Heliophysics in the United States

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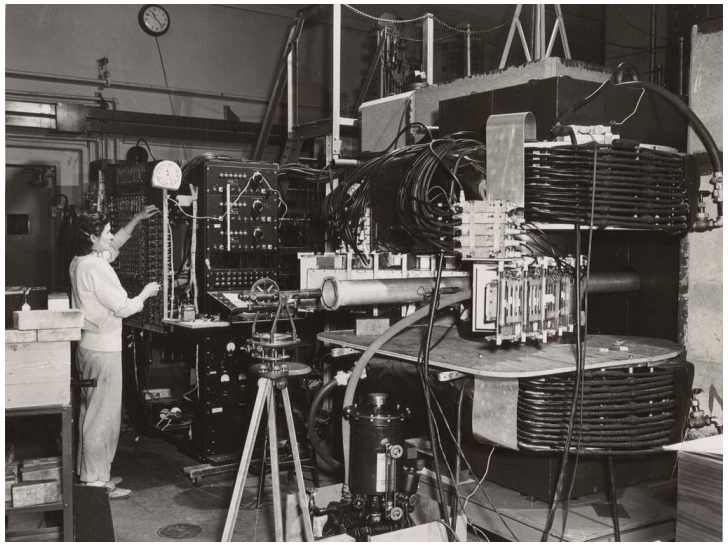
- Advancing Heliophysics: International Principles, Community Collaboration, and Integrated Science

Heliophysics unifies 3 disciplines

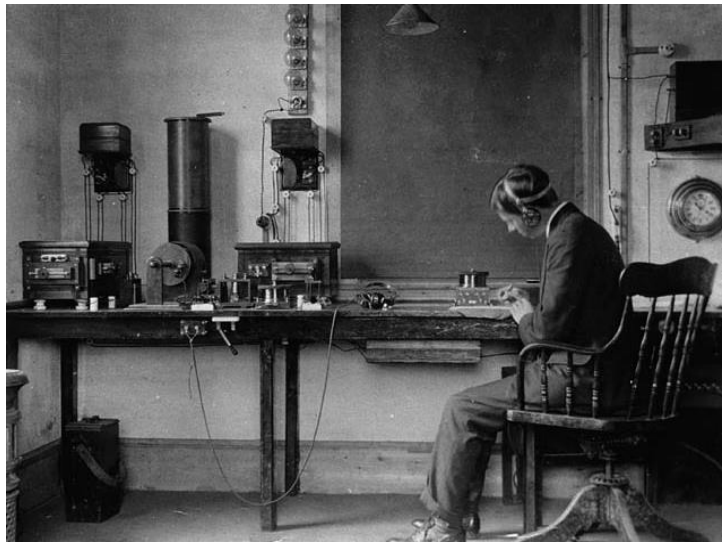
Solar Physics

Largely borne as an offshoot from the broader astronomy community as dedicated solar observatories were built – began by focusing on "the Sun as a star"



Space Physics

Grew from both nuclear/particle physics (e.g., energetic particles and acceleration) as well as electromagnetic theory (e.g., concept of plasma)



Aeronomy

Grew as an applied discipline from the more theoretical work on electromagnetic theory and the growing understanding and application of radio

Heliophysics unifies 2 Professional Societies

Solar Physics

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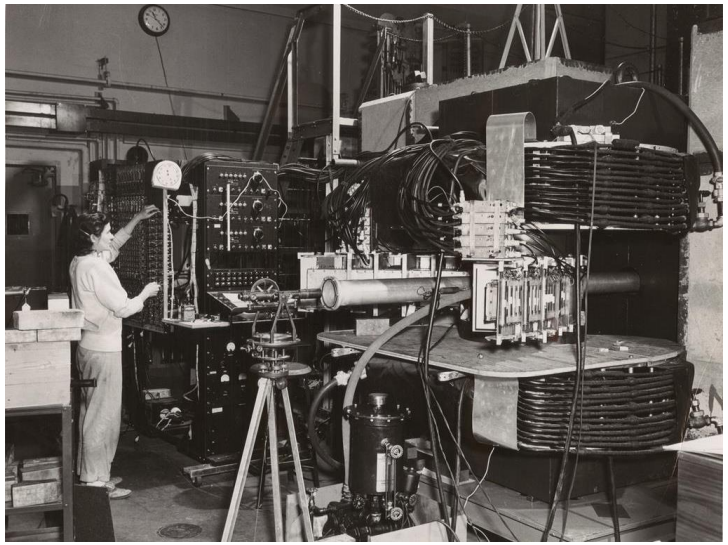

