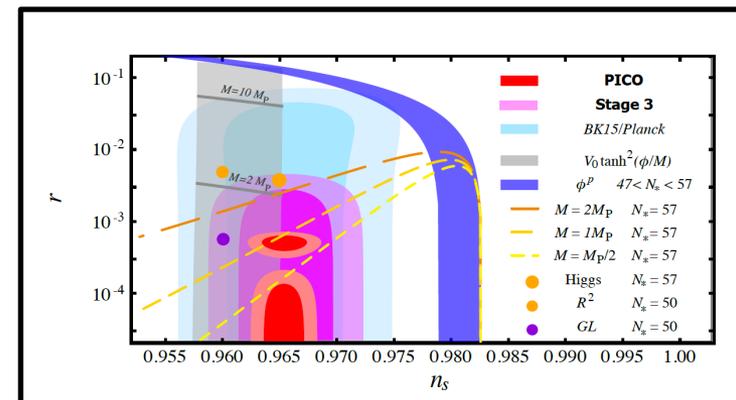
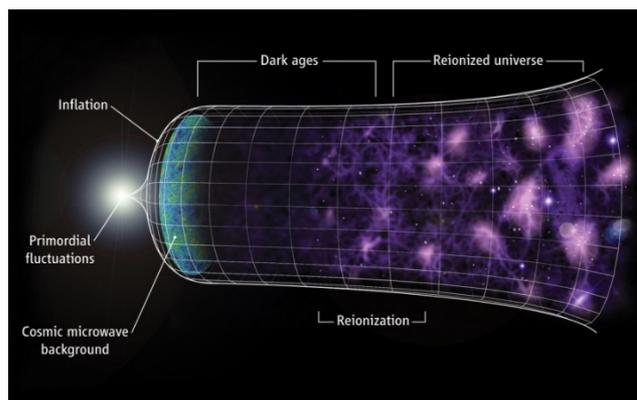
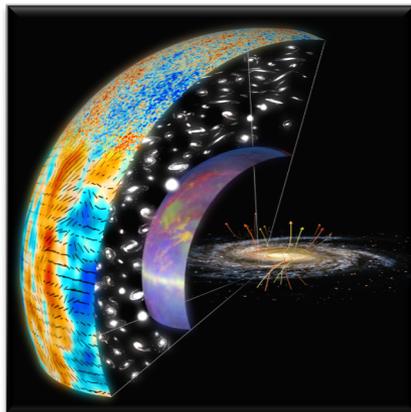


Inflation Probe Science Interest Group Update

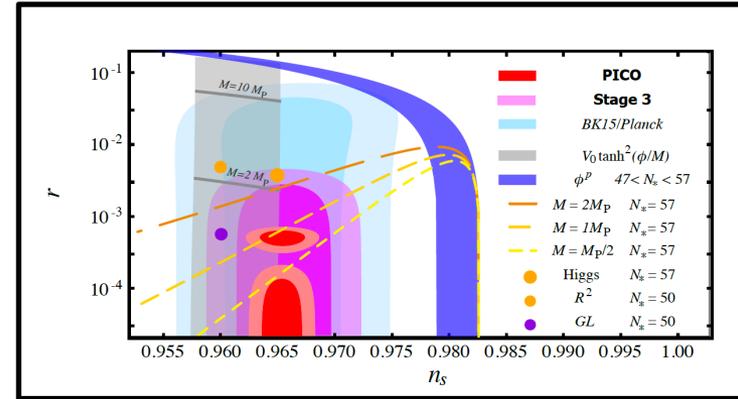
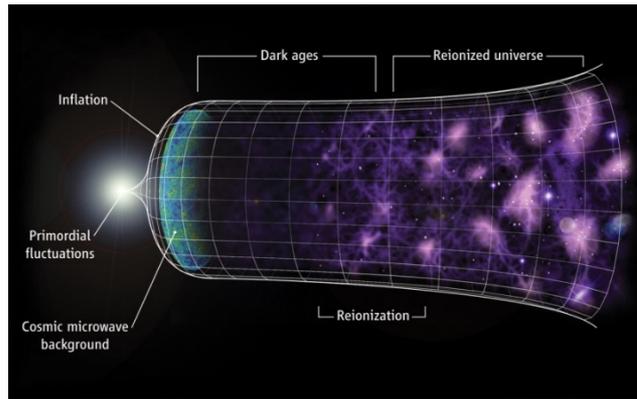
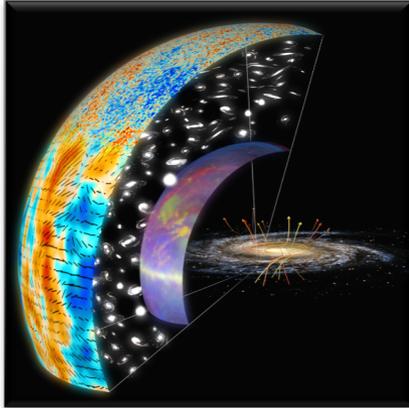


