



## American Society for Gravitational and Space Research – 2020

[douglas.matson@tufts.edu](mailto:douglas.matson@tufts.edu)

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Douglas Matson  
Jamie Foster  
Kevin Sato

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### ASGSR as the US Gravitational Sciences Technical Society

400 members (academia, agency, industry)

Vibrant student outreach HS/UG/grad

Active student chapter

### Annual meeting going on RIGHT NOW – 20 years of ISS habitation

Plenary presentations

287 member submissions / 100 virtual talks

38 undergrad / 62 grad “lightening” presentations

### 2020 Highlights – Initiating activities to support the Decadal

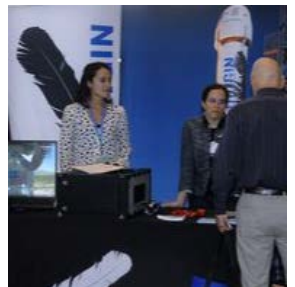
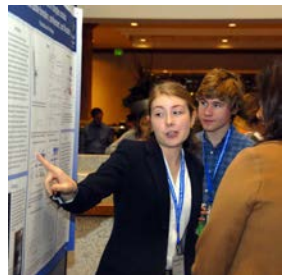
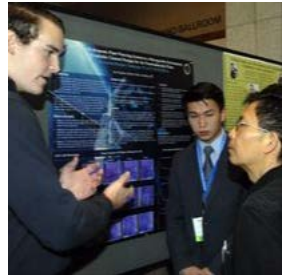
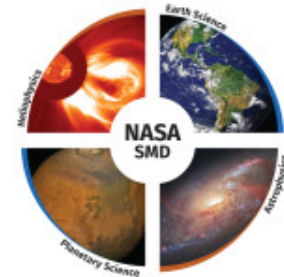
ASGSR as PI/Industry focal point

Upcoming National Academies “White Paper” solicitation

BPS/SMD encourages communication / community involvement

Proposal to NASA supporting ASGSR Decadal Workshop Series

Identify Campaign Champions and Collaborations





## ASGSR Decadal Survey Workshop Series

jfoster@ufl.edu

**Goals** of this Series are to educate stakeholders and foster collaborative efforts to develop potentially transformative ideas into white papers and grand campaigns.

### Objectives

- Provide a public forum to stimulate constructive discussion and identify community leaders.
- Organize cohorts, facilitate networking within collaborative partnerships, and present strategies that optimize communication to ensure capturing a robust and balanced space program.
- Develop a tutorial to guide the science community on how to prepare white papers that address not only the scientific needs, but also how to envision synergy and create a budget to develop grand campaigns.
- Document the progress and lessons-learned by collating community input.

**Approach** is to host a series of virtual topical ① Town Halls, ② community surveys, and ③ interactive MicroLabs with the assistance of a professional facilitator.

KNOWINNOVATION

Acknowledge financial support by NASA SMD/BPS  
Topical Workshop Solicitation #NNH20ZDA001N-TWSC

<https://asgsr.org/decadal-survey/>

**ASGSR Decadal Survey Workshop Series**  
A once in a decade opportunity....

Over the next two years the National Academies of Science, Engineering and Medicine (NASEM) will be developing the next Decadal Survey on Life and Physical Sciences Research in space 2030-2035, which will serve as a critical framework to shape the upcoming vision and strategy plan for NASA research efforts in the area of biological and physical sciences in space.

The NASEM Decadal Survey committee will be reviewing the current state of knowledge in areas of space-related biological and physical sciences research, identify the most compelling scientific challenges and frontiers within Biological and Physical Sciences in Space Research, and develop a comprehensive research strategy to advance these areas of NASA portfolio. The full description of the NASEM Decadal Survey of Task can be found here.

To facilitate the development of this survey, the American Society for Extraterrestrial and Space Research (ASGSR) is collaborating with KnowInnovation hosting a series of workshops to help foster community-wide discussions within and across biological and physical science disciplines. Our primary goal of these workshops is to identify potential Research Campaign Issues, or those potentially transformative research topics that could not be done with a normal single grant and that will drive the momentum for potential new and cross-disciplinary areas.

#### 1. Virtual Topical Town Halls

The goal of these Virtual Town Hall events is to engage the larger Biological and Physical Sciences in Space research community and to identify key subjects and larger research campaigns that should be submitted to the Decadal Survey effort as Concept Papers.

The ideas that are derived from these town hall will be used as a foundation for a series of smaller MicroLab like workshops that will occur in December 2022 and January 2023.

All academic levels are welcome to participate and submit ideas for discussion topics in the Town Halls. You are welcome to participate in multiple events as cross disciplinary thinking is strongly encouraged.

Town Halls will be offered in the following categories of Biological and Physical Sciences in Space: Animal, Plant, Microbiology, Fluid Physics, Complex Fluids, Materials, Combustion and Fundamental Physics. Additionally, we will offer a Town Hall focused on Educational topics as well as Diversity, Equity and Inclusion in the Space Sciences.

Want to learn more about these topics?  
Please click the button to see talks about current capabilities, space access platforms and a series of Plurid talks of where space researchers may see their work in 10 years time.

**2. Post-Town Hall Community Surveys**

For those participants in the Town Hall please complete the post-Town Hall survey. Alternatively if you were not able to participate in a Town Hall, feel free to provide additional comments here.