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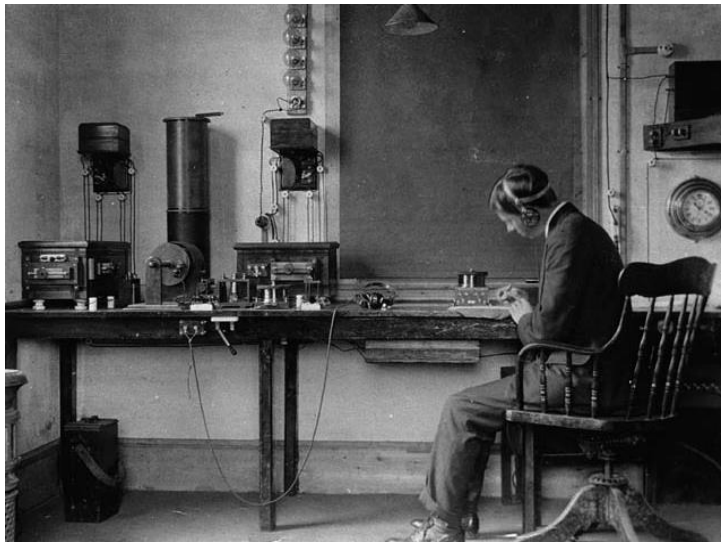