Graça Rocha

Jet Propulsion Laboratory/Caltech
Chair Emeritus, Physics of the Cosmos Program Analysis Group, PhysPAG
Co-Chair, Inflation Probe Science Interest group, IP SIG

graca.m.rocha@jpl.nasa.gov; graca@caltech.edu

Outline



Introduction to **PCOS**, **PhysPAG** and **IPSIG** (reminder)

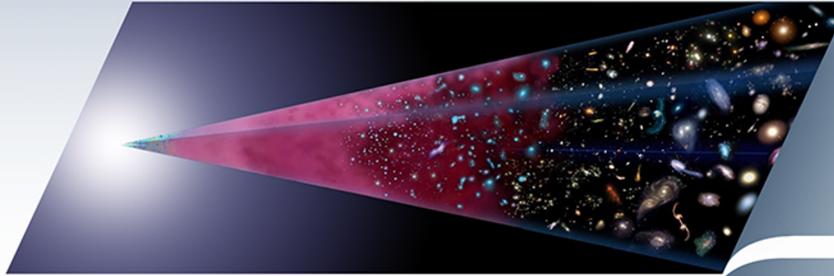
IPSIG Highlights, Activities and Goals

Why Astrophysics?

Astrophysics is humankind's scientific endeavor to understand the universe and our place in it.



How did our universe begin and evolve?



Physics of the Cosmos (PCOS)



How did galaxies, stars, and planets come to be?



Cosmic Origins (COR)



Are we alone?



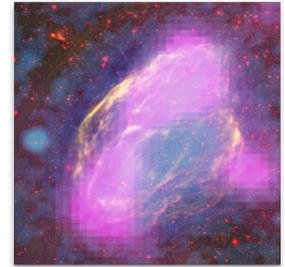
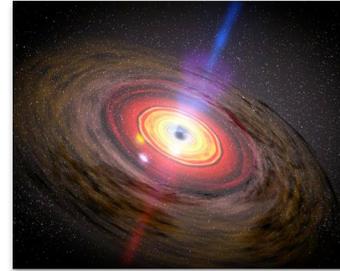
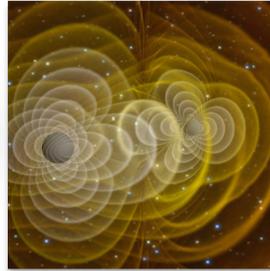
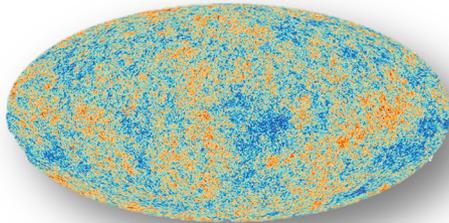
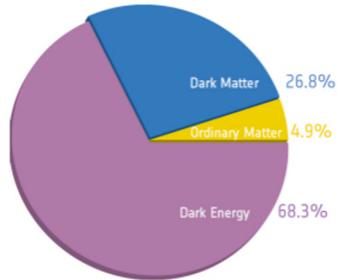
Exoplanet Exploration (ExEP)

Program Office Themes

Enduring National Strategic Drivers



Physics of the Cosmos Science Objectives



- Increase our knowledge of dark energy
- Precisely measure cosmological parameters governing evolution of the universe and test inflation hypothesis of Big Bang
- Test validity of Einstein's General Theory of Relativity and investigate nature of spacetime
- Understand formation and growth of massive black holes and their role in evolution of galaxies
- Explore behavior of matter and energy in its most extreme environments

More resources: <https://pcos.gsfc.nasa.gov>



Physics of the Cosmos

About PCOS

PhysPAG

Mission Studies

Technology

PCOS News Archive

Physics of the Cosmos Science

Physics of the Cosmos spans the fields of high-energy astrophysics, cosmology, and fundamental physics, and includes a wide range of science goals. These include the following:

Dark Energy

The discovery that the expansion of space is accelerating presents one of the most important scientific problems of our time. The implication that the universe is dominated by an unknown entity, now called "dark energy," that counters the attractive force of gravity, may revolutionize our understanding of cosmology and fundamental physics.

