Update from NASA Astrobiology Program

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NASA Public Access to Data

NASA-Funded Research Results

- Home
- Data Management Plan
- PubSpace
- NASA's Data Portal
- FAQs
- NASA Public Access Feedback

Related Topics

- All Topics A-Z

Public Access to Results

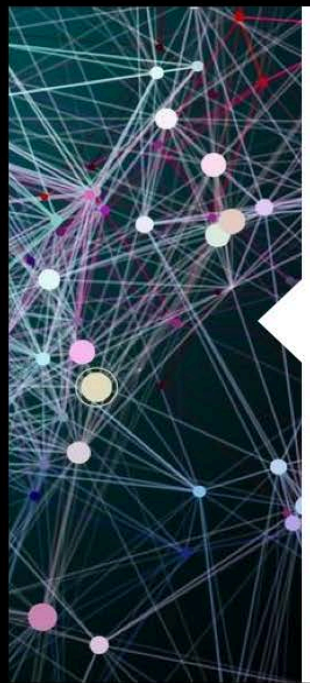
NASA has developed an agency plan, and associated policy, outlining a framework for activities to increase public access to scientific publications and digital scientific data resulting from NASA-funded research.

NASA

NASA's Data Portal

Training Videos

OSTP Policy



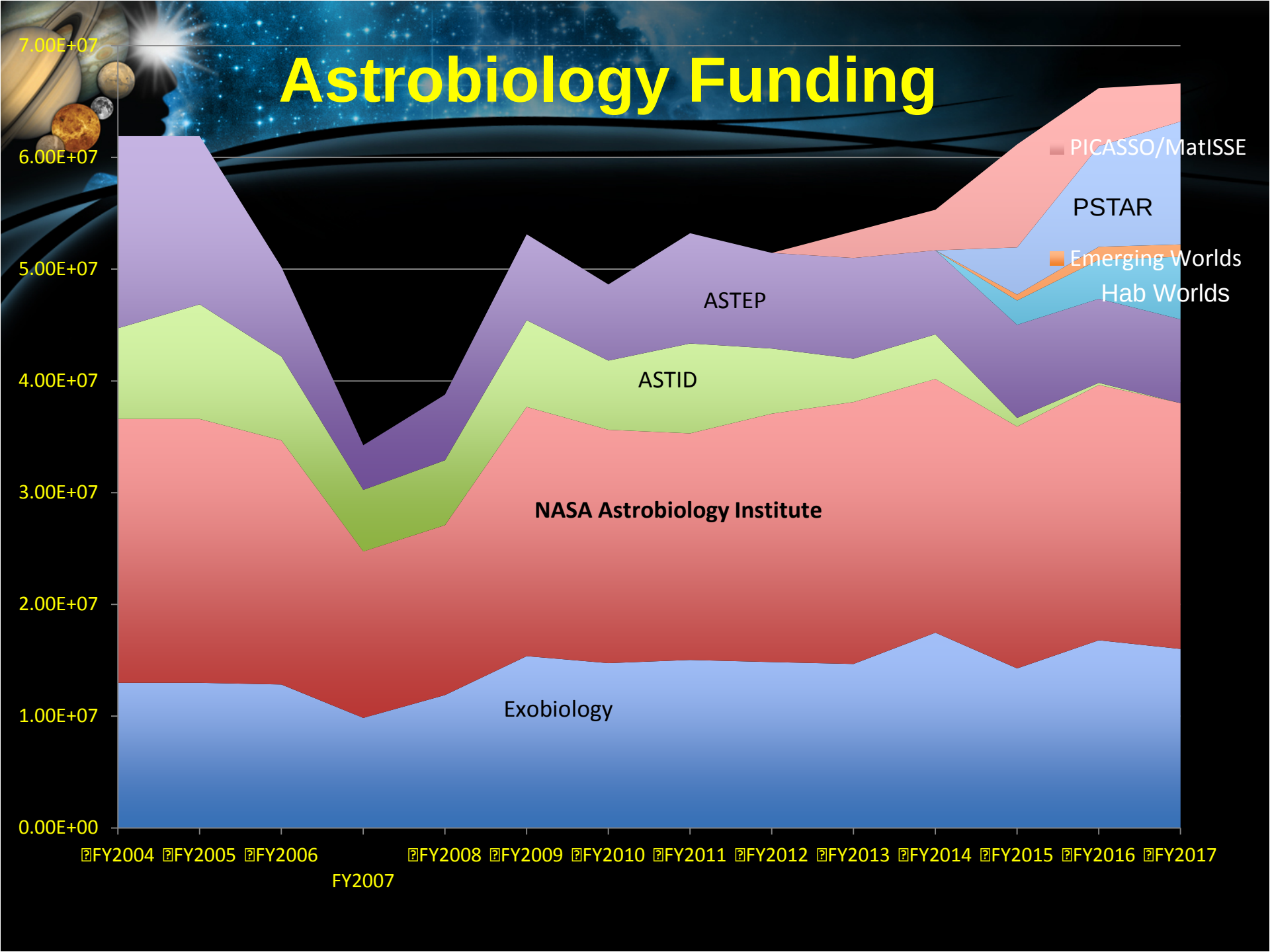
Data Management Plan

NASA-funded extramural and intramural researchers receiving grants, cooperative agreements, and contracts for research are required to follow NASA's policy to develop data management plans as part of their NASA funding proposals. Their plans must describe how they will provide for long-term preservation of, and access to, their unclassified scientific data in digital format in NASA-approved repositories.