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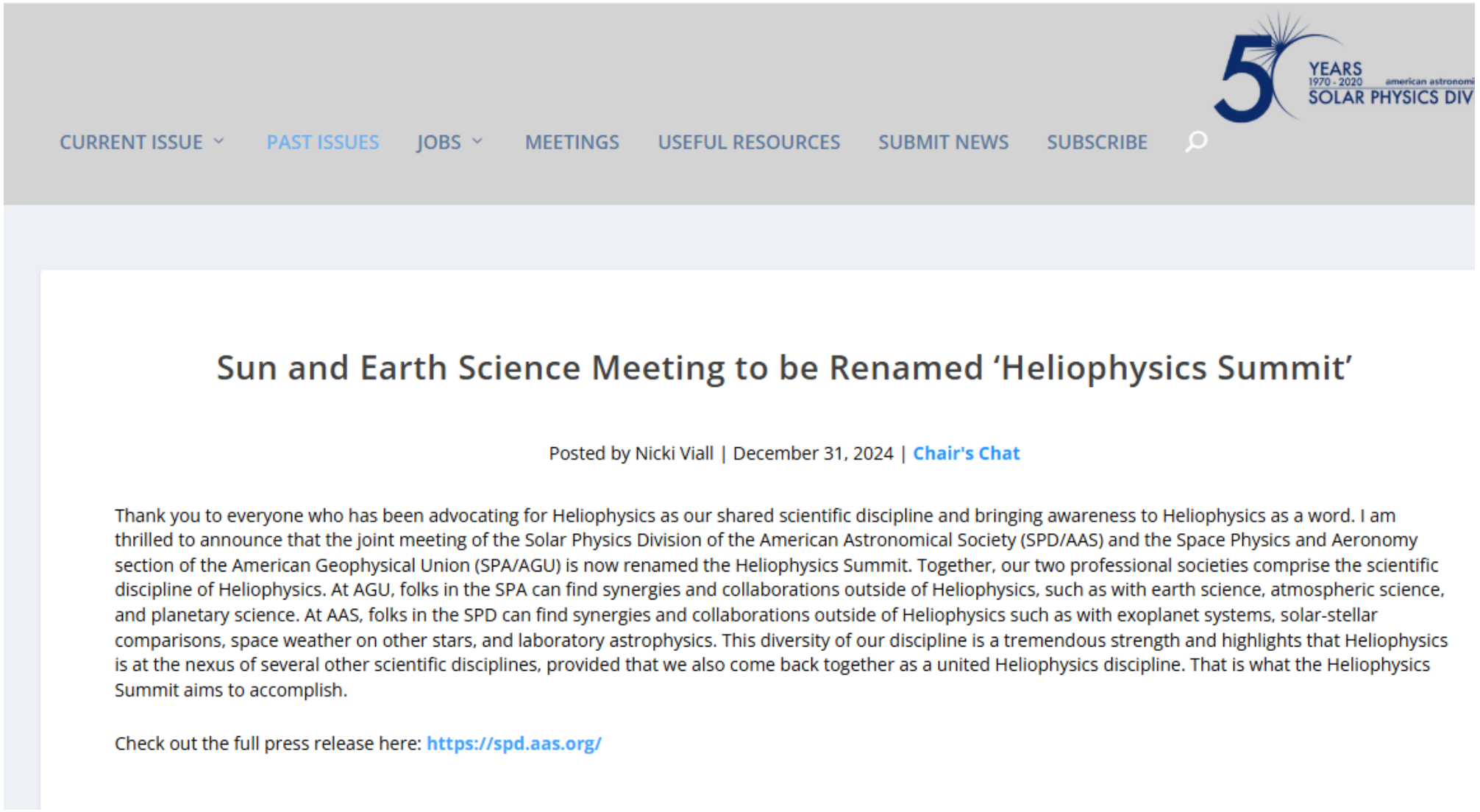
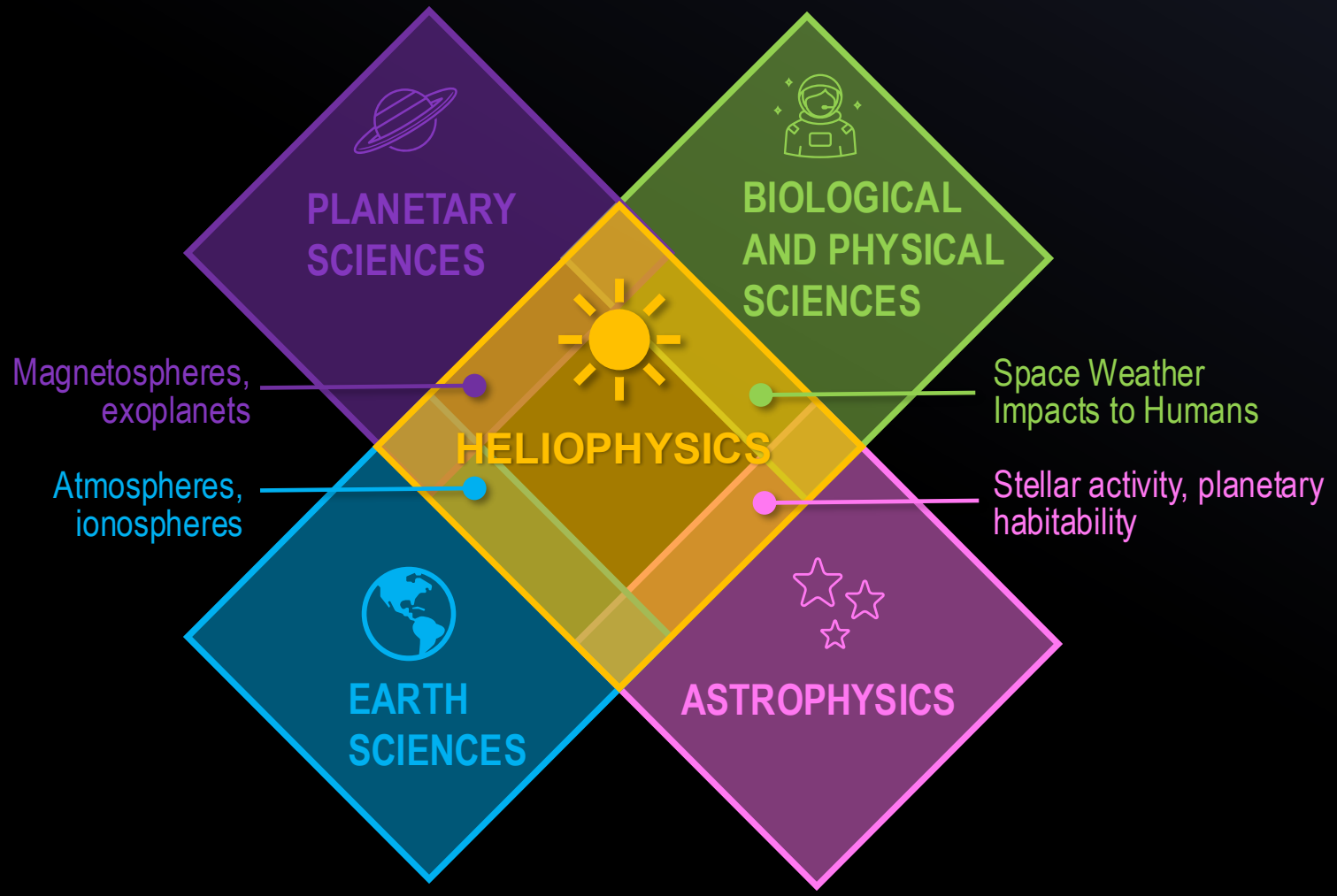
Solar Physics Division of the American Astronomical Society