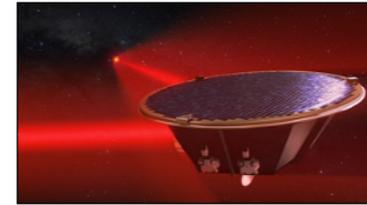
Read more [Expand our knowledge of dark energy](#)

Big Bang and the Evolution of the Universe

The cosmic microwave background (CMB) originated just 380,000 years after the Big Bang, when the Universe was dense, hot, and opaque. As the Universe cooled, the light was decoupled and escape from the matter. We observe that same light today, stretched by the expansion of the universe to a cold 2.7K glow. Observations of the CMB have driven our understanding of the early Universe, and are one of the few probes of the inflationary epoch.

Read more [Precisely measure the cosmological parameters governing the evolution of the universe and test the inflation hypothesis of the Big Bang](#)

General Relativity and the Nature of Spacetime



PCOS News

Program News and Announcements

16 December 2020

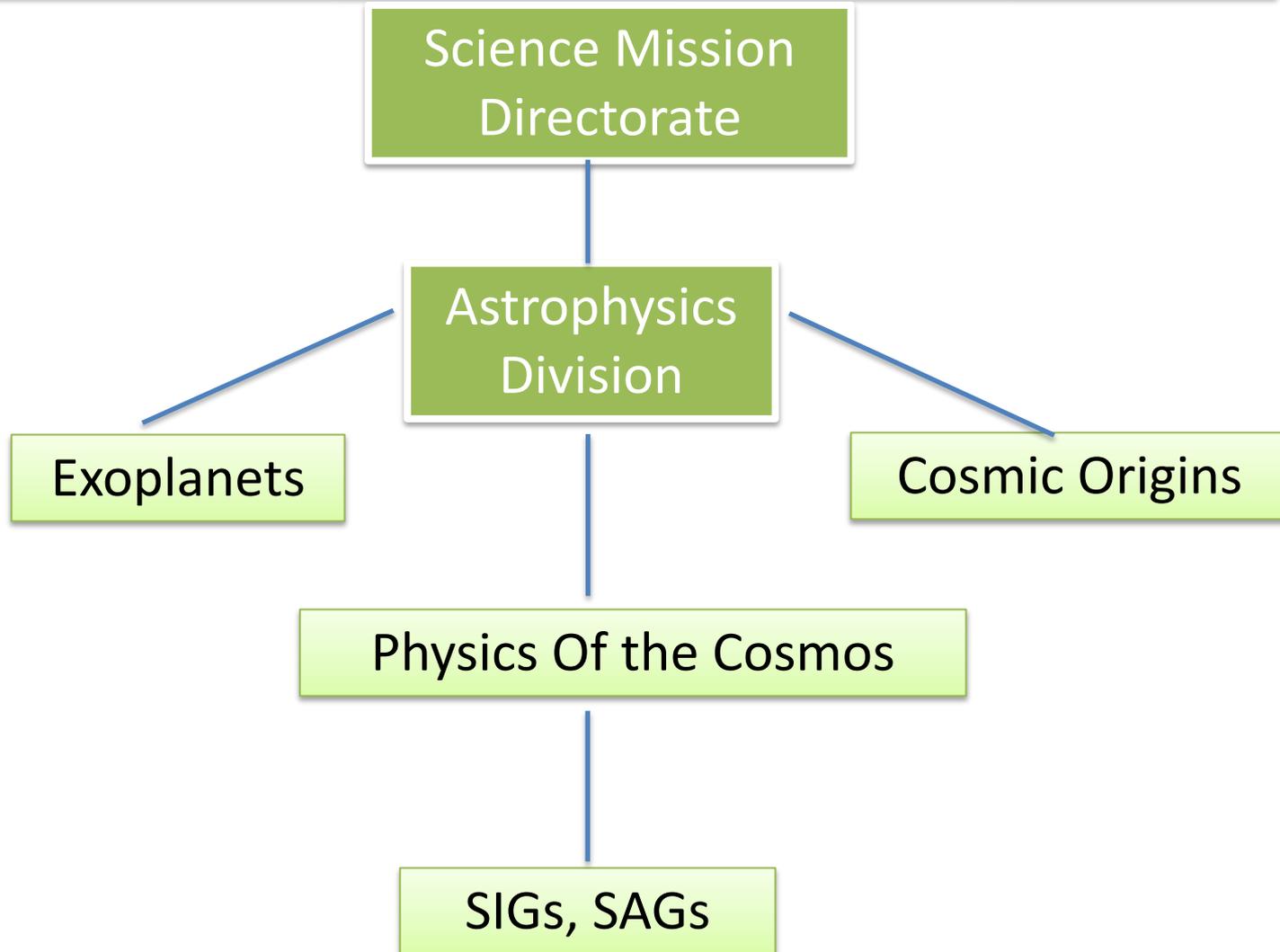
The 237th Meeting of the American Astronomical Society, Virtually Anywhere, 11–15 January 2021, will include Physics of the Cosmos events. The PCOS AAS2021 Meeting page lists currently scheduled sessions, presentations, chats, and displays » [Details](#).

