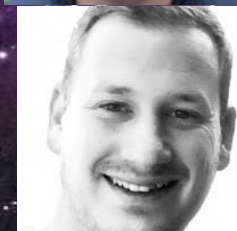


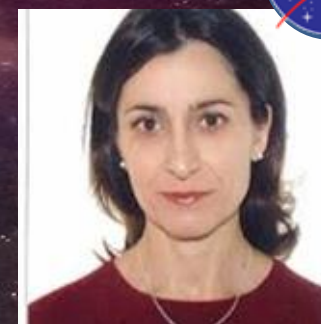


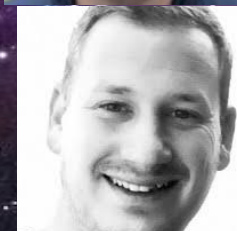


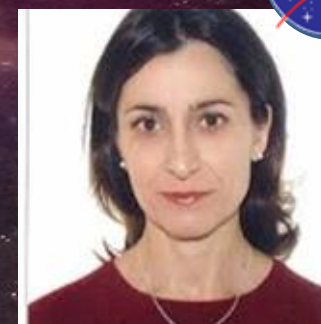


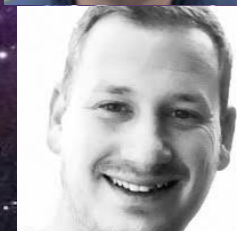


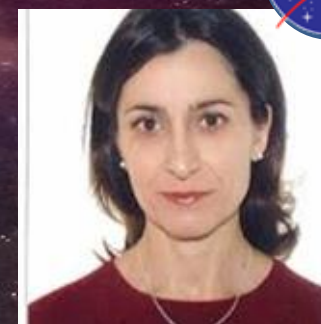


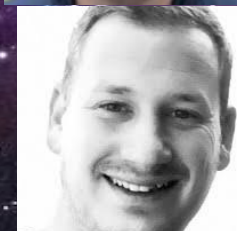


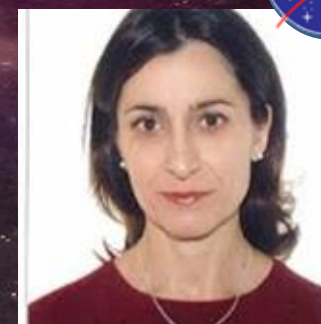


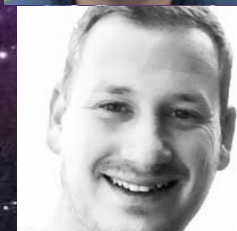


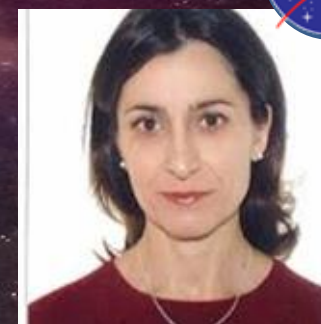


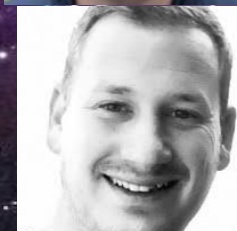


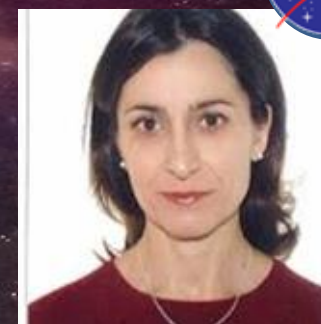


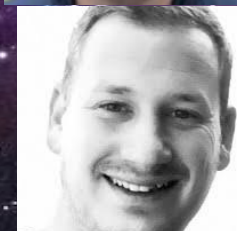


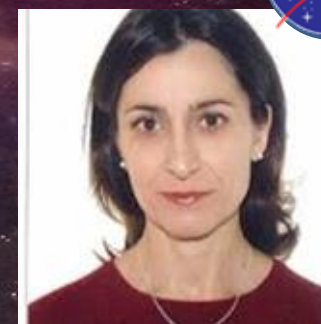


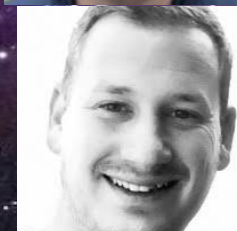


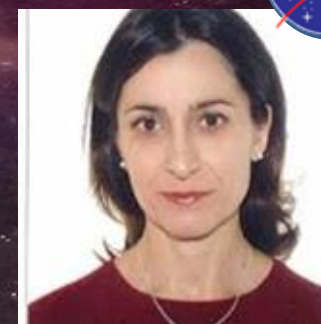


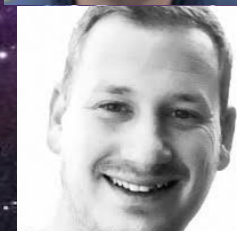


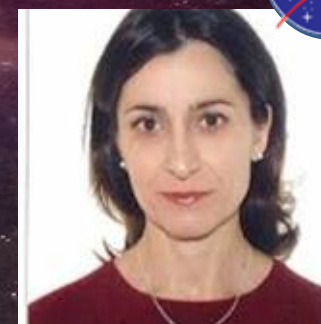


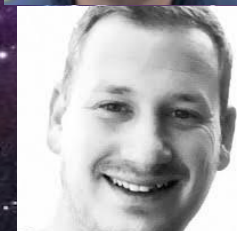


