

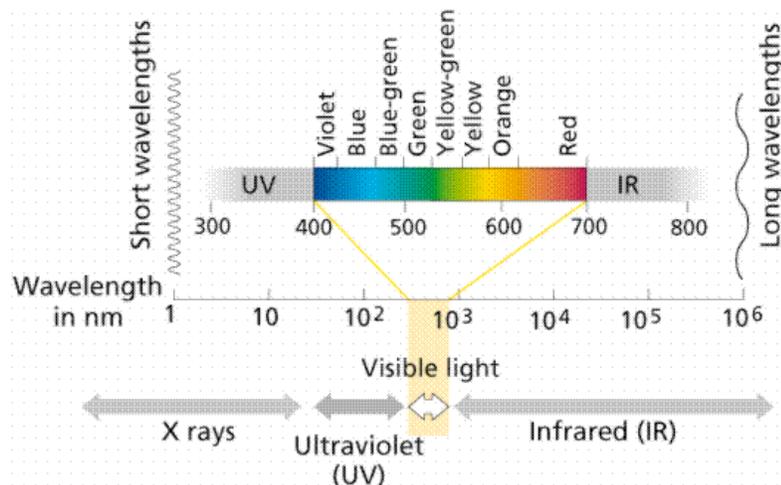
Over the Rainbow: Multi-Wavelength Light Demonstration

Introduction

The multi-wavelength light demonstration will teach visitors about types (bands) of light that are not visible to the human eye. Visitors will also learn about the limits of human vision, and how technology allows us to “see” non-visible light. Familiar objects will be used to demonstrate the properties of near infrared, far infrared, and ultraviolet light bands. Astronomical applications will be incorporated to illustrate how observation of an object in multiple bands can provide a variety of information not “seen” in visible light. Visitors will engage with and analyze objects to reinforce properties of visible and non-visible light. This demo is intended for Adler’s older children (junior high) to adult audience, but terminology and concepts may be simplified for younger children.

Visible Bands of Light

The initial phase of the demo will introduce the multi-wavelength properties of light. With the aid of a graphic representation of light’s wavelengths, visitors will learn how their eyes perceive the visible band as a spectrum of different colors. Using a prism, a beam of “white” light will be “broken” into a color spectrum and projected onto a white surface. The demonstrator will briefly discuss how visible light contains a spectrum of bands that the human eye interprets as the rainbow of colors shown by the prism. The demonstrator will also discuss how some animals (e.g., snakes and insects) can naturally “see” past the visible spectrum that human eyes are limited to; technology makes it possible for humans to “see” past the visible spectrum, too.



Example of a multi-wavelength light graphic. Short and long wavelength information could be omitted for simplification.

Infrared, Near and Far

The next two parts of the demo will illustrate that light contains a spectrum of wavelengths analogous to the color spectrum of visible light. An infrared camera will be used to “see” further past the red spectrum of the rainbow projection into the near infrared wavelength. The demonstrator will discuss: 1) How, like the the visible band, infrared also contains a spectrum that may be roughly divided into near and far infrared, Near infrared is “nearer” to the visible band; far infrared is associated with thermal emission, or heat and it is “farther” from the visible band 2) Near infrared is generally not associated with heat, unless the object/light emitting it is very very hot, like stars.

Visitors will be asked to find a fake plant amongst real plants just by looking and then by using the infrared camera. The demonstrator will explain that the chlorophyll in real plants reflects near infrared light making it visible to the camera, while the fake plant absorbs the infrared light (see pictures below).



