

The Nature of Light

This document provides a very brief explanation that may help you understand why light is called an electromagnetic wave and exactly what's doing the “waving” in light. The answer is that light consists of tiny bundles of electric and magnetic fields (hence “electromagnetic”) and that these fields are oscillating (hence “wave”) at extremely high frequencies as they travel through space at a speed of 300 million meters per second.

If you're uncertain of the meaning of electric and magnetic fields, it may help you to understand that in physics, fields and forces are closely related. Just as a gravitational field is said to exist at any location at which gravitational forces are present, so an electric field exists wherever electric forces act, and a magnetic field exists wherever magnetic forces act. In an electromagnetic wave, the electric and magnetic fields point at right angles to one another and to the direction of the wave's propagation, as illustrated in Figure 1.

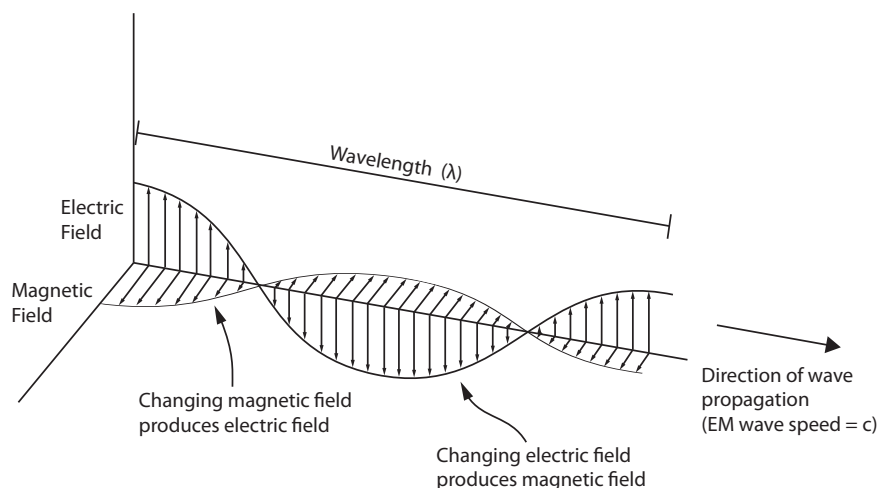


Figure 1: An electromagnetic wave.

Unlike mechanical waves (which include sound waves, water waves, and earthquake waves), electromagnetic waves can travel through a vacuum. That's because a changing electric field produces a magnetic field, and a changing magnetic field produces an electric field. This makes EM waves “self-regenerating” - once they're launched, EM waves travel forever at the same speed and in the same direction unless they encounter an obstacle or a change in the propagation medium. So they can travel easily through the vacuum of outer space. This is why we can see light but never hear sound from celestial objects.

Here is an animation from the University of Hawai'i, Department of Physics and Astronomy, that shows an electromagnetic wave propagating in two opposite directions from the origin. Be patient, the java applet takes a moment to load. When it has loaded, click "Start":

<http://www.phys.hawaii.edu/~teb/java/ntnujava/emWave/emWave.html>

This animation moves more slowly, so you can clearly see how the electric and magnetic field vectors grow and shrink at each location, and the net result of all these alternately growing and shrinking individual vectors is wave propagation:

<http://www.walter-fendt.de/ph14e/emwave.htm>

The next animation from Cabrillo College Physics Department shows how oscillating electric and magnetic fields (an electromagnetic wave) originate from an oscillating electric charge:

<http://www.cabrillo.edu/~jmccullough/Applets/Flash/Optics/EMWave.swf>

Like the previous three, this animation from the National Radio Astronomy Observatory shows that the electric and magnetic fields are perpendicular to one another and both are also perpendicular to the direction of propagation. However, this animation also labels the distance that represents one wavelength of this wave:

http://www.nrao.edu/images/lera/em_anim.gif

(Note: this animation is originally credited to Nick Strobel's Astronomy Notes website: <http://www.astronomynotes.com/light/s2.htm>)

The above animation is linked from a page with more information to read about electromagnetic waves and the electromagnetic spectrum, which reinforces and supplements the information given in Chapter 3:

<http://www.nrao.edu/index.php/learn/radioastronomy/radiowaves>