#### 3. MicroLabs - Highly Interactive Workshops

MicroLabs will be highly interactive 90-minute virtual events that will be held as part of a series to help spur on creative thinking and facilitate the free exchange of ideas.

Members from the ASGSR leadership and the KnowInnovation staff will help catalyze creative thinking and stimulate the emergence of ideas in these events.

The goal of these MicroLabs will be to discuss and begin to outline the major research campaigns that will be submitted to the NASEM Decadal Survey as Concept Papers.

Via email you will receive a list of these MicroLab topics that span the different subtopics within Biological and Physical Space Sciences (e.g., microbiology, animal, plant, fluids/complex fluids, combustion, material science, fundamental physics/biophysics). Each MicroLab can host up to 100 participants.

Participants will be invited from a diverse range of academic backgrounds. If you have interest in participating in these topical MicroLabs please submit the attached form.

Tutorial for Writing a Concept Paper



## Virtual Topical Town Halls 2020

Animal Research:	Nov 12 16:00–18:00 CST
Plant Research:	Nov 17 16:00–18:00 CST
Microbiology Research:	Nov 19 16:00–18:00 CST
Education, Diversity, Inclusion and Equity:	Nov 20 16:00–18:00 CST
Fluid Physics; Complex Fluids; Biophysics:	Dec 1 16:00–18:00 CST
Materials; Combustion; Fundamental Physics:	Dec 3 16:00–18:00 CST

### Discipline-focused Virtual Town Halls

Stimulate ideation and discussions leading to transformative research campaigns while identifying vocal participants who are candidates to serve as team leads moving forward

### GOALS

Engage community in discussions promoting development of “White Papers” for the National Academies Decadal  
Identify stakeholders as leaders in these efforts

### APPROACH

- Ideation of Transformative Research Topics:
- (1) Keystone capabilities on existing hardware
  - (2) Identify cross-disciplinary Research Campaigns

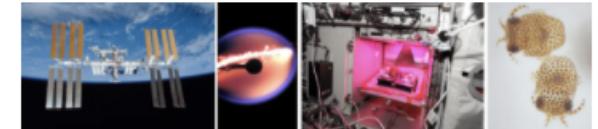
# Register

<https://asgsr.org/decadal-survey/>



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To facilitate the development of this survey, the American Society for Gravitational and Space Research (ASGSR) is collaborating with Knowinovation hosting a series of workshops to help foster community-wide discussions within and across biological and physical sciences disciplines. Our primary goal of these workshops is to identify potential Research Campaign themes, or those potentially transformative research topics that could not be done with a normal single grant and that will provide the momentum for potential new and cross-disciplinary areas.

#### 1. Virtual Topical Town Halls

- The goal of these Virtual Town Halls is to identify key biological and physical sciences research topics and to identify key subjects and larger research campaigns that should be submitted to the Decadal Survey effort as Concept Papers.
- The ideas that are derived from these town hall will be used as a foundation for a series of smaller MicroLab idea workshops that will occur in December 2020 and January 2021.
- All academic levels are welcome to participate and submit ideas for discussion topics in the Town Halls. You are welcome to participate in multiple events as cross-disciplinary thinking is strongly encouraged.
- Town Halls will be offered in the following categories of Biological and Physical Sciences in Space: Animal, Plant, Microbiology, Fluid Physics, Complex Fluids, Materials, Combustion and Fundamental Physics. Additionally, we will offer a Town Hall focused on Educational topics as well as Diversity, Equity and Inclusion in the Space Sciences.

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[Decadal Talks Page](#)



#### 2. Post-Town Hall Community Surveys

For those participants in the Town Hall please complete the post-Town Hall survey. Alternatively, if you were not able to participate in a Town Hall, feel free to provide additional comments [here](#).

[Comments & Feedback](#)  
Post-Town Hall Community Survey  
Survey Survey open until end of 2020

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- MicroLabs will be highly interactive 15-minute virtual events that will be held as part of a series to help spur on creative thinking and facilitate the free exchange of ideas.
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- Via email you will receive a list of these MicroLab topics that span the different subtopics within Biological and Physical Space Sciences (e.g., microbiology, animal, plant, fluids/complex fluids, combustion, material science, fundamental physics/biophysics). Each MicroLab can host up to 100 participants.
- Participants will be invited from a diverse range of academic backgrounds. If you have interest in participating in these topical MicroLabs please submit the attached form.

[MicroLab sign-up](#)  
MicroLabs – highly interactive workshops  
Dates: TBD

[Tutorial for Writing a Concept Paper](#)

[Home](#)

