KEY IDEAS OF RADIATION EXCHANGE

Energy associated with electromagnetic radiation

By J.H. Taylor

Editor's note: In monthly installments, Optics News is pleased to present a series of lecture demonstrations on radiation exchange, by J.H. Taylor of Rhodes College in Memphis, Tenn. Key ideas of radiation exchange will be presented through April, followed by installments showing some applications of radiation exchange. These articles complement Taylor's article, "Radiation Exchange," in the Feb. 15 issue of Applied Optics. The author, a former member of OSA's education council, is a professor of physics at Rhodes, which was formerly Southwestern at Memphis.

I wrote this series of articles because I am concerned that very little coverage of the phenomenon of radiation exchange is included in most introductory college physics courses. "Radiation exchange" is not even mentioned in the index of the most frequently used texts for physics majors in this country, even though I have found this to be an area of considerable interest to most students.

My article, "Radiation exchange," referenced above, pointed out that a key idea involved in radiation exchange is that everything is radiating. In this first installment, I talk about energy associated with electromagnetic radiation, with two lecture-demonstrations.

Kleenex and flash-bulb demonstration

Many students will have had an experience from scouting in which they used a small lens to focus solar radiation and start the burning of dry leaves. By the time they get to college many of them seem to have forgotten that experience.

I like to demonstrate that energy is associated with electromagnetic radiation using the apparatus shown in Fig. 1. In this demonstration I use a large clear flashbulb located in the focal plane of a parabolic mirror of about 1-ft diameter.

The *F*-number of the mirror is quite small and consequently the flashbulb is positioned very near the surface of the mirror. I take a *single* sheet of Kleenex and tape it to the frame shown in Fig. 1. When the flashbulb is energized, the students see a flash of bright light and nothing happens to the sheet of Kleenex.

The flashbulb is then replaced, and the single sheet of white Kleenex is replaced with a single sheet of Kleenex that has been blackened (and allowed to dry thoroughly) using flat black spray paint. The single sheet of blackened Kleenex is now attached to the frame, and the flashbulb is energized. This time the piece of Kleenex bursts into flames!

As simple as this demonstration is, it never fails to evoke great excitement on the part of the students. Who would have thought that there was

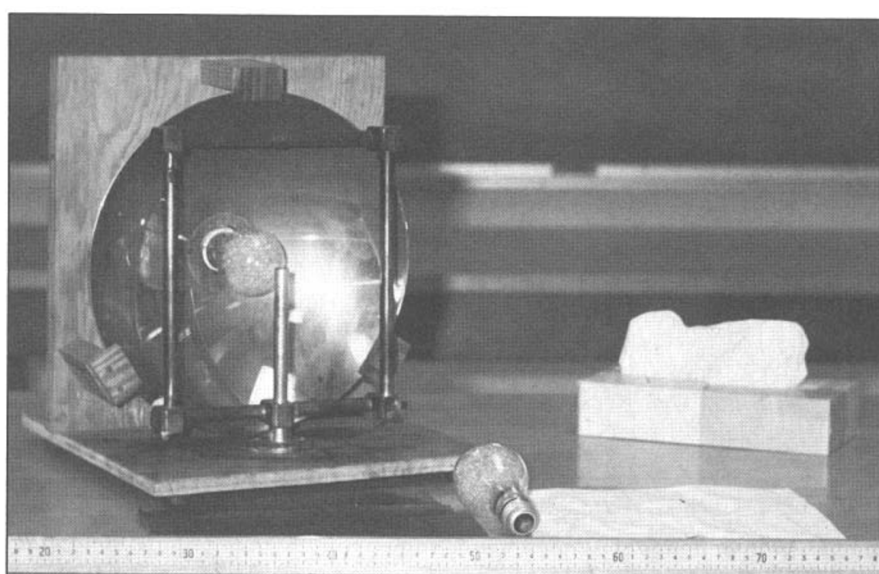

FIGURE 1. Kleenex, concave mirror, and flashbulb apparatus used by the author to demonstrate that electromagnetic radiation possesses energy.

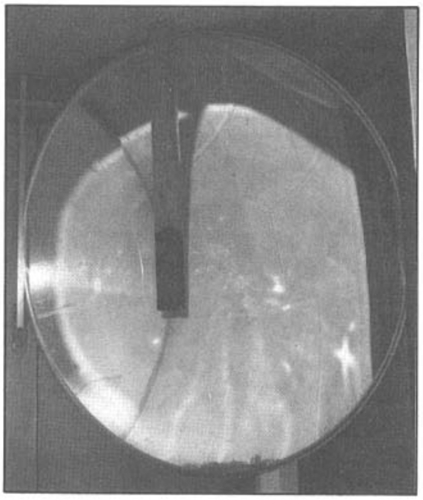

FIGURE 2. Five-foot diameter search light mirror and 2 × 4 used by the author in a beam of solar radiation to demonstrate that electromagnetic radiation possesses energy.

this much energy associated with the radiation from a flashbulb? The students also see very vividly that blackened surfaces do indeed absorb more visible radiation than white surfaces.