Space Physics and Aeronomy section of the American Geophysical Union

SPD/AAS and SPA/AGU: Heliophysics Summit, coming in 2027!



The Diversity that comprises Heliophysics is a huge strength: we are the nexus of many other disciplines and drive multidisciplinary research



Heliophysics
A Core Focus of NASA's Mission

Bridges SMD to Exploration Systems Mission Directorate

Supports Artemis and Human Exploration from the Moon to Mars

Leverages Earth Observations for Deeper Space Insights

Applies Solar System and Stellar Research to Broader Exploration

The Heliophyics Great Observatories & ISTPNext Motivation, Current and Historical Context, and Path Forward

Larry Kepko
NASA Goddard Space Flight Center

And the COSPAR task group on Establishing an International Geospace Systems Program (IGSP)
R. Nakamura & Y. Saito (co-chairs), C. Wang, E. Donovan, M. Taylor, G. Reeves, J. Rae, X. Blanco-Cano, D. Chakrabarty, Y. Daglis, J. Hwang, B. Lavraud, A. Petrukovich, C. Marcos De Nardin, M. Palmorth, A. Vourlidas, C. Mandrini, G. Ho, L. Harra, M. Owens, D. Tripathi, M. Cheung

and

The many members of the Heliophysics community who have been joining the movement

The Heliophyics Great Observatories & ISTPNext
Motivation, Current and Historical Context, and Path Forward

- The science questions within ITM, SIH, and Mag require a **systems approach**
  - Cross-scale coupling (kinetic <-> **mesoscales** <-> global>
  - Cross-regional coupling
- The current approach is inadequate (and was not designed) for system-of-systems/mesoscale science questions
  - Our assets (ground, space, numerical…) are fragmented and largely uncoordinated.
  - Budget profiles around the world are insufficient for large, strategic missions
- Worldwide Heliophysics community **needs to unify under a shared strategic vision** - both pragmatically (we all live with the same star) and for the physics, which requires **coordinated system science observations**.

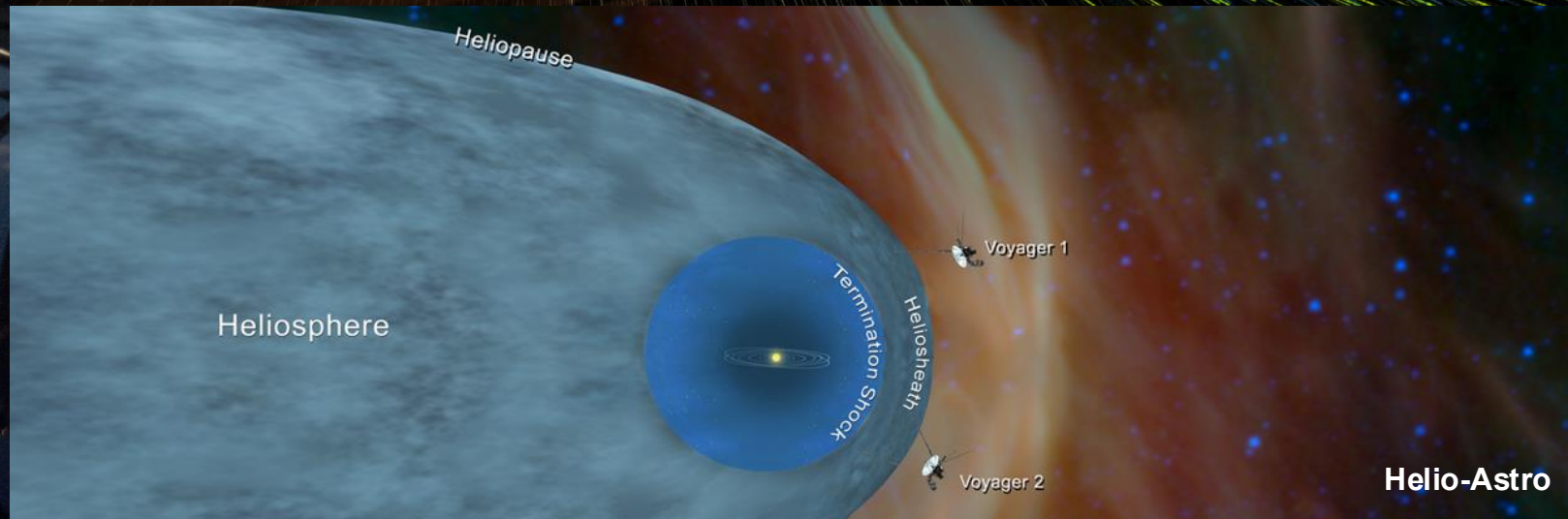
Heliophysics - a new scientific discipline

