Though there was an attempt to ignore Planck's hypothesis, experiments around the world began to result in paradoxes of exactly the form he forecast. Finally, Einstein broke the stand-off in 1905, when he demonstrated that the photoelectric effect could be efficiently explained, if it were assumed that light transfered energy to the ejected electrons in the form of quantum packets. As the intensity of the light was increased, no increase in the kinetic energy of the ejected electrons was observed. Hence, each electron was given a specific amount of kick, which coincided with an individual quantum transfer. That amount of kick would only change if the frequency of the light were changed.

So, here was one example of an energetic phenomenon, acting as a discrete object.

What about matter? A similar category of paradox was popping up all over the study of atomic phenomena, specifically in the spectra of the elements and their isotopes and ions. Louis de Broglie took from Planck the hypothesis that the universe is harmonically organized, and determined a wave structure for

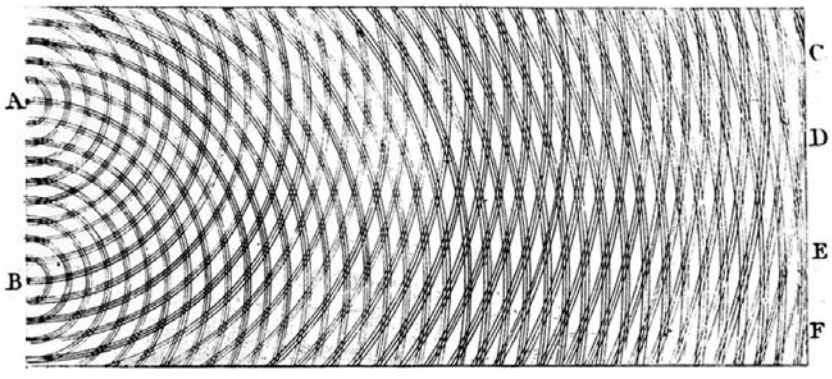
Two-Slit Interference

Wave phenomena are characterized by what is called "interference." Transverse waves, such as those produced on the surface of water, are composed of both peaks and troughs. If two waves cross each other, the heights of the waves "add" to each other, in such a way that two peaks crossing will produce a wave whose height is enhanced, while a peak crossing a trough will produce one whose height is diminished. If one wave encounters a barrier with two holes, each hole will become the source of a new set of waves, and thus two wave sets will propagate on the other side of the barrier. If a screen is set up further on that side, the waves will produce an interference pattern.

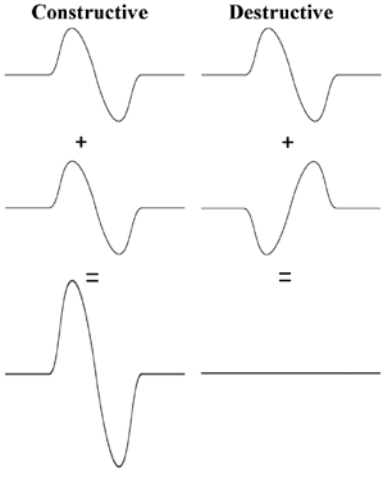
In the image shown here, drawn by Thomas Young, two sets of water waves emanate from the slits at A and B. Each of the circles drawn represent a peak of a circular wave. At the far end is a screen. Between points D and E is the tallest wave, between C-D and E-F are shorter tall waves, and so forth. But, at C, D, E, and F the waves completely cancel each other.

A beam of light passed through two thin slits will also produce such a pattern on a screen. Thus, it was hypothesized that the light must have the same wave characteristics as water. This opened up the question, though, as to what, exactly, was waving?

—Peter Martinson



Thomas Young's sketch of wave interference. Each series of curves represents a wave peak, and where wave peaks cross is a high point of constructive interference.



Constructive interference: *The two waves add to produce a larger wave.*
Destructive interference: *The two waves are each other's negative, and thus add up to zero wave.*