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Bringing the Moon Into the Classroom

Abstract

Understanding the phases of the Moon is a perennial stumbling block in introductory astronomy classes. In the film, "A Private Universe," for instance, both Harvard graduates and gifted high-school students display serious misconceptions about the Moon's phases, believing, among other things, that the Earth's shadow on the Moon is the cause of it all. Part of the problem may stem from textbook illustrations that show a view of the Moon in orbit around the Earth with the Sun of to one side. Students have trouble converting mentally from this "God's eye" perspective into the "geocentric" perspective we experience as observers on the Earth looking at the Moon. As an aid in developing this skill of visualizing the same phenomenon from different frames of reference, I have lately taken to employing video techniques in the classroom. [*excerpt*]

Keywords

Introductory Astronomy Classes, A Private Universe, geocentric, Earth's shadow

Disciplines

Astrophysics and Astronomy | Other Astrophysics and Astronomy

Bringing the Moon into the Classroom

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Understanding the phases of the Moon is a perennial stumbling block in introductory astronomy classes. In the film, "A Private Universe,"¹ for instance, both Harvard graduates and gifted high-school students display serious misconceptions about the Moon's phases, believing, among other things, that the Earth's shadow on the Moon is the cause of it all. Part of the problem may stem from textbook illustrations that show a view of the Moon in orbit around the Earth with the Sun off to one side. Students have trouble converting mentally from this "God's eye" perspective into the "geocentric" perspective we experience as observers on the Earth looking at the Moon. As an aid in developing this skill of visualizing the same phenomenon from different frames of reference, I

Fig. 2. "Geocentric view": Phases of Moon as seen by rotating CCD camera. North is assumed to be at top, west at right. Top row, left to right: waxing crescent, first quarter, waxing gibbous, full. Bottom row, left to right: waning gibbous, last quarter, waning crescent. Bottom right frame simulates Bailey's Beads at New Moon during a total solar eclipse.

have lately taken to employing video techniques in the classroom.

Compact, high-resolution CCD cameras have become readily available in recent years, making it possible to show students views from different reference frames. In the demonstration of the Moon's phases, I mount one camera, equipped with a zoom lens, on the end of a long 2 × 4 board. The video display from this camera represents the "geocentric view" of the moon. A 3-in Styrofoam

ball mounted on the other end of the 2 × 4 with a piece of Velcro represents the Moon. A slide projector, about 20 ft away, provides illumination to simulate the Sun (see Fig. 1).

As the 2 × 4 is rotated, the changing phases of the Moon can easily be seen on the monitor (see Fig. 2). Students react with interest because they can also get a rough "God's eye" view from their seats and can see how much more striking the changes look in the geocentric frame. It is also possible to mount a second CCD camera with a wide-angle (6 or 8 mm focal length) lens above the demonstration table to provide a "God's eye" view on a second monitor (see Fig. 3).

The video camera also makes it possible to demonstrate other phenomena related to lunar phases. It is easy to simulate the inclination of the Moon's orbit to the ecliptic by tilting the 2 × 4 slightly, demonstrating thereby why lu-

Fig. 1. Setup for demonstrating phases of the Moon.

Fig. 3. "God's eye" view: On the left is the apparatus seen from above with room lights on. On the right, with only the projector (the Sun) light on, lit half of Moon can be clearly seen. Students see that half of the Moon remains lit, no matter what the phase.

Fig. 4. Circular shadow of Earth as seen during a simulated lunar eclipse.

nar and solar eclipses do not occur at every Full and New Moon. Alternately, if the light source is positioned properly and the edges of the Styrofoam ball are sufficiently rough, one can demonstrate "Baily's Beads," the bright spots that appear along the edge of the Moon just

before totality of eclipse as sunlight passes through irregularities on the lunar limb (bottom right, Fig. 2). And if the shadow of the camera is circular in cross section, one can simulate the circular shadow of the Earth that can be seen during a lunar eclipse (Fig. 4); students will see that the partially eclipsed Moon looks quite different from any of the phases of the Moon.

Using video to show different frames of reference may have additional appeal to students, many of whom have spent more time watching patterns on fluorescent screens than watching nature itself. But the power of the camera to show different frames of reference dates back at least three decades to the venerable PSSC film, "Frames of Reference." Tiny CCD cameras, only an inch or two square (advertised, for instance, in the Edmund Scientific catalog), even make it possible to show students live video

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Reference

1. Matthew H. Schneps, "A Private Universe: Misconceptions that Block Learning," Pyramid Film and Video, Santa Monica, CA (1989).

et cetera...

▼ Instruction in Mathematics

A study has been made of the skills in mathematics of Chinese and American children. People in the two countries who received their education in the 1920s and '30s

were compared, as were more recent students. The results suggest that there is no IQ difference between the Chinese and American students, but that

...whatever fosters complex arithmetic skills, we were doing it better [in the U.S.] in the 1930s than we are now. Other studies...indicate that elementary math instruction in the United States reached its peak

between the wars, when kids learned the basics more thoroughly.¹

1. C. Holden, *Science* **271**, 297 (Jan. 19, 1996).

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