Engaging Students and Their Families Through STEM

NSSEC
NASA SPACE SCIENCE EDUCATION CONSORTIUM

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Introductions

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- Christina Milotte
- And you?

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Our Three Goals Today

1. To increase your knowledge about providing STEM programming for the entire family – highlighting research, best practices, challenges, etc.

2. To introduce you to NASA curriculum support materials designed for use in out-of-school time

3. To walk you through hands-on STEM activities you can immediately use in your programming

Research Shows…

- Parental involvement has a positive impact on a child's academic performance, including higher scores on standardized tests.
- Children with parents involved in their education have improved problem-solving skills, better school attendance, and fewer disciplinary issues.
- Families have the greatest influence on children's attitudes toward education and career choices.
- These findings span genders, cultures, and income levels.

Research and Resources

https://globalfrp.org/

Research Shows…

In a recent survey of 1,400 parents/caregivers of young children, researchers found:

- Parents want to be involved in their children's learning, but many feel science is less important to support at home than literacy and social skills.
- Parents are less confident about teaching science than other areas of learning.
- Few parents report doing science-related activities daily.

Families need PD, too!

- Models, reinforces, and supports positive whole-family learning dynamics and behaviors
- Addresses motivational issues and other barriers to participation – especially for underserved groups
- Boosts adults' knowledge, confidence levels, and attitudes – especially in challenging content areas
- Extends beyond on-site program

Best Practices in "Family PD"

Providing family supports

Focusing on family assets

Developing family-focused program facilitation

Complementary Learning

Family Involvement

Out-of-School Time

Summer Learning

What got me into family learning?

Involving families in out-of-school time learning takes things to the next level!

What is NASA Family Science Night?

- Nine sessions pilot-tested for 4 years at NASA Goddard Space Flight Center in Greenbelt, MD (Washington, DC area)
- Flexible definition of "families" - one adult + one child aged 11-14
- Pilot sessions at Goddard held on weekday evenings for two hours
- Facilitator guides + resources are available

FAMILY SCIENCE NIGHT

Family Science Philosophy

- Philosophy founded on principles of improved achievement and attitude through parental involvement
- Middle school-age selected as critical STEM target
- Core components:
  - Families must learn *together*
  - Adult-child communication and collaboration
  - Support adults in learning how to learn with children
  - Support continuity in learning beyond these sessions
- Programs must be based on robust evaluation

Family Science Night Sessions

1. How Big? How Far? How Old?
2. Have You Ever Seen the Invisible?
3. You Are Here!
4. Tis the Seasons
5. Be a Star!
6. Exploring the Moon
7. Batteries Not Included
8. Now You See It … Now You Don't!
9. Searching for Other Worlds

And new sessions under development and pilot-testing…

About the Program

- Sessions can stand alone for one-time participants, but build upon each other for repeat visitors.
- Content is directly connected with "the real world" and includes connections with everyday life.
- Activities are chosen to engage participants **as a family** as they approach problem-solving, model-making, and other hands-on tasks.
- Topics were chosen to especially include content often overlooked by classroom curricula.

FAMILY SCIENCE NIGHT

Structure of a FSN session

- **Introductory activity on the table upon arrival** – largely self-directed, absorbs early and late arrivals, paperwork, etc.
- **Opening discussion** – rules, introduce event topic
- **Core activity (or activities)** – explore topic and build understanding, include time to reflect/discuss
- **Transfer of knowledge** – participants strengthen and demonstrate understanding through open-ended exploration of the topic and/or tie the topic back into everyday life

Let's jump right in!

- We've placed an instruction sheet on your table.
- Read the instructions as a family and discuss them. Everyone's ideas and opinions count!
- Record your ideas, charts, diagrams, pictures, etc. on the paper provided (your "notebook" for today).

Let's jump right in!

Dr. Anne Dromeda has found an interesting new object in the sky… but she's not sure what it is! It could be a star or a planet, and she needs more information to figure it out. So she needs the help of your family lab group to determine the differences between stars and planets.

As a family, talk about the characteristics of stars and planets.
What makes them the same? What makes them different?
Create a chart to keep track of this information.
Draw pictures or diagrams if it is helpful.