4 December 2020

Payloads and Research Investigations on the Surface of the Moon (PRISM) Step-2 Due Date. Step-2 proposals now due **3 February 2021**. Step-1 proposal due date unchanged as **11 December 2020** » [Details](#).

4 December 2020

Release of Final text and Due Dates for ROSES Post-COVID Recovery program. Requests received by **4 January 2021** will be





Activities supporting PCOS goals and priorities:

- Managed by the PCOS/COR Program Office at NASA's Goddard Space Flight Center and reported to NASA Headquarters.
- Include:
 - **Mission studies** and pre-project mission oversight, insight, and support
 - **Strategic technology (SAT)** maturation oversight, insight, and support
 - **Community engagement**, including via the Physics of the Cosmos Program Analysis Group (PhysPAG)
 - Maintaining **science cognizance** to enable more successful NASA strategic planning

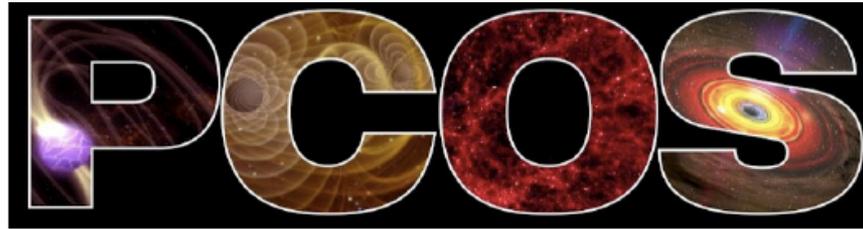
The PCOS Program Office hosts

- Athena Study Office
- LISA Study Office

and oversees

- science and
- technology activities

for NASA's contribution to these ESA-led and other strategic missions.

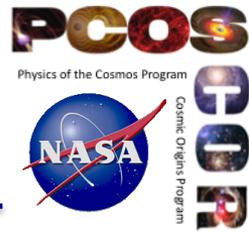


PCOS Chief Scientist enables ground-breaking science from space by working at the interfaces between missions and studies, technology, the community, and NASA HQ.

