Explore!

UV Kid!

Overview

Children use common craft materials and ultraviolet (UV)-sensitive beads to construct a person (or dog or imaginary creature): UV Kid! They use sunscreen, foil, paper, and more to test materials that might protect UV Kid — and ourselves! — from being exposed to too much UV radiation.

Activity Time

60 minutes

Intended Audience

Families or other mixed-age groups, including children as young as 4 years old *with assistance from an older child, teen, or adult*
School-aged children ages 5–7 and 8–9
Tweens up to about age 13

Type of Program

☑ Facilitated hands-on experience
☑ Station, presented in combination with related activities
☐ Passive program
☐ Demonstration by facilitator

What's the Point?

- Ultraviolet radiation comes from our Sun
- While some UV radiation is necessary, too much can harm humans (and other living organisms)
- Engineers and scientists work to keep astronauts safe from UV radiation in space — just like we must protect ourselves from harmful UV radiation here on Earth!

Facility Needs

☐ 3 or more tables
☐ Optional: 15–20 chairs arranged at the table(s) for groups or families to sit together
☐ An outdoor area close by that has both shady and sunny spots, if possible

Materials

For the Facilitator

☐ *Facilitator Background Information* (below)
☐ *Brief Facilitation Outline* (below)

For Each Group of 10–15 Children

- ☐ 30–45 UV beads, available in craft stores as well as through online retailers such as:

  Educational Innovations
  www.teachersource.com

  Steve Spangler Science
  www.stevespanglerscience.com

- ☐ 20–30 *non*-UV pony beads
- ☐ 20–30 chenille sticks in a variety of colors, including at least white, tan, and brown to reflect a diversity of skin colors
- ☐ 3 or more pairs of scissors
- ☐ Various common materials to test for "protecting" UV Kid from UV radiation, such as:
  - ☐ 15 or more sheets of construction paper (in various colors)
  - ☐ 15 or more sheets of copy paper (preferably reused)
  - ☐ 1 roll of aluminum foil
  - ☐ 1 roll of plastic wrap (in various colors)
  - ☐ 5 pairs of paper sunglasses (may be obtained from an optometrist)
  - ☐ 1 (1 oz.) bottle of sunscreen, SPF 30
  - ☐ 1 (1 oz.) bottle of sunscreen, SPF 50
  - ☐ 1 pair of sunglasses that block 99% or 100% of UVB and UVA rays, meet American National Standards Institute Z80.3 blocking requirements, or provide UV 400 protection (since the UV-protective coating is clear, the lenses can be light- or dark-colored)
  - ☐ 1 roll of masking tape
  - ☐ 10 or more strips of cloth
  - ☐ Optional: containers of water

The UV-sensitive beads used in this activity serve as UV radiation detectors. They change color when exposed to UV radiation from the Sun or from UV lights. The brightness of the color corresponds to the intensity of the UV radiation. When shielded from UV sources, or when exposed to light that does not contain UV radiation — such as indoor light bulbs — the beads remain white. The beads are designed for multiple use and, according to the manufacturers, will change color up to 50,000 times.

A child at Sterling Municipal Library (Baytown, Texas) created a UV Kid using beads and chenille sticks. Later in the program, she took her creation outdoors to observe that the special "UV beads" change colors when exposed to UV radiation in direct sunlight and even in shade!

Credit: Sterling Municipal Library and the Lunar and Planetary Institute.

Supporting Media

Websites

NASA's Spot The Station
http://spotthestation.nasa.gov
As the third-brightest object in the sky, the International Space Station is easy to see if you know when to look up. Use NASA's Spot The Station service to find upcoming sighting opportunities for several thousand locations worldwide. Plus, sign up to receive notices of opportunities via e-mail or text message!

International Space Station
www.nasa.gov/mission_pages/station
Find information about the space station, its international crew, and how they live and work in space.

Tour of the Electromagnetic Spectrum
http://missionscience.nasa.gov/ems
Explore the amazing world beyond the visible! Text and images introduce electromagnetic waves, where they come from, how they behave, and how scientists use them. In addition to the website, a book is available for download as a PDF, and there is a companion video. Appropriate for ages 12 and up.