Five-foot diameter searchlight mirror and solar radiation

Our department has a 5-ft diameter mirror that was originally part of an anti-aircraft installation from World War II. These are very useful mirrors, and I would encourage teachers to try to obtain one, perhaps through your state outlet for government surplus properties.

These are all metal mirrors, i.e., they are not catadioptric systems. Since there is no glass associated with these mirrors, they are quite useful to students for infrared studies of planets, lightning, meteors, and so on. They are also useful as "big ears" for work in sound.

I have found such a mirror to be very useful as another way in which to demonstrate that there is energy associated with electromagnetic radia-

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OSA Search for Summer 1987 Education Fellowship Applicants

The Optical Society of America (OSA) is seeking applicants for a summer 1987 fellowship position to conduct projects of mutual interest to the fellow and the Optical Society of America. The position requires the fellow to work for approximately three months (June-August 1987) in the OSA executive office in Washington, D.C. Some support for relocation expenses is available.

The primary purpose of the education fellow will be to implement several precollege education projects of the Society's education council. Thus, an elementary, high school, or college educator with a strong interest in optics education would be an ideal candidate.

Examples of projects already begun that will fall under the purview of the fellow are: 1) monitoring the use of 1986 optics education grant funds and preparing a followup report on the nine precollege education projects granted funds; and 2) managing the production and distribution of an already-prototyped optics kit and accompanying booklet for use by primary and secondary school science teachers. Other projects include planning of video-tape programs for a new OSA education resource center, compiling materials for the center, and, most importantly, *implementing a project(s) of the fellow's choice* (It is estimated that the fellow will spend 50% of their time on this project.)

Interested applicants should send a cover letter and resume detailing their interest in this position, qualifications, appropriate experience, and salary requirements. A description of the project(s) that the applicant wishes to implement with the help of the Optical Society should be included. This project(s) is expected to have national impact in the area of precollege or college-level optics education.

The deadline for submission of materials is February 15, 1987. Applicants will be evaluated by the education council of the Optical Society. The selection process will be completed by March 31, 1987.

Reply to:
William A. Borrelle
Manager of Technical Activities
Optical Society of America
1816 Jefferson Place, N.W.
Washington, D.C. 20036

For more information, call the OSA executive office: (202) 223-8130.

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tion. There is something fascinating about a big mirror to most students.

Our physics building is a six-story tower with the sixth floor devoted to most of our astrophysical work. It also contains a porch on which students can set up apparatus. I keep this 5-ft diameter mirror stored on the sixth floor, and with about three students helping me, we roll it out to the porch and *carefully* point it toward the sun.

Next I locate in the focal plane of the mirror a piece of 2 × 4 about 5 feet long. The end of the 2 × 4 that is placed in the focal plane has previously been blackened using flat black spray paint. Within a matter of seconds the end of the 2 × 4 in the focal plane will burst into flames.

Students are told in their texts that the solar constant is about 1400 W/m^2. This, by definition, is the power density from the sun at the top of the earth's atmosphere and is obviously less on the surface of the earth. Many students have very little feeling for what the solar constant means from an energy point of view. After seeing the 2 × 4 burst into flames, they have a much better feeling for the numbers involved.

Figure 2 is a photograph of the 5-ft diameter searchlight mirror used in this demonstration.

Next month: Planck's radiation law.

J.H. (Jack) Taylor

EMPLOYMENT MARKETPLACE

11-D — Ph.D. (expected in 1987). Experience in development of excimer and gas lasers. Seeks R&D position. Not U.S. citizen.

12-A — M.S. (1948) in physics. Senior scientist/engineer with 40 years experience in optical instrument development, production, and management.

12-B — B.S. (1984) in physics. Experience in image processing, laser/optical systems, and HEL systems engineering. Seeking active R&D/engineering position with similar projects. DOD secret clearance.

12-C — Ph.D. (1985) in physical chemistry. Experience in photoacoustic, resonance ionization, and atomic and molecular spectroscopies using cw and pulsed lasers. Seeking R&D position.

12-D — Ph.D. (June 1987) experience in dye laser physics. Seeks R&D position.

12-E — M.S. (1980) in optics from the U. of Rochester. Seeking position in optical engineering (layout, design, and code V).

12-F — Experience in laser physics with emphasis in nonlinear optics, phase conjugation, and optoelectric engineering. Lecturer of physics for 8 years. Seeks research or visiting scholar position. Not U.S. citizen.

1-A — M.S. (1986) in nonlinear optics, M.S. (1981) in optics. Experience in four-wave mixing, holography, optical lens system design and optical waveguide. Eight papers published. Not U.S. citizen.

1-B — Ph.D. (expected in 1987) from Cornell U. Papers published on topics such as piezopolymer sensors/controllers, polarization optics, photoelastic holography, chaotic motion, and wave propagation. Seeking academic or R&D position. Permanent resident.

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