Activity 3 — TELESCOPE LAB

In this brief lab, students will use one of the MicroObservatory telescopes, built and maintained by the Harvard-Smithsonian Center for Astrophysics and located at the Whipple Observatory in Amado, Arizona to take a series of images of their "target" star. These images will form the basis of students' subsequent investigation.

SUGGESTIONS FOR LEADING THE LESSON.

Taking an image. Explain to students that they will control the robotic telescope remotely. They will select the target star and several observing times. At night, the telescope will automatically point to the star at the requested times and will take an image. The following morning, their images will be waiting for them in the Image Lab. The image will appear as pending until the telescope actually takes the photo during the night. NOTE: All times are Arizona time, where the telescopes are located.

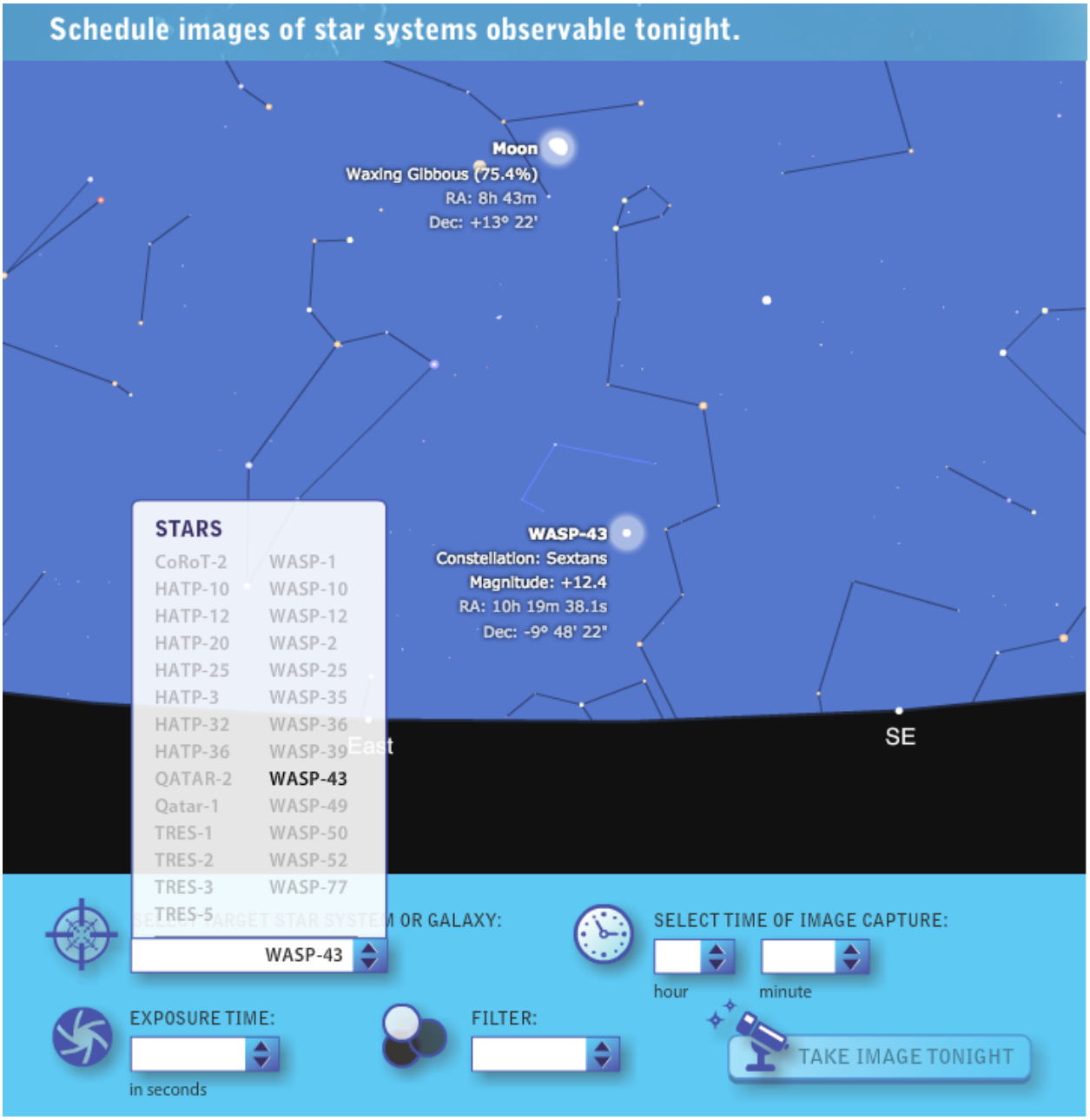
Planning and managing student image requests. A calendar of which exoplanet systems are available as telescope targets each night is downloadable on the Teacher page. While students can take as many or as few of the available images of the target star as they wish, you may wish to assign them to particular time slots, e.g. Students 1-5 request the first half hour of slots; Students 6-10 request the next half hour of slots, etc. That way, during the Image Lab you can more easily and efficiently have different groups of students take responsibility for measuring subsets of the data. Since a typical 4-5 hour transit run will have 80 to 100 images, another way to allocate images among students is to have them take every 8^{th} or 10^{th} image (e.g., assign student 1 the first telescope time slot, and then every 8^{th} slot after that; assign student 2 the second slot, and every 8^{th} slot after that, etc). *PLEASE NOTE: When YOU, the teacher, take just a single image using your class account, the ENTIRE set of images for the night will appear in your class image list in the Image Lab and be available to all students (just in case they forget to request an assigned observation ☺)*