Dr. Dromeda is counting on you to help her classify this new discovery!

FAMILY SCIENCE NIGHT

Family Science Night Rules

- **Rule #1**: Work as a family to complete the tasks.
- **Rule #2**: Respect each other during group discussions.
- **Rule #3**: Be willing to think outside the box and express yourself.
- **Rule #4**: Have fun!

Debrief: Stars and Planets

- What are some characteristics of **stars**?
- What are some characteristics of **planets**?
- What are some of the key **differences** between stars and planets?

Debrief: Stars and Planets

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Debrief: Stars and Planets

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- If our **Sun** is a star then why does it look so much bigger than the others… when it is just an average star?

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Why do we use this as an opening engagement activity with families?

It's your chance to be a star!

- What holds a star together?

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- Do stars change over their lifetimes?

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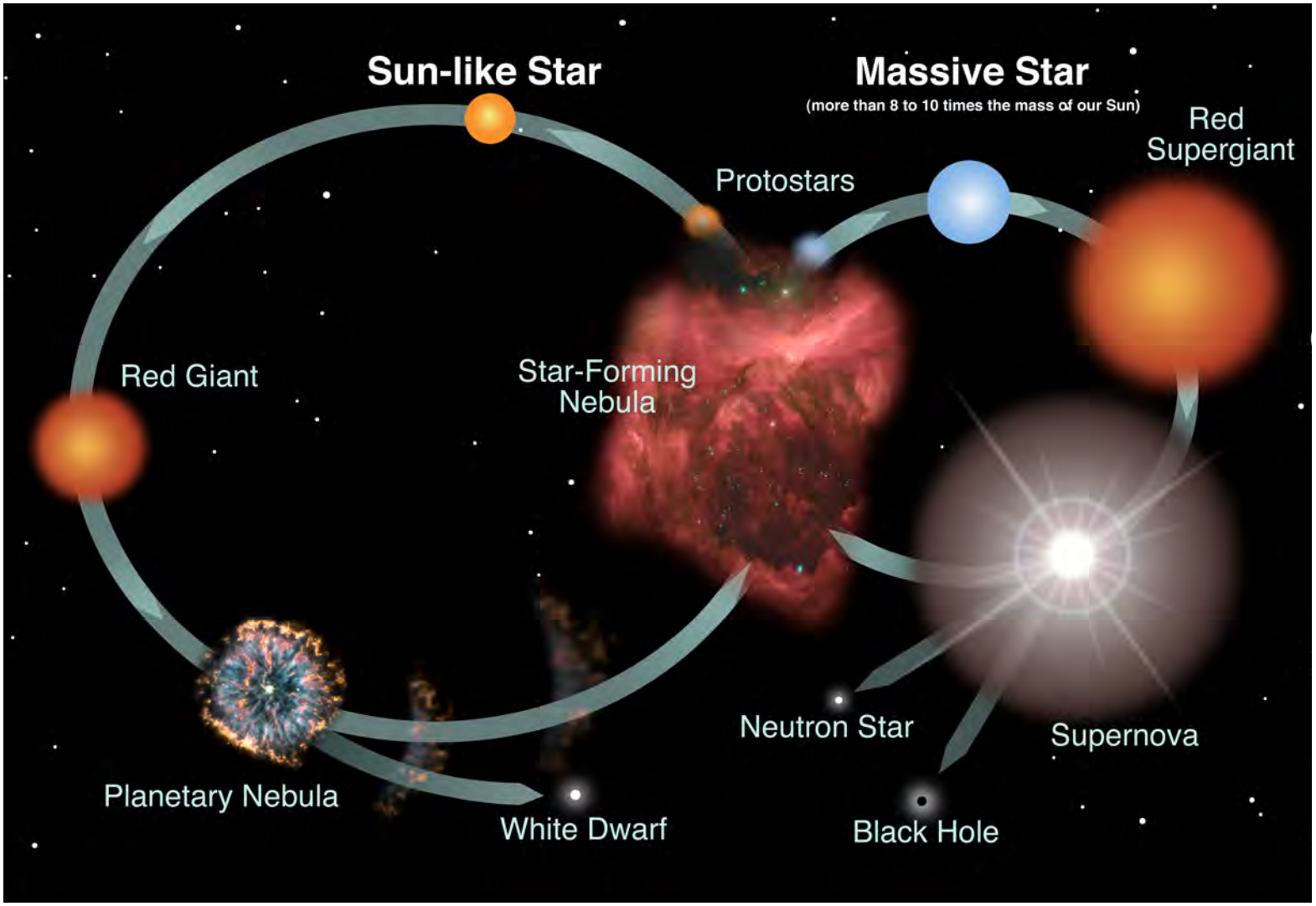
- What holds a star together?
- Do stars change over their lifetimes?