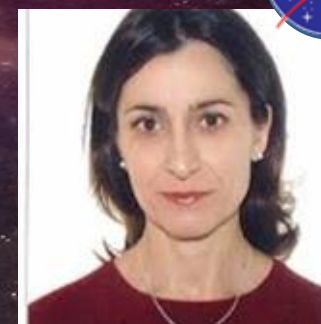


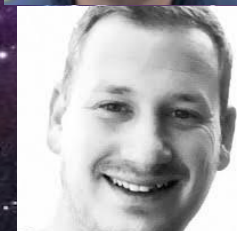


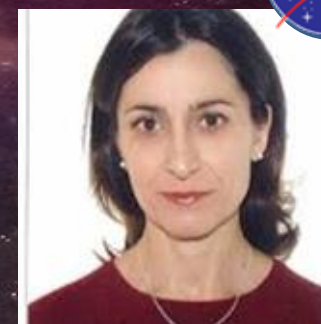


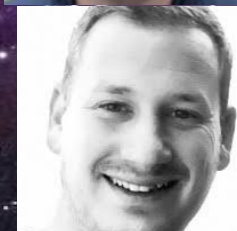


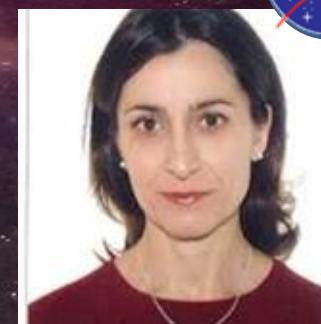


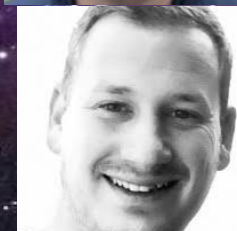


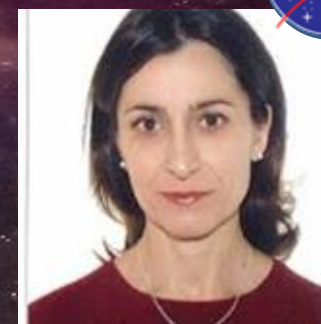


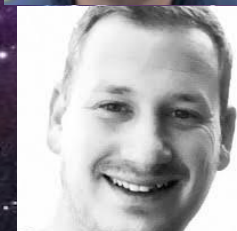


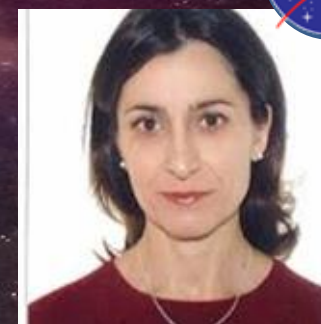


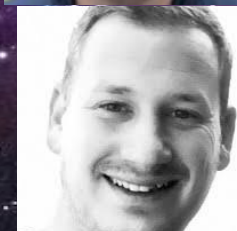


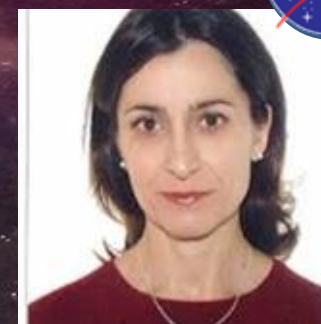


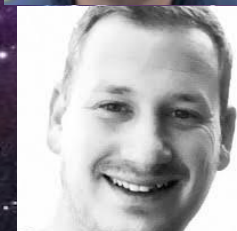


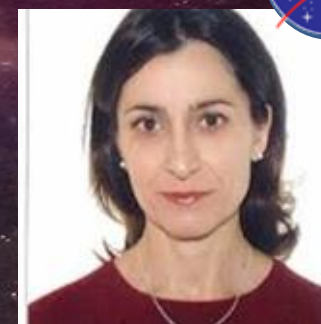


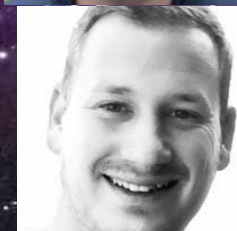


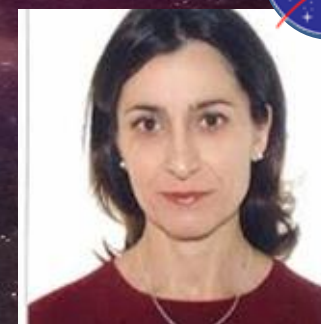


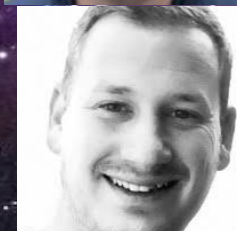


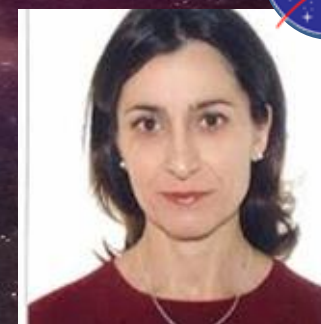


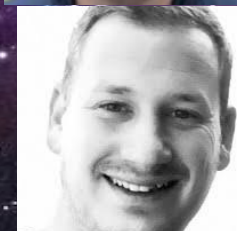


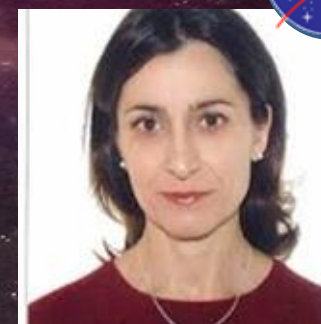