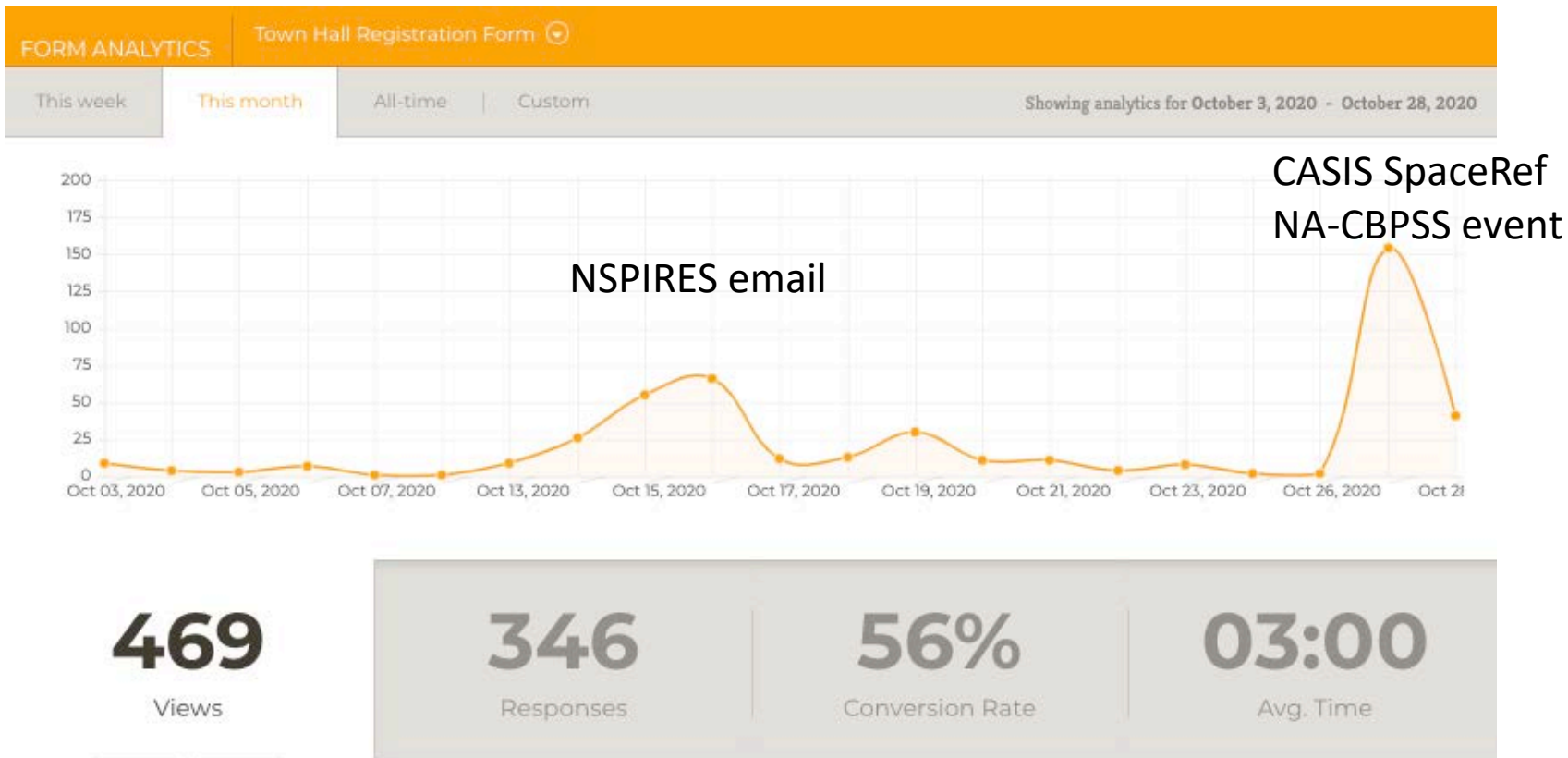


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<https://asgsr.org/decadal-survey/>

## Virtual Town Hall Registration (data as of 10/28/20)



Town Hall	Registrants
Microbiology	196
Plants	170
Animals	170
Education, Diversity, Inclusion, Equity	154
Materials	108
Biophysics	107
Fundamental Physics	95
Fluid Physics	87
Complex Fluids	70
Combustion	64
Grand Total	1221

