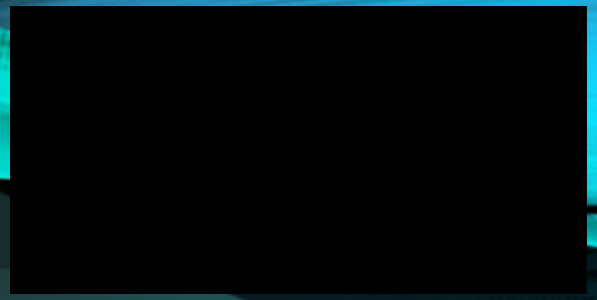
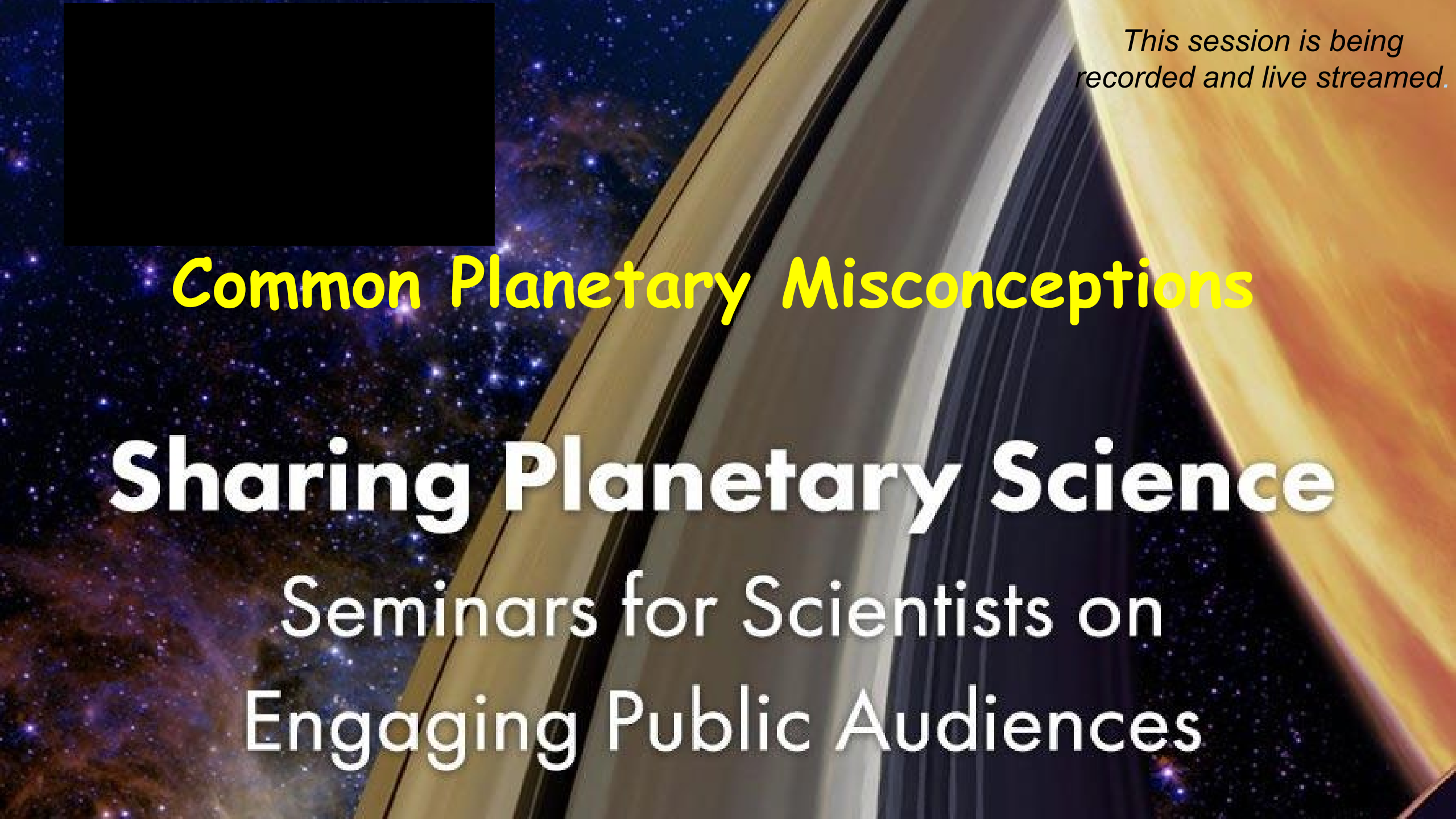
# ICEBREAKER

What current fact about your life would most impress your 5-year old self?

