Trick of the Trade

Modeling the Behavior of Light with a Light Cone

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I have developed a simple yet effective way to illustrate the formation of a real image by a converging lens. Using a light cone model that employs athletic cones, spaghetti noodles, and plastic wrap, students come to realize that a very large number of rays are actually involved in the formation of an image (see Fig. 1). This essential concept is often not understood, because the simple ray diagrams found in most texts often only focus on two or three principal rays. In contrast, the light cone model provides students with a more complete picture of how a converging lens forms a real image.

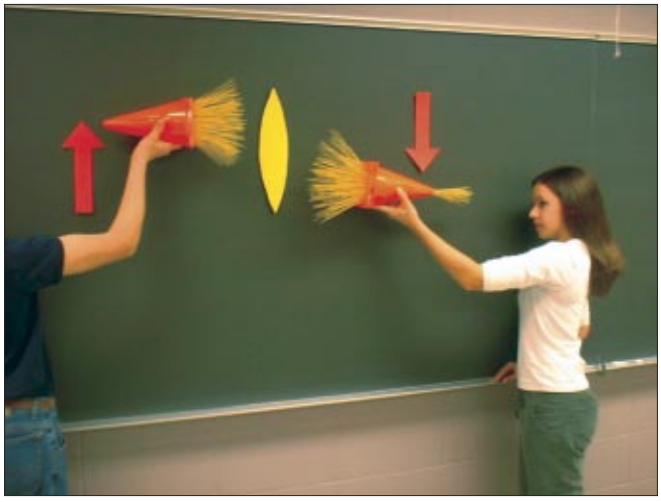

Fig. 1. Diverging (left) and converging (right) light cone models for the behavior of light.

The converging and diverging light cones are easy to construct. All that is needed are three small athletic cones, long hard spaghetti noodles, and plastic wrap. To make the converging light cone, use a utility knife to cut the apex off one of the cones. Then push as many noodles as you can through the small opening. At this point, friction should hold the noodles in place. Finally, use a pen to push a small crumpled piece of plastic wrap into the middle of this bundle of noodles. This will cause the noodles to spread out. The noodles protruding through the opening in the apex represent light rays diverging from the image point.

To produce the diverging light cone, push enough crumpled plastic wrap into a cone so that the noodles can't slide more than halfway into the cone. Place two or three layers of plastic wrap over the base of the cone. Slide a second cone over the plastic wrap-covered cone to hold the plastic wrap in place. Finally, carefully push the noodles through the surface of the plastic wrap cover to produce a diverging bundle of light rays.

When using the light cones the instructor should emphasize that the diverging light rays beyond the image point are behaving exactly like the diverging light rays at the object point. That is, we see objects and real images for exactly the same reason: light is diverging from a point. A converging lens in essence recreates the same situation at the image point that is occurring at the object point.

I believe the use of the light cone model can greatly enhance student understanding of the behavior of light, for not only can the model be used to clarify image formation by a converging lens, it may also be used to conceptually model the inverse-square law.

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