



What makes the colours in butterfly wings?



As an experiment, some of our SciBar participants prepared this glossary, independently of Hywel Curtis. You may find it informative to consider these concepts and visit the website. Your comments on this experiment are most welcome.

<p>Band gap the range of blocked frequencies that cannot be transmitted by a photonic crystal, and so are strongly reflected</p> <p>Biomimetics (biomimicry) taking useful design principles from systems that work well in living things</p> <p>Bragg reflector (also called Bragg mirror) alternating layers of two materials with different optical properties. For the right design (depending on the thicknesses and the refractive index contrast), reflections from the different interfaces produce interference and a strong (bright) reflection. A Bragg reflector is a one-dimensional photonic crystal. In butterfly wings this structure is multiple layers of scales and air.</p> <p>Frequency the frequency of light relates to its colour</p> <p>Interference the addition of two or more waves to produce patterns of alternative maxima and minima of intensity</p> <p>Iridescence a change in colour that appears as the angle of view changes. When white light shines on a photonic crystal the colour reflected may vary with angle of view because different frequencies are blocked at different angles.</p> <p>Nanometre (nm) one billionth of a metre (1×10^{-9} m)</p> <p>Periodic medium a material whose properties repeat in a regular way. A periodic medium with just the right sized scale of repeats can affect the light or other electromagnetic radiation that is transmitted, reflected or absorbed. These repeats must be similar to the wavelength. The wavelength of visible light is about 400-600 nm.</p> <p>Photon the particle composing light and other electromagnetic energy. Light can act as a particle and a wave.</p>	<p>Photonic crystal (also known as photonic band-gap material) a material with a periodic structure whose repeats are similar in size to the wavelength of light. This forces light (photons) transmitted or reflected by the structure to be restricted to certain frequencies separated by gaps called band gaps. Light having such blocked frequencies will be strongly reflected by the structure.</p> <p>Natural photonic crystals are found in some feathers, butterfly wings, beetles and mother of pearl. Materials inspired by natural photonic crystals could be used in environmentally friendly dyes or cosmetics that do not use heavy metal pigments. Artificial photonic crystals could also be used to guide light in optical fibres or optical processors.</p> <p>Refractive index a quantity that describes by how much light is bent (changes direction) at a surface between one medium and another. Photonic crystals have layers of alternately high and low refractive index.</p> <p>Refractive index contrast the ratio of the highest and lowest refractive indices occurring in a structure. The contrast determines whether the material will be antireflective (like many insect eyes and moth wings) or highly reflective (like butterfly wings).</p> <p>Structural colour an effect caused by the way light interacts with the structure of a material, rather than by coloured pigments. Bright colours in nature are often caused by structural colour due to natural photonic crystals.</p>
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Useful weblinks: An article from Physics World magazine on natural photonics:
http://newton.ex.ac.uk/research/emag/pubs/pdf/Vukusic_PW_2004.pdf