The next activity acts out the lives of **small stars** and **large stars,** and explores how they **change** over time!

Life Cycle of a Star



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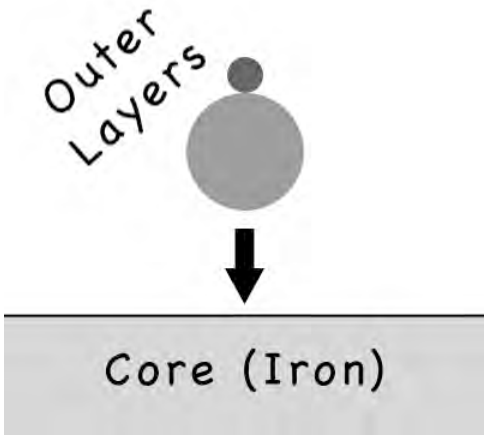
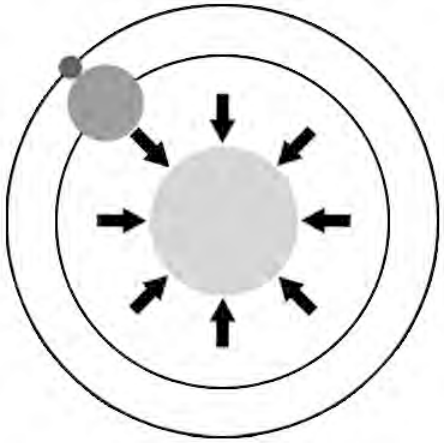
- If we drop each ball independently, what happens?
- What would happen if we stack the smaller ball on top of the larger and drop them together? **Let's make some predictions and test them!**

Let's go SUPERNOVA!

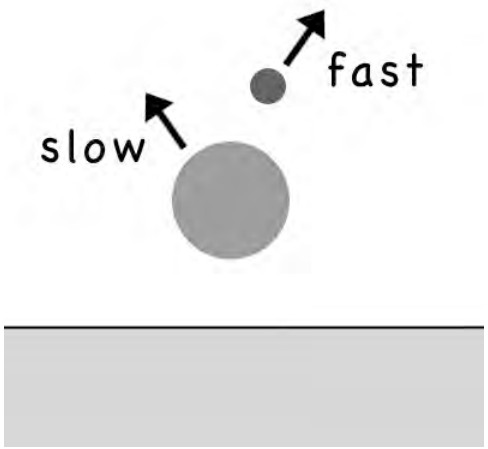
In this activity, the balls represent the outer layers of the star's atmosphere… falling inward toward the iron core (the floor).

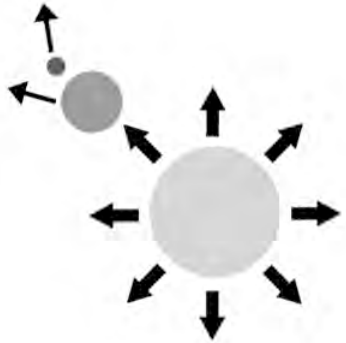




Let's go SUPERNOVA!

The outer layers of the star's atmosphere go flying off into space, similar to how the ping pong ball flew higher than it did when you dropped it alone.
This is the **supernova** explosion!





Debrief: Life Cycles of Stars

- Take 2 minutes to reflect with your family.
  Write and draw pictures on the paper provided.

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- Which stars live longer – smaller or larger stars?

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Why do we use this set of activities with families?