*Share something in the chat that you never thought you would do or be…*




This session is being recorded and live streamed.
Common Planetary Misconceptions
Sharing Planetary Science
Seminars for Scientists on Engaging Public Audiences

**Dr. Sanlyn Buxner**, Planetary Science Institute

Sanlyn's current research interests include examining issues related to scientific literacy; how to measure it and investigating how it is changed by education, outreach, and online media. Additionally, she investigates how science research experiences can be used to improve both science understanding and empowerment of teachers and students.

**Dr. Molly Simon**, Arizona State University

Molly utilizes citizen science as tool to bring authentic research and data-rich experiences to students in both in-person and online courses. She also develops active learning materials designed to engage students in critical thinking while promoting increased disciplinary fluency.

**Christine Shupla**, LPI

Christine manages the LPI education and public engagement staff, leads LPI's scientist engagement efforts, and has extensive experiences engaging different audiences in astronomy and planetary science.

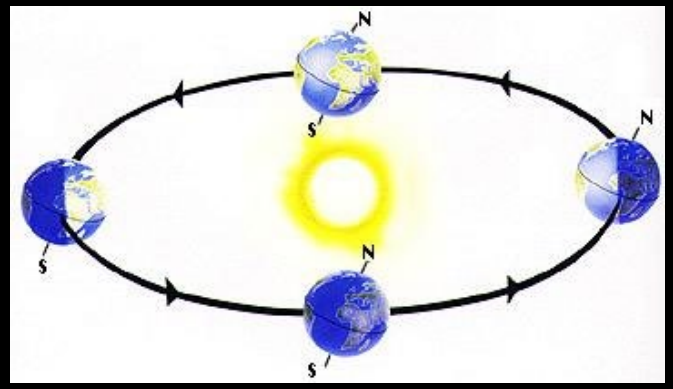
# What are “Misconceptions”

Please share your ideas in the chat.

# What are “Misconceptions”

Better terms: *Conceptual and Reasoning Difficulties*

- Can be robust fundamental beliefs, based on personal experiences
- Not always informed by prior knowledge
- May be transitional
- May not be internally consistent




- *Moving from a deficit model to an asset model of learning*

# Construction of Knowledge

*(People have) "preconceptions about how the world works. If their initial understanding is not engaged, they may fail to grasp the new concepts and information …"*

- HOW PEOPLE LEARN, National Research Council, National Academy Press, 2000.

Learners must construct their own knowledge - we cannot do the work for them.

Learning is based on interest, motivation, and prior experiences.

# Overcoming Conceptual Difficulties

Part of learning

- Intuitive internalized model may be memorized.
- Transitional understanding when learner becomes aware of contradictions and seeks to resolve them.
- Finally, scientific model internalized, but this does not necessarily mean the prior understanding are totally extinguished.

# Reasoning Difficulties

- Not the same as a lack of knowledge
  - "Reasoning difficulties" about Bennu…
- Easier to address some simple issues with terminology and definitions
  - Solar System vs Galaxy
  - Rotation vs Revolution
  - Other commonly confused terms?

- More difficult to address models
  - Day/night as a function of Earth's orbit

# Research about Understanding Science

- Your audience is likely to create an original hybrid idea from your info and their own ideas.
- Be careful about the assumptions you make, even with "educated" audiences.

From Claudine Kavanagh, "The Research Perspective on Teaching and Learning Science" during 2006 LPSC workshop *Public Understanding of Planetary Science*.

https://www.lpi.usra.edu/education/score/public_understanding

What are the most common topics that your audiences struggle with?