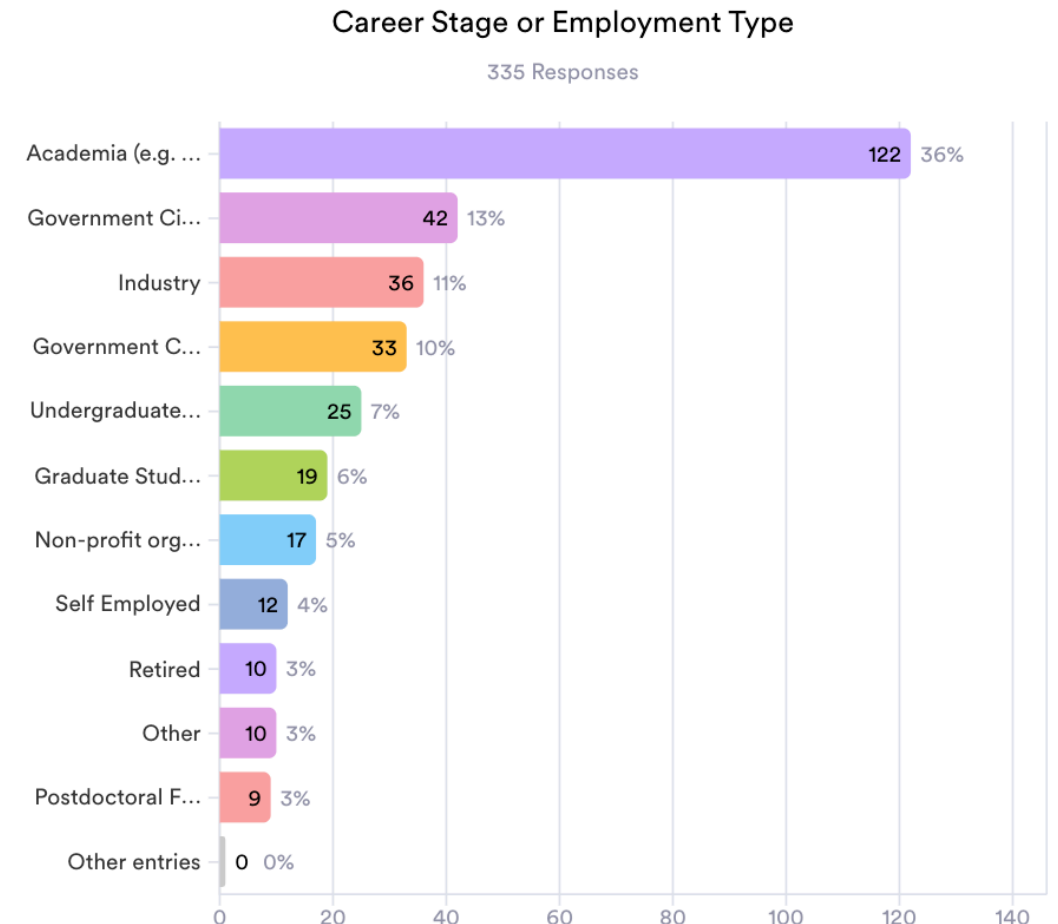
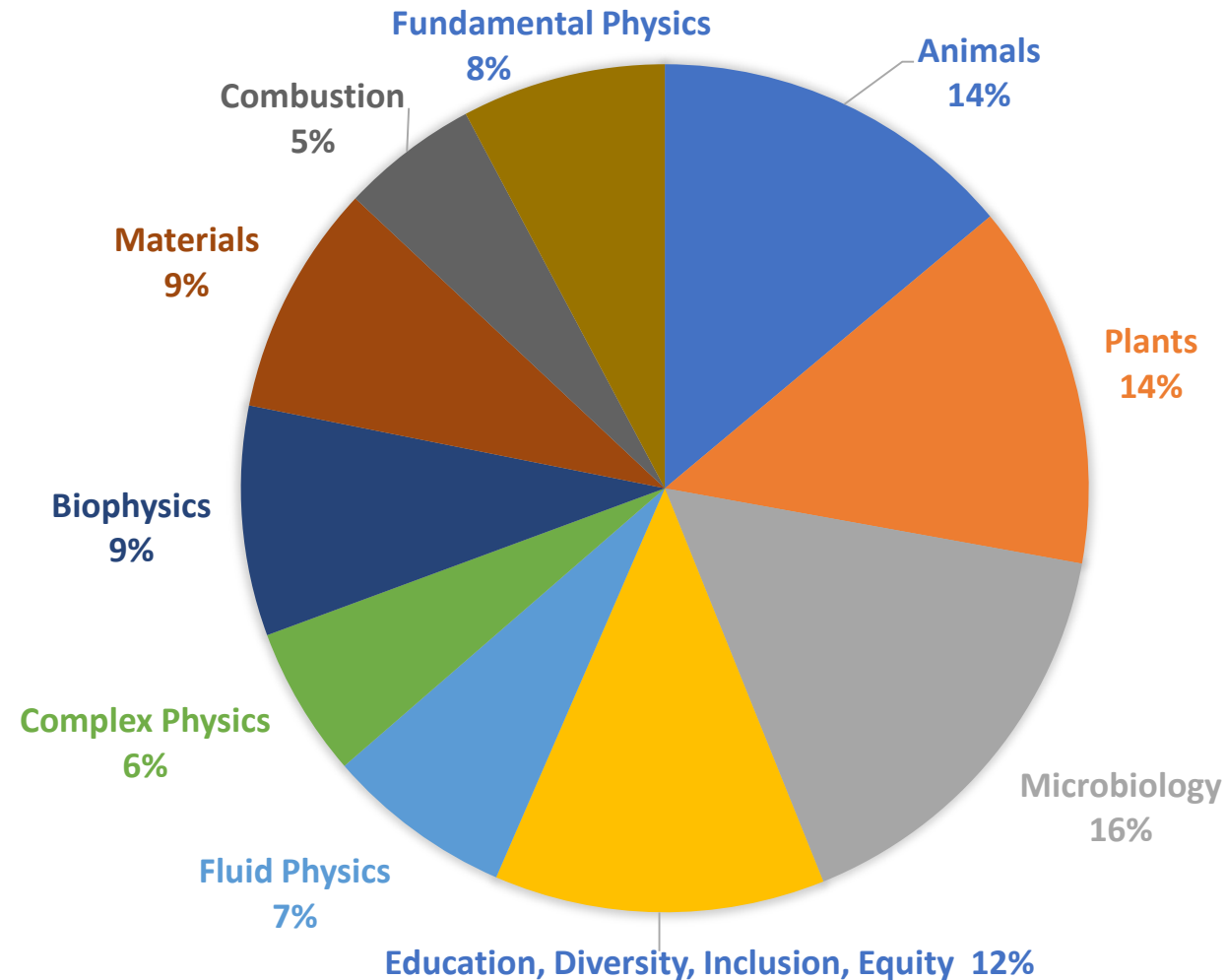


