

ExoPAG

TECHNO SIGNATURE SAG

Sofia Sheikh, on behalf of SAG 25

ExoPAG 31

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INSTITUTE



A brief introduction to technosignatures

- “Technosignatures” = Astronomically-observable traces of technologically-capable life in the universe
- Sub-category of biosignatures
- Some technosignature detection techniques are directly analogous to biosignature techniques (e.g., CFCs in exoplanet atmospheres), others are unique (e.g., narrowband radio emission)
- Critical component to understanding the “origin, evolution, **distribution**, and **future** of life in the universe”



Technosignatures SAG-25: Goals



1. Investigate which technosignature projects should play a role in NASA's portfolio
2. Identify the most promising technosignature investigations to prioritize for development
3. Identify science and technology gaps relevant to technosignature searches
4. Identify existing NASA programs most relevant to technosignature searches and determine how they can be more responsive to technosignature searches
5. Identify best practices for NASA program officers and review panelists to evaluate technosignature proposals in XRP and other programs
6. Identify potential new initiatives to build community and intercommunications with other astrobiology efforts

SAG-25 Steering Committee



Sofia Sheikh



Eddie Schwieterman



Daniel Angerhausen



Benji Fields



Jason Wright



Steve Croft



Mark Elowitz



Adam Frank



Megan Grace Li

Technosignatures SAG-25: Structure



- Steering Committee: **9 total leads**, 2 of which are executive secretaries
- Membership: **74 total members** across a range of career stages, sub-fields, and institutions
- Working Groups: Two larger groups on **Exoplanetary** and **Non-Exoplanet** Technosignatures (encompassing the first 4 goals), two smaller groups on **Proposal Review** (goal 5) and **Astrobiology Integration** (goal 6)



Technosignatures SAG-25: Timeline



2024 Q4	Q1	2025			2026 Q1
		Q2	Q3	Q4	
Kickoff!					
	First WG Meetings				
	WG3: Produce Materials and Section Drafts				
	WG4: Produce Materials and Section Drafts				
	WG1: Produce Materials and Section Drafts				
	WG2: Produce Materials and Section Drafts				
				Steering Committee: Synthesis for ExoPAG	

Technosignatures SAG-25: Leadership in the NASA DARES RFI



- Organizing technosignature-related responses to the NASA DARES RFI (affiliate activity)

Index	Lead Author(s)	Author Contact Information	White Paper Title	Status
0	Sofia Sheikh	ssheikh@berkeley.edu	Technosignatures in the DARES Report: Motivation, Omnibus of Responses, and Resource Hub	In draft stage
1	Chenoa Tremblay / Joe Lazio	ctremblay@seti.org	Commensal Observations: An Emerging Opportunity for Astrobiology	In draft stage
2	Jason Wright	astrowright@gmail.com	Exoplanet Technosignatures	In draft stage
3	Megan Grace Li	megangrace@g.ucla.edu	Early-career groups in technosignatures strengthen community	In draft stage
4	Sofia Sheikh (+ SAG WG3 and WG4)	ssheikh@berkeley.edu	Better Integrating Technosignatures in NASA's Approach to Biosignatures and Astrobiology	In draft stage
5	Jeremy Tregloan-Reed	jtreed@setiap.org	TBD (Detecting industrially-caused climate change on exoplanets through transmission spectroscopy)	Just idea, has leader
6	Dave DeBoer (?)	ddeboer@berkeley.edu	TBD (Lunar Farside Radio Telescope)	Just idea, has leader
7	???	???	TBD (Coherent direct EM SETI on a space-based mission)	Just idea, no leader
8	???	???	TBD (Encouraging more and easier cooperation with ground based facilities for projects)	Just idea, no leader
9	???	???	TBD (Post-detection paper out of the UK group?)	Just idea, no leader



Technosignatures SAG-25: Leadership in the NASA DARES RFI

- SAG Steering Committee is writing a technosignatures “**omnibus submission**” to the **DARES RFI**
- Will serve as a...
 - **Motivation** for the inclusion of technosignatures in DARES
 - **Omnibus** of other technosignature responses
 - **Hub** for recent technosignature literature/workshop reports

Technosignatures in the DARES Report: Motivation, Omnibus of Responses, and Resource Hub

Sofia Sheikh, Jason Wright, Adam Frank, Edward Schwieterman,
Other SAG Steering Committee Members

