ASTRONOMY from the GROUND UP
An Educational Collaboration of ASP, NOAO & ASTC
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Red Hot, Blue Hot: Mapping the Invisible Universe

Activity Guide

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Type of Activity:	Drop-in station or classroom, facilitated
Set up Time:	15 minutes (plus time to freeze ice and boil heat pack)
Time to Do:	20 minutes
Audience age:	10 years and older
Group size:	up to 10

What's This Activity About?

Many astronomical images show galaxies, nebulae and other objects in bright rainbow colors, but these are not the colors we would see if looking at these objects with our eyes, since the light from these objects may not be visible to us. Scientists chose the colors in the image to represent the invisible wavelengths of light. This activity explores the ideas of invisible light and representational color and lets participants create their own representational color map of the temperature of a surface.

Materials

- Cookie sheet *
- Heat pack *
- Ice on a flat plate or Styrofoam tray
- Colored tiles * or squares of paper or felt (at least four different colors)
- Rusty the infrared dog and U.S.A. postcards *
- Astronomical images with representational color (optional)
- Color key worksheet (page 5)

**indicates that this material is included in the AFGU toolkit. You may need to replenish these supplies. See the list of sources on page 4.*

Setting Up the Activity

You will need to be sure to have **ice** and a **charged heat pack** for this activity. You could freeze some water in a flat Styrofoam tray (such as the kind used for meat) to have a nice flat block of ice that will fit under the cookie sheet. If the heat pack is solid, you'll need to boil it in water for ten minutes. Alternatively, you could use a heating pad, but you should consider how to hide the cord.

Shortly before starting the activity, without letting the participants see, activate the heat pack and place it and the ice under the **cookie sheet**. Be sure to have a variety of **colored squares** ready. There should be more than enough to cover the surface of the cookie sheet with a variety of color combinations. Also have the **postcards** on hand.

Suggestions for Introducing the Activity

Scientists learn a lot from the light we see coming to us from the rest of the Universe. But there is more to light than just the colors of light we see in a rainbow. There is more energetic light (e.g., UV, X-ray, gamma ray) and less energetic light (e.g., infrared and radio) that our eyes are not sensitive to, that we cannot detect. We need different kinds of detectors. To get a complete picture and understanding of something, we need to look at it in a variety of ways.

Show the satellite image of U.S.A. Is this what the U.S. looks like from a satellite out in space? What can we tell from this? Can we see where the mountains are? How about the forests? Deserts? By just looking, can we tell where it is warm or cold? Can we tell where the rocks are naturally radioactive? Where is cell phone coverage best? For those we need special detectors. You can't use just your eyes.

Now show the other images of the U.S. Start with the temperature map. Explain that this map is used to show the temperature of the air in various parts of the country. Is the air or the land that color?

Now take a look at the gamma ray map. Natural radioactivity is common in the rocks and soil that make up our planet. There is nowhere on Earth that you cannot find natural radioactivity. Radioactive rocks naturally emit gamma rays – in very low doses. If you look at a rock, can you tell if it is radioactive? Here is a map of the natural emission of gamma rays. Is the ground really these colors? Where are the gamma rays weakest? How can you tell? The map is using different colors to represent different intensities of gamma-ray radiation and the key tells us what the colors mean.

Finally, take a look at the map showing cell phone reception. A cell phone is like a radio receiver. How do you know where the signal is strong? Can you look around you and see the radio waves coming at you? What do you need to do? What do you suppose the shading on this cell phone coverage map represents? This could once again be using different colors to represent different signal strengths. Would it be OK to use blue instead of gray for the strong signal? Of course, as long as you have an explanation of what the colors mean.

The same is true for some of the great astronomy pictures you see. The colors are beautiful, but often they are representational color, telling a much richer story to the astronomer who created it.

An alternative to using the postcards is to ask what you can tell about someone just by looking at him or her. Can you tell if that person has high blood pressure? Or whether he had gone a week without taking a bath? What detectors would you use to find out those things? What does a doctor use to know if you have a broken bone? What would you use to find out if I have a fever? You need different measuring/detecting devices to learn these things. You can't just use your eyes.

The Universe in a Different Light card-sorting game is a nice complement to this activity. If you would like to use it, this would be a good point, before moving on to the main part of this activity.

Doing the Activity

Show photo of Rusty, the dog. Can you tell by looking at the dog which parts are warm and which are cold? Now show the infrared image of Rusty. Does Rusty ever actually look like this? This is an infrared photo that shows us the temperature of Rusty. Which parts of Rusty are the warmest? Which coolest? What color is being used to represent the warmest parts? What other color could have been used? At this point, it is important to stress that we could use any colors to represent the different temperatures. We are taking energy we can't see and converting it into something our eyes CAN interpret – different colors representing different temperatures.

Now explain to the participants that this is their opportunity to be scientists and communicate using representational color. Show them the cookie sheet. Can we tell how **warm** or **cold** this pan is by just looking at it? What do you need to do to find that out? Have them feel the surface.

What colors would you use to represent the different temperatures you are feeling? Have them create a representational color image by placing colored squares on the surface to represent the different temperatures. When they have done that, they can create a key using the "color key" worksheet (page 5).

If you are trying this activity with parents and children, have one of the parents refrain from feeling the cookie sheet. Once the child has created the image and key, have the parent describe the temperature of the surface just by looking at it and then have them feel it to check.

If you have more than 3 or 4 people, let each person feel the pan for a few seconds then have them pick up a small pile of squares (or paper and 3-4 crayons or color markers) and go to another area to map out what they felt.

Wrap-up

Now we have created a representational color image. You chose colors of visible light to represent temperature on a surface. Could you have chosen different colors? It is important to stress this point – that the colors are somewhat arbitrary. The tendency is to choose red for hot and blue for cold. You could point out that blue stars are actually the hottest and red ones the coolest. If you feel the participants do not understand this point, create your own key (e.g., green is hot and orange is cold) and have them create another image using your key.

This is what scientists do to create many of those beautiful astronomical images you see. If you have some images, show them. Taking photos using invisible light and then representational color can show where high-energy X-rays are being emitted, indicating a black hole, or where the

warm or cool dust is in a galaxy – the raw materials for new stars. We cannot tell where these areas are just using our eyes. NASA uses special telescopes that can detect this energy, similar to how you used your hand to detect heat or cold on this plate.

Complementary Activities:

- Secret Messages
- The Universe in a Different Light card-sorting game
- Seeing Through Alien Eyes

Materials Sources:

Thermo-Pad heat packs --

Model 404 from:
Hood Thermo-Pad Canada Ltd., 5918 Kennedy St., Summerland, BC V0H 1Z1
1-800-665-9555, http://thermo-pad.com, admin@thermo-pad.com

Colored tiles --

SKU 0203 from:
Wizard of Math / ALIV Enterprises Inc., 34 Lion St., Staten Island, NY 10307
(718) 605-0820, http://www.wizardofmath.com

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COLOR KEY

Place colored squares on this sheet to make a color key for your representational color image.

Hot

Warm

Cool

Cold