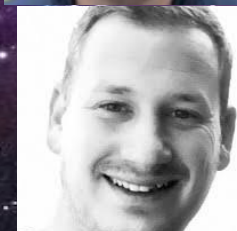


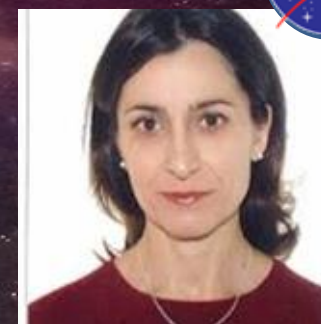


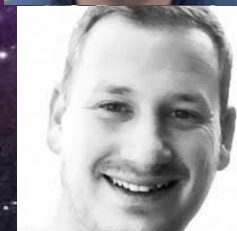


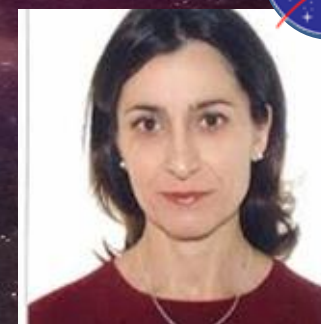


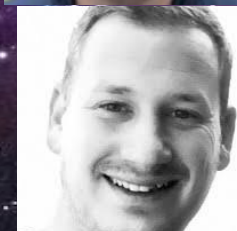


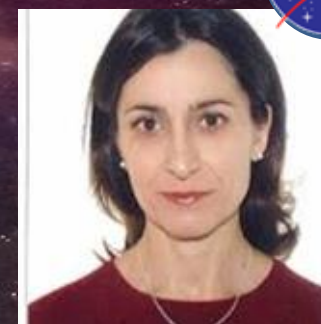


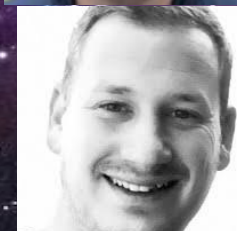


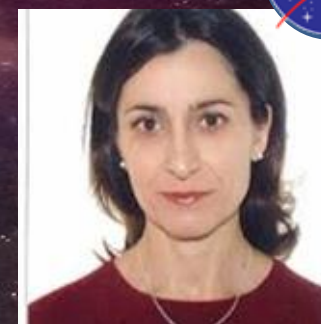


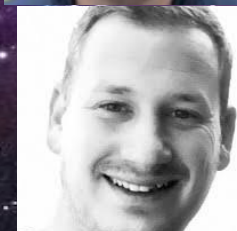


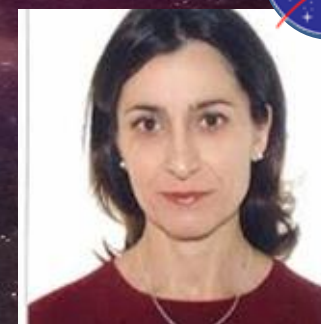


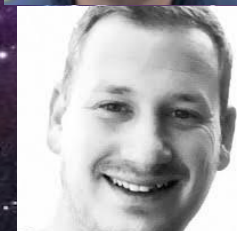


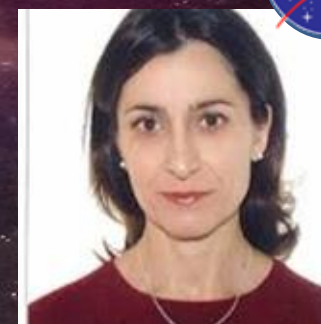


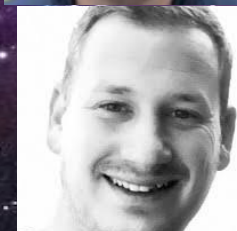


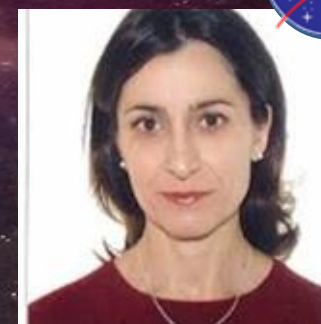


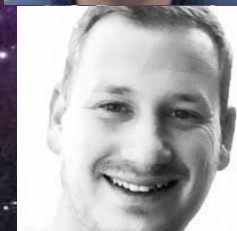


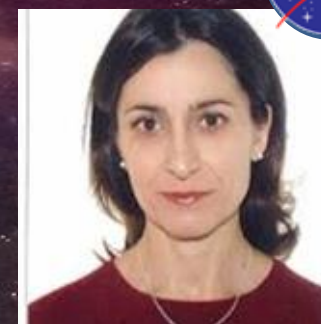


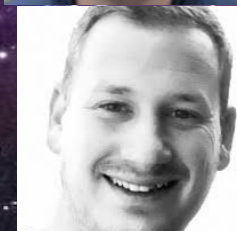


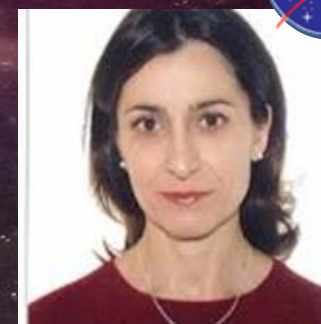


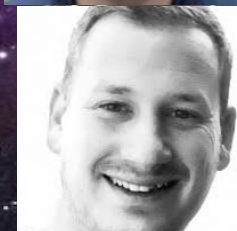