December 2024

1 Technosignatures and Astrobiology

Astrobiology is the study of the origin, evolution, distribution, and future of life in the universe. Finding life beyond Earth would greatly advance our understanding all of these topics, and is a primary goal within modern astrobiology. However, given that our *in situ* exploration is (for now) confined to the solar system, much of the search for life beyond Earth is dependent on searching for life's byproducts: using the methodology of astronomy to look for remotely-detectable biosignatures in electromagnetic radiation. The overwhelming diversity of life across its kingdoms on Earth — life that is both single- and multi-cellular, some life that shows intelligent or tool-using behaviour — leads to an equally diverse array of biosignatures on the surface, oceans, and atmosphere of our planet. For example, single-celled organisms can produce gaseous or atmospheric biosignatures such as CH₄ as direct or indirect products of metabolism [Schwieterman et al., 2018]. However, human technology also produces atmospheric constituents at levels that would be impossible from purely abiotic sources, e.g., NF₃ or SF₆. These technosignatures are not metabolic, but distinctly imply the presence of humans, a technologically-capable species, on the surface of our planet. From this example, where the same methodology (the atmospheric characterization of exoplanets) could deliver the same discovery (life beyond Earth), it is straightforward to see that scientifically, technosignatures are a sub-category of biosignatures.

However, in NASA's last major astrobiology strategy document in 2015, technosignatures were not considered as part of astrobiology, or at least, not those that were delineated as “traditional SETI (Search for Extraterrestrial Intelligence)” [Authors and Reviewers, 2015]. Wright [2018] motivates the need for technosignatures' inclusion in a future NASA portfolio by outlining a few key ideas: worries of a “giggle factor” should not influence US science priorities; technosignature work is not an “all-or-nothing” proposition, and has led to significant scientific



Technosignatures SAG-25: Working Group 3 Case Study

- WG3 Task 1: Identifying ROSES proposal calls in the last 10 years that are relevant to technosignature science

Year	Division Letter	Division	Number	Name and Link to ROSES-2024 Documentation	ID # (for non-2024 calls)	Most recent ROSES appearance	Initials of Skimmer	Relevance Score	Notes
2024	A	Earth Science	A.18	Atmospheric Composition: Radiation Sciences Program		2022	SZS		Wrong link for 2022 - need to find correct one
2024	A	Earth Science	A.19	Atmospheric Composition: Atmospheric Composition Modeling and Analysis		2024	SZS	1	Modelling for Earth atmosphere data, could be relevant for "pollution sourced aerosols where they impact cloud
2024	A	Earth Science	A.20	Atmospheric Composition: Tropospheric Composition Program		Not Solicited In Last 10 Years	SZS	0	
2024	A	Earth Science	A.21	TEMPO/ACX Science and Applications Team		2024	MGL	1	One of the objectives is to model how pollution and climate change affect the atmosphere
2024	A	Earth Science	A.22	NASA Energy and Water Cycle Study		2024	MGL	0	Solicited in 2025 - Research that understands the physical processes that drive the Earth's energy and water cycle
2024	A	Earth Science	A.23	Terrestrial Hydrology		2024	MGL	0	Research to understand hydrologic processes associated with the land-atmosphere interface, and terrestrial water stores
2024	A	Earth Science	A.24	Weather and Atmospheric Dynamics		2024	MGL	1	Understanding for the physical processes that drive the Earth's weather and climate system
2024	A	Earth Science	A.25	Earth Surface and Interior		2024	MGL	1	Work using infrared data to measure "thermal and chemical signatures" of the Earth's surface
2024	A	Earth Science	A.26	Rapid Response and Novel Research in Earth Science		2024	MGL	2	Includes space for "Exceptionally novel and innovative research that does not fit within ESD's current slate of solicitations and could be a good way to use that new proposal
2024	A	Earth Science	A.27	NASA-ISRO Synthetic Aperture Radar Mission (NISAR) Research and Applications		2023	MGL	1	This is a call to use Radar data for understanding Earth's surface
2024	A	Earth Science	A.28	Remote Sensing Theory for Earth Science		2024	MGL	2	General remote sensing call for any science that can be done with remote sensing
2024	A	Earth Science	A.29	EMIT Science and Applications Team		2023 - not being offered until 2026	MGL	N/A	the link on 2023 links to a different proposal and the 2026 link is not yet available
2024	A	Earth Science	A.30	Understanding Changes in High Mountain Asia		2023	MGL	0	I don't think encouraging a technosignature angle in this call



Technosignatures SAG-25: Summary of SAG activities so far

- Established mission statement / list of goals
- Formalized steering committee
- Held open call for membership, accepted members
- Decided on Working Group structure and membership
- Held kickoff meeting (Nov. 2024)
- Holding initial Working Group meetings, undertaking WG goals (Jan. 2025)
- Leading and organizing submissions to the DARES RFI