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Kovalets I., Korshun V., Matusevich O.

Electromagnetic Waves in Space

Belarusian National Technical University
Minsk, Belarus

The universe is full of stuff: heavy stuff, light stuff, hot stuff and cold stuff, but what about the stuff you can't see or touch? You may already be familiar with some of the uses of electromagnetic waves. Microwave ovens cook food. Ultraviolet rays kill germs. Infrared "heat lamps" help soothe aching muscles. But electromagnetic waves have other uses with which you may not be so familiar. This article will present their use in space and other areas.

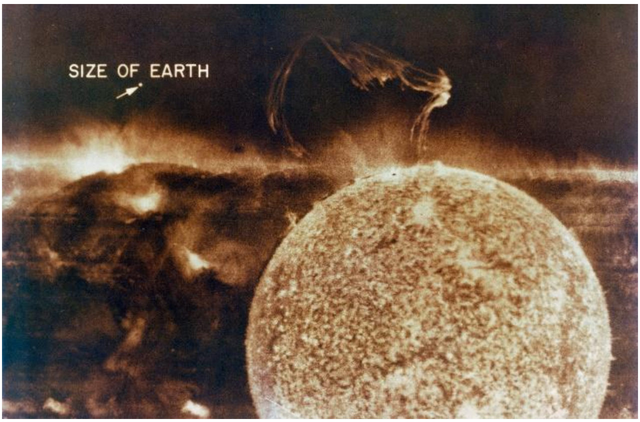

Figure 1. The Ultraviolet Photo of the Sun

Before space flight, astronomers could only study the universe with ground-based telescopes. These instruments were sensitive only to visible and radio wavelengths. Nowadays, rockets carry telescopes outside earth's atmosphere. These tools have taken photos of the sky in all wavelengths, from radio waves through gamma rays. Figure 1 displays an ultraviolet photograph of the sun that gives information not available in other kinds of photographs. Photographs like this one have helped astronomers learn about the composition of the sun's atmosphere [1].

Astronomers also study the sky in the infrared region of the electromagnetic spectrum. The infrared photos in Figure 2 show jets of gas being emitted by a quasar. Quasars appear to be galaxies moving away from the earth at nearly the speed of light. By studying the infrared photographs, astronomers measured the speed of these jets of gas.

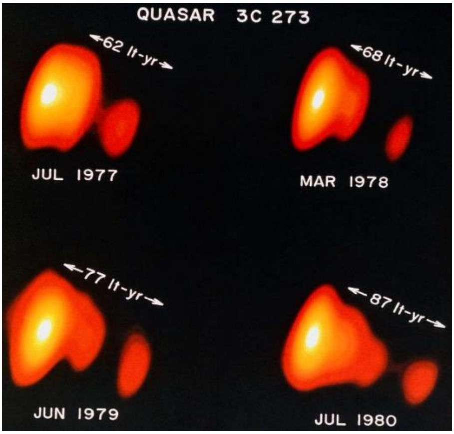

Figure 2. Jets of Gas Being Emitted by a Quasar

Characteristic patterns like fingerprints within the spectra allow astronomers to identify an object's chemical composition and to determine such physical properties as temperature and density. NASA's Spitzer Space Telescope observed the presence of water and organic molecules in a galaxy 3,2 billion light-years away [1]. Viewing our Sun in multiple wavelengths with the Soho satellite allows scientists to study and understand sunspots that are associated with solar flares and eruptions harmful to satellites astronauts and communications here on the earth. Specialists are constantly learning more about our world and universe by taking advantage of the unique information contained in the different waves across the electromagnetic spectrum [2].

Scientists have built a device that amplifies light, a laser. The latter concentrates a great deal of energy into a narrow beam of light that does not spread. A laser produces a pencil-thin beam of light that travels in one direction. This property makes laser light quite different from light from a lightbulb or from the sun. Ordinary light spreads out in many directions as it travels. Laser light also differs from other light because of its wavelengths. Light from a glowing object is made of a range of wavelengths. For example, the light from the sun is yellow. But you know that it also shines in the ultraviolet, infrared, X-ray, and so forth. Light from a laser, on the other hand, contains a very narrow range of wavelengths. So a laser may emit light only in the infrared or visible or ultraviolet.

To understand how a laser works, think about the electrons in orbit around an atom. Refer to Figure 3. When an atom absorbs energy, an electron moves to a higher energy level. Very quickly the electron returns to its original energy level. As it drops down, it releases a photon of light. This photon then interacts with an electron from another excited atom, causing it to jump to a lower level. Another photon emitted, with the same wavelength as the first.

The process is repeated over and over. As more photons are released, the light builds up, or amplifies. The released photons travel back and forth along rod. They reflect off a mirror at each end. However, the light in the rod soon becomes strong enough to pass through the thinner mirror at one end. An intense beam of laser light is then emitted.

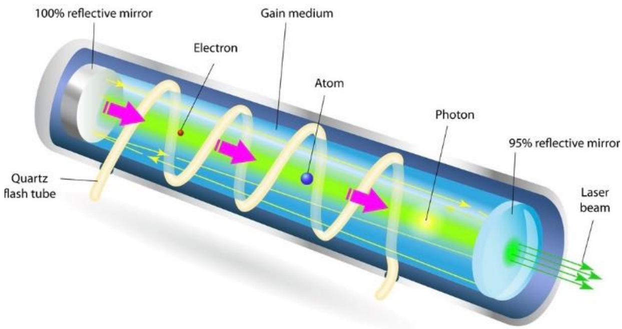

Figure 3. Laser Diagram

The unusual properties of laser light make lasers very valuable. Laser light does not spread out like normal light does. So laser light can be focused to a pinpoint. The focusing also concentrates the energy of the light into a point. Very high temperatures are produced. Industry uses this property of laser light to melt extremely hard materials.

The behavior of an electromagnetic wave in a substance depends on its frequency or wavelength. The differing behaviors of various groups in the electromagnetic spectrum make them suitable for a range of uses [2].

References:

1. Anatomy of an Electromagnetic Wave [Electronic resource]. – Mode of access: https://science.nasa.gov/ems/02_anatomy. – Date of access: 13.03.2021.

2. Types of Electromagnetic Waves and Their Uses [Electronic resource]. – Mode of access: https://physicsabout.com/electromagnetic-waves. – Date of access: 07.03.2021.