Working Together to Find Life Beyond the Solar System: NASA's Nexus for Exoplanet System Science

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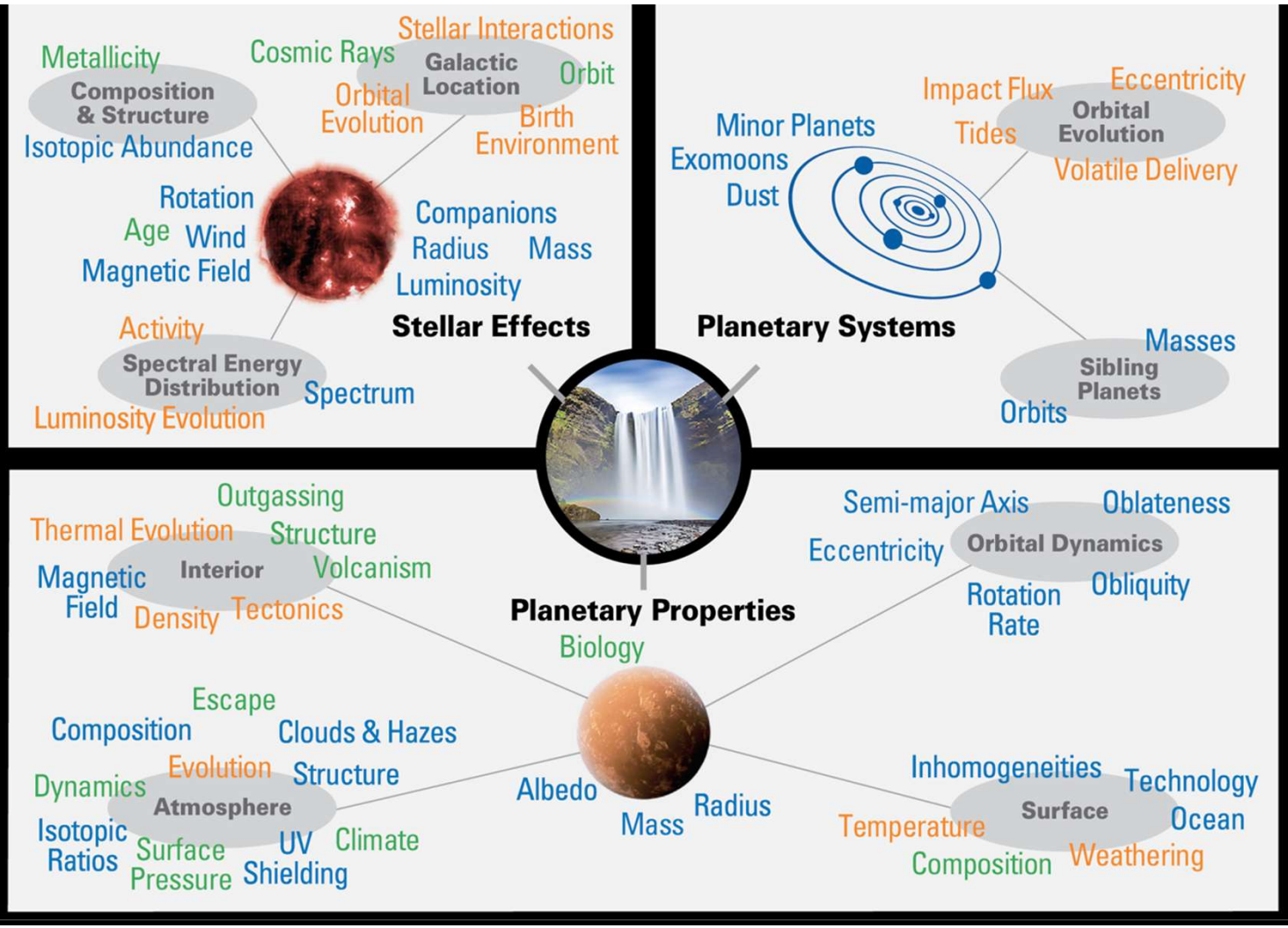
Dawn Gelino (IPAC/NExScI), Victoria Meadows (UW), Daniel Apai (UofA), Shawn-Domagal Goldman (GSFC)