"**Heliophysics, the study of the Sun and its effects throughout the solar system.** The term Heliophysics was adopted by NASA in 2005 to describe what were previously separate fields of research. The name is based directly on the existence of **four clearly distinct physical domains**. Although these domains share many common physical processes, their individual studies are so different that the studies constitute distinct science disciplines. **"Helio"-physics is the study of the physical domain defined by the Sun** — the heliosphere — just like **"astro"-physics is the study of the physical domain defined by stars** — the rest of the universe. […] **This physical domain includes the Sun itself, the solar system, and stretches out to the start of interstellar matter.** In principle, Heliophysics studies everything inside the Sun's domain of influence, **but the planets and other solid bodies are so physically different […] that they define a separate physical domain and discipline, Planetary Science.** One of the planets, in turn, is of such **extreme importance and its study so unique that it defines the fourth discipline, Earth Science**."

Based on S. Antioch's definition from 20 years ago. Appears in Kepko et al [2024]

Heliophysics is a science of connections

Helio-Planetary



Helio-Astro

Helio-Earth

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(a COSPAR publication)

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Heliophysics Great Observatories and international cooperation in Heliophysics: An orchestrated framework for scientific advancement and discovery

Larry Kepko[a,*], Rumi Nakamura[p], Yoshifumi Saito[t], Angelos Vourlidas[b], Matthew G.G.T. Taylor[o], Cristina H. Mandrini[f], Xóchitl Blanco-Cano[s], Dibyendu Chakrabarty[g], Ioannis A. Daglis[k,w], Clezio Marcos De Nardin[e], Anatoli Petrukovich[u], Minna Palmroth[r,x], George Ho[b], Louise Harra[m], Jonathan Rae[l], Mathew Owens[n], Eric Donovan[i], Benoit Lavraud[c], Geoff Reeves[j], Durgesh Tripathi[h], Nicole Vilmer[q], Junga Hwang[v], Spiro Antiochos[a], Chi Wang[d]

