Infrared Light and Infrared Astronomy

Learning Plan
Day 3: Beyond the Visible

Targeted Idea: There is invisible light in the EM spectrum.

Overview of Day 3:

Students examine two photos of a toaster behind a black garbage bag: one taken with a regular camera and one with an IR camera. After viewing NASA videos about the electromagnetic spectrum and infrared light, students continue talking about their own mental models of visible and invisible light. Teachers then introduce students to infrared astronomy, highlighting SOFIA as an example. Students are also introduced to the IR camera and get their first glimpses of themselves and their classroom in the infrared.

Students will build their understanding toward these Disciplinary Core Ideas (DCIs) in Day 3 (see Unit Overview for more detail):

PS4.B Electromagnetic Radiation
Electromagnetic radiation (e.g., radio, microwaves, light) can be modeled as a wave ~~of changing electric and magnetic fields or as particles called photons~~. The wave model is useful for explaining many features of electromagnetic radiation while the particle model explains other features.

PS4.A Wave Properties
- PS4.C Information Technologies and Instrumentation

Middle School Performance Expectations (PEs) / Disciplinary Core Ideas (DCI) also relevant to today's work:

- MS-PS4.A Wave Properties
- MS-PS4.B Electromagnetic Radiation

Students are building their skills in / understanding of these Science and Engineering Practices (SEPs) in Day 3:

- **Asking Questions**
- **Developing and Using Models**
- **Obtaining, Evaluating, and Communicating Information**

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Instructional Materials	Resources
Handouts (one per student unless otherwise indicated) • SOFIA mission lithograph • EM Spectrum Review • Science Case Study – Jupiter **Materials (one per class unless otherwise indicated)** • Black garbage bag • Small sheet of Plexiglas • IR camera	• PowerPoint for Day 3 • Enlarged version of the Classroom Unit Graphic Organizer- either on a white board, bulletin board, or with large sheets of chart paper. • Ability to project videos: • "Introduction to the Electromagnetic Spectrum" https://science.nasa.gov/ems/01_intro • "More Than Your Eyes Can See" https://www.youtube.com/watch?v=2--0q0XlQJ0
Teacher Role	**Student Role**
• Distribute handouts. • Encourage students to work independently and also contribute to group efforts, accordingly. • Reassure that you are only looking for thoughts not "right answer". • Watch for misconceptions, but do not use this time to instruct. • Emphasize the importance of multi-wavelength astronomy and the unique role of infrared research. Include importance of high altitude to get above moisture in Earth's atmosphere. • Provide reading support as needed while going through the Science Case Study. Rephrase and paraphrase as needed. Suggest reading strategies for students.	• Listen closely to ideas of peers. • Share own thoughts and reasoning. • Be aware of own understanding and not understanding while reading the Science Case Study. • Record thoughts and questions about the Case Study on the Reading Organizer and in their own notes.

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Steps to follow:

1. *Engage:* Project the slide in PowerPoint with the questions: "Can special cameras detect light that our eyes cannot see? Could a camera see through this object? Is the object a filter or a block – absorber?"
    - Remind students that in the Fancy Cameras probe, Wei suggested that cameras cannot detect light our eyes cannot see.
    - Hold up the garbage bag and ask for responses to questions 2 and 3 by a show of hands.
    - Repeat questions 2 and 3 holding up a piece of Plexiglas.
    - Project next PowerPoint slide showing both visible and IR images of toaster behind garbage bag.

2. *Explain:* Show the video "Introduction to Electromagnetic Spectrum." As a focus for viewing, guide the students to note some of the ways the modern world uses the Electromagnetic Spectrum. Also note that the video offers a great deal of content on the EMS, which will be explored on later days.
    - After viewing, reiterate that scientists use the wave model to help them understand and predict how light behaves.
    - Show the video "More Than The Eyes Can See."
    - Distribute EM Spectrum Review – Multiwavelength Milky Way handout.
    - Ask the groups to also think of other technologies that can detect other forms of light (e.g. X-rays), or allow us to see things that we ordinarily could not see; as well as technologies that effects everyday lives. (UV sunscreens, microwave ovens, radio)
    - Ask 2 or 3 group to share 1 of their technologies.
    - Next, ask students by a show of hands if they agree or disagree with Jared statement in the Fancy Camera Probe. ("Each image looks different because of the speed of the waves. For example, the radio images looks different because that light travels much slower than visible light, and the infrared light travels the fastest.")

3. Introduce the example of a technology that can detect things that our eyes cannot see: the SOFIA telescope. Enthusiastically share briefly some experiences of time on SOFIA, including a description of how high the plane flew and why it was necessary to go above moisture in atmosphere. Encourage conclusions:
    - SOFIA flies up to 45,000 feet to get above most of the moisture in the atmosphere. It does this because almost all the IR light is absorbed by the moisture in the atmosphere.
    - Instruments on board have been engineered to be sensitive to different wavelengths of light.
    - Data is collected on a hard drive during the flight.
    - The astronomers use computers to compile data and generate images or curves or plots.