System Science for Planetary Evolution, Habitability and Biosignatures

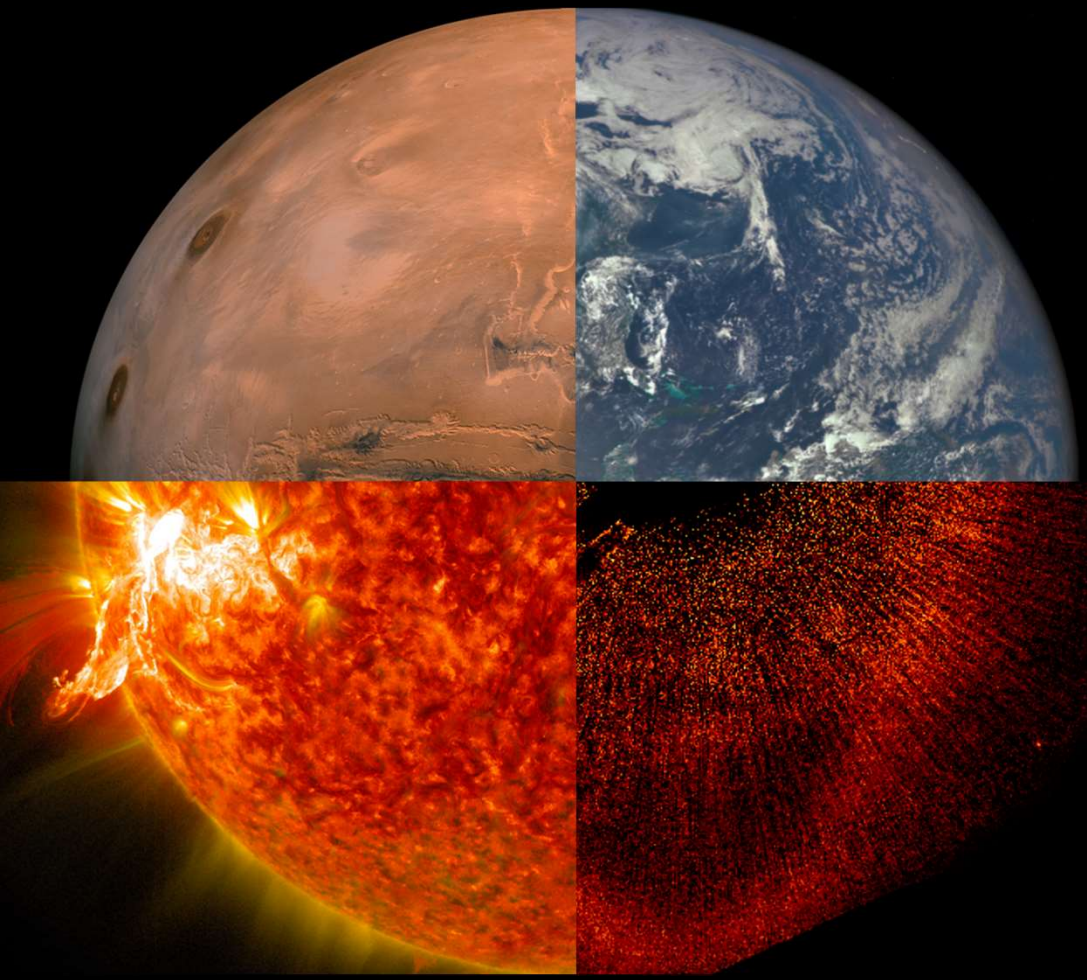


Meadows & Barnes 2018

Exoplanet studies, especially those that focus on habitability and biosignatures are inherently interdisciplinary, and by collaborating across disciplines we can work more efficiently to answer one of humanity's oldest questions:

Are we alone?

Achieving NExSS Goals Requires Interdisciplinarity



NExSS addresses the complexity inherent in exoplanet characterization by leveraging NASA-funded research across the four NASA science divisions: Planetary Science, Astrophysics, Heliophysics, and Earth Sciences.

NExSS IS…

- An interdisciplinary research coordination network (RCN) founded in 2015, and dedicated to the study of planetary habitability and the search for life on exoplanets
- A NASA cross-division initiative bringing astrophysicists, planetary scientists, Earth scientists, and heliophysicists together to bring a "systems science" approach to this problem
- A way to leverage NASA investments in research and missions to create a community that will accelerate discovery and characterization of potential life-bearing worlds, and break down barriers between SMD divisions
- One of the five RCNs that incorporate ICAR teams
  - 410 members, 66 teams, 114 institutions, 15 countries
  - 368 US members (89.8%) and 42 International (10.2%)
  - 398+ papers with NExSS acknowledgements
  - Almost 10,000 citations for NExSS in the literature

HQ Reps:
Mary Voytek (PSD)
Richard Eckman (ESD)
Doug Hudgins (APD)
Jared Leisner (HPD)

Co-Leads:
Daniel Apai (UA)
Dawn Gelino (IPAC/NExScI)
Victoria Meadows (UW)
Shawn Domagal-Goldman (GSFC)

