will display patterns of constructive and destructive interference. When the opening is much larger than the wavelength, waves travel through it without being affected.

The de Broglie wavelength of a 0.15 kg baseball moving at 30 m/s is about 1.5×10^{-34} m. This is almost a trillion trillion times smaller than the diameter of a typical air molecule—much smaller than any possible opening through which we could observe interference effects. This explains why the de Broglie wavelength of objects cannot be observed in our everyday experience.

However, in the microscopic world, the wave effects of matter can be observed. Electrons ($m = 9.109 \times 10^{-31}$ kg) accelerated to a speed of 1.4×10^{7} m/s have a de Broglie wavelength of about 10^{-10} m, which is approximately equal to the distance between atoms in a crystal. Thus, the atoms in a crystal can act as a three-dimensional grating that should diffract electron waves. Such an experiment was performed three years after de Broglie's thesis by Clinton J. Davisson and Lester H. Germer, and the electrons did create patterns of constructive and destructive interference, such as the pattern in **Figure 2.** This experiment gave confirmation of de Broglie's theory of the dual nature of matter.

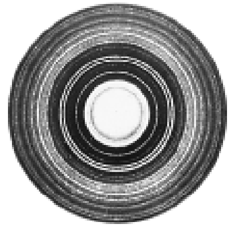

Figure 2
In this photograph, electron waves are diffracted by a crystal. Experiments such as this show the wave nature of electrons and thereby provide empirical evidence for de Broglie's theory of the dual nature of matter.

The electron microscope

A practical device that relies on the wave characteristics of matter is the electron microscope. In principle, the electron microscope is similar to an ordinary compound microscope. But while ordinary microscopes use lenses to bend rays of light that are reflected from a small object, electron microscopes use electric and magnetic fields to accelerate and focus a beam of electrons. Rather than examining the image through an eyepiece, as in an ordinary microscope, a magnetic lens forms an image on a fluorescent screen. Without the fluorescent screen, the image would not be visible.

Electron microscopes are able to distinguish details about 100 times smaller than optical microscopes can. Because of their great resolving power, electron microscopes are widely used in many areas of scientific research.

SCILINKS.
www.scilinks.org
Topic: Electron Microscopes
Code: HF60487

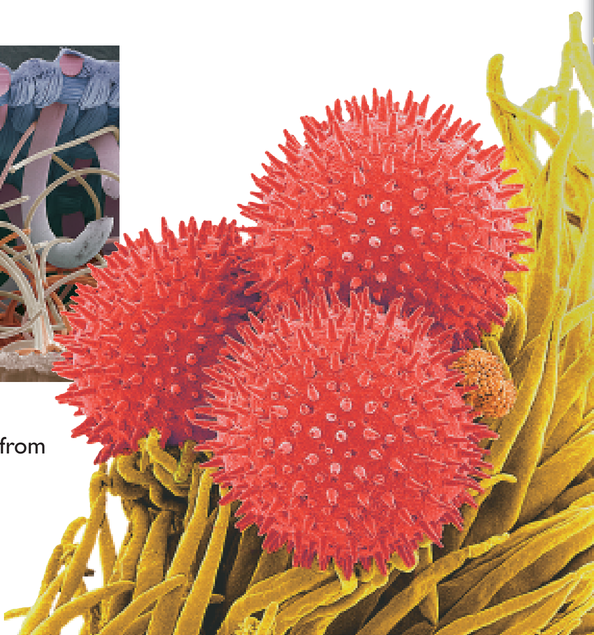

Figure 3
These color-enhanced images from a scanning electron microscope show, from left to right, a bean weevil emerging from a bean seed, two strips of velcro fastened together, and pollen grains.