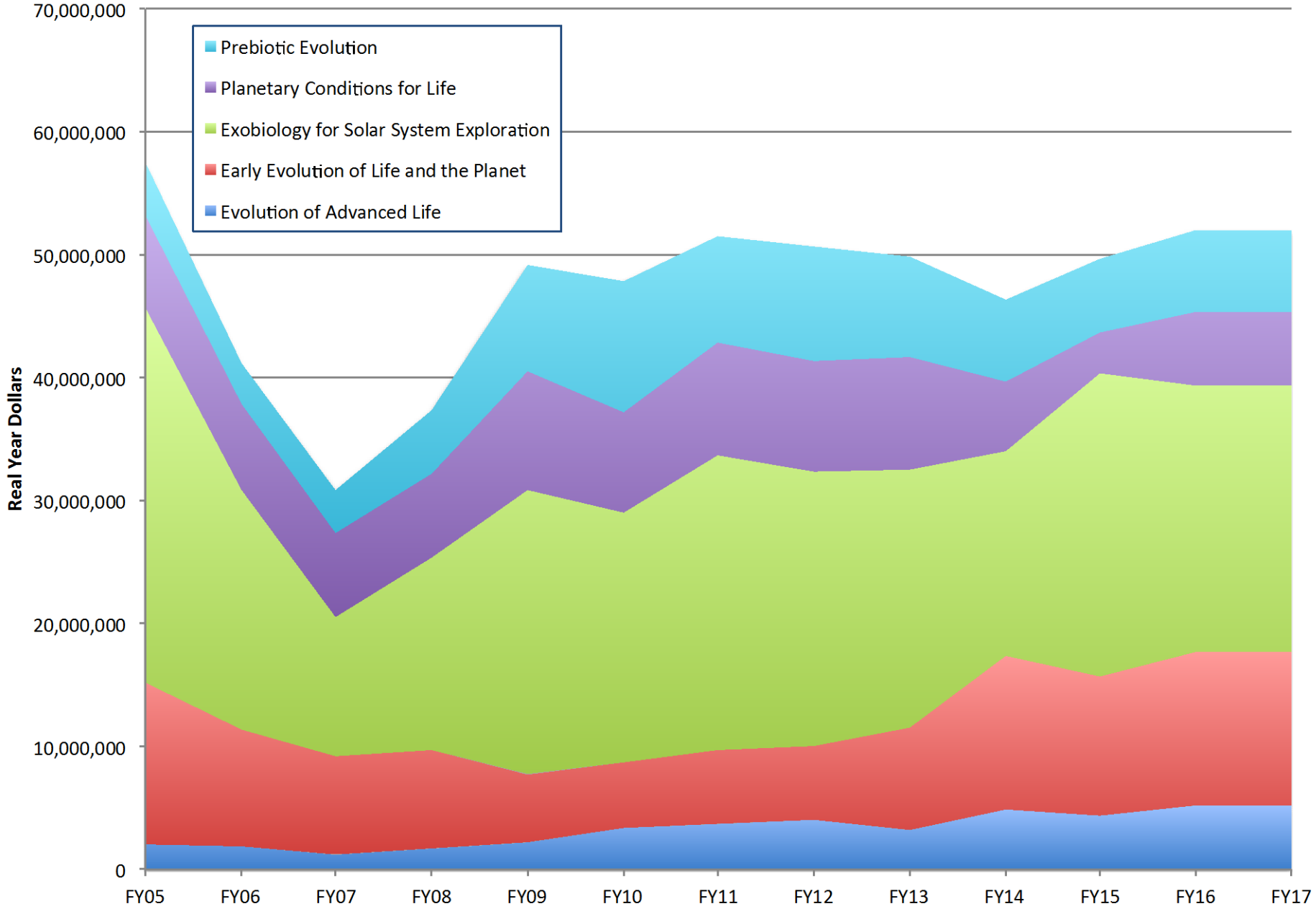
PubSpace

NASA-funded authors and co-authors deposit copies of their peer-reviewed scientific publications and associated data into NASA's publication repository, PubSpace.

Astrobiology Funding



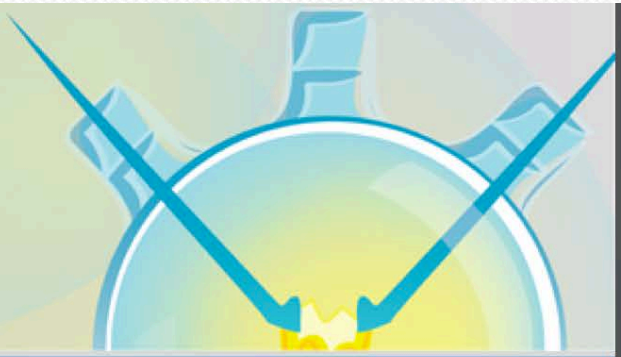
Astrobiology Research Portfolio



Centers for Chemical Innovation Program

Supports research centers focused on major, long-term fundamental chemical research challenges. CCIs integrate research, innovation, education, and informal science communication and broaden participation of underrepresented groups.

CENTER FOR CHEMICAL EVOLUTION



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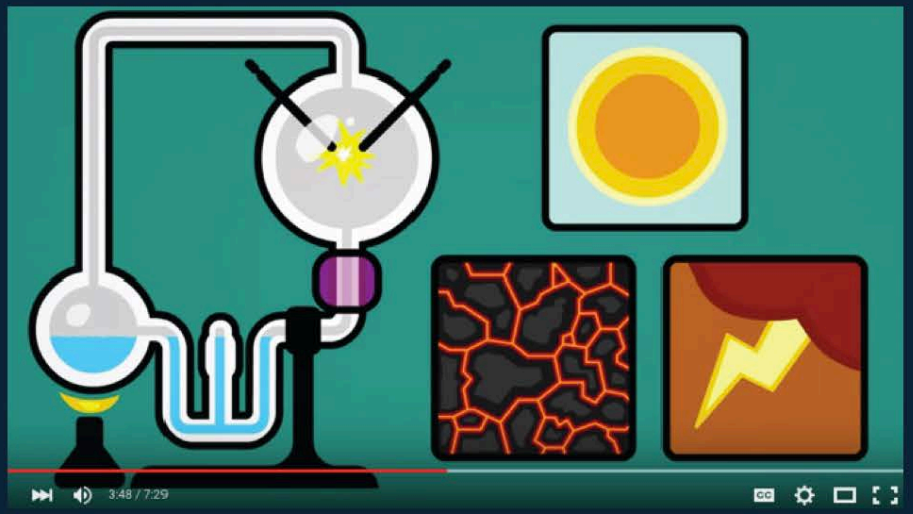
New from Stated Clearly: What was the Miller-Urey Experiment?



The Miller-Urey experiment was the first attempt to scientifically explore ideas about the origin of life.

What was the Miller-Urey Experiment?