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[u] *Space Research Institute, Moscow, Russia*
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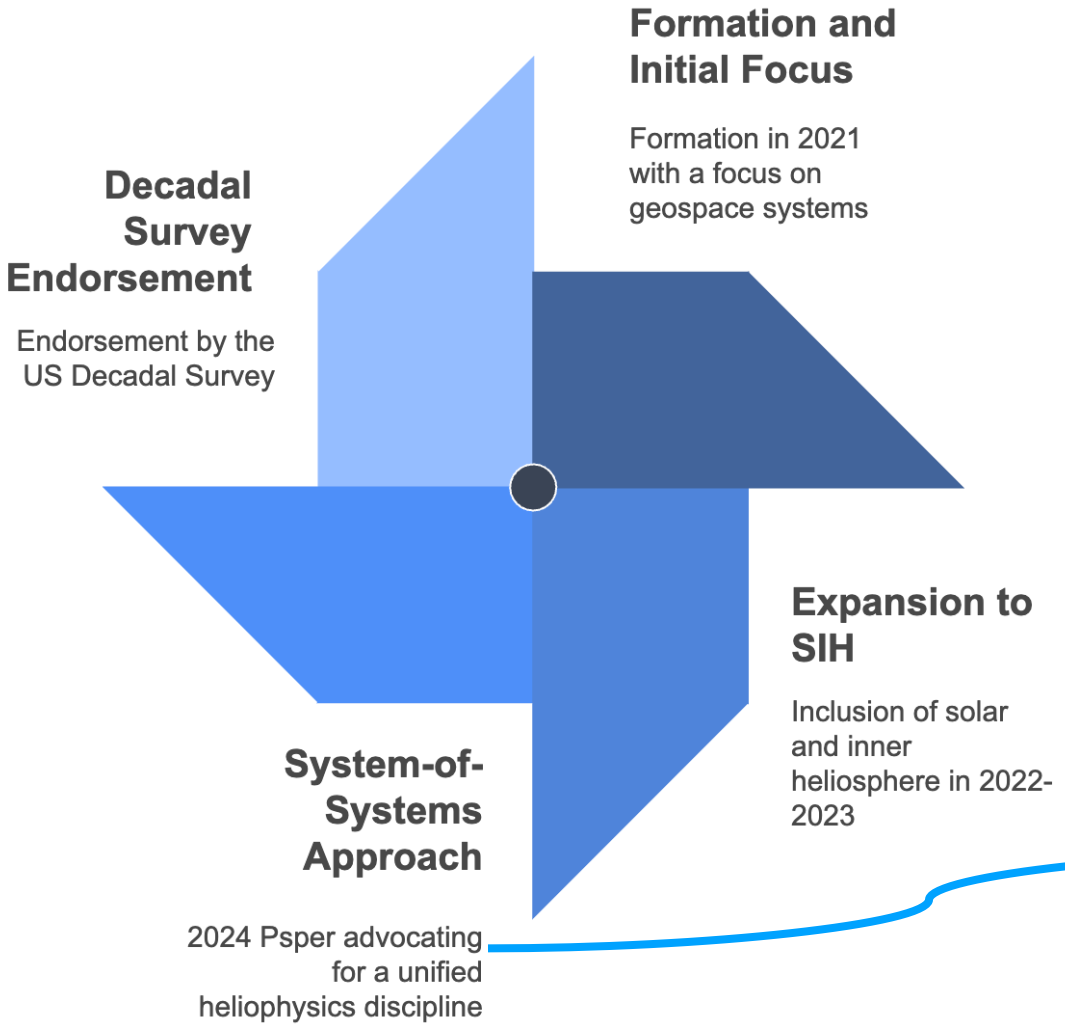
COSPAR task group on establishing an International Geospace Systems Program (TGIGSP)