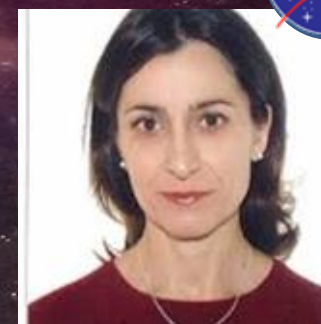


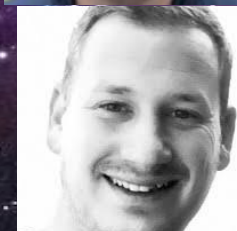


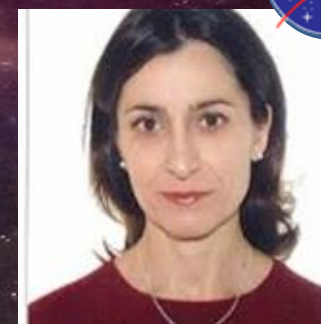


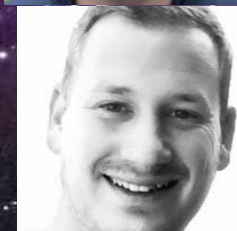












Mission-Concept Type Binning Process

91 submissions in total

51 submissions list COPAG relevance

Some general observations:

some concepts were instruments or measurement types, some were not stand-alone mission, concepts were at various stages of development and maturity,

Concepts were binned according to type with input from EC and working with Program Office

- Bins are intended to be a grouping of concepts that could be studied by a single study team
- Bins were formed based on the submissions
- Specificity favors a large number of bins.
 - This allows identifying trends in science and capabilities
- Responding to ASTRA Initiative charge favors a small number of bins.
 - Large number of concepts per bin increases their weight
- We seek to find a compromise in this tension

Mission-Concept Type Binning

A preliminary COPAG assessment of the concept submissions created the following:

1. Gravitational Wave – 8 concepts
2. Radio/Submm Interferometry – 9 concepts
3. CMB Probe – 2 concepts (PhysPAG only)
4. FIR Interferometry – 2 concepts
5. MIR/FIR Spectroscopy – 8 concepts
6. NIR-MIR Interferometry – 3 concepts (ExoPAG only)
7. NIR-MIR Wide Field Imaging – 6 concepts
8. UVO interferometry – 5 concepts
9. UV Spectroscopy – 2 concepts
10. X-ray Imaging and Spectroscopy – 13 concepts
11. Gamma Ray/Cosmic Ray – 14 concepts
12. Constellations of Small Apertures – 7 concepts
13. Novel Architectures – 16 concepts