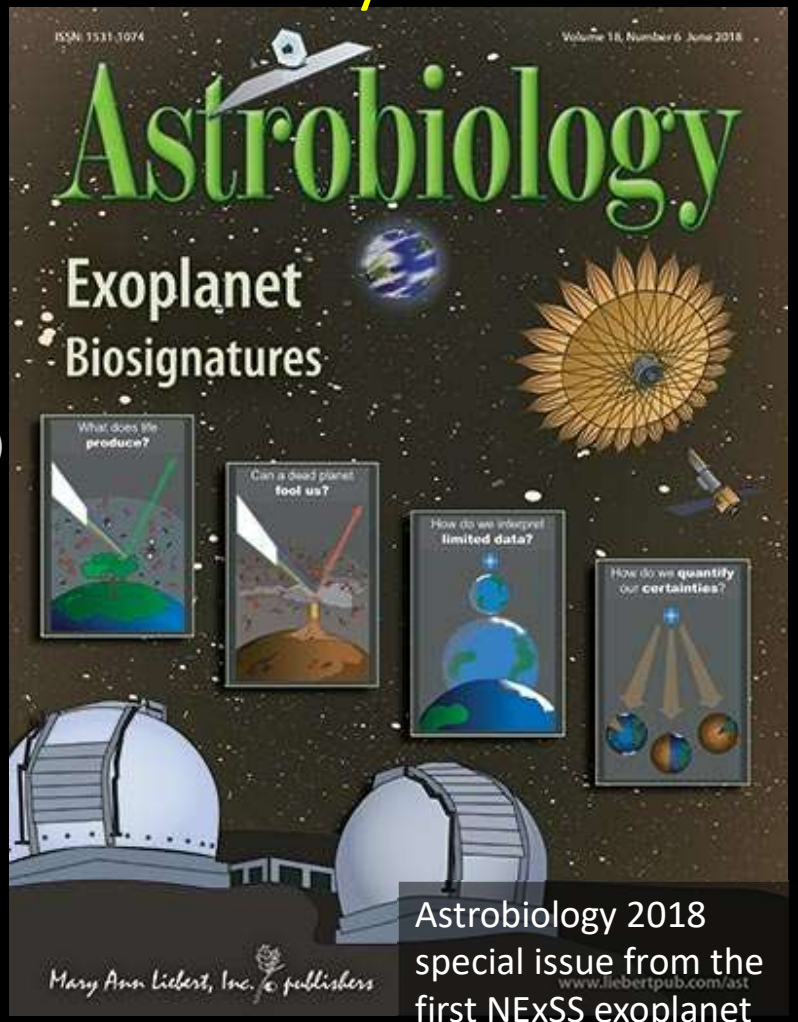
NExSS NPMP:
Jessica Noviello (GSFC)

Example NExSS Activities

- Coordinate Community White Papers
- Postdoc Opportunities
- Science Working Groups
- HabEx/LUVOIR Leadership
- Workshops Without Walls
- Habitable Worlds conference series
- Science Communications Working Group
- Student Summer Schools
- Webinars
- PAWS Early Career Professional Development Series
- Public Outreach: Manyworlds.space

NExSS Activities to Integrate Teams and Build Community

- Collaborative Community Observing Proposals for Exoplanet Science
  - JWST ERS proposals, TRAPPIST-1 JWST Community Initiative
- Workshops and Reports
  - Biosignatures Assessment Framework (Joint with NfoLD 2021/2022)
  - 1D & 3D GCM Model Comparison Workshop (2021/22)
  - Magnetic Field Effects on Habitability (2021/22)
  - Habitability Quantification (Dec. 2020)
  - Technoclimes (Aug 2020), Technosignatures mini-symposium (6/2021)
- Science Working Groups
  - Quantitative Habitability Assessment (Apai, Barnes)
  - Technosignatures (Frank, Wright)
  - Climate Model Intercomparisons (Fauchez, Sohl)
  - Planetary Atmospheres (DasGupta, Brain)
  - Planet Formation (Bose, Krijt)
  - Biosignatures (Olson, Mandell)
- Communications Working Group
  - Science Nuggets, Opportunities, Knowledge Exchange
- Regular Steering Committee (PI) telecons , Publication Bulletin
- Slack Workspace w/working group/early career channels, NExSS Newsletter, email lists



Astrobiology 2018 special issue from the first NExSS exoplanet biosignatures workshop

NExSS Science Working Groups (1)