Exposure time. Explain that each *exposure time* is automatically set to 60 seconds. This uniformity allows all students, in all schools, to share and compare data. (If the exposure times were allowed to differ, this would affect the measured brightness of the target star.)

Opaque filter. Explain that the telescope will automatically take a so-called "dark image" — i.e., an image using an opaque filter that lets no light through. This image will be used to help calibrate students' measurements. As we'll see, these images will *not* be completely black, because the telescope itself produces some electronic noise. (In a dark room, you can see flashes and floaters produced not by any light but by the "noise" in your eyes, retinas and brain.) This dark image will be waiting for each student with his or her other images.

ABOUT THE PLANETARIUM. The interactive planetarium shows a map of the sky as it looks right now at the Arizona telescope site. You can change the time to see how the sky would look at any other time. And you can scan the sky in any direction. (Use the arrow keys or click on the map and use the mouse.)

When you select a target star, the planetarium moves to the predicted location of the star for the beginning of the night's observing run. The planetarium is also useful for seeing whether the Moon might interfere with your measurements.



The target Exoplanet systems. Currently there are more than two dozen stars with recently discovered exoplanets orbiting them in the MicroObservatory target list. As scientists discover more of these systems that are observable from our telescopes in Arizona, the list will grow. While your students will be observing stars where orbiting planets have previously been discovered, each set of telescope data they collect will consist of brand new observations of that system *that have never been analyzed by anyone before*. The ExoLab curriculum focuses on engaging your students in the authentic data analysis procedures that the original discoverers used to determine the features of the observed exoplanet from the transit light curve. But the details of the transits that your students may (or may not) observe and analyze are NOT foregone conclusions. Depending upon the quality of the telescope data and the precision of your students' analysis, the light curves that they generate can yield discoveries on a number of fronts—from unexpected variation in the host or comparison stars, to detections of abnormalities in our telescope's CCD detector. The observations of many transits by many ExoLab classrooms over time even have the potential to contribute to discoveries of additional planets orbiting these stars!

BACKGROUND INFO. The MicroObservatory telescope, a reflecting telescope with a 6-inch mirror, is tiny compared to the world's largest telescopes, but it can see a billion light-years into space. This telescope magnifies only about 30 times, but its 6 inch "pupil" and CCD detector gathers about 500,000 times more light than your own eye can.

Demo images. Students may find images of stars to be visually boring (it's just a field a white dots). To enliven the class, and to give a feeling for the immensity of the universe, a sample of galaxy images are also available in the Demo Images list within Image Lab. Explain that the galaxies are huge collections of stars far beyond our own Milky Way galaxy. (We can't make out individual stars in these distant galaxies. All the stars we see with the telescope are within our own Milky Way galaxy.) Students can learn more about the MicroObservatory telescopes, and even use them to take their own images of non-exoplanet targets, at www.microobservatory.org.