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<https://asgsr.org/decadal-survey/>

## Virtual Town Hall Registration (data as of 10/28/20)







## Pre-meeting material to stimulate discussion

## Town Hall to be run as a series of break-out sessions

<https://asgsr.org/decadal-survey/>

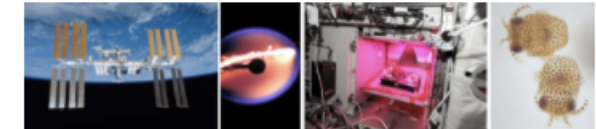


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#### 1. Virtual Topical Town Halls

- The goal of these Virtual Town Hall events is to engage the larger Biological and Physical Sciences in Space research community and to identify key subjects and larger research campaigns that should be submitted to the Decadal Survey effort as Concept Papers.
- The ideas that are derived from these town halls will be used as a foundation for a series of smaller MicroLab idea workshops that will occur in December 2022 and January 2023.
- All scientists are welcome to participate and submit ideas for discussion topics in the Town Halls. You are welcome to participate in multiple events as cross-disciplinary thinking is strongly encouraged.
- Town Halls will be offered in the following categories of Biological and Physical Sciences in Space: Animal, Plant, Microbiology, Fluid Physics, Complex Fluids, Materials, Combustion and Fundamental Physics. Additionally, we will offer a "Town Hall" focused on Educational topics as well as Diversity, Equity and Inclusion in the Space Sciences.

Want to learn more about these topics? Please click the button to see talks about current capabilities, space science platforms and a series of Plant-based and Microbiology-based research topics that may see their work in space.

Decadal Table Page

#### 2. Post-Town Hall Community Surveys

For those participants in the Town Hall please complete the post-Town Hall survey. Alternatively, if you are not able to participate in a Town Hall, feel free to provide additional comments here.

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- MicroLabs will be highly interactive 15-minute virtual events that will be held as part of a series to help spur on creative thinking and facilitate the free exchange of ideas.
- Members from the ASGSR leadership and the Knowinovation staff will help catalyze creative thinking and stimulate the emergence of ideas in these events.
- The goal of these MicroLabs will be to discuss and begin to outline major research campaigns that will be submitted to the NASEM Decadal Survey as Concept Papers.
- Via an ongoing hosting team of these MicroLabs topics that span the different subtopic areas within Biological and Physical Sciences in Space (e.g., microbiology, animal, plant, fluids/complex fluids, combustion, materials science, fundamental physics/biophysics). Each MicroLab can host up to 100 participants.
- Participants will be limited from a diverse range of academic backgrounds. If you have interest in participating in these topical MicroLabs please submit the attached form.

Tutorial for Writing a Concept Paper

Submit Ideas

youtube.com/playlist?list=PL2otGG0bPu59MGjgysIFtDEZ/CmWSh2L

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Animal Research in Space Sciences

1 video • 16 views • Last updated on Oct 19, 2020

ASGSR ASGSR Decadal Survey Town Hall Talks

SUBSCRIBE

**VIDEO FORMAT**  
Plus-Ten (+10)  
YouTube on what "Animal-based Research" will look like at the 2030 ASGSR Annual Meeting

ASGSR

ASGSR Animal-Research Town Hall

In your opinion, what are the most important ideas or future directions for the next 10 years in Animal Research related to the Next Space Life Sciences? What do you envision as a major Research Campaign for Biological and Physical Space Sciences? Please keep your answers concise but also specific. Also, most importantly please think beyond your immediate comfort zone as you imagine the great breadth of information needed to address long-standing research issues in space.

Please keep a copy of your questions so that you have them available to you during the workshop.

Question or Research Campaign Idea 1

Question or Research Campaign Idea 2

Question or Research Campaign Idea 3

FIN SUBMIT

**WRITTEN FORMAT**  
In your opinion, what are the most important ideas or future directions for the next 10 years in "Animal Research" related to the field Space Life Sciences? What do you envision as a major Research Campaign for Biological and Physical Space Sciences?

ASGSR Decadal Survey Workshop Series

Below are the ASGSR-led Town Hall series of technology and forward-thinking talks that can be viewed prior to the start of each Town Hall. After watching the videos, please answer the following: In your opinion, what are the most important ideas or future directions for the next 10 years in Biological and Physical Space Sciences? Please keep your ideas concise but also specific. Also, most importantly please think beyond your immediate comfort zone as you imagine the great breadth of information needed to address long-standing research issues in space. Please submit your answers (and keep a copy for yourself) to the Town Hall event.