- Biosignatures/Life Detection (Olson, Mandell)
  - Enhance confidence that a planet is truly inhabited, or truly uninhabited
    - Mitigating scientific (synthesis of planetary, stellar, geochemical, and biological phenomena) and structural/cultural challenges
    - Advancing an integrated strategy for exoplanet life detection

- Climate Model Intercomparisons (CUISINES; Fauchez, Sohl)
  - Focus community effort on benchmarking, comparing, and validating the performance of exoplanet models, both with respect to other models and observations
  - Identify and (where appropriate) smooth out differences between model predictions within the same model category (i.e. GCM vs GCM) or between categories (e.g. GCM vs. 1D climate models)
  - Evaluate model performances with comparisons to data (when available), as well as computational efficiency
  - CUISINES data, multi-model outputs, and scripts will all be made publicly available in a standardized format to guarantee easy reproducibility of the results

CUISINES model intercomparisons

NExSS Science Working Groups (2)

- Planetary Atmospheres (DasGupta, Brain)
  - Constrain the origin and evolution of atmospheres of rocky planets in our Solar System and exoplanetary systems
  - Explore all mechanisms of loss and gain of an atmosphere and its constituents for different rocky exoplanetary systems from Earth-like planets to Super-Earths and Sub-Neptunes
  - Tackle a number of topics and specifically improve communication between them such that better holistic models of atmospheric compositions of rocky planets can be developed
- Planet Formation (Bose, Krijt)
  - Address planet formation from an interdisciplinary point of view
- Quantitative Habitability Assessment (Apai, Barnes)
  - Rory will speak about this in detail
- Technosignatures (Frank, Wright)
  - Serve as an additional resource to build the technosignature research community both within astronomy and across other disciplines, including but not limited to astrobiology, planetary science, and heliophysics
  - Held ½ day webinar (6/21) that brought techno-and bio-signature researchers together, several sessions at AbSciCon (5/22), PSETI Symposium (6/22); several community papers now published from Technoclimes meeting (8/20)
- Communications Working Group
  - Inter-team, Science Community, HQ
  - Science Nuggets, Opportunities, Knowledge Exchange, Newsletter, Social Media, Website, PAWS

NExSS Science Working Groups: CUISINES

- Climate Model Intercomparisons (CUISINES; Fauchez, Sohl)
  - CAMEMBERT: Exoplanet General Circulation Models (GCMs) for mini-Neptunes; Lead: Duncan Christie
  - CRÈME: Exoplanet General Circulation Models (GCMs) for Earth; Lead: Kostas Tsigaridis
  - FILLET: Energy Balance Models (EBM) for ice belts and polar caps; Lead: Russel Deitrick
  - MALBEC: Radiative transfer models; Lead: Geronimo Villanueva
  - PIE: 1D photochemical models for terrestrials; Lead: Sonny Harman
  - SAMOSA: Exoplanet General Circulation Models (GCMs) for terrestrials; Lead: Jacob Haqq-Misra

CUISINES model intercomparisons

- CUISINES has 6 new model intercomparison projects that span from terrestrials to mini-Neptunes and for 1D photochemical models, energy balance models, GCMs and radiative transfer models
- Protocol papers are currently being written for each of them, SAMOSA is already submitted in a dedicated special issue in PSJ, the others will follow soon
- Once the protocol papers are published, the teams will begin the intercomparisons and will publish results papers over the next couple of years
- In addition, an overall CUISINES protocol paper describing general best practices for model intercomparisons is being written, and BASIL (Benchmark Atmospheric Simulations for Intercomparison Linkage), a paper that will aim to identify the best benchmarks to compare/validate exoplanet model, is also being written
- A BUFFET-2 workshop will be planed around October 2022 (leads: Fauchez & Kofman)
- PI Fauchez is working on the CUISINES webpage on the NExSS website so people can access to all the data and the papers directly from there
  - Participation is always welcome, please just reach PI Thomas Fauchez (thomas.j.fauchez@nasa.gov)

NExSS and Decadal Precursor Activities

- The NExSS community is encouraged to propose activities that align with the priorities recommended in the Decadal and that could potentially support the Pathway to Habitable Planets

- This could be via:
  - Participating in existing aligned activities in the NExSS Science Working Groups
  - Suggesting new topics of study in the NExSS Science Working Groups
  - Suggesting a new Science Working Group
  - Organizing a community conference on a key topic
  - Developing community collaborations for precursor observations

- The NExSS and SWG Co-leads would love to hear your ideas and help you get the collaborations and support you need for your activities

Collaborations between NExSS, ExoPAG, Planetary AGs

- NExSS prioritizes enabling interdisciplinary research among the exoplanet research community, to address intellectual and academic goals. NExSS therefore covers a broad range of exoplanet research topics, including the integration of science from all four NASA mission directorates, with researchers from all four communities intrinsically involved.