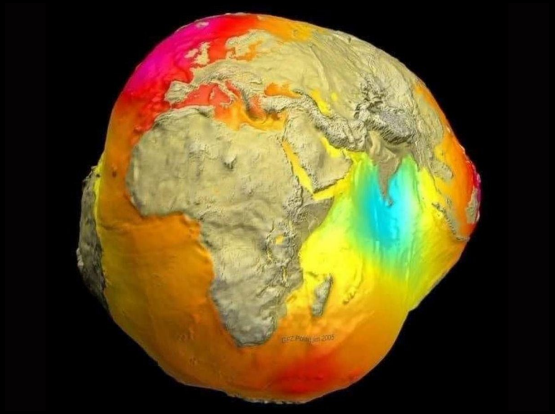
*Type your answers in the chat.*

# Systemic Confusion for General Planetary Science Concepts

Many individuals never understand lunar phases or seasons

- Underlying cause is a lack of understanding of spatial relationships, size and scale, and orbital shapes
- We accidentally introduce incorrect ideas that lead to conceptual difficulties through graphics and emphases
- This may lead to struggles in understanding planetary systems in general

# General Public Understanding General Scientific Concepts



Issues with terms we use all the time in science courses:

- Many students conflate mass and density
- Students think higher density means more massive, without taking volume into account (Williamson & Willoughby, 2012; Simon et al., 2018)
- This can have implications for their understanding of the role of gravity - misapplying the gravitational force law

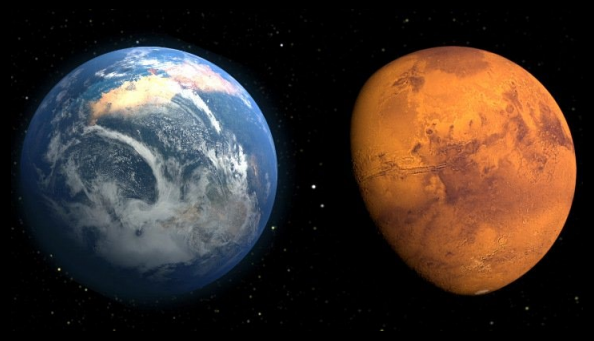
*How does this affect a lecture where you introduce the concept of gravity?*

# General Public Understanding of Planetary Science

Most do know the names of the planets and their order.

Issues with scale and systems:

- Most don't know how big or far planets are.
- Most don't know the difference between the Solar System and the Galaxy.
- Many students believe the Solar System consists of multiple stars, including the constellations we see in our night sky (Simon et al., 2018)

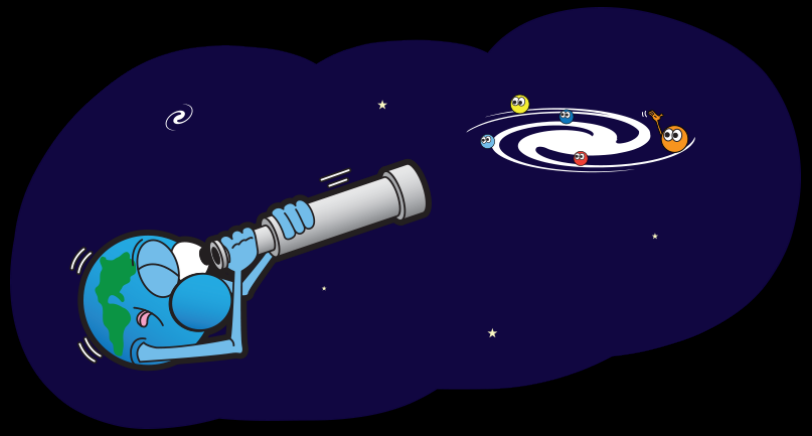


*How does this affect your public engagement or star parties?*

# General Public Understanding of Planetary Science

Issues with astronomical and geological time:

- Most have no idea how long ago the Solar System formed.
- Most think it formed during the Big Bang
  - In a study of over 1100 introductory astronomy students, 44% attributed Solar System formation to the Big Bang (Simon et al., 2018; Wallace et al., 2012)