Handouts

SunWise Program (U.S. Environmental Protection Agency)
http://www2.epa.gov/sunwise
The EPA's SunWise Program offers a toolkit and a variety of downloadable resources in English and in Spanish, some of which offer fun comparisons to the sun-safety habits of animals.

Preparation

Six months before the activity

- Prepare and distribute publicity materials for programs based on this activity. If possible, build on the children's knowledge by offering multiple science, technology, engineering, art, and mathematics (STEAM) programs.
- Order UV beads and other materials that may not be readily available.
- Review the *Facilitator Background Information*.
- Plan for any introductory activities or extensions that you'd like to incorporate with this activity. Consider using an "icebreaker" activity to help the children get to know each other.
- For young children, plan to provide assistance with cutting and threading the beads on the chenille sticks. Consider allowing extra time for this activity for young children.
- Create a UV Kid to serve as an example for the children to follow.

The day before the activity

- Place the example UV Kid where everyone can access it.
- Arrange the materials on the tables so that participants can access them.

Activity

1. Share ideas and knowledge.

- Introduce yourself. Help the children learn each other's names (if they don't know each other already).
- Frame the activity with the main message: Engineers work to keep astronauts safe from UV radiation in space — just like we must protect ourselves from harmful UV radiation here on Earth!

Humans need UV radiation because our skin uses it to manufacture vitamin D — vital for maintaining healthy bones. About 10 minutes of Sun each day allows our skin to make the recommended amount. However, too much UV exposure causes the skin to burn and leads to wrinkled and patchy skin, skin cancer, and eye damage.

On Earth, we are protected by our atmosphere from most UV radiation coming from the Sun. The ozone layer absorbs much of the UV, but some still gets through. We can protect ourselves by covering with clothing and using sunscreen.

In space there is no atmosphere to protect astronauts from UV radiation. Astronauts have to provide their own protection in the form of space suits, helmets with protective visors, and space stations. While these measures work very well for protecting against UV radiation, the higher-energy radiation is not completely blocked. Even with protective shielding, astronauts onboard the International Space Station receive a daily dosage of radiation about equal to eight chest X-rays! Astronauts wear special radiation detectors — dosimeters — that help determine how much exposure they have had to radiation.

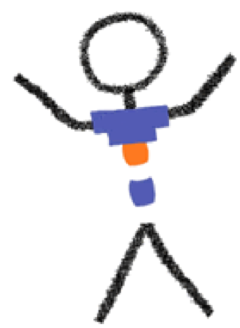
- Invite the children to talk about what they already know about UV radiation, what they've experienced at home, and how they protect themselves in their daily lives. Use open-ended questions and invite the children to talk with you and each other.

Use discussion to help them start to think about prior experiences and build new understandings about UV radiation and ways to protect ourselves from it, both on Earth and in space. Some conversation-starters are:

- Have you ever had a sunburn?
- What do you think causes sunburns?
- How do you protect yourself from getting sunburned?

For older children, guide the conversation toward identifying the Sun as the source of UV energy or radiation. Clarify that this energy is invisible to our eyes and we cannot feel it, but it still affects our bodies. As necessary, explain that Earth's atmosphere blocks much of the Sun's UV light. The ozone layer in our upper atmosphere forms a protective sphere, absorbing much of the UV energy.

2. Guide the children in each creating a person or creature with a built-in UV-radiation "detector." Explain that they will incorporate UV beads, which are made from a special pigment that is very sensitive and turns colors when exposed to UV rays. With the help of UV Kid, they will investigate the source of UV radiation and how we can best protect UV Kid — and ourselves! — from it. Have the children follow these steps to create a UV Kid (and make their own variations, if they'd like!):



a. Cut two pipe cleaners in half.
b. Fold one piece in half; these will be his/her legs.
c. Connect a second piece to the legs to make his/her torso.
d. Thread the beads onto his/her torso, alternating UV with non-UV beads. Slide all the beads toward UV Kid's legs.
e. Twist the third piece around the torso above the beads to make his/her arms.
f. Form a circle with the last piece and use it for his/her head.