Animal / Plant / Microbiology / Fluid Physics / Complex Fluids / Biophysics / Materials / Combustion / Fundamental Physics

Animal-Based Research Town Hall	Plant-Based Research Town Hall	Microbiology-Based Research Town Hall
The ASGSR-led Town Hall for issues related to animal-based research in the space life sciences will be held Nov 12, 2020.	The ASGSR-led Town Hall for issues related to plant-based research in the space life sciences will be held Nov 17, 2020.	The ASGSR-led Town Hall for issues related to microbiology-based research in the space life sciences will be held Nov 19, 2020.
<a href="#">Link to the Animal Research Talks</a>	<a href="#">Coming Soon! Link to the Plant-Based Research Talks</a>	<a href="#">Coming Soon! Link to the Microbiology Research Talks</a>
After watching the videos, click the link below to take you to the survey form.	After watching the videos, click the link below to take you to the survey form.	After watching the videos, click the link below to take you to the survey form.
<a href="#">Submit your ideas</a>	<a href="#">Submit your ideas</a>	<a href="#">Submit your ideas</a>

Education, Diversity, Inclusion and Equity Research Town Hall	Fluid Physics Research Town Hall	Complex Fluids Research Town Hall
The ASGSR-led Town Hall for issues related to education, diversity, inclusion and equity in the space sciences will be held Nov 20, 2020.	The ASGSR-led Town Hall for issues related to fluid physics research in space sciences will be held Dec 1, 2020.	The ASGSR-led Town Hall for issues related to complex fluids research in space sciences will be held Dec 1, 2020.
<a href="#">Coming Soon! Link to the Education Research Talks</a>	<a href="#">Coming Soon! Link to the Fluid Physics Research Talks</a>	<a href="#">Coming Soon! Link to the Complex Fluids Research Talks</a>
After watching the videos, click the link below to take you to the survey form.	After watching the videos, click the link below to take you to the survey form.	After watching the videos, click the link below to take you to the survey form.
<a href="#">Submit your ideas</a>	<a href="#">Submit your ideas</a>	<a href="#">Submit your ideas</a>

Biophysics Research Town Hall	Materials Research Town Hall	Combustion Research Town Hall
The ASGSR-led Town Hall for issues related to biophysics research in space sciences will be held Dec 1, 2020.	The ASGSR-led Town Hall for issues related to materials research in space sciences will be held Dec 3, 2020.	The ASGSR-led Town Hall for issues related to combustion research in space sciences will be held Dec 3, 2020.
<a href="#">Coming Soon! Link to the Biophysics Research Talks</a>	<a href="#">Coming Soon! Link to the Materials Research Talks</a>	<a href="#">Coming Soon! Link to the Combustion Research Talks</a>
After watching the videos, click the link below to take you to the survey form.	After watching the videos, click the link below to take you to the survey form.	After watching the videos, click the link below to take you to the survey form.
<a href="#">Submit your ideas</a>	<a href="#">Submit your ideas</a>	<a href="#">Submit your ideas</a>

Fundamental Physics Research Town Hall
The ASGSR-led Town Hall for issues related to fundamental physics research in space sciences will be held Dec 3, 2020.
<a href="#">Coming Soon! Link to the Fundamental Physics Research Talks</a>
After watching the videos, click the link below to take you to the survey form.
<a href="#">Submit your ideas</a>



## Post-meeting Community Surveys to focus discussion

### ASANA COMMUNITY SURVEYS

Essentially virtual post-it note compilation of ideas  
Coordinated by Knowinnovation using Asana online platform  
and hosting a slack channel as a repository of community ideas

### GOALS

Generate campaign topics  
Identify participants for invitation to upcoming MicroLabs  
Begin collation of larger emerging topical ideas

### Post-Town Hall Survey

What are the ideas and questions you have lingering after the Town Hall events?

Submit your post-Town Hall comments and thoughts: \*

Name \*

First Name Last Name

E-mail \*

ex: myname@example.com

example@example.com

Did you participate in any of the ASGSR Town hall events?

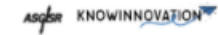
☐ Yes ☐ No

Would you like to be considered for participation in the focus MicroLabs groups that will be occurring in December 2020?

☐ Yes ☐ No

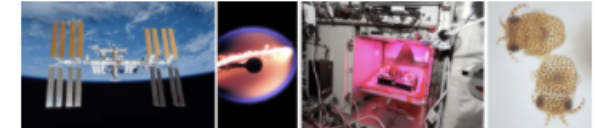
Submit Feedback

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- The ideas that are derived from these town hall will be used as a foundation for a series of smaller MicroLab like workshops that will occur in December 2020 and January 2021.
- All academic levels are welcome to participate and submit ideas for discussion topics in the Town Hall. You are welcome to participate in multiple events as cross discipline thinking is strongly encouraged.
- Workshops will be offered in the following categories of Biological and Physical Sciences in Space: Animal, Plant, Microbiology, Fluid Physics, Complex Fluids, Materials, Combustion and Fundamental Physics, Astronomical Physics, and other "Town Hall" focused on Educational topics as well as Diversity, Equity and Inclusion in the Space Sciences.

Want to learn more about these topics?  
Please click the button to see details about current topics, space science platforms and a series of Plurid talks of interest. Some researchers may see their work in 10 years time.

Decadal Table Page

#### Register here

Virtual Topical Town Halls 2020  
Animal Research  
Nov 10 10:00-11:00 Series  
Plant Research  
Nov 17 10:00-11:00 Series  
Microbiology Research  
Nov 18 10:00-11:00 Series  
Education, Diversity, Inclusion and Equity  
Nov 22 10:00-11:00 Series  
Fluid Physics, Complex Fluids, Biophysics  
Dec 1 10:00-11:00 Series  
Materials, Combustion, Fundamental Physics  
Dec 8 10:00-11:00 Series

#### 2. Post-Town Hall Community Surveys

For those participants in the Town Hall please complete the post-Town Hall survey. Alternatively, if you were not able to participate in a Town Hall, feel free to provide additional comments here.