NSF/NASA Ideas Lab

Inputs: Grand Challenge Topic, Creative People, Money

⬇

Creative Environment: “Ideas Lab”

⬇

Outputs: Potentially Transformative, Novel, Adventurous, Innovative, Interdisciplinary Ideas

NSF-NASA Joint Ideas Lab

Theme: “The Origin of Translation”

Timeline

- Due Aug 5, 2016
- Participant Selections Aug 20, 2016
- In Person “Ideas Lab” Late September 2016
- Final Proposals Due December 2016

Participant Selection Process

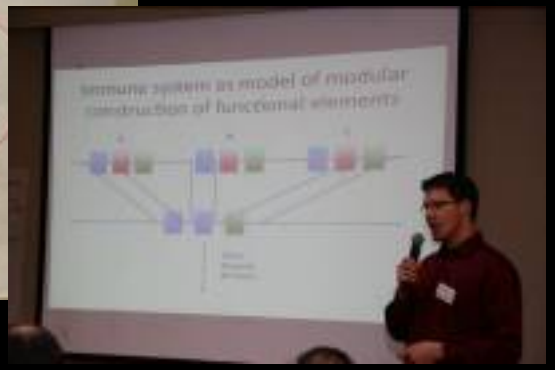
Open call for participants

- 2-page application
  - Expertise, experience
  - Teamwork, communication, “outside the box”

Selection panel

- Panel of Experts
- Advised by organizational psychologist

Selection of participants made by NSF/NASA Program Officers



Interact

Clarify

Ideate

Develop

Implement

Five day residential Ideas Lab

2 months

Submit full proposals

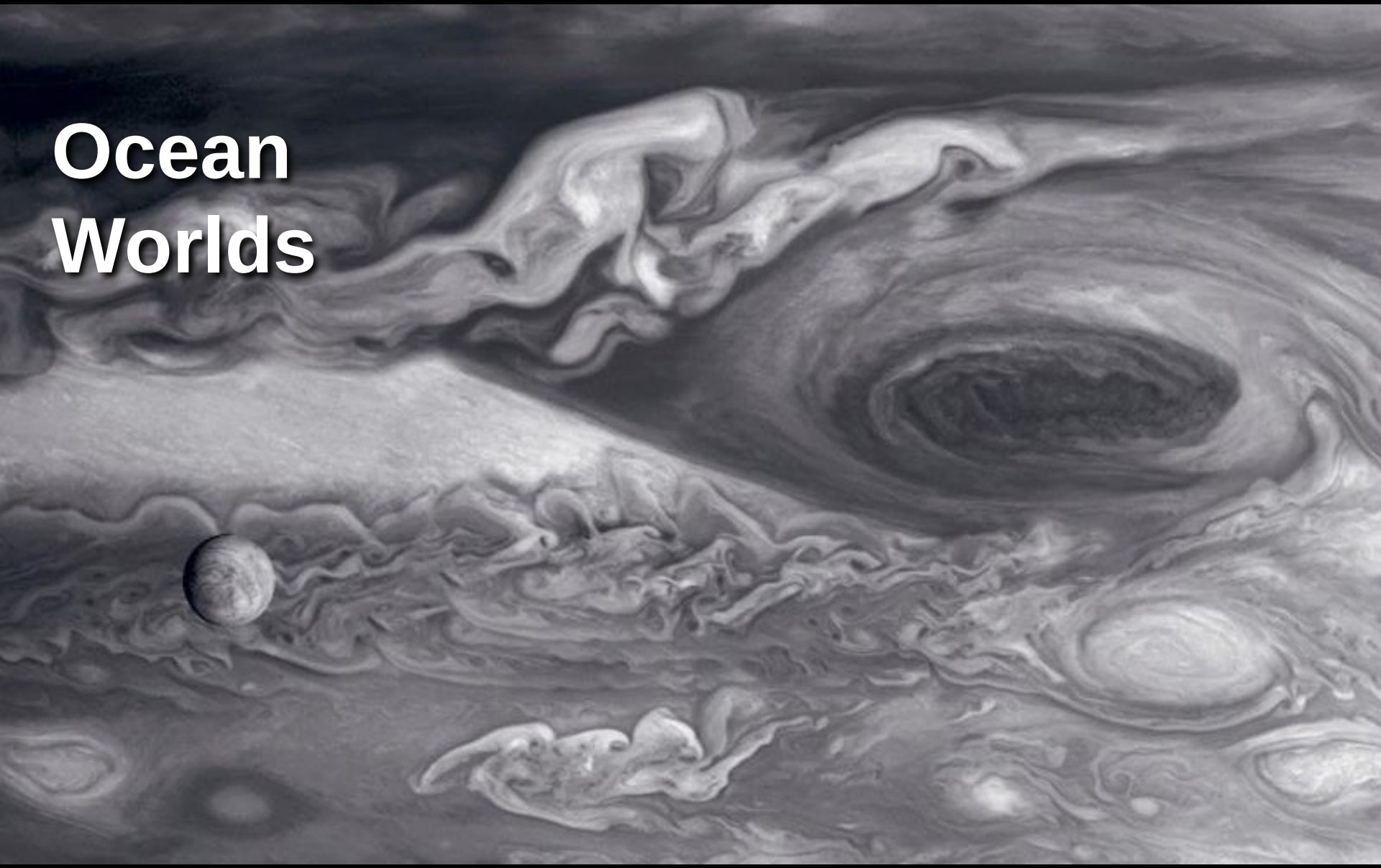
Real time peer review

Select project ideas

Statement of Intent to Release a Cooperative Agreement Notice for the NASA Astrobiology Institute

The time line for the CAN 8 solicitation is intended to be:

Release of CAN…….January 2017
Pre-proposal conference……~2 weeks after CAN release
Step-1 proposal due……~8 weeks after final CAN release
Proposal……..~18 weeks after CAN release
Selection of CAN 8 teams…….Sept 2017 (target)
Start of new awards……..January 2018


Ocean
Worlds

Ocean Worlds Exploration

- Science-Roadmap
  - Ocean worlds are possibly the best place to search for extant (living) life and a second, independent origin.
  - We are on the brink of revolutionizing biology.
  - Comparative oceanography (Earth, Europa, Enceladus, Titan) will spark new discoveries and insights regardless of habitability.
- Technology
  - Convergence of launch vehicle, propulsion, landing, and instrumentation needs.
  - Diversity of mission options: some low-cost missions (Titan lake landers, Enceladus plume fly-through) and some larger mission (Europa melt-probes).
  - Win-win of exploring Earth as a bridge to exploring ocean moons.