3. Observe UV Kid's UV radiation detectors (i.e., the UV beads) indoors, in shade, and finally, in full sunlight. Encourage the participants to discuss their predictions first, then their observations, with each other and with you. Be thoughtful about your approach and keep the UV beads covered when walking outside to a shady spot. After making observations, "reset" the beads by covering them for about one minute and have a discussion to predict what will happen in full sunlight. After moving to full sunlight, continue making observations and discussing possible explanations for those observations.

The color of the UV beads remain white or creamy indoors. In shade, the UV beads become lightly colored, indicating that, even in the shade, there is some UV radiation reaching the detectors and our skin. In full sunlight, the UV beads become deeply colored, reacting to the intensity of the UV radiation to which they are being exposed.

Allow the children's thinking to be shaped by the experience — refrain from giving any of your own conclusions or expectations. Encourage them to talk to each other (in pairs or small groups) as they note their observations and form predictions about how the UV beads will change in the different settings. Ask questions to help them explain their conclusions, e.g., that the UV beads become brightly colored in full sunlight because UV radiation from the Sun is falling on them. Some children may say light caused them to change, and others may say heat. Remind them of their observations about the beads inside; the beads were white, even though they were in the light of the room. Ask them what happened to their beads when they brought them back inside; the beads changed from a colored state in the Sun back to white in the room light. Light does not affect the beads. If it is heat that causes the change, invite the children to hold beads in their fists; the beads do not change color when heated. They can also heat the beads with a hair dryer. The cause of the change comes from the Sun; it is from the part of the Sun's spectrum we do not see or feel directly.

4. **Test two materials to see if they protect UV Kid from UV radiation.** Once indoors, continue making observations about the beads' appearance and discussing possible explanations for those observations. Generate ideas for how the children might prevent the beads from changing again in full sunlight. Use everyday experiences, such as wearing clothing, using sunscreen, using umbrellas, or staying inside, to consider how UV Kid — and astronauts in space — can similarly protect themselves. Invite the children to thoughtfully test different materials:

   a. Make a construction paper poncho or shirt to cover the top UV bead.
   b. Select two additional materials and use them to cover other UV beads.
   c. Take UV Kid into full sunlight and observe how the UV beads do or do not change.
   d. In pairs or small groups, discuss ideas for why some materials protect UV Kid better than others and share those ideas with the whole group.

5. **Conclude.** Summarize that we encounter UV radiation every day from sunlight. While some UV radiation is necessary for our health, too much can harm humans (and other living organisms). Overexposure to UV radiation causes the skin to burn, sometimes badly (ouch!!). Extreme or excessive burning of the skin can lead to skin cancer. UV radiation can harm our eyes, as well. Engineers and scientists test materials — just like the children did — to find ways to keep astronauts safe from UV radiation in space. On Earth, we can protect ourselves from harmful UV radiation by wearing protective clothing, using sunscreen, wearing sunglasses, not staying out in the Sun for extended periods, and not expecting the shade to protect them. Challenge the group to continue testing UV Kid's protective materials in other settings, such as inside a car or outdoors on cloudy days.

Extension

Challenge the participants to use craft items to construct and decorate a space capsule for UV Kid! Offer a variety of building materials, such as:

- *Miscellaneous craft and everyday items:* Straws, aluminum foil, plastic wrap (of all colors), old CDs, pipe cleaners, toothpicks, wire, wire cutters, Legos®, construction paper (variety of colors, including black), tinsel, ribbon, fabric, gauze, wood dowels/skewers, rubber bands, shiny streamers, etc.
- *For spacecraft body:* Pint-sized milk containers, coffee cans, soup cans (tape all sharp edges), disposable cups, empty (clean) Play-Doh® containers, black plastic or biodegradable seedling (plant) trays, paper towel tubes, empty egg cartons, cereal boxes, 2-liter soda bottles, different-sized Styrofoam blocks, other empty plastic or cardboard containers/boxes, etc.
- *Other:* Use your imagination and best judgment for providing safe, fun, and readily available materials!

Offer illustrations of the engineering design process (The Works or Design Squad are good options), and encourage the participants to iteratively test and change their designs — just like professional engineers do!

Correlation to Standards

Next Generation Science Standards[1]

Performance Expectations

3-5-ETS1-3. Engineering Design. Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.
4-PS3-2. Energy. Make observations to provide evidence that energy can be transferred from place to place by sound, light, heat, and electric currents.