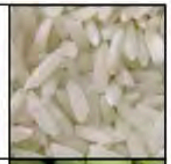
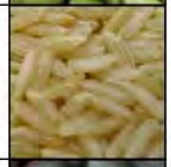
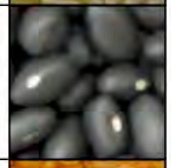
Our Connection to the Stars

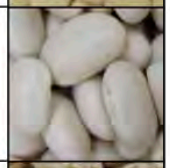
What's in each bottle?

Use the key to identify the elements and match an object listed on the key.

Please don't open the bottles!

Our Connection to the Stars

Hydrogen (H) White Rice	
Helium (He) Green Split Peas	
Oxygen (O) Brown Rice	
Carbon (C) Black Beans	
Iron (Fe) Red Lentils	

Nitrogen (N) Brown Lentils	
Argon (Ar) White Beans	
Silicon (Si) Pinto Beans	
Magnesium (Mg) Red Beans	

The Sun

Element	# atoms
H	92.1%
He	7.8%

Supernova Remnant

Element	# of atoms
O	42.2%
Fe	36.7%
C	11.1%
Si	3.7%
Mg	2.8%

Earth's Atmosphere

Element	# of atoms
N	78%
O	21%
Ar	1%

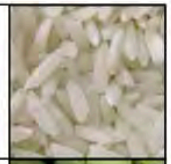
Meteorite

Element	# of atoms
O	44.3%
H	30.8%
Mg	6.2%
Si	5.5%
Fe	4.9%
C	4.2%

Universe

Element	# atoms
H	90%
He	9%

Our Connection to the Stars

Hydrogen (H) White Rice	
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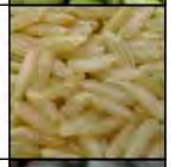
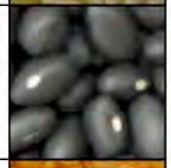
Oxygen (O) Brown Rice	
Carbon (C) Black Beans	
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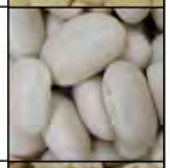
Argon (Ar) White Beans	
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Here's the catch – we've also got a **mystery bottle**!

Can you figure out what ingredients are inside this bottle?

What do you think this bottle represents?

Debrief: Element Bottles

- How does this activity complement the others we've done today?

- How do these activities build real-life skills that can be utilized beyond an in-person event?
  What happens next?

Kitchen Science

- Providing families with a take-home activity sheet motivates them to do science at home
- "Kitchen Science" activities are easy and use household items
- Can be incorporated into your evaluation strategy if you have returning families

FAMILY SCIENCE NIGHT

Family Name: _____

Kitchen Science: Pumping Straw - a centrifugal pump

Make a pump out of a straw and a skewer and soak all your friends.

What you need:

- *A straw*
- *A wooden skewer*
- *A small amount of tape*
- *A bowl of water*

What to Do:

1. Cut slits into the straw a third and two thirds of the way along its length. They should be perpendicular to the length of the straw.
2. Push a wooden skewer through the center of the straw.
3. Bend the two ends of the straw together and tape them to the skewer.
4. Place the pointy end of the straw into some water and spin it about the skewer.

Write your observations in your notebook:

_____

_____

_____

_____

BRIGHT IDEAS START HERE

Discussion: “Be A Star” Session

Challenges in Family STEM Engagement

- Mixed age/experience audiences are tricky
- One size never actually fits all – dealing with younger and older children
- Family members and implementers alike have preconceived notions of teacher-learner dynamics
- Sufficient staffing levels and implementer PD
- Timing – never the perfect time, never enough time!
- Recruitment of families (especially beyond "the usual suspects")

Supporting Continued Family Learning

Five takeaways from that recent survey:

1. Parents don't have to know the "right answer" to help their children learn science.
2. Science exploration can start with wondering aloud.
3. Science is for home, school, and all the places in between.
4. Science is watchable, readable, playable, and doable.
5. Science learning should be accessible to all.

What We Learned

- Activities should be hands-on and exploratory; limited lecture, presentations, demos, etc.
- Activities should encourage participation from all family members as equal partners in learning
- Keeping things simple pleases families and implementers alike (less can be more) – low cost + low tech ≠ low engagement
- Bring the event to populations you'd like to reach

Evaluation

- It was not only important to us to evaluate the effectiveness of our sessions, but also to develop effective evaluation tools
- We did not evaluate the 'content' that anyone learns, but the interactions of the families as they work together
- Mixed-methods evaluation led by the RIT Insight Lab:
  - Observations during each session by two trained observers
  - Surveys at the start and end of each session (for families, parents, and children)
  - Follow up conversations with participants
- Our tools and reports are available.

