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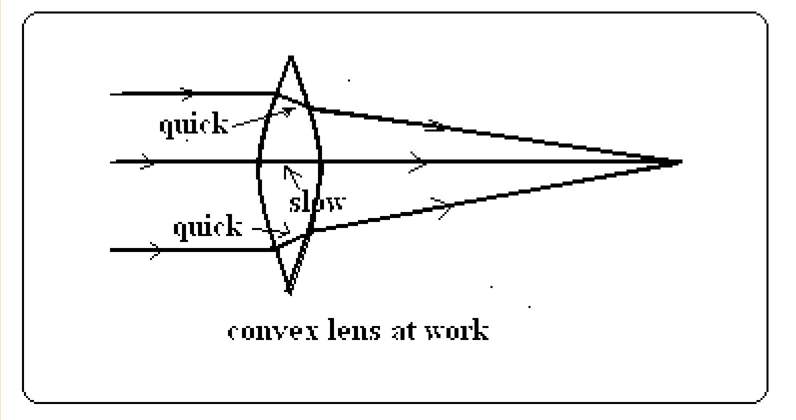
Ocean waves in focus

Chinese engineers are using ‘diffraction’, to focus ocean waves, says S.Ananthanarayanan.

One way of focusing light rays is with lenses, which rely on the slower speed of light when it passes through glass. Thus, if the lens is thicker in the middle, light that comes through edges of the lens get through faster and the beam *converges*, like shown in the picture.



Another kind of focusing

Similar focusing of light happens when light passes through a plane glass sheet with fine parallel lines ruled on its surface. This kind of sheet is called a *grating* and its property is that it focuses each colour of light in a beam at a different point, which enables splitting of the various colours, like with a prism. (lenses also do this, but its more marked in gratings).

This effect is called *diffraction* and is explained by the wave nature of light. The effect is easy to understand with the help of an example of waves at the seaside.

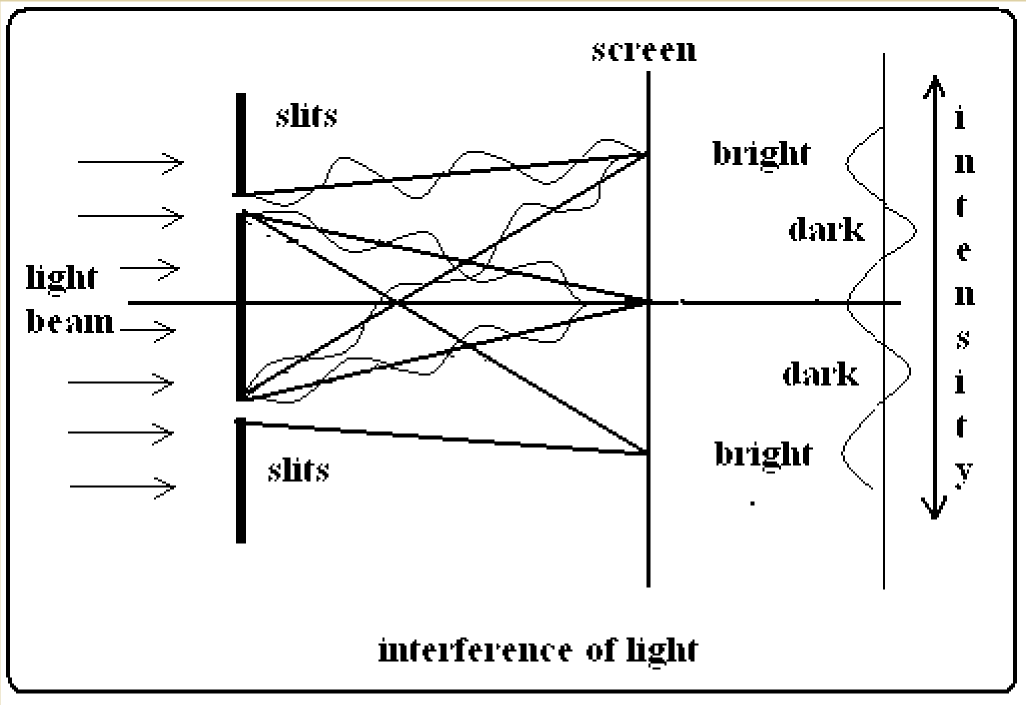
Seaside waves

We know that the waves in the sea, like ripples on water, are a progression of up-down motion of water. While ripples usually start from a point and spread out in circles, ocean waves are caused by winds and the wave-fronts do not show marked curvature. And the crests and troughs of the waves are separated by a constant distance, called the wavelength.

Now, if two waves were to ‘collide’ or to cross, then the combined effect at any point would depend on whether one ‘crest’ came right where the other ‘crest’ was, or at the place of the other ‘trough’, or somewhere in between The pattern is thus a checkerboard of double-crests and double-troughs and places of less disturbance. We can see this effect vividly at the beach, where waves coming in cross the waves returning after hitting the seashore. Sometimes the waves ‘add up’ and we get a real big one. And sometimes the waves ‘cancel’.

Interference of light

When a light beam passes through a pair of parallel slits, the light that emerges begins to act like two different light waves originating at the two slits. Thus, when they strike a screen placed in their way, the illumination of any point depends on whether the waves from the two slits reached that point ‘in phase’, that is ‘troughs and crests’ of both waves arriving together, or ‘out of phase’. As we can see in the picture, the centre point, equidistant from the slits, is always bight. But a little away, the light ‘cancels’ out and we have a dark band. And again, a little after, there is a bright band, followed by a dark band and so on.



This pattern of bands can be made very much more intense and sharp by using a large number of parallel slits. An arrangement like this, which is made by ruling lines on a glass sheet, is called a *grating*. As the wavelength of light is extremely small, of the order of millionths of a meter, the lines are also very close together, like thousands in a centimetre.

Grating and ocean waves

While the wave nature of light was first understood with the help of seaside waves, now the idea of the optical grating has been carried backwards, to focussing ocean waves. Xinhua Hu and Che Ting Chan of the Hong Kong University of Science and Technology have tried building an array of concrete pillars in the sea to affect sea waves like a grating acting on light waves. The ocean waves passing through the gaps between pillars act like new sources of waves and change the uniform progress of the wave-front into an interference pattern. With a concrete pillar grating some kilometres across, points of waves of huge amplitude can be developed, along with some places where the waves die out altogether.

But at the places where the waves ‘add up’ and concentrate energy, devices can be set up to convert the energy into electricity. The present methods to use the energy of the sea have used either the rising of the water level with the tides or floating arms in the sea to channel wave energy. The new idea of using interference looks like a much more effective and ‘continuous ‘ technology.