TGIGSP Efforts

Evolution of TGIGSP



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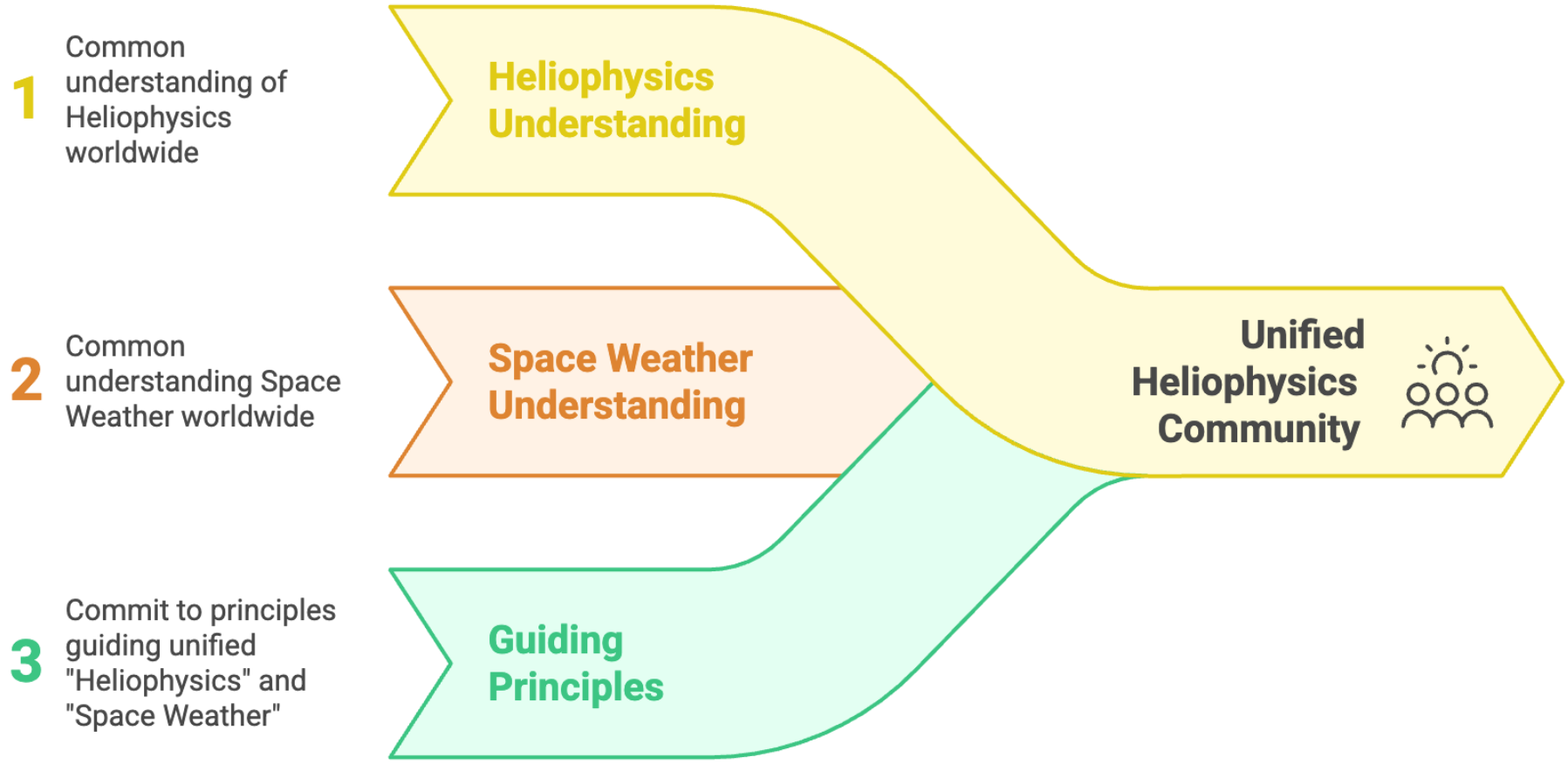
The Heliophysics Principles

For Cooperation for the Scientific Discipline of Heliophysics

Building a Global Heliophysics Framework



Heliophysics is a word!

Slang & Trending

heliophysics

Noun

the scientific study of how the sun works and its effects on the solar system

What does *heliophysics* mean?

Heliophysics refers to the physical processes (such as nuclear fusion) and phenomena (such as solar flares) of the sun and its influence on the solar system, as well as the scientific study of these processes and influences, especially their effect on what is termed "space weather," which has an impact on satellite communications, power grids, etc.

Examples of *heliophysics*

> The odds are low that in any given year a storm big enough to cause effects this widespread will happen. And the severity of those impacts will depend on many factors, including the state of our planet's magnetic field on that day. But it's a near certainty that some form of this catastrophe

"Heliophysics" is a trending word!

Posted by Nicki Viall | April 30, 2025 | Chair's Chat

If you search "heliophysics" on Merriam Webster now you'll find that "heliophysics" is a trending word! Thank you to everyone who has been advocating for Heliophysics as our shared scientific discipline and bringing awareness to Heliophysics as a word. Community cohesion is particularly important in uncertain and rapidly changing times. We will begin planning soon for the 2027 Heliophysics Summit – the joint meeting of the Solar Physics Division of the American Astronomical Society (SPD/AAS) and the Space Physics and Aeronomy section of the American Geophysical Union (SPA/AGU).

The future of Heliophysics rests in our hands

We are all heliophysicists - a "new" scientific discipline

- This presents an opportunity to highlight our "science of connections", our relevance to society

Important to build unified, worldwide Heliophysics community, with a shared scientific vision.

The system-of-system/mesoscale science requires coordinated efforts, and we have to find a way to make that happen.

We have compelling science. It excites the public.

Advocate for the community and Heliophysics

- For the future health and vibrancy of our unified field important to speak with a common community voice "Heliophysics" "System of Systems" .

We are all on "Team Science"