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VARIATIONS ON A FAMOUS WHITE-LIGHT EXPERIMENT OF ISAAC NEWTON

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May 1971

In one of his best-known experiments, Isaac Newton dispersed a beam of sunlight into its rainbow-like color spectrum by means of a prism. Then he ran the dispersed light through a second prism oriented so as to bend the light beam oppositely to the way it was bent by the first prism. Thus the various colors were recombined and gave white light again.

It occurred to me that this experiment might be done using two diffraction gratings instead of two prisms. It turns out to be very easy. The result is spectacular.[1]

All you need is two cheap replica transmission gratings (one pair for each student).[2] You also need an ordinary frosted or (preferably) "soft white" light bulb to provide the white light, and a darkened room. The detector is your eye. You hold one grating in your left hand about 6 or 8 inches from your eye and oriented so that the colors are dispersed vertically. Using your left hand to block out the direct light from the bulb to your eye, displace your left hand vertically upwards until you see the first-order color spectrum coming from the aperture of the grating to your eye. Now with your right hand hold the second grating close in front of your eye and oriented parallel to the first grating. If you look towards the place in space where the real light bulb would appear (if you could see through your left hand) you will see there a lovely virtual white light bulb. Optics works: it's astounding!

The alignment of the two gratings is not critical; they may be held freely in your hands. By slight shifting vertically of the grating held in the left hand (the one farthest from your eye) you may allow less than the full color spectrum diffracted at that grating to be incident on the second grating. Thus you may make the virtual bulb appear red or blue rather than white. But by slight adjustment of your left hand you may insure that the bulb will appear white. The experiment is best done in a very dark room, or at night, since the virtual bulb is not very bright. In a room not completely dark the experiment will still work if you provide a darker background than your hand by paper-clipping the first grating to the edge of a dark-covered book or piece of dark cardboard. The book is used in place of your hand to block out the direct light from the bulb, and to provide a dark background for viewing the virtual light bulb.

Once you have seen the bulb you can put other objects near the bulb so as to be illuminated by it; for example, a crumpled up wad of aluminum foil. The whole scene is recreated in its original colors by the second grating. A dim sharp image floats there like a ghost in space, just where the real object would be if your hand were transparent. It's ravishing!

References

1. I have not heard of this demonstration before, but I have not searched the literature.

2. I used the replica transmission gratings available at 25¢ each (or 10¢ each in lots of 100) from Edmund Scientific Co., 300 Edscorp Bldg., Barrington, N. J. 08007.

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