Fake plant amongst real plants



Fake plant amongst real plants with IR

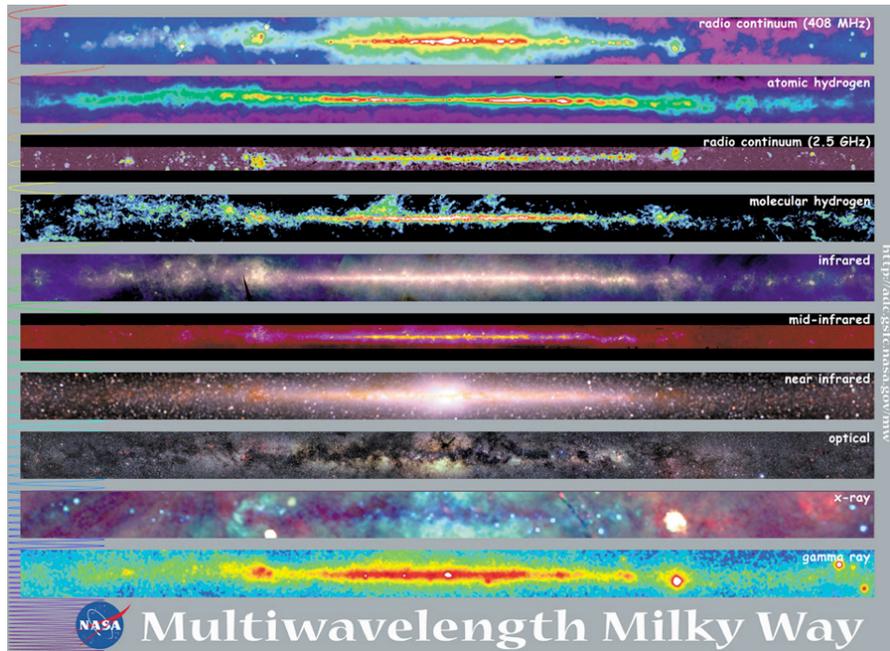
Next, two hair irons (or another heat source such as hand warmer sticks) will be used to demonstrate far infrared (to emphasize that far infrared is associated with heat, while near infrared typically is not). One iron is on and the other is off. Visitors are asked to determine which is on only by looking at the irons (switch will be obscured). Some hints can be given (e.g., Can you see heat? etc). Alternatively, visitors would be asked to discover which of two closed boxes contain a hot item. Visitors will comprehend that it is not possible to accurately answer without the IR camera, thus illustrating that visible light as perceived by the human eye does not provide thermal information about an object while far infrared does. Finally, the demonstrator will again mention that animals like snakes have special organic receptors that allow them to “see” heat in far infrared.

Ultraviolet

Returning to the wavelength graphic, the demonstrator will review visible/infrared bands, and then move onto the other end of the visible spectrum, blue light. Visitors will be asked what kind of light extends from the blue end of the spectrum, as infrared red does from the red end. Hints may be given (“It’s similar to blue, purple, violet, etc”). Ideally, someone will respond with UV. The demonstrator will then indicate the UV band on the graphic and on the rainbow projection using a UV camera (if UV cannot be seen extending from the prism, light from a fluorescent bulb will be projected onto the same surface). They could also mention that “ultra” means “beyond” in Latin. Next, a black-light will be viewed with the naked eye then with the UV camera. A UV fluorescent plant like dandelion or periwinkle will also be viewed under visible light, and then under a UV black-light. Visitors will be asked to compare the object with and without the UV light. The demonstrator will explain how some plants “glow” (fluoresce) under UV light and that some animals like bees can “see” UV light to help with pollination.

Astrological Application

The final part of the demo will incorporate multi-wavelength astronomy. Referring to multi-wavelength images of the Milky Way Galaxy (see below), the demonstrator will discuss how visible, near infrared, far infrared, and UV light is used by astronomers and explain how different characteristics of an object are revealed using visible and non-visible light bands; astronomers put these different observations of an object together to form a detailed description of it. More bands such as x-ray and gamma will be briefly discussed and visitors will be encouraged to learn more about them at Adler’s various exhibits.



Multi-wavelength images of the Milky Way Galaxy (NASA/GSFC). Each horizontal stripe shows the an image of the Milky Way in a different frequency band.