- ExoPAG was created to give specific community feedback to NASA HQ and the Astrophysics Divison. ExoPAG has historically focused on topics related to scientific support and use of NASA observatories, including technology development, and it consists primarily of scientists funded by or that work on missions or science led by APD
  - However, with the recent expansion of the Exoplanet Research Program to become cross-divisional, there has been growing interest in including representatives from other Divisions on the ExoPAG EC, and in forging stronger links with Solar System scientists.

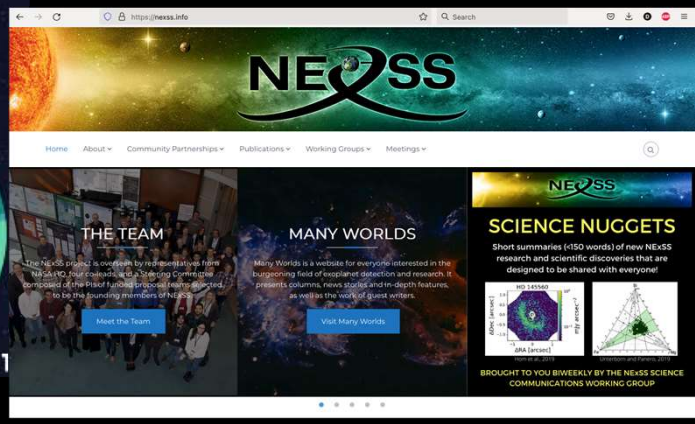
- There is strong collaboration between these two entities in supporting community activities:
  - Joint ExoPAG/OPAG/VExAG meeting on Solar System/Exoplanet Synergies (Exoplanets in Our Backyard) supported by NExSS
  - ExoPAG SAG15 (Direct Imaging Mission Science report), SAG16 (2016 *first* Biosignature Workshop) and SAG22 (Stellar Contamination report) had strong collaboration with NExSS activities and were led by NExSS team members
  - ExoPAG SIG3 Solar System Synergy Tutorial Presentations also supported by NExSS members and hosted on the NExSS website

You Can Get Involved in NExSS!

- Three mechanisms:
  - Be a member of a relevant, accepted NASA proposal
  - Join one of our science working groups, or participate in our workshops, conferences and other community activities
  - Join as a NExSS affiliate:

https://nexss.info/about/nexss-affiliates/

- Join NExSS to get access to:
  - Email Announcements
  - Publication bulletins
  - Newsletter
  - Slack space



Thanks!

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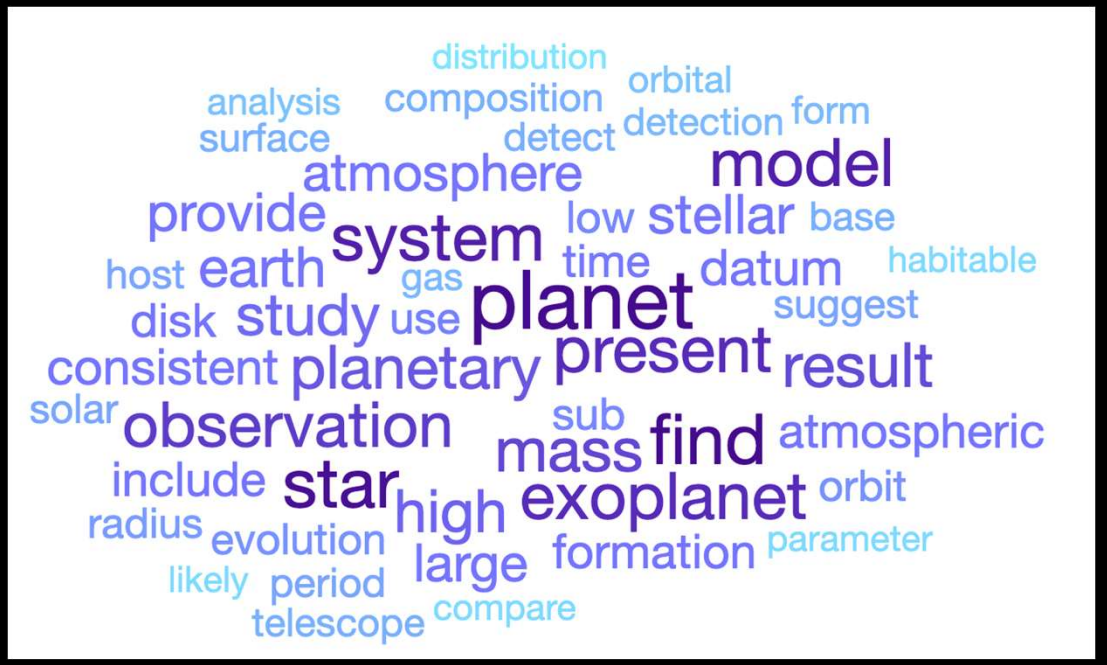


