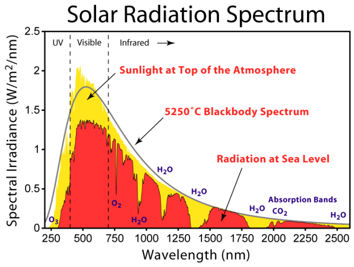
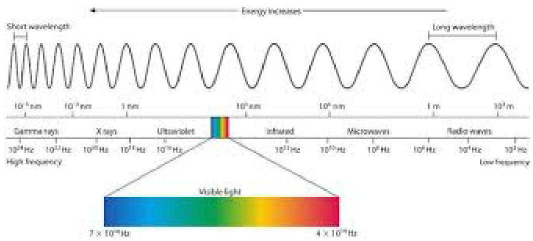
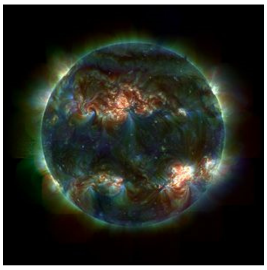
Sun – Part 17 - Sunlight 1





Electromagnetic spectrum



False colour X-ray image

Sunlight is the electromagnetic radiation given off by Sun, particularly infrared, visible and ultraviolet light On Earth, when not blocked by cloud, it is experienced as sunshine, a combination of bright light and radiant heat, and is essential to almost all life on Earth. It takes about 8.3 minutes to reach Earth from the solar surface. However, a photon's journey through the Sun itself takes much longer. If it is produced at the Sun's centre and changes direction every time it encounters a charged particle, it would take 10,000-170,000 years to reach the solar surface.

The total amount of energy received on Earth from the Sun depends on distance to the Sun and, thus, on time of year. In January, at perigee, it is about 3.3% higher than average and, in June, at apogee, about 3.3% lower. At the top of Earth's atmosphere, sunlight is composed of about 50% infrared, 40% visible and 10% ultraviolet light. It is about 30% more intense, there than on Earth's surface. In terms of energy, sunlight at Earth's surface is around 52-55% infrared. 42-43% visible, and 3-5% ultraviolet. The important difference in ultraviolet percentage is a consequence of absorption of 70% of damaging short-wave ultraviolet by the atmosphere.

The Sun emits radiation across most of the electromagnetic spectrum during normal energy emission including X-ray, ultraviolet, visible, infrared, microwave and radio waves. The exception is very high energy gamma rays. These are produced as a result of nuclear fusion, but are converted by internal absorption and thermalisation to lower energy photons before reaching the solar surface and emitted into space. The Sun does emit some gamma rays, during active events like solar flares, but the amount is tiny. tThe Moon produces more gamma rays (from cosmic rays striking heavy elements in the Moon) than the Sun does.

In addition to electromagnetic radiation, solar nuclear fusion also produces neutrinos. These tiny almost massless particles interact very weakly with surrounding matter and, unlike photons, escape quickly from the core without colliding with the overlying material. Their passage through the Sun takes only 2 seconds.

Gamma ray radiation Solar gamma rays scatter off electrons from the core to the photosphere, collisions with solar material making them less energetic. Their speed is not affected, but the energy loss is marked by wavelength changes. As they make their arduous journey to the surface, these rays are continuously absorbed by the solar plasma and re-emitted at lower frequencies. By the time they reach space they have shifted to shifted frequency to ultraviolet, visible and infrared and are not gamma rays any more.

X-ray radiation In the solar system, the Moon is the main source of X-ray emissions, although most of this brightness arises from reflected solar X-rays. X-rays are absorbed by Earth's atmosphere, so detection needs to take place at high altitudes using balloons, sounding rockets and satellites. X-ray emission was expected from celestial objects with very hot gases at temperatures from about 1–100s of millions K. It was in the 1940s that, during a V-2 rocket flight, X-rays were first observed emanating from the Sun. Solar x-ray emission was later confirmed by the Yohkoh satellite in 1991.

The Sun's X-ray emission is about a million times less than its visible radiation. While some X-ray radiation is emitted during solar flares, the solar corona is the main source of solar X-rays. This is explained by the fact that coronal temperature averages 1-3 million K, with hottest regions having temperatures of 8-20 million K, temperatures high enough to produce X-ray radiation. However, an explanation for the source of such high temperatures, when the temperature of the photosphere (surface) is only around 5,500 K and insufficient to achieve such temperatures via direct heat conduction, has yet to be found. Two possible answers to the so-called coronal heating problem have been proposed, both associated with turbulent motion in the convection zone below the photosphere. However, the ability of either high temperature waves travelling outwards and dissipating into the corona and/or heat produced during magnetic activity emitting heat in solar flares and coronal mass ejections to heat the corona to such high temperatures remains uncertain.

Aside from this problem, it is known that, while cycles in solar activity only slightly alter the amount of visible light emitted (about 0.1%), they can change levels of X-ray and ultraviolet emissions by a hundred-fold. Solar flares can dramatically alter levels of both X-ray and ultraviolet emission from the Sun over the course of a just a few minutes.

Sources: Ridpath, I (Ed) (2012) Oxford dictionary of astronomy 2nd ed rev, www.en.wikipedia.org, www.quora.com, www.windows2universe.org, www.universetoday.com, www.solar.physics.montatn.edu, www.missionscience.nasa.gov