Concepts for Ocean worlds Life Detection Technology (COLDTech)

COLDTech seeks to:

A) develop and advance the maturity of science instruments, especially those focused on the detection of extant or extinct life in the ocean worlds of the outer Solar System,

B) sample acquisition, delivery and analysis systems for such missions, and,

C) spacecraft technologies required to access the oceans.

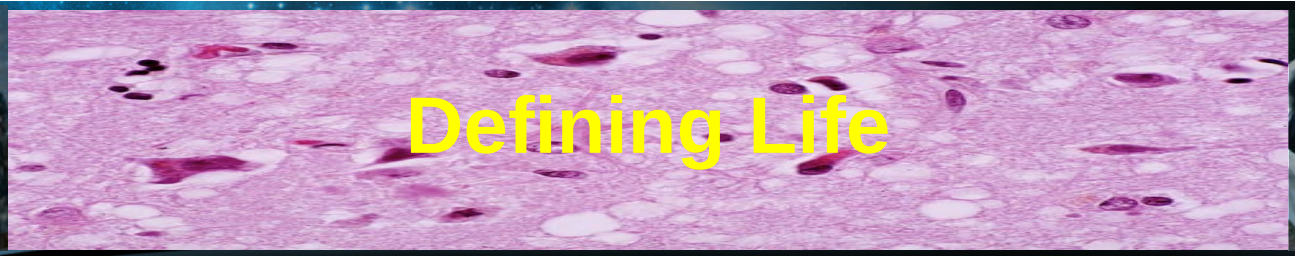
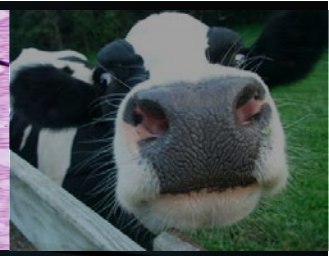
PSTAR Funds Ocean worlds

German “Oases for life beneath ice-covered oceans: bio-signature pathways from seafloor ecosystems to the overlying ice-shell”

Camilli “Cooperative Exploration With Under-actuated Autonomous Vehicles in Hazardous Environments”

Schmidt “RISE-UP: Ross Ice Shelf and Europa Underwater Probe Georgia Tech Research Corporation”

Girguis “Development and deployment of an Autonomous Biogeochemical Instrument for In Situ Studies (the ABISS)”

Defining Life

Life is chemistry with a history (and memory).

NASA: Life is a self-sustaining chemical system capable of Darwinian evolution.

Definition → General theory of living systems

E.g. Terran life: Uses water as a solvent; Is built from cells, exploits a metabolism that focuses on the C=O carbonyl group; Is a thermodynamically dissipative structure exploiting chemical energy gradients; and Exploits a two-biopolymer architecture that uses nucleic acids to perform most genetic functions and proteins to perform most catalytic functions.

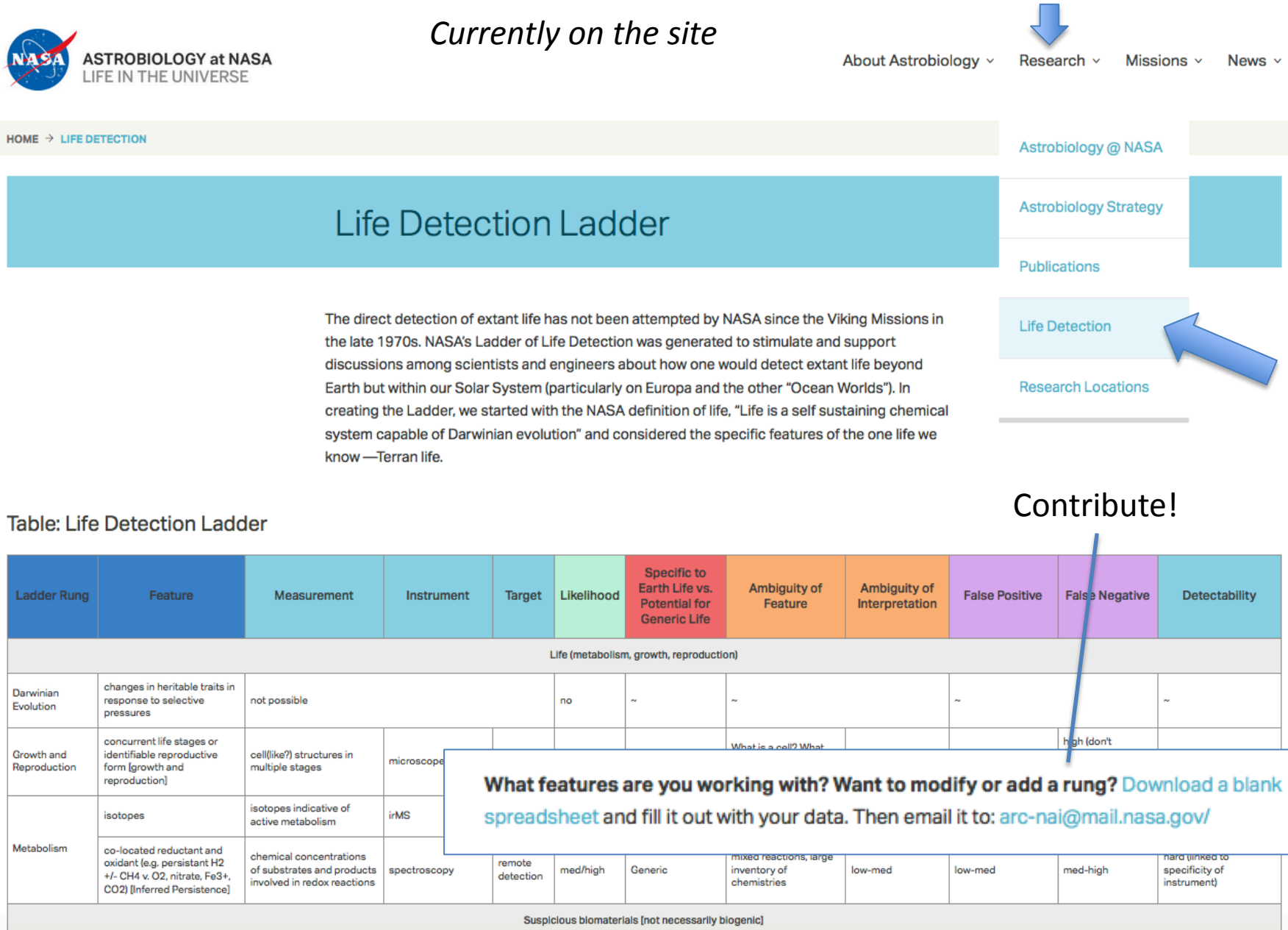
How to detect Life?