#### Submit your feedback

Post-Town Hall Community Surveys  
Survey open until end of 2020

#### 3. MicroLabs - Highly Interactive workshops

- MicroLabs will be highly interactive 10-minute virtual events that will be held as part of a series to help spur on creative thinking and facilitate the free exchange of ideas.
- Members from the ASGSR leadership and the Knowinnovation staff will help catalyze creative thinking and stimulate the emergence of ideas in these events.
- The goal of these MicroLabs will be to discuss and begin to outline major research campaigns that will be submitted to the NASEM as Concept Papers.
- Via an online platform, each of these MicroLabs topics that span the different subtopics within Biological and Physical Space Sciences (e.g., microbiology, animal, plant, fluids/complex fluids, combustion, material science, fundamental physics/biophysics). Each MicroLab can host up to 100 participants.
- Participants will be limited from a diverse range of academic backgrounds. If you have interest in participating in these topical MicroLabs please submit the attached form.

#### MicroLabs sign-up

MicroLabs - highly interactive workshops  
Dates: TBD

Tutorial for Writing a Concept Paper

Write Your Paper



## MicroLab interactive workshops – January 2021

### MicroLab WORKSHOPS

Up to 100 participants per MicroLab – 150 min virtual event  
Outline major research campaigns based on outlines generated during the previous Town Hall and Survey activities

### GOALS

Identify “Champion” who will lead each campaign  
Identify writing team members for white paper development

### APPROACH

Mentors from Knowinnovation will manage small-group interactive breakout sessions to catalyze creative thinking and stimulate the emergence of big-picture ideas

[jfoster@ufl.edu](mailto:jfoster@ufl.edu)

**Sign-up for ASGSR White Paper MicroLabs**

Due to limited space signing up does not guarantee a spot in a MicroLab

Participant Name

First Name Last Name

E-mail Institution

ex: myname@example.com example@example.com

Career Stage or Employment Type

Please Select

Select the MicroLab you would like to participate in

- ☐ Animal-focused Research MicroLab, TBD
- ☐ Plant-focused Research MicroLab, TBD
- ☐ Microbiology-focused MicroLab, TBD
- ☐ Education and Diversity, Equity, and Inclusion MicroLab, TBD
- ☐ Fluid Physics MicroLab, TBD
- ☐ Biophysics MicroLab, TBD
- ☐ Combustion MicroLab, TBD
- ☐ Materials MicroLab, TBD
- ☐ Complex Fluids MicroLab, TBD
- ☐ Fundamental Physics MicroLab, TBD

Is there a particular White Paper that you would like to champion?

Submit Registration Clear Fields

<https://asgsr.org/decadal-survey/>

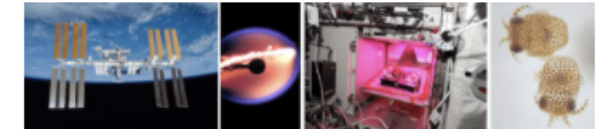


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A once in a decade opportunity....



Over the next five years the National Academies of Science, Engineering and Medicine (NASEM) will be developing the next Decadal Survey on Life and Physical Sciences Research in space 2030-2035, which will serve as a critical framework to shape the upcoming vision and strategy plan for NASA research efforts in the area of biological and physical sciences in space.

The NASEM Decadal Survey committee will be reviewing the current state of knowledge in areas of space-related biological and physical sciences research, identify the most compelling scientific challenges and frontiers within Biological and Physical Sciences in Space Research, and develop a comprehensive research strategy to advance these areas of NASA's portfolio. The full description of the NASEM Decadal Survey of Task can be found here.

To facilitate the development of this survey, the American Society for Space Research (ASGSR) is collaborating with Knowinnovation hosting a series of workshops to help foster community-wide discussions within and across biological and physical sciences disciplines. Our primary goal of these workshops is to identify potential Research Campaign Issues, or those potentially transformative research topics that could not be done with a normal single grant and that will drive the momentum into potential new and cross-disciplinary areas.

#### 1. Virtual Topical Town Halls

- The goal of these Virtual Town Hall events is to engage the larger Biological and Physical Sciences in Space research community and to identify key subjects and larger research campaigns that should be submitted to the Decadal Survey effort as Concept Papers.
- The ideas that are derived from these town halls will be used as a foundation for a series of smaller MicroLab idea workshops that will occur in December 2020 and January 2021.
- All academic levels are welcome to participate and submit ideas for discussion topics in the Town Halls. You are welcome to participate in multiple events as cross-disciplinary thinking is strongly encouraged.
- Town Halls will be offered in the following categories of Biological and Physical Sciences in Space: Animal, Plant, Microbiology, Fluid Physics, Complex Fluids, Materials, Combustion and Fundamental Physics. Additionally, we will offer a Town Hall focused on Educational topics as well as Diversity, Equity and Inclusion in the Space Sciences.

Want to learn more about these topics?  
Please click the button to see talks about current capabilities, challenges, and a series of Panel talks of where the research may see their work in 10 years time.

#### 2. Post-Town Hall Community Surveys

For those participants in the Town Hall please complete the Post-Town Hall survey. Alternatively, if you were not able to participate in a Town Hall, feel free to provide your comments here.