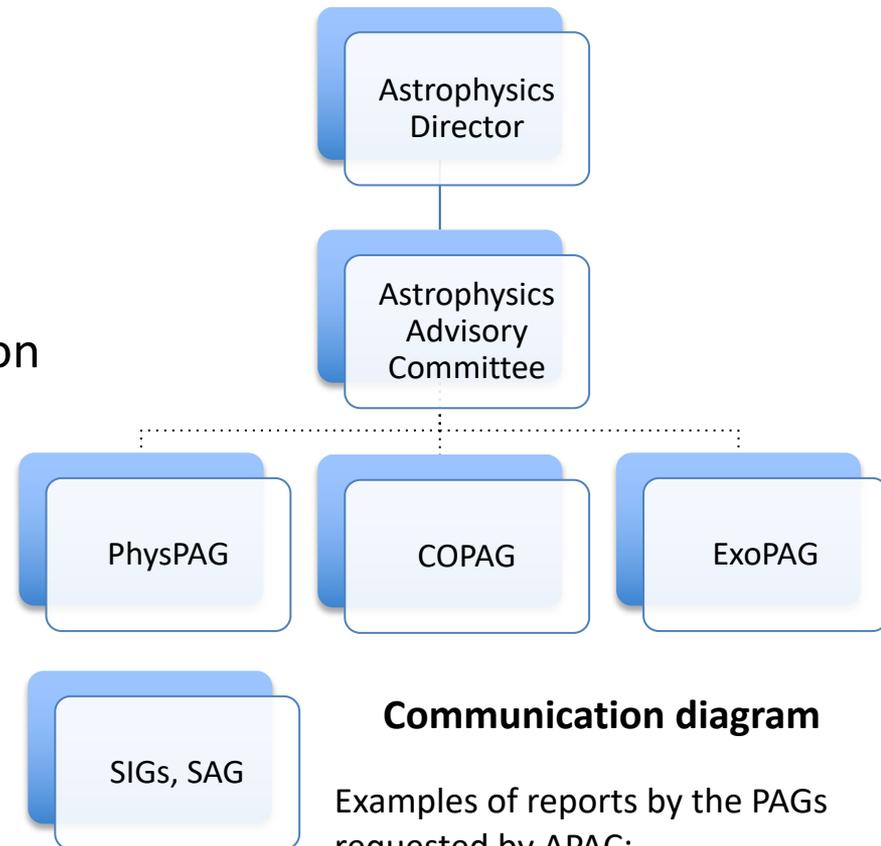
Current PCOS Science Goals and Priorities:

- Ensure a more successful **Decadal survey** by supporting community preparations and HQ activities, spanning the range of inputs: from science to missions, technology, and state of the profession, which all impact our ability to do ground-breaking science
- Ensure more **successful missions** by
 - supporting on-going mission studies and pre-projects, eg LISA, Lynx, Athena;
 - through technology efforts, eg SAT;
 - by coordinating with current missions; and
 - by preparing for studies for mission recommended by the Astro2020 Decadal
- **Engage the community** to support a successful APD portfolio.

Communicating with NASA Astrophysics via the Program Analysis Groups (PAGs)



- The Physics of the Cosmos Program Analysis Group (**PhysPAG**) **coordinates input and analysis** from the scientific community in support of the PCOS program objectives.
- Study Analysis Groups (**SAGs**) **conduct specific analyses**. PCOS just closed a SAG on Multi Messenger Astrophysics (**MMASAG**)
- Science Interest Groups (SIGs) are **longer-standing discipline fora**.
 - IP SIG
 - GW SIG
 - XR SIG
 - GR SIG
 - CR SIG
 - CoS SIG

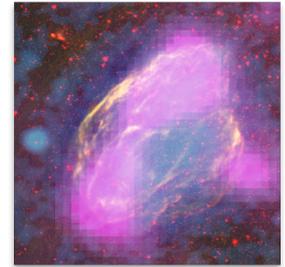
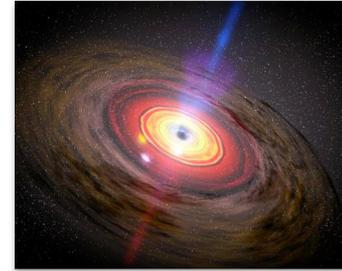
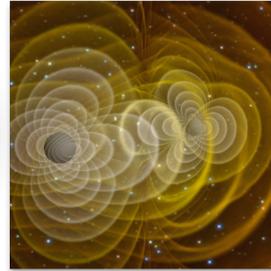
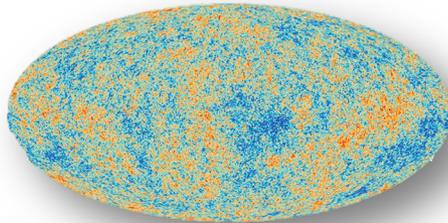
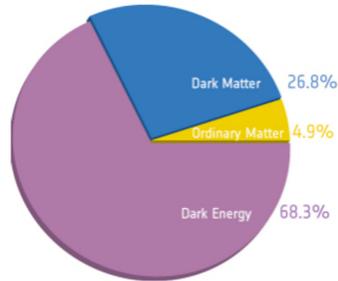
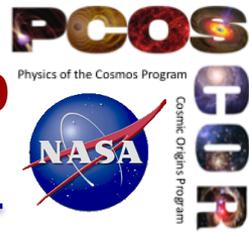


