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Bringing the Moon Into the Classroom

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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 on 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
Understanding the phases of the Moon is a perennial stumbling block in introductory astronomy classes. In the film, "A Passion Unveiled," 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 phenomena from different frames of reference, I 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 x 4 board. The video display from this camera represents the "geocentric view" of the moon. A 3-in Skydome ball mounted on the other end of the 2 x 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 x 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 actually get a rough "God's eye" view from their seats and can see how much more realistic the changes look in the geocentric view. 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 (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 x 4 slightly, demonstrating thereby why lunar and solar eclipses do not occur at every Full and New Moon. Alternatively, if the light source is positioned properly and the edges of the Skydome 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 computer screens than watching nature itself. The power of the camera to show different frames of reference dates back at least three decades to the venerable PSSC films, "Frames of Reference." This CCD camera can only make inch by one-inch squares (advertised, for instance, in the Edmund Scientific catalog), even makes it possible to show students live video from gliders on air tracks, model rockets, and other moving objects.

Acknowledgment
Thanks to Don Spelius and Gary Hammer for help with the apparatus.

Reference

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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," 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 phenomena from different frames of reference, I 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 monocular, on the end of a long 2 x 4 board. The video display from this camera represents the "geocentric view" of the moon. A 3:1 Skyview ball mounted on the other end of the 2 x 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 x 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 actually see this "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 x or 8 x 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 x 4 slightly, demonstrating thereby why lunar and solar eclipses do not occur at every Full and New Moon. Alternatively, if the light source is positioned properly and the edges of the Skyview 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 computer 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 PSCF film, "Frames of Reference." This CCD camera, only an inch or two square (advertised, for instance, in the Edmund Scientific catalog), even makes it possible to show students live video from gliders on air tracks, model rockets, and other moving objects.

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Reference

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