Disciplinary Core Ideas

ETS1.A: Defining and Delimiting Engineering Problems
- Possible solutions to a problem are limited by available materials and resources (constraints). The success of a designed solution is determined by considering the desired features of a solution (criteria). Different proposals for solutions can be compared on the basis of how well each one meets the specified criteria for success or how well each takes the constraints into account.

ETS1.B: Developing Possible Solutions
- At whatever stage, communicating with peers about proposed solutions is an important part of the design process, and shared ideas can lead to improved designs.
- Tests are often designed to identify failure points or difficulties, which suggest the elements of the design that need to be improved.

ETS1.C: Optimizing the Design Solution
- Different solutions need to be tested in order to determine which of them best solves the problem, given the criteria and the constraints.

PS4.B: Electromagnetic Radiation
- When light shines on an object, it is reflected, absorbed, or transmitted through the object, depending on the object's material and the frequency (color) of the light.
- •When light or longer wavelength electromagnetic radiation is absorbed in matter, it is generally converted into thermal energy (heat). Shorter wavelength electromagnetic radiation (UV, X-rays, gamma rays) can ionize atoms and cause damage to living cells.

PS3.B: Conservation of Energy and Energy Transfer
- Light also transfers energy from place to place.

Crosscutting Concepts

Energy and Matter
- Energy can be transferred in various ways and between objects.
- Energy may take different forms (e.g., energy in fields, thermal energy, energy of motion).

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[1] Excerpted from NGSS Lead States. 2013. *Next Generation Science Standards: For States, By States*. Washington, DC: The National Academies Press.

Nature of Science: Scientific Investigations Use a Variety of Methods

- Science investigations use a variety of methods and tools to make measurements and observations.

Science and Engineering Practices

Asking Questions and Defining Problems

- Define a simple design problem that can be solved through the development of an object, tool, process, or system and includes several criteria for success and constraints on materials, time, or cost.
- Ask questions that can be investigated and predict reasonable outcomes based on patterns such as cause-and-effect relationships.

Planning and Carrying Out Investigations

- Make observations to produce data to serve as the basis for evidence for an explanation of a phenomenon or test a design solution.
- Make predictions about what would happen if a variable changes.
- Collect data to produce data to serve as the basis for evidence to answer scientific questions or test design solutions under a range of conditions.
- Conduct an investigation and/or evaluate and/or revise the experimental design to produce data to serve as the basis for evidence that meets the goals of the investigation.

Science and Engineering Practices: Analyzing and Interpreting Data

- Analyze and interpret data to provide evidence for phenomena.
- Analyze and interpret data to determine similarities and differences in findings.
- Analyze data using tools, technologies, and/or models (e.g., computational, mathematical) in order to make valid and reliable scientific claims or determine an optimal design solution.

Constructing Explanations and Designing Solutions

- Apply scientific ideas to solve design problems.
- Generate and compare multiple solutions to a problem based on how well they meet the criteria and constraints of the design problem.
- Apply scientific ideas or principles to design an object, tool, process, or system.
- Design or refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations.

Explore!

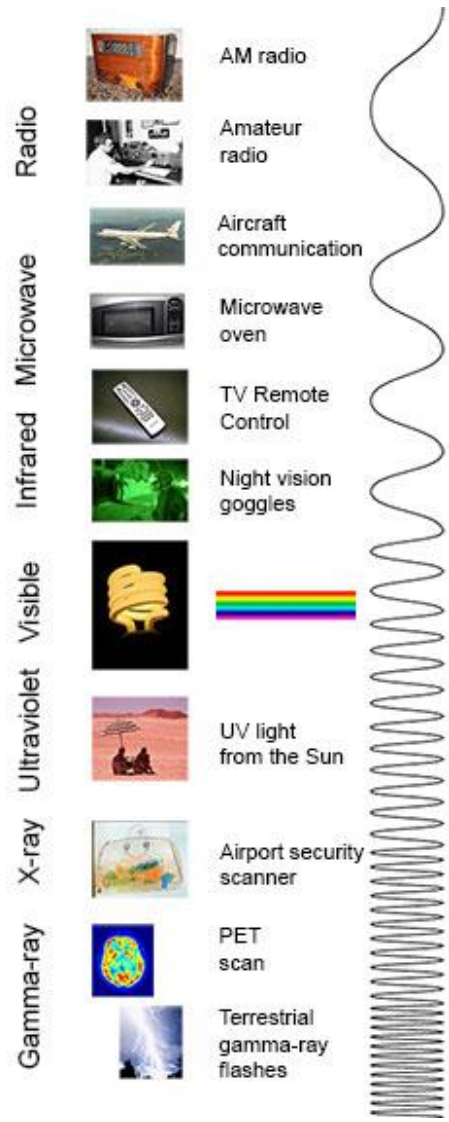
UV Kid!

