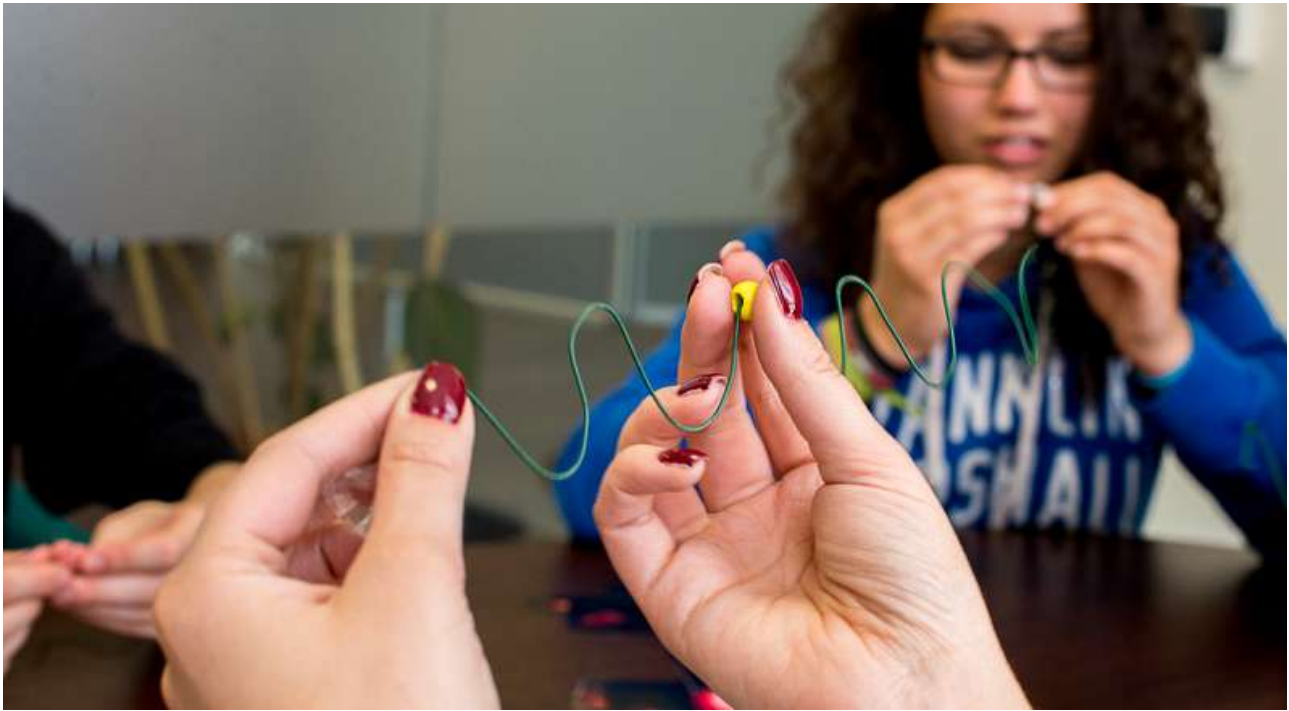


# Let's give light on the Universe



## Astrophysics interactive laboratory





**Title:** Let's give light on the Universe

**Area:** Astrophysics

**Type of activity:** Interactive laboratory

**Whom is it addressed to:** Junior high school students

**Duration:** 45-50

**Goals of the activity:** Making students to understand that visible light is not the only existing one. Other type of radiation revealed by ad hoc instruments can show us things invisible to the human eye.

**Competences needed for students:** Reading and visual skills.

**Competences needed for teacher:** Basic knowledge of the physics of waves.

**Material:**

- Thin baling wire (3x70 cm per each group)
- Tiny acrylic/plastic beads (3 per each group)
- Objects with various sizes
- Images of galaxies (as attached; give one set of images per each group)
- Computer
- Overhead/computer projector

**Aims/skills:**

The Universe stretches out far beyond the limits we can observe with our naked eye, but also with our most powerful telescopes. This is so because the Universe sends us any sort of signals, most of which cannot be perceived by the human eye. Luckily enough, thanks to specific detectors and instruments, we can catch these signals and translate them in images fitting our perception. Throughout this activity, the student will learn that there exist different types of radiation phenomena, each one with its own characteristics, and that each single wave signal is crucial in the understanding of the Universe.

# Instructions

## 1. Preparation of the activity

Before the beginning of the activity, build three different models of a wave per each group of students. the three models need be shaped so as to have a wavelength of 1cm, 2cm, and 3cm, respectively. Insert one plastic bead at the tip of any wave (be sure that the hole in the bead allows the wire to pass through without problems, and that the bead does not get stuck in the points where the wave shape curves the most).