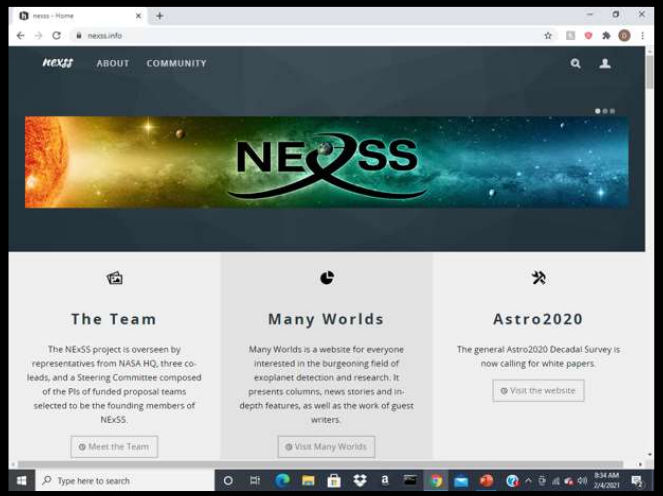
Backup

NExSS Science Goals

- Understand planets in context throughout their formation and coevolution with their parent star and planetary system
- Investigate the diversity of exoplanet characteristics and learn how their properties and evolution can create the conditions for life
- Understand how to identify the best exoplanet targets for life searches
- Learn how to recognize, and search for, signs of habitability and life on exoplanets

Science Communications Working Group (SCWG)

- A group of NExSS members passionate about science communication
- Four teams: Newsletter, Social Media, Website, and Science Nuggets
- Communication in English and Spanish
- Working on creating workshops now
- Any NExSS member is welcome to join!



MANY WORLDS

www.manyworlds.space

Posted on 2016-04-25 by Marc Kaufman

Leave a comment

Breaking Down Exoplanet Stovepipes

The search for life beyond our solar system requires unprecedented cooperation across scientific disciplines. NASA's NExSS collaboration includes those who study Earth as a life-bearing planet (lower right), those researching the diversity of solar system planets (left), and those on the new frontier, discovering worlds orbiting other stars in the galaxy (upper right). (NASA)

About Many Worlds

There are many worlds out there waiting to fire your imagination.

Marc Kaufman is an experienced journalist, having spent three decades at The Washington Post and The Philadelphia Inquirer, and is the author of two books on searching for life and planetary habitability. While the "Many Worlds" column is supported by the Lunar Planetary Institute/USRA and informed by NASA's NExSS initiative, any opinions expressed are the author's alone.

This site is for everyone interested in the burgeoning field of exoplanet detection and research, from the general public to scientists in the field. It will present columns, news stories and in-depth features, as well as the work of guest writers. Many Worlds will be updated at least once a week.