Communication diagram

Examples of reports by the PAGs requested by APAC:

- **Community Survey on High-Impact Research Science**
- **Community Survey on Possible Delay in 2020 Decadal Survey**

Physics of the Cosmos Program Analysis Group



□ Six Science Interest Groups (SIGs)

- Cosmic Ray (CR SIG)
- Cosmic Structure (CoS SIG)
- Gamma Ray (GR SIG)
- Gravitational Wave (GW SIG)
- **Inflation Probe (IP SIG)**
- X-ray (XR SIG)

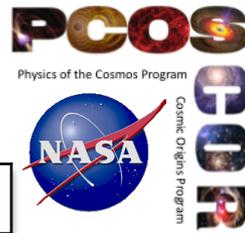
Want go get involved?

Go to:

<https://pcos.gsfc.nasa.gov/phypag/sigs-sags.php>

and subscribe to the relevant SIG emailing list

Annual call again this fall!



PhysPAG EC Membership

Name	Affiliation	Area of Expertise	Term Ends
Graça Rocha (Chair Emeritus)	JPL/Caltech	IP SIG/CoS SIG	Dec 2021
Ryan Hickox (Chair)	Dartmouth College	XR SIG	Dec 2021
Grant Tremblay (Vice Chair)	SAO	XR SIG	Dec 2021
Kevin Huffenberger	Florida State Univ.	CoS SIG/IP SIG	Dec 2021
Marcos Santander	Univ. of Alabama	CR SIG / GR SIG	Dec 2021
Jillian Bellovary	Queensborough Comm Coll.	GW SIG / XR SIG	Dec 2022
Sean McWilliams	WVU	GW SIG	Dec 2022
Bindu Rani	SURA, GSFC	GR SIG	Dec 2022
Justin Finke	NRL	GR SIG	Dec 2023
Vera Gluscevic	Univ. of Southern California	CoS SIG	Dec 2023
Andres Romero-Wolf	JPL	CR SIG	Dec 2023

*New Roles

*Term extended

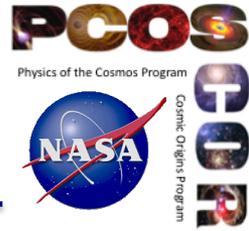
*New members as of January 2021

We thank the members rotating off in December 2020 for their service:

John Conklin, Sylvain Guiriec, James Rhoads, Abigail Viereggs and Nicolas Yunes

IPSIG - Inflation Probe Science Interest Group

<https://pcos.gsfc.nasa.gov/sigs/ipsig.php>



Goal: to provide quantitative metrics and assessment to NASA in regard to a future Inflation Probe mission. Specifically:

- Review and update mission science goals following current developments in the field (e.g., **Planck**, **sub-orbital** measurements),
- Review and update information about and requirements on potential foreground contaminants and their removal,
- Review and update requirements on and developments in control of systematic errors,
- Assess necessary technology developments and prioritize areas for increased technical emphasis.
- Organize mini-symposia at the AAS and APS meetings to present updates of IPSIG related activities and participating in relevant meetings (as is the case here)
- Facilitate community organization of white papers and Decadal Survey inputs (eg, **PICO**, **CMB-S4**..)

The IPSIG is open to all members of the community. If you are interested in contributing to the work of the IPSIG, please subscribe using the webpage above. For other inquiries, e-mail **Co-Chairs:**

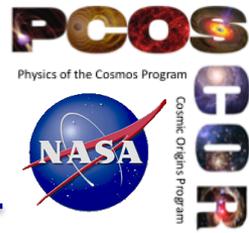
Kevin Huffenberger

khuffenberger@fsu.edu

Graça Rocha

graca.m.rocha@jpl.nasa.gov

the Inflation Probe Science Interest Group highlights and updates



□ IP SIG

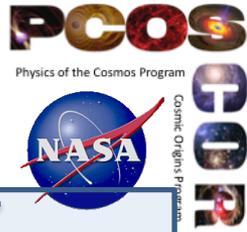
- Main activity of community during 2019 was the production of ~ **20 Science whitepapers** and **8 APC whitepapers** for Astro2020 decadal
For information on the SWP please take a look at the IP SIG webpage

Participation of IPSIG Co-chairs in the PhysPAG EC activities - these include recent Cross-PAG activities around the following topics:

- **Cross-cutting Technology** – organization of a Joint Technology Session at a future winter AAS meeting with emphasis on technology development that could be cross-cutting
- **Data analysis frameworks and transferability** - Is there a specific analysis the PAGs could do that would be useful to NASA HQ and so help motivate a SAG?
- **NASA Science at Under-Served Institutions** - Engagement in NASA astrophysics research from under-represented groups

IPSIG – Science White Papers

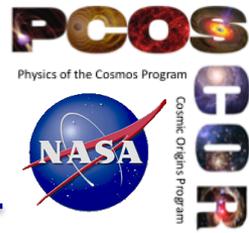
<https://zzz.physics.umn.edu/decadal2020/doku.php?id=start>



- Primordial Gravitational Waves and Inflation
- Light Relics (Neff, BBN Abundances)
- Neutrino mass
- Dark Matter (focus: CMB/21-cm probes of DM interactions)
- Dark Energy and Modified Gravity
- BBN
- Primordial Non-Gaussianity
- Reionization
- Galaxy Cluster Feedback & Thermodynamics
- CIB and Star Formation
- Cluster Cosmology
- Galaxy clustering & growth of structure [Legacy Catalogs]
- Extragalactic radio sources
- Polarization of extragalactic sources
- Galactic Science
- Mapping Dark Matter on Small Scales with ultra-deep, high-resolution CMB measurements
- CMB Summary
- Summary of non-CMB Science from CMB Surveys
- Gravitational Probes of Ultralight Axion Dark Matter

<https://baas.aas.org/astro2020-science>

the Inflation Probe Science Interest Group highlights and updates



□ IP SIG

- Main activity of community during 2019 was the production of ~ **20 Science whitepapers** and **8 APC whitepapers** for Astro2020 decadal.

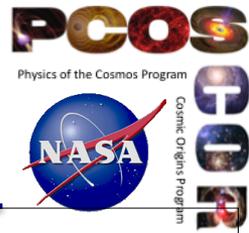
– APC whitepapers:

- 3 related explicitly to space-based projects: **PICO**, **LiteBIRD**, and description of a program for **CMB spectral distortions**
- Others related to technological development or ground-based projects (Ground-based efforts highly complementary to space based efforts)
- 1 paper, “The need of better tools to design future CMB experiments”, has a sub-section dedicated to space vs ground complementarity

<https://pcos.gsfc.nasa.gov/sigs/ipsig.php>

<https://baas.aas.org/astro2020-apc>

the Inflation Probe Science Interest Group highlights and updates



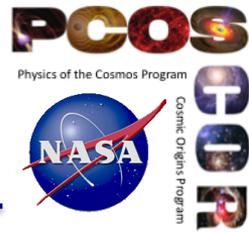
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 - **NASA Science at Under-Served Institutions** – Engagement in NASA astrophysics research from under-represented groups

https://pcos.gsfc.nasa.gov/physpag/meetings/AAS_Jan2021/AAS2021-Meeting.php

the Inflation Probe Science Interest Group highlights and updates



- ❑ **IP SIG** - Organized a session at April APS 2020 - Virtual Meeting

Inflation Probe SIG Minisymposium

Saturday, 18 April 2020, 6:30 P.M.–7:59 P.M. (EDT)

Chair: Graça Rocha

Watch Recording: <https://aps-april.onlineeventpro.freeman.com/live-stream/15336170/D25-Invited-Session-Mini-Symposium-NASA-Inflation-Probe-Science-Interest-Group>

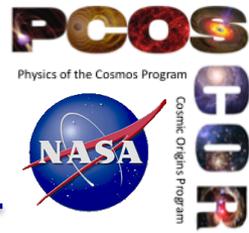
Agenda

6:30 PM–6:45 PM	IPSIG Update [PDF]	Graça Rocha
6:45 PM–7:00 PM	PICO Update [PDF]	Shaul Hanany
7:00 PM–7:15 PM	Complementarity of Space and Ground-Based CMB Experiments [PDF]	Alan Kogut
7:15 PM–7:30 PM	Interplay of Foregrounds and Systematics: The Case for Low-Frequency Observations [PDF]	Krzysztof Gorski
7:45 PM–8:00 PM	Data Analysis - Do We Have All The Necessary Tools? [PDF]	Reijo Kesitalo