Facilitator Background Information

Light and heat are part of the spectrum of energy — or radiation — our Sun provides. We can "see" light and we can "feel" heat. Yet our Sun also produces other types of energy that we can't see or feel. Radio waves, microwaves, UV rays, X-rays, and gamma-rays are all parts of the spectrum of electromagnetic energy — or radiation — from the Sun.

Radio waves, microwaves, visible light, and infrared radiation have relatively long wavelengths and low energy. Ultraviolet rays, X-rays, and gamma-rays have shorter wavelengths and higher energy. These shorter wavelengths are so small that these wavelengths interact with human skin, and cells, and even parts of cells — for good or for bad!

Our Sun also produces cosmic radiation. Cosmic rays are very-high-energy, fast-moving particles (protons, electrons, and neutrinos) that can damage DNA, increasing the risk of cancer and causing other health issues. Cosmic rays have such high energy that it is difficult to design shielding that blocks them. Cosmic rays do not only come from our Sun, but from other places in our galaxy and universe. Earth's magnetic field extends into space beyond the atmosphere, and provides some protection to astronauts aboard the International Space Station from cosmic rays.



From low-energy radio waves (shown at the top) to high-energy X-rays and gamma rays (shown at the bottom), we encounter different parts of the electromagnetic spectrum in our daily lives.

Credit: NASA

Earth's atmosphere protects us from most of the high-energy cosmic, gamma, and X-ray radiation — and much of the UV portion of the spectrum (UVB and UVC). Some UV radiation still gets through the atmosphere (UVA and a bit of UVB). Humans need UV radiation because our skin uses it to manufacture vitamin D, which is vital to maintaining healthy bones. About 10 minutes of Sun each day allows our skin to make the recommended amount of vitamin D. However, too much exposure to UV causes the skin to burn and leads to wrinkled and patchy skin, skin cancer, and eye damage. We can protect ourselves by covering up, limiting our time in the Sun, and using sunscreen.