LIFE DETECTION LADDER

Ladder Rung	Feature	Measurement	Instrument	Likelihood	Specific to Earth Life vs. Generic Life	Ambiguity of Feature	Ambiguity of Interpretation	False Positive	False Negative
Life (metabolism, growth, reproduction)									
Darwinian Evolution									
Growth and Reproduction									
Metabolism									
Suspicious biomaterials [not necessarily biogenic]									
Functional Molecules									
Potential Building Blocks									
General indicators									
Habitability									
Environmental conditions									

Life Detection on ABP Website

Currently on the site



ASTROBIOLOGY at NASA
LIFE IN THE UNIVERSE

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HOME → LIFE DETECTION

Astrobiology @ NASA
Astrobiology Strategy
Publications
Life Detection
Research Locations

Life Detection Ladder

The direct detection of extant life has not been attempted by NASA since the Viking Missions in the late 1970s. NASA's Ladder of Life Detection was generated to stimulate and support discussions among scientists and engineers about how one would detect extant life beyond Earth but within our Solar System (particularly on Europa and the other "Ocean Worlds"). In creating the Ladder, we started with the NASA definition of life, "Life is a self sustaining chemical system capable of Darwinian evolution" and considered the specific features of the one life we know —Terran life.

Contribute!

Table: Life Detection Ladder

Ladder Rung	Feature	Measurement	Instrument	Target	Likelihood	Specific to Earth Life vs. Potential for Generic Life	Ambiguity of Feature	Ambiguity of Interpretation	False Positive	False Negative	Detectability
Life (metabolism, growth, reproduction)											
Darwinian Evolution	changes in heritable traits in response to selective pressures	not possible			no	~	~		~		~
Growth and Reproduction	concurrent life stages or identifiable reproductive form [growth and reproduction]	cell(like?) structures in multiple stages	microscope				What is a cell? What			high (don't	
Metabolism	isotopes	isotopes indicative of active metabolism	irMS								
	co-located reductant and oxidant (e.g. persistant H2 +/- CH4 v. O2, nitrate, Fe3+, CO2) [Inferred Persistence]	chemical concentrations of substrates and products involved in redox reactions	spectroscopy	remote detection	med/high	Generic	mixed reactions, large inventory of chemistries	low-med	low-med	med-high	hard (linked to specificity of instrument)
Suspicious biomaterials [not necessarily biogenic]											

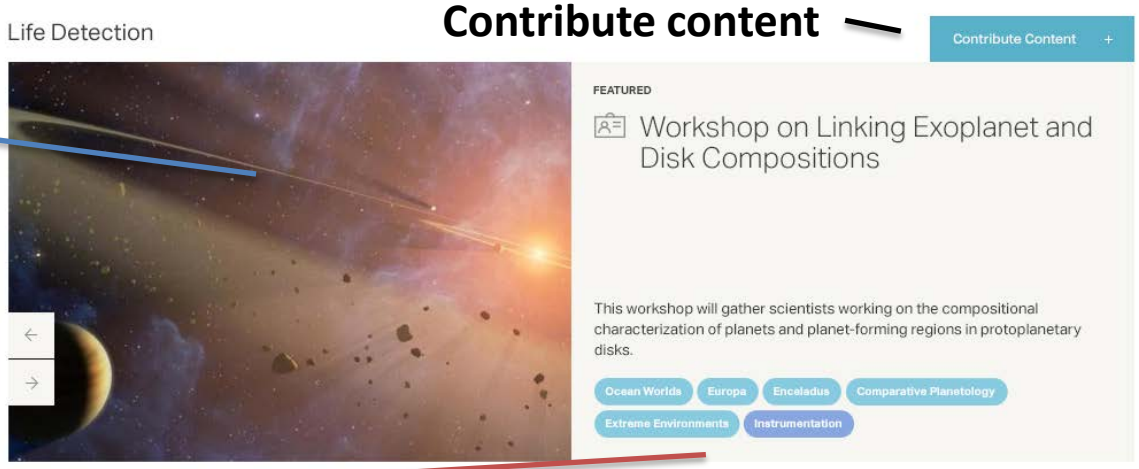
What features are you working with? Want to modify or add a rung? Download a blank spreadsheet and fill it out with your data. Then email it to: arc-nai@mail.nasa.gov/

Coming Soon to ABP Life Detection

Cycling banner highlighting:

- About this web-section
- Upcoming events
- Important discoveries
- Life detection ladder