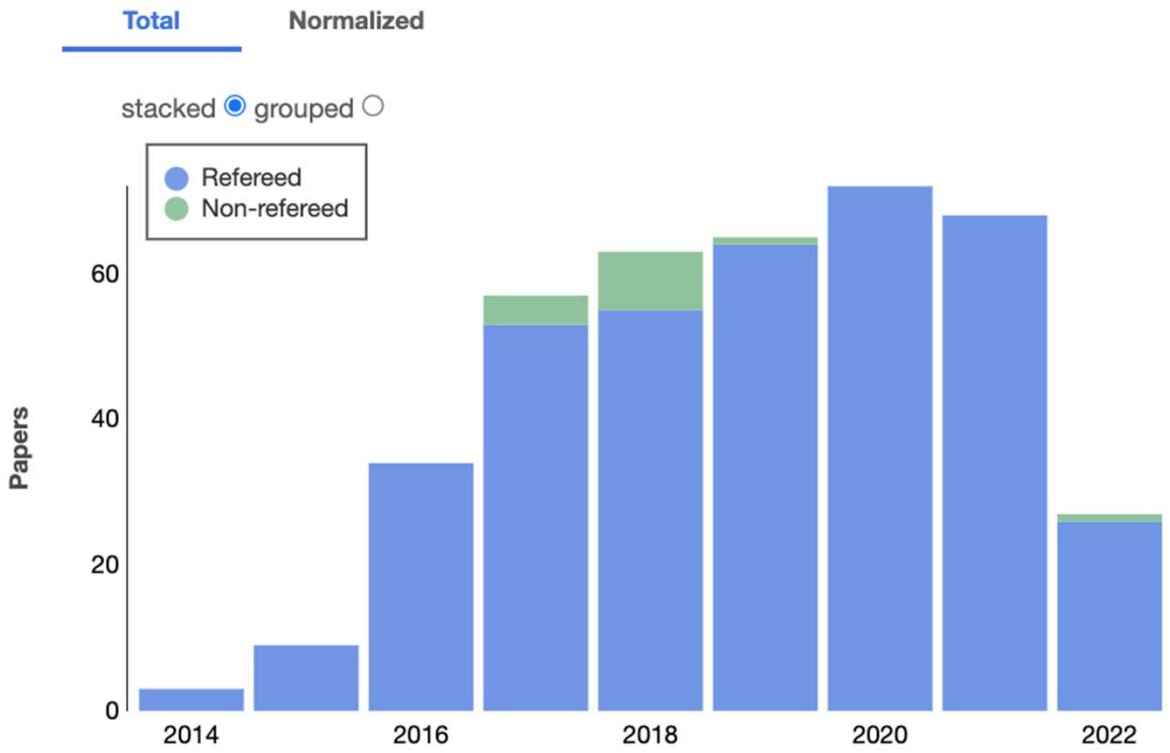
To contact Marc, send an email to marc.kaufman@manyworlds.space.

NExSS

Public Outreach:

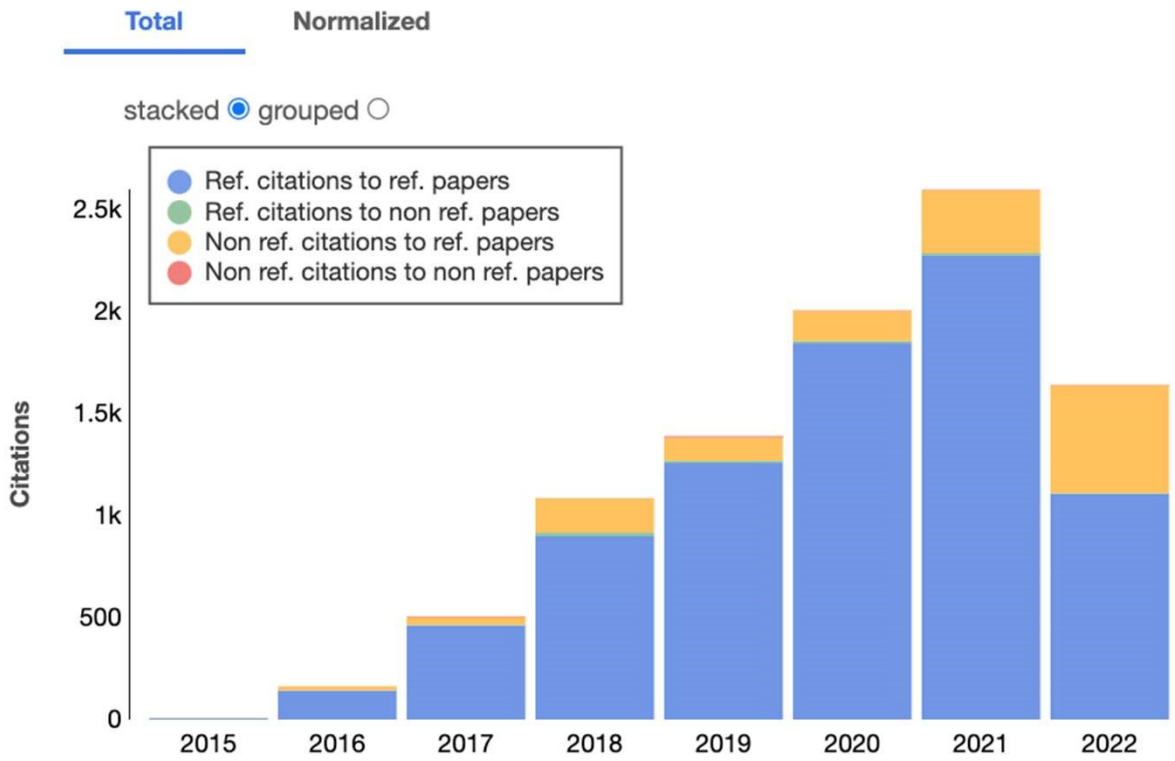
Science writers Marc Kaufman and Elizabeth Tasker blog about NExSS related research