- SOFIA flies, therefore it can travel to special locations (such as the center of the Pluto Occultation shadow).
- SOFIA observes in visible and near, mid, and far-infrared wavelengths.
- Instruments on SOFIA use filters to restrict the wavelengths that reach the instrument.

4. Distribute Self-Guided Tour and Mission lithographs. Students review the SOFIA lithos.
   - Ask students to turn to a partner and list a few ways in which the design/engineering of SOFIA makes it special? What special capabilities does it have that allow it observe things that other telescopes cannot? Share out.

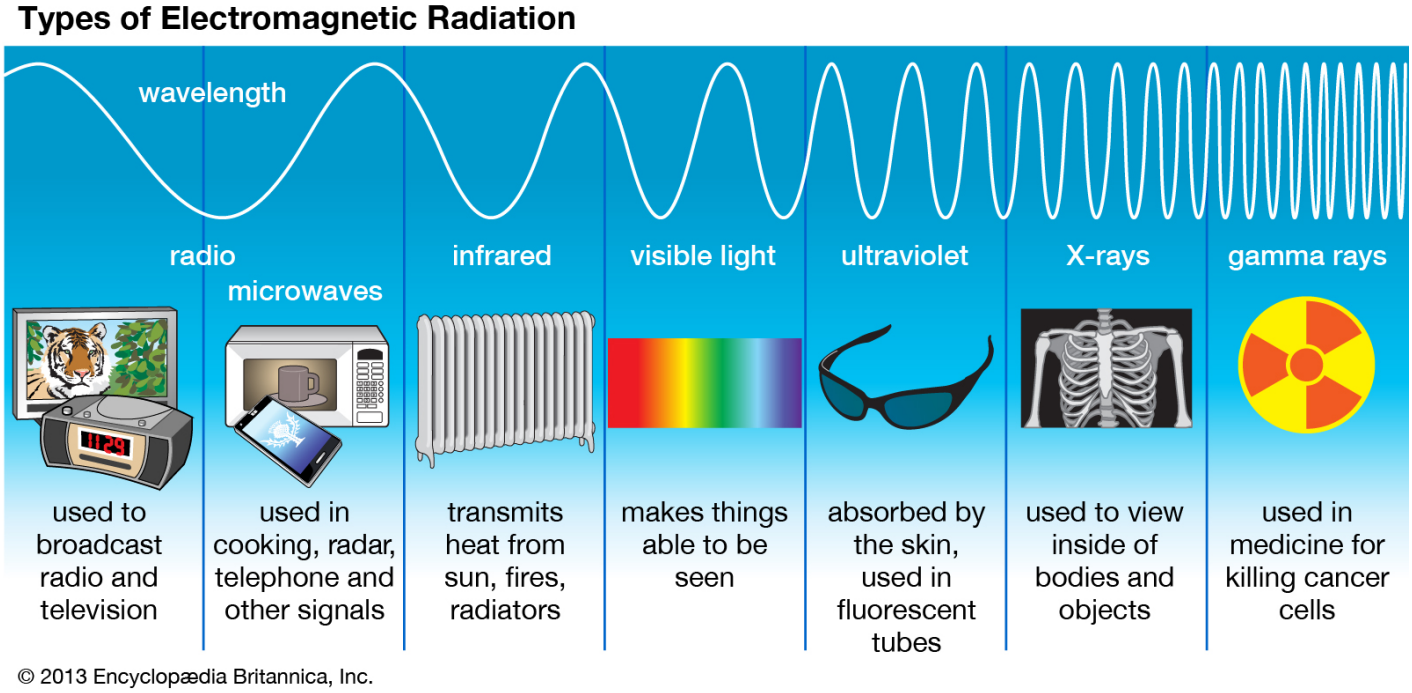
5. *Explore:* Take out FLIR C2 IR camera.
   - Explain that it has similar capabilities to SOFIA as it can observe light beyond what our eyes can see.
   - Turn camera on and ask one student to stand up. Show how the camera captures the remaining warmth of their chair, which we cannot see.
   - However, also like SOFIA it cannot observe through certain things that are transparent to our eyes. Then hold the Plexiglas in front of the camera lens to demonstrate that to the IR camera; Plexiglas is opaque.
   - Summarize: different wavelengths of light can find different substances opaque or transparent (i.e.- infrared light is absorbed, transmitted, and even reflected). View reflected infrared light with the IR camera.

6. Return to the Unit Graphic Organizer and SOFIA Science Case Study Focus Questions. Remind the students that these sheets will help them think about the unit experiences, as well as the readings.

7. Distribute SOFIA Science Case Study (Jupiter) and look it over together as a class.

8. *Assign Homework: 1)* Complete the SOFIA Case Study graphic organizer questions for the Jupiter Case Study and the Unit graphic organizer for Day 3 and *(Evaluate)* 2) Write a short paragraph describing everyday uses of the EM spectrum in their everyday life.

EM Spectrum Review. All light travels at the same speed.



The Milky Way Galaxy in different wavelengths.