ASTRA · COPAG

Mission-Concept Novel Architectures

1. **SHADOW EYES - (Next gen universal model)** , Lead Author: Alex Massaro
2. **EGSP - A UNIFIED THEORY OF GRAVITY, QUANTUM MECHANICS, AND COSMOLOGY** , Lead Author: Andrew "AJ" Ensor
3. **Hybrid Solar Sail System**, Lead Author: Arya Chakraborty
4. **SALTUS: Single Aperture Large Telescope for Universe Studies** , Lead Author: Christopher Walker
5. **OBERON: A Mission-Scale Multi-Messenger Inference Architecture for Black Hole Discovery and Localization**, Lead Author: Bernard Kelly
6. **ASPECT: Astrometry Space Probe for Exoplanet Characterization and True-mass**, Lead Author: Eduardo Bendek
7. **Fluidic Telescope (FLUTE): Transformative Science with Ultra-Large, Single-Aperture Space Observatories**, Lead Author: Edward Balaban
8. **SpectrE** , Lead Author: Eric Huff
9. **A servicing mission to bring second-generation coronagraph instrumentation to the Habitable Worlds Observatory** , Lead Author: Garreth Ruane
10. **Hybrid Observatory for Earthlike Exoplanets** , Lead Author: John Mather
11. **SPACE STUDY IMPORTANCE FOR HUMAN LIFE AND BODY** , Lead Author: Mahi Hemang Kumar Bhatt
12. **A Coordinated Fleet of Flaglet-Scale Missions** , Lead Author: Regina Caputo
13. **Evolutionary Alignment Gravitational Loop Embodiment (EA-GLE) of the Precursor Alignment Core (PAC) Engine in the Unified Anthropic Gravity Framework**, Lead Author: Roberto Guenzani
14. **Solar Gravitational Lens Observatory (SGLO)**, Lead Author: Slava G. Turyshev
15. **Starshade: A Broad-Band, High-Throughput Architecture** for ExoEarth Discovery and Characterization, Lead Author: Stuart Shaklan
16. **Ardua: Unveiling the Baryon Cycle from Stars to the Cosmic Web** , Lead Author: Carlos Vargas

Summary Concept Matrix with Capabilities

	D	E	F	G	H	I	J	K	L	M			
Technology Dev Needed? More Required - Red More Useful - Yellow More Would be Nice - Green	Sub-Hz Gravitational Wave	Radio Submillimeter Interferometry	CMB Polarization & Spectral Distortion	FIR Interferometry	MIR-FIR spectroscopy	NIR-MIR Interferometry	NIR-MIR Wide Field Imaging	UV-Optical Interferometry	UV Spectroscopy	X-Ray Imaging & Spectroscopy	Gamma & Cosmic-Ray	Constellations of Small Apertures	Novel Architecture
Number of Concepts Submitted	8	8	2	2	8	2	8	5	3	14	14	7	
Harmonized Concept Category Mapping (from ASTRA cross)	H4	H5, H6, H7	H1	H10	H17, H18	H14	H16	H12, H13		H9, H8, H10	H2, H3	H11	H12, H13, H20
Detectors													
Interferometer Systems (inc. THz-FIR, Photonic L/O's and Mixers)		X		X									X
Sub-K / Quantum Detectors			X	X				X		X			X
Photon Counting Detectors (ext. sub-K)						X	X	X	X	X			X
Energy-Resolving Detectors								X		X	X		X
High Energy Astrophysics Detectors (inc. novel X-ray)										X	X		X
Gravitational Wave Detector Systems	X												X
Atom Interferometers or Atomic Clocks	X												X
Readout Electronics (inc. non-COTS readout, Converters)		X	X	X						X	X		
Optical Elements													
Antenna/Detector Coupling (inc. mirrors)			X	X						X			
Polarimetry		X	X	X		X	X	X		X			
High Resolution Dispensers (Etalons, VIPAs, Echeles)													X
Diffraction Gratings / GRISMs / Interference Gratings				X		X		X	X	X			X
Integral Field / Multi-Object Spectroscopy							X		X	X			
Coronagraphy / Nulling					X	X		X					
High Surface-Accuracy Primitives									X	X			X
Deployable Primary					X							X	X
Ultra-Wide Field Imaging							X					X	
Telescope System Infrastructure													
Beam-Connected / Deployable Apertures				X		X		X					X
Free-Flying Apertures (Drag Free, Reconfigurable Multi-Element)	X	X		X				X		X		X	X
Notes / Considerations (see: Blueprints & Reports / B77a)				X		X		X					X