*How does this affect a talk about the cosmological time?*

# General Public Understanding of Planetary Science

## Issues with planetary characteristics

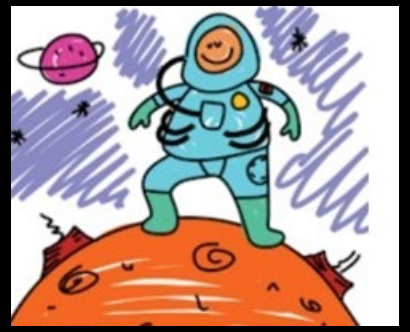
- Most do not know how hot or cold the planets are; they may think Mars is red-hot.
- Most think that the gas giants are giant clouds of gas without any structure or denser materials.
- Students believe the Sun's heat determines the composition of our Solar System's planets, **not** the condensation temperature of elements at a planet's specific location (Simon et al., 2018)

*How does this affect a presentation about our Solar System?*

# General Public Understanding of Planetary Science

Issues with understanding of exploration

- Most know that we went to the Moon (although some doubt it).
- Many think humans have traveled to Mars and even further.
- Many think that all spacecraft return to Earth.



*How does this affect your activities about Perseverance?*

# General Public Understanding of Planetary Science

Issues with geology

- Most think granite is any type of rock with large crystals.
- Most have difficulty remembering the difference between igneous and metamorphic, and don't know any rock types.
- Most don't know the difference between tectonism and plate tectonics.


*How does this affect a presentation about Mercury or the Moon?*

# Addressing Misunderstandings

*What are your ideas?  What have you tried before?*

# Promoting Understanding in Short Interactions

- Don’t assume knowledge–you can never go too introductory.
- Ask questions to elicit your audience’s ideas.
- Find more than one way to convey what you want to communicate. Consider hand-gestures, demonstrations, and visuals.
- Be careful with language (bigger vs wider, rotate vs. revolve, round vs spherical).
- Be careful with graphics.
- Be respectful of the audience’s lived experiences and questions.
- Go with the audience’s interests.

# Promoting Understanding in Longer Interactions

- Don't assume knowledge–you can never go too introductory.
- Depth over breadth.
- Ask questions to elicit your audience's ideas.
- Help your audience come to the correct conclusion on their own.
- Lectures don't allow individuals in your audience to critically examine their own prior knowledge; *you may not be able* to address deep-seated misunderstandings.
- Find more than one way to convey what you want to communicate; include gestures, demonstrations, and visuals.
- Be careful with language.
- Be careful with graphics.
- Be respectful of the audience's experiences and questions.
- Use active learning strategies, i.e. Think-Pair-Share questions and lecture tutorials.

# Practicing Solutions

## Scenario:

During a science festival at a school, you are at a table and an adult asks why Venus orbits the Sun backwards.

*What strategies do you use to respond?*

# Practicing Solutions

## Scenario:

During a conversation in a crowded elevator, a 12 year old asks you about the Moon landings and says that her father (standing next to her) says that they were fake.

*What strategies do you use to respond?*

# Practicing Solutions

## Scenario:

You are giving a public lecture on Mars and a distinguished guest asks why the astronauts didn't fall off the planet.

*What strategies do you use to respond?*

# Resources

## Lecture Tutorials for Introductory Astronomy

*www.pearson.com/store/p/lecture-tutorials-for-introductory-astronomy/P100002679340/9780137619641*

The third edition is available on Amazon, and the fourth edition (including updated tutorials and new tutorials on planet formation, comparative planetology, and terrestrial geology) will be available in the coming month.

## Center for Astronomy Education Website

*www.as.arizona.edu/cae/materials_resources*

Includes how-to guides, a question bank of Think-Pair-Share Questions, and additional resources to promote active learning in the general education college classroom.

## Conference "Misconceptions" Strand

*smdepo.org/post/3860*

In 2012 at a SMD Education, several presentations addressed the topic of conceptual and reasoning difficulties. Presentations are available online by Ed Prather, Theresa Moody, Janelle Bailey, and Georgia Bracey.

## Public Understanding of Planetary Science

*www.lpi.usra.edu/education/score/public_understanding*

This 2006 workshop held in conjunction with LPSC explored the public's understanding of planetary science. Participants explored reasoning difficulties that might be held by audiences and considered tools that could be used to identify and address them.


# THANKS!

Past seminar recordings and presentations:
***www.lpi.usra.edu/education/scientist-engagement***

Contact us with your thoughts and questions!

Christine Shupla, shupla@lpi.usra.edu
Sanlyn Buxner, buxner@psi.edu
Molly Simon, molly.n.simon@asu.edu