Science Outreach
InsightLab
@R·I·T
Learning Research

Evaluation Surveys

- Pre-session survey from families:
  - Understand and describe the "whole family" – who is there, who isn't there?
  - Uncover any other recent family science activity
  - Discover any impacts of previous sessions
- Post-session surveys for parents and kids:
  - Understand most and least effective parts of the event
  - Discover likelihood of return to future programs and of describing the science to others
  - Uncover plans to engage in science over the next month
  - Find out if they are able to report learning anything new

Evaluation

- Measured outcomes from the program:
  - Family members are observed to be engaged in the activities, as a family group (not just the kids)
  - Participants are able to state something new that they learned: about science or about their families
  - Families complete science activities outside of the workshop, which they report with increasing frequency the more workshops that they attend
  - Families can describe how science relates to their everyday lives
  - Return rate was high – after they came twice

The "Real World" Connection

- Children – and adults – respond to content that is relevant and relatable
- Draws connections to activities in everyday life that are "doing science" – even if they don't realize it
- Helps participants realize their own capabilities in science

Anyone can "do science"!

After this workshop…

- We'll be holding two follow-up webinars on **March 25th** and **April 22nd** covering:
  - Strategies for conducting family science events – supplies, recruitment, logistics, evaluation, etc.
  - Best practices for supporting whole-family learning
  - NASA Family Science Night resources in greater depth
- Webinar participants who conduct a family science event and complete evaluations receive a certificate and a NASA education packet

FAMILY SCIENCE NIGHT

What's coming next for FSN

- New session about the Milky Way and other galaxies currently under development
- We'll be looking for pilot-testers to try out this and other new sessions as we evaluate and refine them
- We're looking for topics and activities to incorporate into future session expansions

FAMILY SCIENCE NIGHT

Discussion

- How could you incorporate whole-family learning into your programming, resources, or professional development?
- What lessons can you share from your own experiences?
- What support do you need?