Capability includes:

- Technology, e.g., detectors, optics, etc
- Telescope infrastructures
- Type of measurement
- Orbit or location requirements (cis lunar, L2, etc)

Summary Concept Matrix with Science Questions—*Work in Progress*

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
	Primary Approaches - Red (As per decadal Survey STM) Mission Primary Science - Yellow Secondary Science - Green	MIR-FIR spectroscopy	Sub-Hz Gravitational Wave	FIR Interferometry	CMB Polarization & Spectral Distortion	Radio Submillimeter Interferometry	Gamma & Cosmic-Ray	NIR-MIR Interferometry	NIR-MIR Wide Field Imaging	UV-Optical Interferometry	Constellations of Small Apertures	UV Spectroscopy	X-Ray Imaging & Spectroscopy	Novel Architectures
1	Determining new planetary environments and exoplanets to their host stars.	X												
2	Identifying and characterizing Earth-like planets, particularly those in habitable zones.			X						X				
3	Determining the composition and atmospheres of potentially habitable planets.	X								X				
4	Searching for biosignatures and other evidence of life beyond the Solar System.									X				
5	Understanding the processes governing star and planet formation.	X		X		X								
6	New Messengers and New Physics													
7	Understanding the nature and growth of black holes.					X							X	
8	Understanding neutron stars and their extreme physics.		X										X	
9	Studying black-hole and neutron-star mergers.		X											
10	Understanding stellar explosions and other transient phenomena.		X										X	
11	Combining observations of electromagnetic radiation, gravitational waves, neutrinos, and cosmic rays.	X	X			X	X				X	X	X	X
12	Investigating the earliest moments of the Universe.				X									
13	Constraining the nature of dark matter and dark energy.				X									
14	Testing fundamental physics under extreme conditions.		X										X	
15	Understanding cosmic inflation and the origin of cosmic structure.				X									
16	Cosmic Ecosystems													
17	Understanding how the first galaxies formed and evolved.	X												
18	Determining how galaxies acquire the gas needed to form stars.	X												
19	Understanding the circumgalactic and intergalactic media.													
20	Determining how stars form within galaxies.													
21	Understanding the formation and growth of supermassive black holes.													
22	Understanding feedback between stars, black holes, gas, and galaxies.													
23	Connecting galaxy evolution to the formation of stars and planetary systems.	X												
24	Understanding galaxy evolution across cosmic time and across a huge range of physical scales.													
25														
26														
27														
28														

Began classifying according to science using Astro2020 Decadal Survey Panel Questions

Harmonizing Bins with Other PAGs

We have begun mapping our bins to the other PAGs harmonized bins

- CMB Probe—H1
- Gravitational Wave—H4
- Radio/Submm Interferometry—H5, H6, H7
- FIR Interferometry —H16
- MIR/FIR Spectroscopy —H17, H18
- NIR-MIR Interferometry —H14
- NIR-MIR Wide Field Imaging —H19
- UVO interferometry —H12, H15
- UV Spectroscopy
- X-ray Imaging and Spectroscopy —H8, H9,H10
- Gamma Ray/Cosmic Ray —H2, H3
- Constellations of Small Apertures —H11
- Novel Architectures —H12,H13,H20

What have we learned so far?

COPAG has binned (classified) concepts into 13 types

These have binned according to capability and science

We have begun harmonizing the bins with the other two PAGs

What are the next steps?

Need to complete harmonization the COPAG concept type bins with the work of other PAGs bins

Create matrices that maps the mission concept types against science and capabilities (inspired by *Enduring Quests, Daring Visions, Kouveliotou, et al. 2014*)

This will be completed in the next two months

These results will be incorporated into a report to NASA Astrophysics Division Director