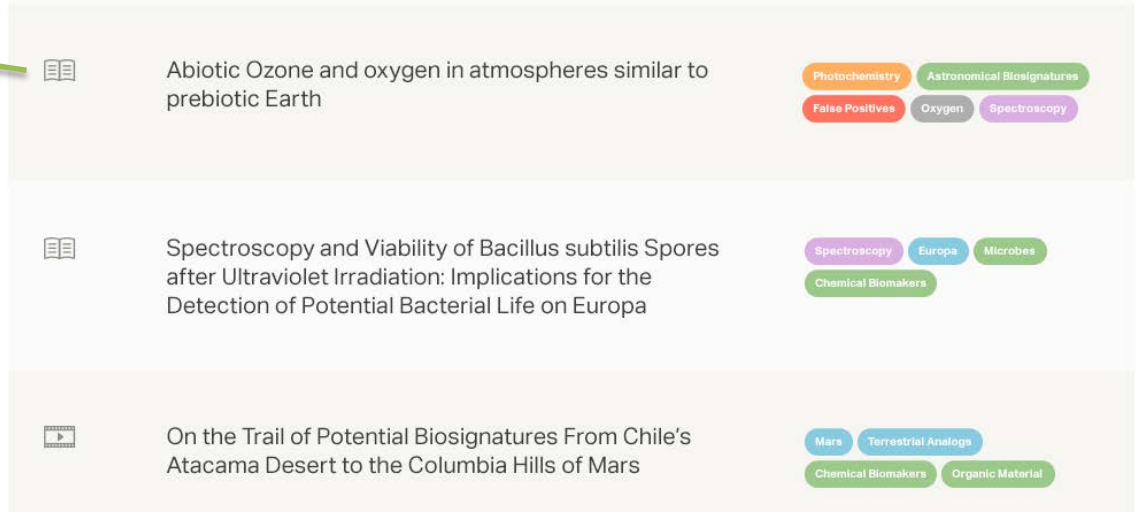
Contribute content



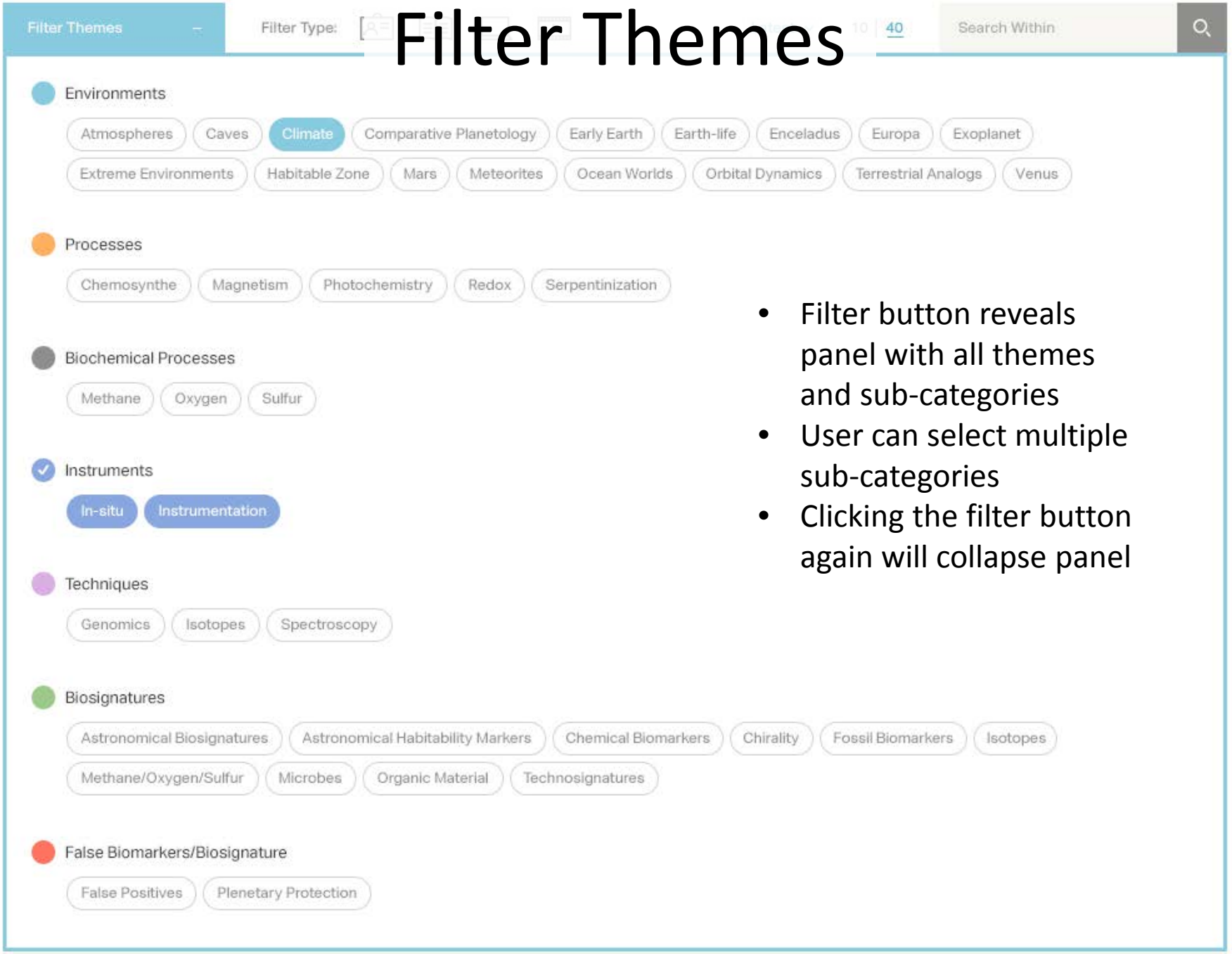
Robust Filtering / Tagging system

Content Types:

- Workshops
- Publications
- Websites
- Videos



Filter Themes



- Filter button reveals panel with all themes and sub-categories
- User can select multiple sub-categories
- Clicking the filter button again will collapse panel

Workshop on Linking Exoplanet and Disk Signatures

Ocean Worlds | Europa | Enceladus | Comparative Planetology | Extreme Environments | Instrumentation