➤ Current goals

- Continue organizing sessions and engage the community
- Prepare for Decadal outcomes

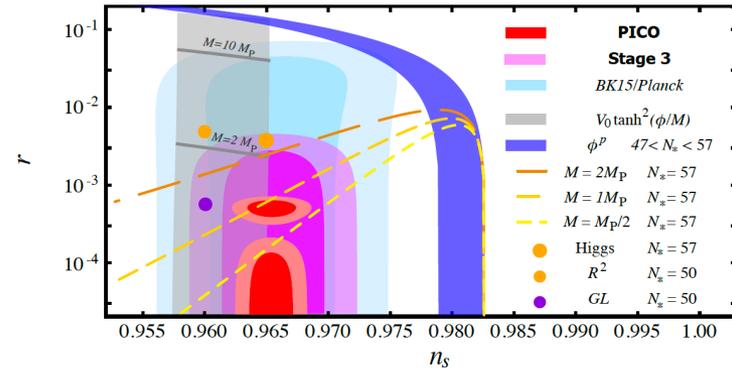
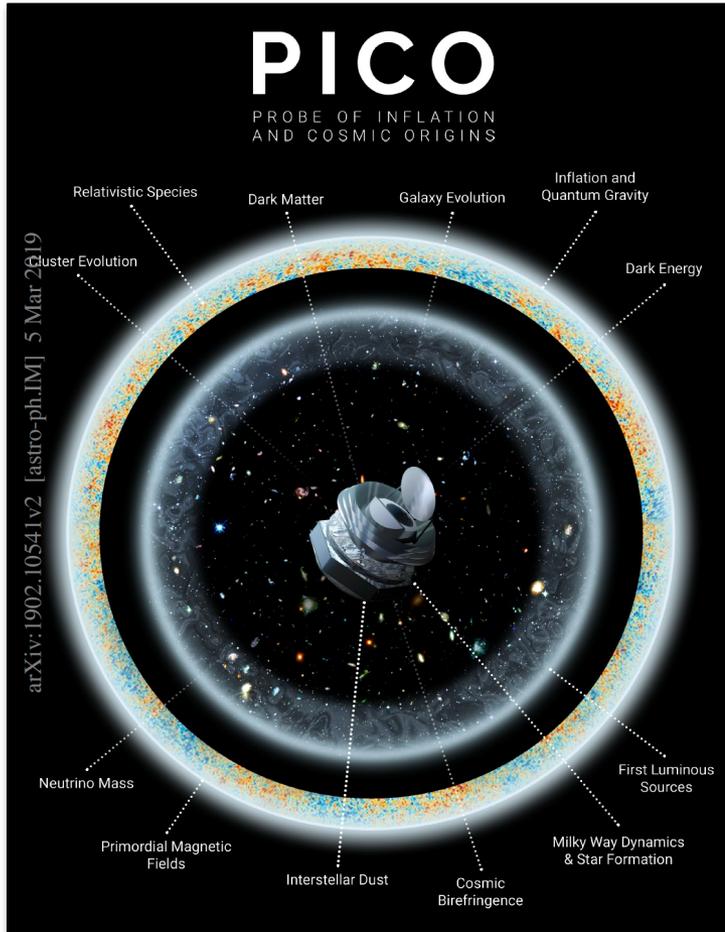
the Inflation Probe Science Interest Group highlights and updates



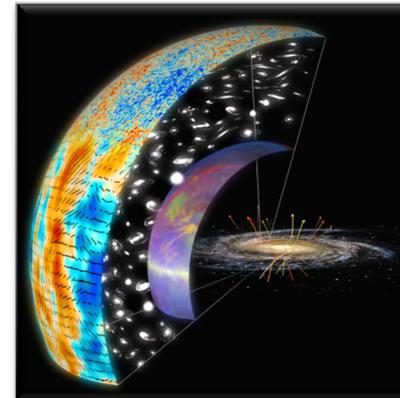
It's a exciting time for Inflation-probe science

Final report delivered to NASA and Astro2020

PICO APC paper



KISS study: *Designing future CMB experiments*



Several
APC papers

PhysPAG/SIG Meetings and Activities

- Winter AAS meeting, January 2020, Honolulu
- April APS, April 2020, Washington, DC - Virtual Meeting
- AAS HEAD, September 2020
- **AAS (Virtual) meeting, January 2021 – this meeting!**
- **APS meeting, 2021**