Two Nice Diffraction Experiments

BY MICHAEL KNOTTS

This month I bring you two excerpts from Robert Ehrlich's book *Turning the World Inside Out and 174 Other Simple Physics Demonstrations* (see "Light Touch," January 1998). Ehrlich is professor of physics at George Mason University in Fairfax, Va. The demonstrations described produce nice results, yet are very simple and inexpensive to set up. A small pen light with a Krypton bulb or a small decorative bulb serves as an excellent light source for them. Enjoy!

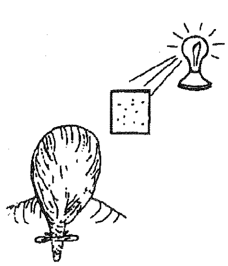
Q.12. Pinholes in aluminum foil

Demonstration

Diffraction and interference patterns can be seen when you look at an unfrosted light bulb through pinholes in aluminum foil.

Equipment

Aluminum foil; a fine needle; and an unfrosted light bulb, preferably one with a small filament.



Comment

Make a number of holes in the aluminum foil using the needle; keep them as small as possible. (It may help to put the aluminum foil on a hard surface before you stick the needle into it.) In one region of the foil, create pairs of holes, with the spacing between the two holes in each pair as small as possible. When you darken the room and view the unfrosted light bulb through the single holes from 10–15 feet away, you should see diffraction rings. It may be difficult to see very many concentric rings, but you should certainly see a central bright region surrounded by a dark ring and a bright one. If the holes are not exactly circular, or if the size of the light bulb filament is appreciable, the regularity of the rings will be destroyed, but some more complex and unusual patterns may be produced. When you view the light bulb through the double holes, you should see a pattern of stripes—interference fringes—superimposed on the diffraction pattern. The spacing of the stripes is inversely proportional to the distance between the two adjacent holes, so the holes must be quite close together to get noticeable stripes.

Q.15. Diffraction rings through a mist

Demonstration

You see diffraction rings when you view a bright light through a fine mist on a glass onto which you have exhaled. The average size of the water droplets can be determined from the size of the rings.

Equipment

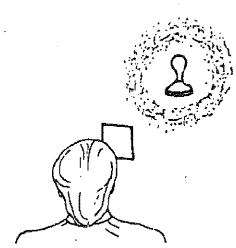
An unfrosted light bulb; a meterstick; and a small piece of glass (or a pair of eyeglasses, if you wear them).

Comment

Diffraction rings, also called coronas, are seen in a variety of natural situations, including viewing the moon through thin clouds, or viewing street lights through a fog. The diffraction results when light waves bend around fine water droplets by an amount that depends on the size of the droplets. In order to see a distinct ring when you view a light source through many droplets, the droplets must all have the same diameter—otherwise, the rings from different droplets would have different radii and the pattern would wash out.

It is surprisingly easy to duplicate the diffraction rings seen in nature by exhaling and fogging a piece of glass or your eyeglasses, causing a fine mist to be deposited. If you view an unfrosted light bulb through the glass in a darkened room, faint colored rings surrounding a central blob can be seen for a few seconds before the mist evaporates. (If the glass is chilled before fogging, the condensed mist persists much longer.) The central blob will have blue on the inside and red on the outside, because shorter wavelengths exhibit less diffraction. You probably will not see more than one faint ring around the central blob, unless the source is very bright.

Hold a meterstick at arm's length, and estimate the radius to the edge of the central blob, r. Find the angular radius in radians by dividing r by the length of your arm. The angular radius A of the edge of the central blob (the first minimum in the diffraction pattern) is related to the wavelength λ, and the diameter d of the water droplets, through the equation $\sin A = 1.22\,\lambda/d$. Thus you can calculate the size of the water droplets causing the diffraction using the measured radius A, and a value of λ = 600 nm for the average wavelength of light. You will probably observe an angular radius of a few degrees, which corresponds to a droplet diameter of 0.02 mm—about the same size as some cloud droplets.



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