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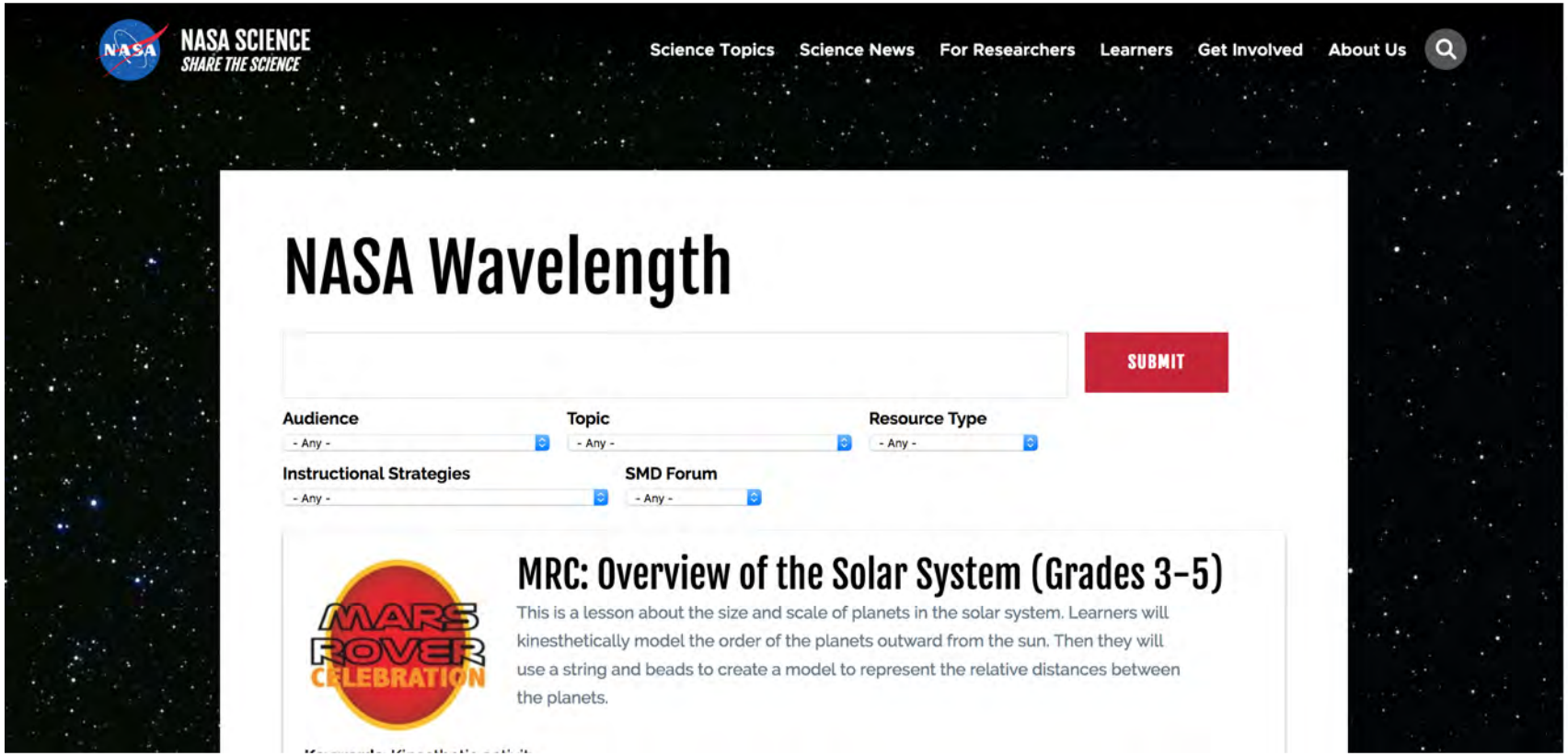
FAMILY SCIENCE NIGHT

For more information…

- Join us for webinars **March 25th** and **April 22nd**
- Contact us for more information about resources and opportunities for pilot-testing
- Evaluation tools and reports available upon request
- Research on family learning: http://www. globalfrp.org/

NASA Wavelength



Another resource: Afterschool Universe

- 12-session curriculum (45-60 minutes each)
- Explores the Universe beyond our solar system and how we study it
- Designed for middle-schoolers in out-of-school-time
- Resource guide provides all needed background info on astronomy topics
- Very hands-on with interdisciplinary learning techniques
- Flexible implementation to suit different schedules

Afterschool Universe Topics

- Two introductory sessions to start the students thinking:
  - "Modeling the Universe" draws out mental models participants have at the beginning and end of the program.
  - "Cosmic Survey" addresses size/scale/distances.

Afterschool Universe Topics

- Three tools sessions to discuss discuss how astronomers use light to gather data:
  - "Telescopes" allows the students to construct a simple telescope.
  - "Invisible Light" discusses the light that we cannot see with our eyes.
  - "Spectroscopes" allows the students to construct a spectroscope with paper towel tubes.

Afterschool Universe Topics

- Five sessions discuss components of the Universe and how they fit together:
  - "Life Cycles of Stars" (two sessions) explores what makes stars shine and how they live out their lives.
  - "Our Cosmic Connection to the Elements" discusses the origins of the chemical elements in space.
  - "Galaxies" allows students to model our own Milky Way Galaxy and figure out our place in the Universe.
  - "Black Holes" busts myths about these mysterious and fascinating objects.

Afterschool Universe Topics

- Scientist/Engineer visit provides answers to questions and provides an exposure to careers in STEM fields

- Final session is a repeat of the 1st session so that students and leaders can compare and see changes

Afterschool Universe Resources

- Comprehensive manual to run all of the sessions in the program
- Each session is a self-contained recipe with background, activities, and extensions
- YouTube videos to help illustrate several activities

Afterschool Universe

BRINGING ASTRONOMY DOWN TO EARTH

Wrap-up

- Comments or questions?

- Please contact us if you would like to be involved:
  - sara.mitchell@nasa.gov
  - sarah.e.eyermann@nasa.gov

Thank you for coming!

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