## 2. The game

Divide the students into groups and give them the sets of images of the galaxies. Ask the pupils to group together the images they think refer to the same portion of the sky. Drop the hint that measures and shapes of the card are picked randomly, which will add a further level of difficulty to the matching. Leave them 5-10 minutes approximately to find the groups of cards.



## 3. The slides and the game solution

5–10 minutes later, provide the solution, which is contained in the first 10 slides of the included slideshow.

In the second part, have the students ponder on the notion of light as a "mirror" for the Universe, and on the double nature of light (wave/particle).

Introduction of the notion of wavelength; terminology of the electromagnetic spectrum according to the wavelength considered (X rays, Gamma rays, radio waves, IR, UV, optical rainbow, etc.), and associated physical properties/technological implications. Provide some examples of reference scales in em spectrum.

Waves through mediums: have the pupils think about what happens when a wave tries to pass through an object (to this end, use the different objects gathered together for the experiment), also with reference to the three models of waves they have at hand.



Use the motion of the plastic beads along the wave profile to add further clarifications [mean free path, decay....

Wave and object must be placed on the same surface and close enough, so that the students understand that only in objects with a size comparable with that of the wavelength the light can pass, otherwise one needs a larger wavelength.

State that something quite similar happens in the Universe, and that waves with different wavelengths can pass through different mediums — leading principle in the construction of detectors. Effects of the atmosphere of the Earth on the radiation incoming from the outer space. Important role of X rays and Gamma rays; dedicated detectors. Have the pupils acknowledge the importance to build orbital telescopes to avoid the shielding/smearing effect of the atmosphere, and explore the related images.

### Remarks for facilitators/teachers

The baling wire can have sharp edges and points: better have its loose ends covered in duct tape after the pearl beads has been placed on the wave shape.

### For a broader/deeper/more advanced discussion,

Google the expression "multiwavelength universe" to get more images. Also, check the pages "Wavelength" and "Frequency" on Wikipedia for more information.



## ATTACHMENT 1:

### Comments of slides of the interactive activity

### LET'S GIVE A LIGHT TO THE UNIVERSE

**Slides from 2 to 12:** solutions to the game where students have to find images that refer to the same object.

**Slide 13:** In this slide students are invited to think about that everything we see in the universe, by means of different instruments, is simply light, that is electromagnetic radiation.

**Slide 14:** The light has two natures: the wave nature and the particle one. This means that light can be represented both as a wave and as a particle (photon) that travels in the space. To make things easier let's imagine a particle that moves along a wave.

**Slide 15:** Waves are characterized by a measure named wavelength: it measures the distance between two maximal (or two minimal) points of the wave itself.

**Slide 16:** Different wavelengths have different properties: in the picture is represented the electromagnetic spectrum where is spotlighted the zone corresponding to what can be seen by the human eye (using very powerful optical telescopes also). Now educators can introduce the activity with baling wire and beads, in order to show the students that different wavelengths allow to pass different types of obstacles.

**Slide 17:** In this slide we want to give an idea of the measurement scale used for different types of radiations: radio waves have a wavelength in the order of meters, therefore of buildings around us, whereas gamma waves have wavelength similar to those of subatomic particles, that is why they can get into the DNA and can mutate it.

**Slide 18:** This slide describes which celestial objects can be observed when we observe the sky with instruments able to reveal the different types of radiations.

**Slide 19:** This slide describes how not every kind of electromagnetic radiation can reach the earth surface. Indeed some are stopped by the atmosphere, that is why it is necessary to send some telescopes in orbit.

**Slide 20:** In this slide the topic of the previous one is continued. Some telescopes get installed on the earth (for example radio sampling equipment, because that radiation is not filtered or weakened by the atmosphere), on the mountains (to reduce the thickness of the atmosphere on top), on air balloons or in orbit.

**Slide 21:** These are some examples of telescopes currently operating: Chandra, James Webb Telescope, Alma, Ska (in the near future), Keck, ...

**Slide 22:** Another explanatory example of already mentioned telescopes with the radiations to which they are sensitive to respectively.

**Slide 23:** All the radiations of electromagnetic spectrum are not only typical of the universe, but are used by humans in their everyday (almost) life.  
Gamma rays: atomic explosions

Microwaves: microwaves oven, mobile phones

Infrared: infrared video cameras

**Slide 24:** Continuation....

Ultraviolet: tanning lamps

X-rays: radiography

Radio waves: radio

**Slide 25:** and finally optical: here a picture taken from SISSA balcony. Of course it can be substituted with any other picture.

## ATTACHMENT 2: Galaxies images