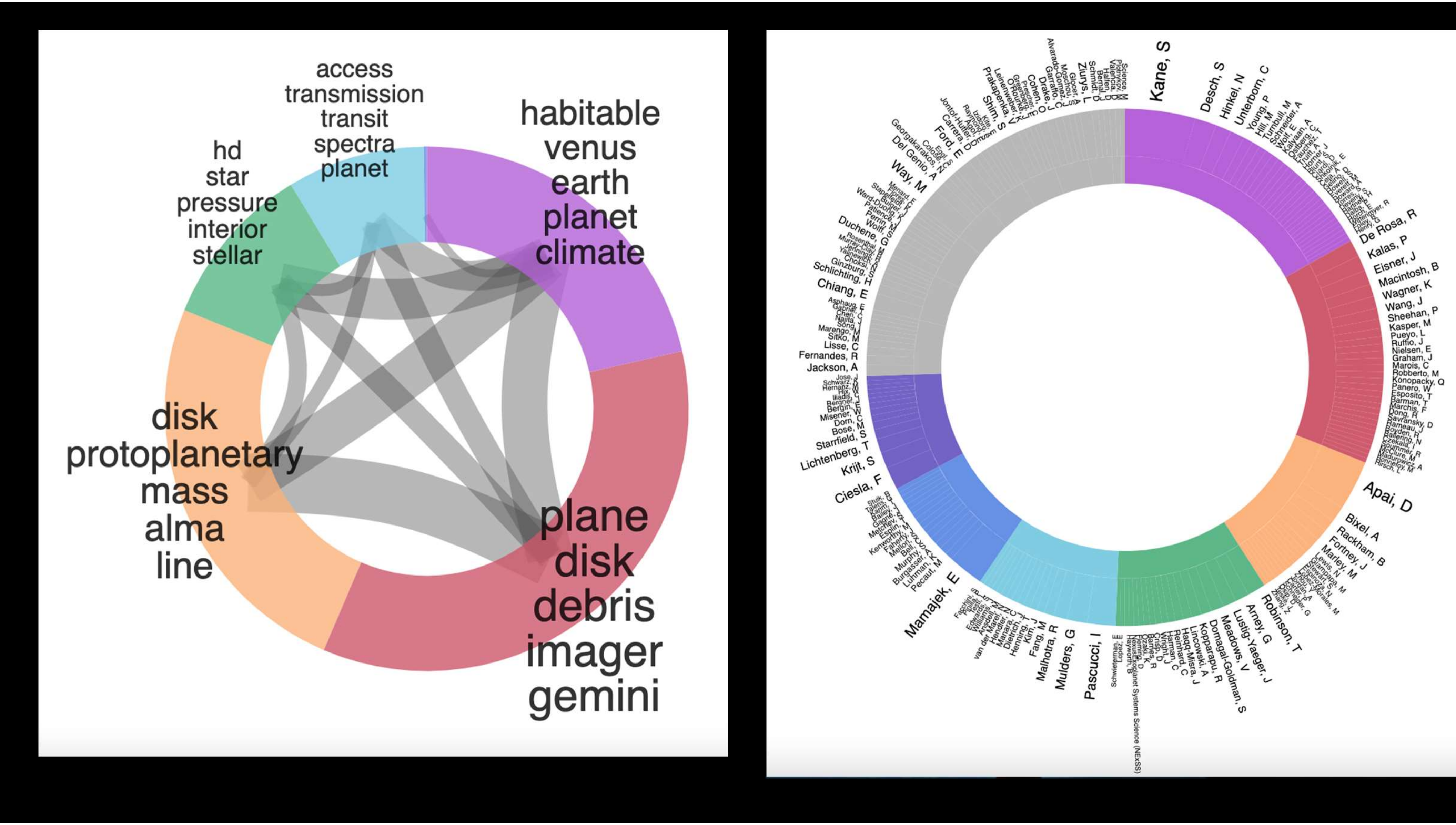
	Totals	Refereed
Number of papers	398	384
Normalized paper count	87.7	82.6



Citations

	Totals	Refereed
Number of citing papers	4867	4812
Total citations	9400	9322
Number of self-citations	1144	1143
Average citations	23.6	24.3
Median citations	12	13
Normalized citations	1897.3	1822.2
Refereed citations	8047	7991
Average refereed citations	20.2	20.8
Median refereed citations	10	10.5
Normalized refereed citations	1623.7	1568.7

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disk
debris
imager
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Hinkel, N
Unterborn, C
De Rosa, R
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