

Lawrence Berkeley National Laboratory

Recent Work

Title

VARIATIONS ON A FAMOUS WHITE-LIGHT EXPERIMENT OF ISAAC NEWTON

Permalink

<https://escholarship.org/uc/item/4zq21284>

Author

Crawford, Frank S.

Publication Date

1971-05-01

Submitted to "Notes and Discussions"
of the American Journal of Physics

UCRL-20812
Preprint *e.p.*

RECEIVED
LAWRENCE
RADIATION LABORATORY

JUL 6 1971

LIBRARY AND
DOCUMENTS SECTION

VARIATIONS ON A FAMOUS WHITE-LIGHT
EXPERIMENT OF ISAAC NEWTON

Frank S. Crawford

May 1971

AEC Contract No. W-7405-eng-48

TWO-WEEK LOAN COPY

*This is a Library Circulating Copy
which may be borrowed for two weeks.
For a personal retention copy, call
Tech. Info. Division, Ext. 5545*

34
LAWRENCE RADIATION LABORATORY
UNIVERSITY of CALIFORNIA BERKELEY *e*

UCRL-20812

DISCLAIMER

This document was prepared as an account of work sponsored by the United States Government. While this document is believed to contain correct information, neither the United States Government nor any agency thereof, nor the Regents of the University of California, nor any of their employees, makes any warranty, express or implied, or assumes any legal responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by its trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof, or the Regents of the University of California. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof or the Regents of the University of California.

VARIATIONS ON A FAMOUS WHITE-LIGHT
EXPERIMENT OF ISAAC NEWTON

Frank S. Crawford

Lawrence Radiation Laboratory
University of California
Berkeley, California 94720

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.

LEGAL NOTICE

This report was prepared as an account of work sponsored by the United States Government. Neither the United States nor the United States Atomic Energy Commission, nor any of their employees, nor any of their contractors, subcontractors, or their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness or usefulness of any information, apparatus, product or process disclosed, or represents that its use would not infringe privately owned rights.

TECHNICAL INFORMATION DIVISION
LAWRENCE RADIATION LABORATORY
UNIVERSITY OF CALIFORNIA
BERKELEY, CALIFORNIA 94720