Detail View

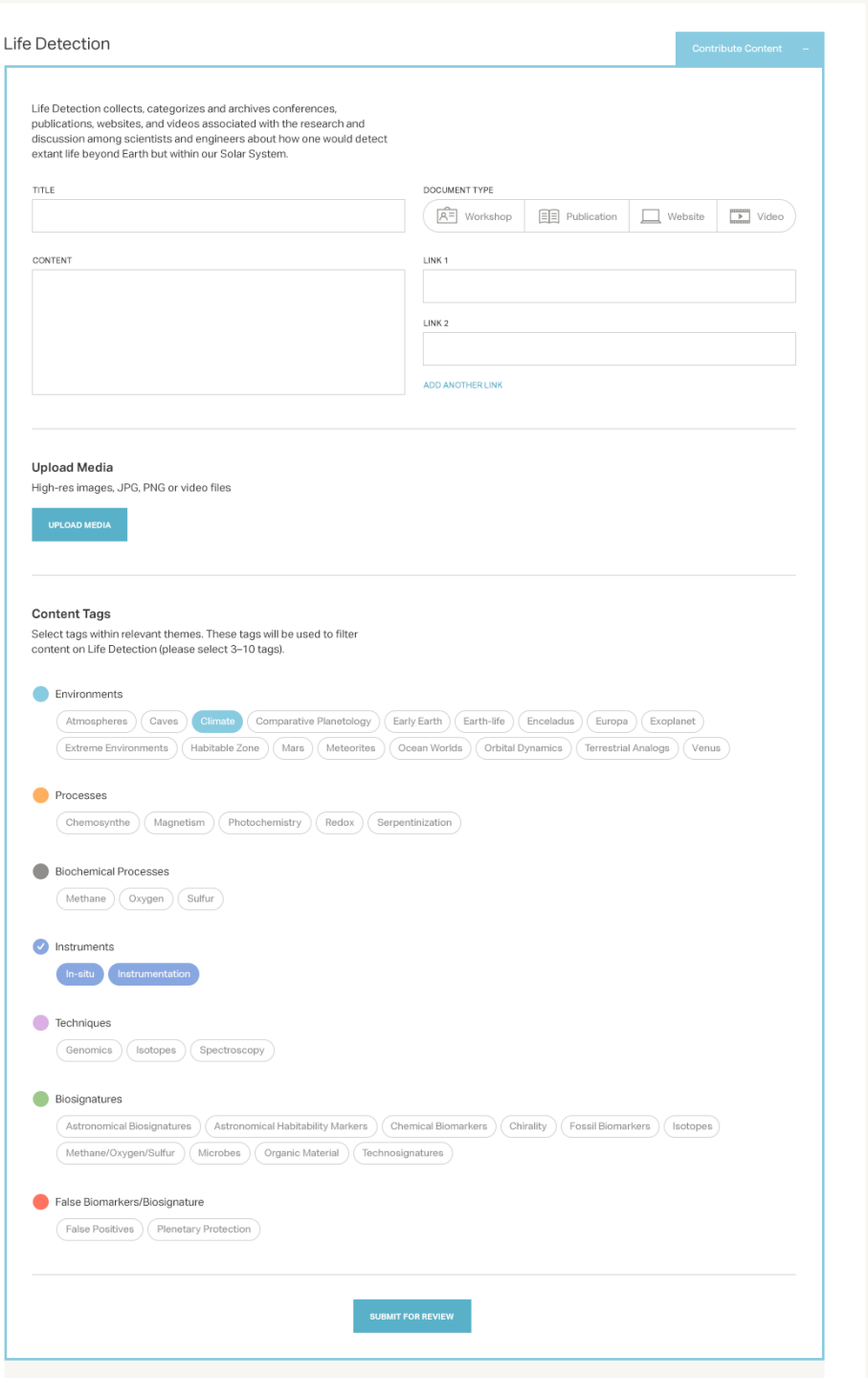
This workshop will gather scientists working on the compositional characterization of planets and planet-forming regions in protoplanetary disks. Recent and upcoming advancements make it timely to have a round-table conversation among the communities involved, to join forces in tackling our most compelling questions on the origins of exoplanet diversity. Do exoplanet compositions retain the imprint of large-scale disk processes? Do disks include compositional trends that imprint planets? What do we learn in this context from observations of Solar System bodies? And what can we test with observations of disks and exoplanets in the near future? We intend to identify long-lasting and observable links between exoplanet and disk compositions, to help the community in shaping ongoing modeling efforts as well as the essential parameter space to cover with existing and upcoming observatories for exoplanet and disk characterization.

September 11–13, 2016, Baltimore, MD

For more information, visit the website:
http://www.cvent.com/events/linking-exoplanet-and-disk-compositions-workshop/event-summary-3aca8e7335f0450badf5ed99cfb6b8d8.aspx

Contribute!

- Add content
- Provide links
- Upload multimedia
- Tag it



Agnostic Biosignatures

September 7-9, 2016

"Rethinking Biosignatures" Workshop

a.k.a. "Agnostic Biosignatures

a.k.a. "Recognizing life as we don't know it"

Key Questions

Can a framework be developed for defining *biosignatures* based not on a small number of (preselected) *features* of an *object* but on measures (distributions) over sets of features of the object?

How valuable would such a framework be?

How can such a framework be implemented and tested?

Object = an artifact, environment, ecosystem, collection of organisms, collection of molecules, *etc.*

Feature = a measureable and quantifiable property of an object

Biosignature = a measurement result interpreted as indicative of the current or past presence of life

Some Conclusions

There are a number of possible approaches to defining biosignatures that are independent of our understanding of how Terran life works.

Key to these approaches is a set of *null hypotheses* — what do we expect to see in the complete absence of life.

An iterative “model-test-model-test…” approach to developing agnostic biosignatures is necessary.

Some possible approaches

Molecular complexity: is there a limit to the *complexity* of organic molecules that can be produced abiotically?

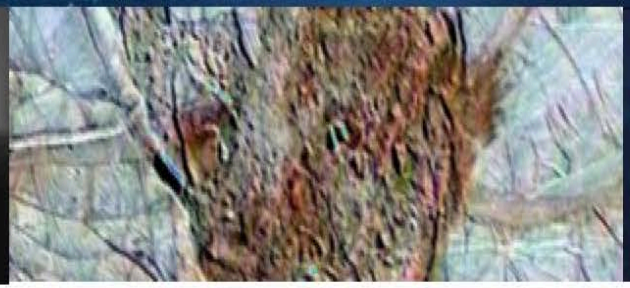
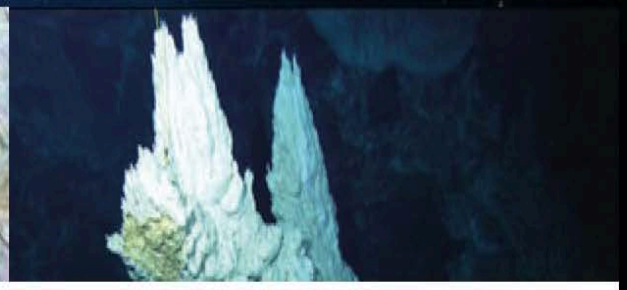
Chemical processes: given a set of measured molecules, and a set of measured inputs, are the properties of the inferred chemical reaction network *lifelike*?

- Linear networks vs. cycles
- Multiple intermediates vs. small number of common ones

Molecular distributions: does the distribution of molecules (say in exact MW space) match that of abiotic chemistry or is there evidence of *selectivity*?

- What about the distributions of metals?

Biosignatures of Extant Life on Ocean Worlds Workshop

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- Registration and Logistics
- Meeting Format
- Organizers
- Program and Presenter Information
- Contacts
- Meeting Portal Login

Biosignatures of Extant Life on Ocean Worlds Workshop

September 12-14, 2016

Goddard Space Flight Center, Greenbelt, MD

Building 34, Room W150

New Updates!