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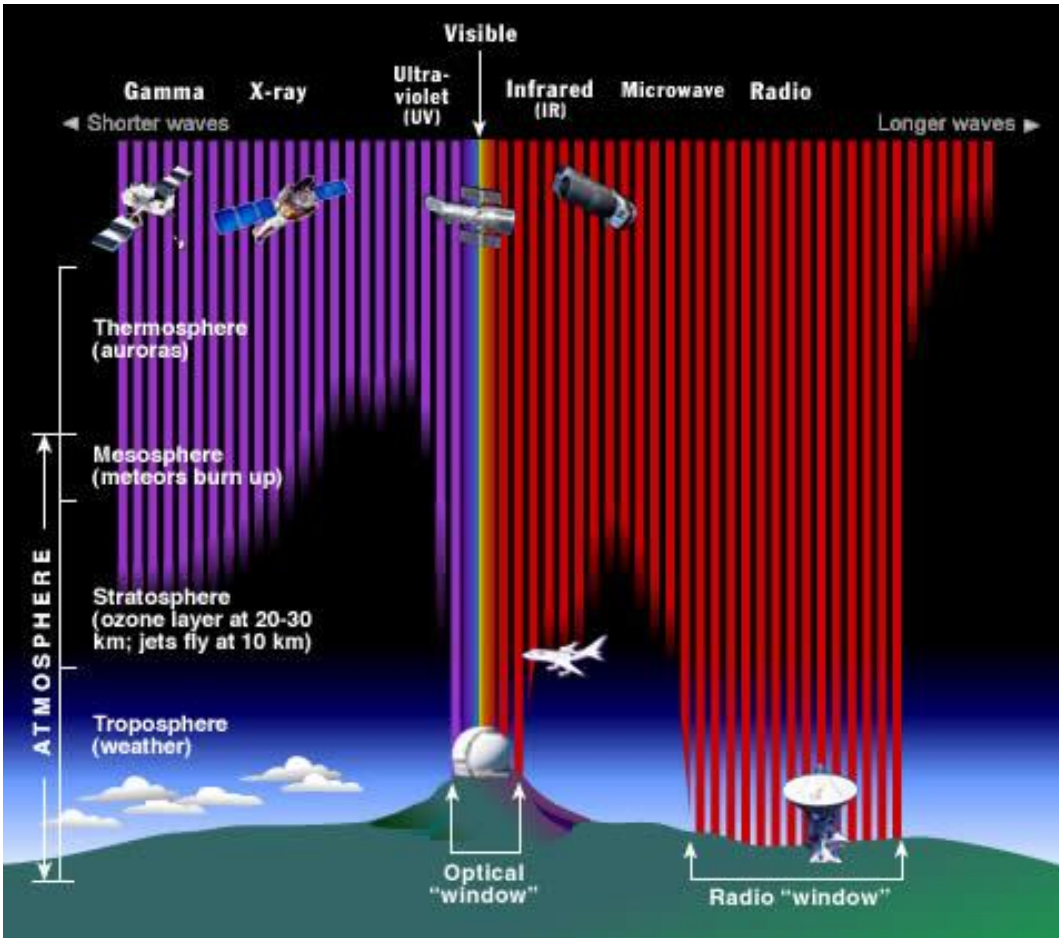
Explore! Health in Space
Lunar and Planetary Institute, Contribution Number 1365
Universities Space Research Association (USRA)
www.lpi.usra.edu/explore



Earth's atmosphere prevents high-energy gamma and X-rays, as well as much of the UV portion of the spectrum, from reaching the ground. As this illustration shows, only some UV radiation, visible light, and some radio waves reach Earth's surface. Other types of radiation reach various levels of Earth's atmosphere before they are blocked.

Credit: Space Telescope Science Institute/John Hopkins University/NASA

In space there is no atmosphere to protect astronauts from UV radiation — or from X-rays and gamma rays, or even more dangerous cosmic rays. Astronauts have to provide their own protection in the form of space suits and spacecraft. They work in spacecraft that have special shielding, wear special suits when they work outside of the spacecraft, and even have special visors to protect their eyes. NASA tests different materials and coatings for spacecraft and space suits to protect the astronauts. These measures work very well for protecting against UV radiation, but the higher-energy radiation is not completely blocked. Even with protective shielding, astronauts onboard the International Space Station receive a *daily* dosage of radiation equal to about eight chest X-rays! Astronauts wear instruments, called dosimeters, that monitor how much radiation each of them has received. Once they reach certain levels, they do not continue to work in space.

Explore!

UV Kid!

Download the full activity at www.lpi.usra.edu/explore

Brief Facilitation Outline

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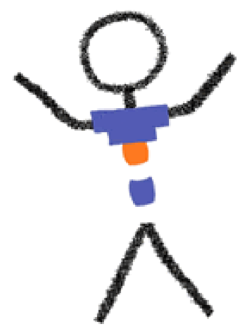
- Introduce yourself. Help the children learn each other's names (if they don't already).
- Frame the activity with the main message: Engineers work to keep astronauts safe from UV radiation in space — just like we must protect ourselves from harmful UV radiation here on Earth!
- Invite the children to talk about what they already know about UV radiation, what they've experienced at home and how they protect themselves in their daily lives. Use open-ended questions and invite the children to talk with you and each other.

2. Guide the children in each creating a person or creature with a built-in UV-radiation "detector." Explain that they will incorporate UV beads, which are made from a special pigment that is very sensitive and turns colors when exposed to the UV rays. With the help of UV Kid, they will investigate the source of UV radiation and how we can best protect UV Kid — and ourselves! — from it. Have the children follow these steps to create a UV Kid (and make their own variations, if they'd like!):



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c. Take UV Kid into full sunlight and observe how the UV beads do or do not change.
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