Bridging the Gap: Art, Physics, and Photography

The Planets

The elusive but beautiful planets Saturn and Jupiter have fascinated astronomers for centuries. These massive gas giants are some of the brightest objects in our night sky, but can be incredibly difficult to photograph. Unlike galaxies or nebulae, the planets are typically very bright but incredibly small in the sky, and when there is lots of wind or atmospheric turbulence, they can be difficult to capture clearly. I found it most effective to use a technique called "Lucky Imaging," in which the distortion caused by atmospheric turbulence is counteracted using statistics.

I looked high-speed videos of the gas giants to capture thousands of frames in just a few seconds, and averaged together only the least distorted frames with a program called Registax 6. I used a Meade 8" telescope, a 2x Barlow lens for additional magnification, and a 12 mm eyepiece to view Saturn and Jupiter. I held up an iPhone camera to the eyepiece to capture 240 fps video of each planet, and combined 500 frames for each planet. The figures below show the final images of the planets after post-processing.

I used VPython, a visualization package for the Python programming language, to generate the images to the right and below. The image on the right shows the Earth at the orbital distance of Rhea, Saturn's second largest moon. I wrote the program to automatically calculate and display the angular size of the planet in degrees, and found that if the Earth were orbiting Saturn at the distance of Rhea the planet would take up 29° in our sky. I wrote a similar program for Jupiter, showing the Earth at the orbital distance of Io, the innermost of Jupiter's four main moons. I found that the planet would take up about 20° in our sky. I calculated the field of view of the background images using the formula

\[
\alpha = 2 \arctan \left( \frac{d}{f} \right)
\]

where \(d\) is the size of the sensor in the direction measured and \(f\) is the focal length of the lens. For a 40 mm lens, the vertical field of view (the smaller side) is 33.4 degrees. Knowing this, I was able to superimpose my images of the planets over other photographs and size them relative to the field of view of the background.

The Moon

For millennia, humans have been enchanted by the Earth's natural satellite, crafting spiritual explanations for its existence, using its orbit as a method for keeping time, and attempting to understand the stories behind the craters and seas that cover its surface. The Moon remains one of the most important and astounding objects for amateur astronomers to observe, as so much of its detail is visible even through a small telescope.

I wanted to visualize what our sky would look like if the Moon were significantly closer to the Earth. I used the VPython package for the Python programming language to generate the following graphic, showing the Earth-Moon system to scale and calculating the Moon's angular size in the sky.

At this scale, the Moon is only about half a degree in diameter, and an observer can cover it up by holding their thumb in front of it at arm's length. I wrote my VPython program to allow the distance to the Moon to be continuously adjustable. The graphic below represents the same system, but if the Moon were 30 times less far away—that is, the distance from the Earth to the Moon was divided by a factor of 30. From this program I determined that, in my image, the Moon needed to be 30 degrees across.

I chose to use analog methods to create this image, choosing the component images on film, developing the film, and combining them using the traditional darkroom printing process, in which the negative is projected onto light-sensitive paper. Using multiple negatives for one print is known as "Combination Printing."

I photographed the Moon using a 35 mm Nikon film camera and Fuji Acros 100-speed film. With the 35 mm camera attached to the back of the telescope, the crescent moon took up almost the entire field of view of the image. I developed the film in Caffenol (a photo developer made from household products) and selected a background image shot at the Guilford lake. The negatives from this print were combined to produce the image on the left.

My process of combining the images began with outlining the image on a blank sheet of 11x14 paper. I used the formula for camera field of view to determine that a 50 mm lens on a 35 mm camera has a 27° field in the vertical direction. Using this information, I determined how large to print the Moon's angular size in the sky.

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