Draft program is now posted

The Nexus for Exoplanet System Science

Research Coordination Network

A Cross-division Initiative

https://nexss.info

Workshops:

Upstairs Downstairs: Consequences of Internal Planet Evolution for the Habitability and Detectability of Life on Extrasolar Planets

- Tempe, AZ, Feb. 17-19 (led by PSD)
- Joint NExSS-NAI-NSF effort, in-person + virtual participation (Workshop Without Walls) + winter school for students/postdocs

Biosignatures workshop (led by PSD, APD),July 2016

- Joint NExSS-NAI-ExEP effort
- Partnering with tentatively approved ExoPAG SAG-16 in support of JWST, WFIRST, HabEx/LUVOIR studies

Exoplanetary Space Weather, Climate and Habitability Workshop

-Dec 2016 (Led by Helio, ESD, and PSD)

Identifying which stars the are best place to search for habitable planets and life

Exoplanet Biosignatures Workshop (With and) Without Walls

A NExSS & NASA Astrobiology Program Joint Workshop
In-person workshop (and online broadcast): July 27 - 29, 2016, Seattle, WA
Pre-workshop online activities to commence: June 13, 2016

The 3-day in-person workshop focused on advancing the science of biosignatures, and understanding the technological needs and capabilities for their detection.

Included member of the Science Technology Definition Teams (STDTs) of upcoming planet-observing missions.

Outputs from this workshop will include summary reports, which will be circulated to the community for feedback. These reports will be filed with a dedicated Exoplanet Biosignatures Study Analysis Group (SAG 16) of the Exoplanet Exploration Program Analysis Group (ExoPAG).

Agenda

Pre-workshop online activities

Meetings will be held twice a week at different times to ensure maximum participation from international participants

Meeting 1: Topic: Review biosignatures described in Des Marais et al., (2002) Astrobiology 2(2):153-181
Meeting 2: Discuss advances in biosignature research since 2002 review
Meeting 3: Overview of observation technologies

In Person Workshop

Plenaries
Working groups
Report Outs

- **Theme 1: State of the Science Review of Pre-Workshop Online Activities**
- **Theme 2: Advancing the Science of Biosignatures**
- **Theme 3: Confidence Standards for Biosignature Observation and Interpretation**

Some Findings (Meaningful measurements)

- Stellar characteristics (SED, activity, age)
- Habitability Indicators
  - H_2O, CO_2, CO, N_2, SO_2, T, P, clouds/hazes, ice, sulfur, silicates…
- Potential Biosignature gases
  - O_2, O_3 ,N_2O, CH_4,
- Surface biosignatures
  - Red Edge, photosynthetic pigments, non-photosynthetic pigments, UV screening pigments, etc.
- Thermodynamic disequilibrium
  - O_2/CH_4, O_3/CH_4, N_2/O_2/ocean
- Temporal Variability
  - Seasonal vegetation, CO_2, CH_4
- Isotopes, Hazes

Discovering Biosignatures (*a priori*)

Reliability

Is it/could it be produced by life?

Is it less likely to be produced by planetary processes such as geology and photochemistry?

Survivability

Does it avoid the normal sinks in a planetary atmosphere: destruction by photochemistry, reaction with volcanic gases, reaction with the surface, dissolving in an ocean?

Detectability

Is it detectable via transmission, secondary eclipse, phase curves or direct imaging? Is it active in the observed wavelength region and is it clear of overlap with other common planetary species?

CONTEXT MATTERS

The State of the Field

- We have long lists of potential biosignatures, but we now need to turn to a more rigorous exploration to identify environmental context and search for false positives and their discriminants.
- Biosignature identification must be made in the context of the planetary environment
  - many different measurements may be needed.
  - Biosignature identification will likely be given as a probability
- The host star can enhance or destroy biosignatures.
- False positives for life will occur and will depend on planetary composition and environment, stellar spectrum and photochemistry.
- Identifying, searching for and ruling out potential false positives enhances our confidence in biosignature detection.
- Biosignatures may be most detectable on planets orbiting M dwarfs, but these planets may have the highest probability for false-positives as well.
- When exploring possible biosignatures, we must also focus on its ultimate detectabilty, and how we will make the measurements to increase our confidence.
- The generation and detectability of biosignatures are the product of an interacting, multi-parameter phase space that can be explored with modeling, lab and field work, prior to observational study.

New Research Opportunities

E.4 HABITABLE WORLDS

NASA's Habitable Worlds Program includes elements of the Astrobiology Program, the Mars Exploration Program, the Outer Planets Program (all in the Planetary Science Division) and Exoplanet research in the Astrophysics Division. A common goal of these programs is to identify the characteristics and the distribution of potentially habitable environments in the Solar System and beyond.

11/18/2016 (Step-1)
01/20/2017 (Step-2)

E.? LIVING WITH A STAR

The Living With a Star (LWS) Program emphasizes the science necessary to understand those aspects of the Sun and Earth's space environment that affect life and society. The ultimate goal of the LWS program is to provide a scientific understanding of the system, almost to the point of predictability, of the space weather conditions at Earth and the interplanetary medium, as well as the Sun-climate connection.

The NASA Astrobiology Debates

…future leaders of America engaging astrobiology

Resolved: An overriding ethical obligation to protect and preserve extraterrestrial microbial life and ecosystems should be incorporated into international law.

100 graduate and undergraduate students have participated as debaters, judges and hosts, including 76 debaters from 23 different U.S. universities, the Japanese National Team and Ecole de Guerre.

NASA Astrobiology Debates will engage over 2000 university and secondary education students during the 2015-16 school year. Remaining events include an online tournament for college & HS students and an “in-person” championship for DC middle schoolers on May 21, 2016.

LOC Astrobiology Symposium

“The Emergence of Life: On the Earth, in the Lab, and Elsewhere”

Thursday, September 15, 2016

The emergence of life is among the most compelling questions in astrobiology. This symposium will bring together scientists, humanists, and authors to explore what we know about the origins of life, how we came to know it, and what it means.

Hosted by Astrobiology Chair Nathaniel Comfort.

The fourth Baruch S. Blumberg NASA/Library of Congress Chair in Astrobiology

Luis Campos will begin on Oct. 1, 2016, and be in residence for 12 months.

A historian of science, Campos is currently associate professor of history at the University of New Mexico.

Campos will use the Library collections to examine the intersection between synthetic biology and astrobiology, one seeks to engineer novel forms of life and the other is interested in discovering novel forms of life.

Questions???