#### 3. MicroLabs – Highly Interactive Workshops

- MicroLabs will be highly interactive 150-minute virtual events that will be held as part of a series to help spur on creative thinking and facilitate the free exchange of ideas.
- Members from the ASGSR leadership and the Knowinnovation staff will help catalyze creative thinking and stimulate the emergence of ideas in these events.
- The goal of these MicroLabs will be to discuss and begin to outline major research campaigns that will be submitted to the NASEM Decadal Survey as Concept Papers.
- Workshops hosting seven of these MicroLabs topics that span the different subtopics within Biological and Physical Space Sciences (e.g., microbiology, animal, plant, fluids/complex fluids, combustion, materials science, fundamental physics/biophysics). Each MicroLab can host up to 100 participants.
- Participants will be limited from a diverse range of academic backgrounds. If you have interest in participating in these topical MicroLabs please submit the attached form.

Tutorial for Writing a Concept Paper

Make Video





## Panel questions

**TARGET:** Transformative Science

**APPROACH:** White papers addressing

Keystone capabilities using focused facilities (existing → future)

Campaign development (cross-disciplinary)

## Acknowledgements

Jamie Foster, Jeff Willey

Anna-Lisa Paul, David Urban

Gale Allen, Emily Eicher

### Panel questions – “Current topics in Microgravity/Biological and Physical Sciences in Space”

After a detailed review of NASA’s plans, what are the major challenges confronting experimentation in microgravity, including integration of new commercial and university contributors?

- Scheduling
  - Time delay from award to flight using existing hardware has severe budget impacts especially when NASA spreads out or compacts the milestones → continuous rebudgeting
  - Lack of time following flight to allow completion of ground-support activities with respect to unexpected /transformative results
- Reliability of on-time launches. Biological experiments are particularly sensitive to “rolling slips” and delays as many biological payloads have developmental or viability constraints that are compromised with delays – especially ones that keep rolling over day by day.
- Limited options on-orbit resources such as
  - preservation protocols such as need for “snap freezing” for biology (crucial for some downstream protocols)
  - habitats for biological organisms with reduction in extraneous environmental stresses; provide comparable ground units in sufficient abundance to conduct pre-flight verification tests.
  - Imaging and analysis capabilities
    - downlink capability
    - real-time monitoring
    - microscopy support
  - Traditional resource limitations: power, cooling, and limited crew time, which confines the complexity of experiments and technology development
- Restrictions of up-mass and down-mass curtail the kind of replicate numbers expected of most biological experiments, leads to storage problems on-orbit
- Prioritization of science - the perception in the academic, peer-reviewed scientific community is that commercial, tech demo, and political payloads sometimes trump access from experiments that have been peer-reviewed and are NASA grant supported.
- Emphasis on flight programs with limited portfolio of ground-based feeder projects – high risk/high reward is the defining characteristic of transformational research topics
- NRA structure
  - Timing of periodic release of overly restrictively targeted NRA topic – emphasis on a robust program at the expense of being nimble: lack of simultaneous continuity/adaptability
  - Silo-ed descriptions often stifle cross-disciplinary thinking. Examples are *Combustion* and *Materials* in Physical Sciences.
- Limited partial gravity platforms to investigate gravity as a continuum
- How to leverage international/interagency partnerships; how do they fit into the Decadal process?
- Outreach to industry needs improving – perception of high fiscal risk with severe operational limitations needs to be mitigated by education and seed funding



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## Panel questions – “Current topics in Microgravity/Biological and Physical Sciences in Space”

Are there breakthroughs on the horizon that enable new insights into potential commercial products or new lines of research?

### ➤ Biological Sciences

- Dynamic evolution of microbiome under spaceflight conditions
- Use of probiotics to prevent disease, control biofilm development and improve spacecraft health
- Application of synthetic biology for development of transgenic microbial, plant and animal species to improve survivability and productivity in space
- “Micro-laboratory” technologies have the capacity to be utilized on orbit to an increasingly greater degree – such as DNA- and direct RNA-sequencing with nanopore technology. Some of the constraints to this tech are the processing power it will take to obtain useable data in real time (as opposed to just doing the reactions on orbit for further analysis on return).
- Some of the new epigenomic technologies and tools (for post flight analyses) are getting very sophisticated and enable a look into changes in DNA structures, DNA-protein interactions, and alternative splicing in transcriptional responses. This aspect opens a new window into how biology physiologically adapts to spaceflight and how spaceflight might initiate new genomic strategies that are less commonly seen in the response to terrestrial stresses to which they evolved
- Elimination of the “Hut – no Hut” debate to support rodent research. Space facilities with comparable ground-based control habitats are enabling to attract industry participation.

### ➤ Physical Sciences

- Physical and Chemical Behaviors Near the Thermodynamic Singularity, when combined with the recent growth in molecular dynamics modeling, will reveal new phenomena and physics that are relevant to a wide range of advanced earth and space-based applications including energy, propulsion and synthesis of nanomaterials with novel physical properties.
- Complex fluids and Fundamental Physics have a huge potential for transformational research contributions
- Manufacturing in Space is a rapidly evolving field with direct impact on both exploration AND terrestrial industrial application
- Resource management topics need higher emphasis (fuels, oxygen, water and waste recycling, dust mitigation, power balancing, in-situ resource utilization, etc.)