

# Imaging the night sky

by Bob Riddle

As the ease and use of digital photography have increased due to the rising availability of smartphones and digital cameras, likewise, capturing images of the night sky and celestial objects has also become easier. Unlike their film-based predecessors, digital cameras provide immediate feedback after a picture is taken, as opposed to sending a roll of film to a lab or doing darkroom work before seeing results. With digital photography, corrections to exposure time, for example, can be made on the spot, and the photograph retaken right away using different settings. In addition, the increase in digital cameras' pixel capabilities brings their image resolution to near, matching, or better than the resolution of print film.

With a digital camera, students can relatively easily take pictures of the Moon at different phases and in conjunctions with planets or bright stars. Satellites orbiting overhead become visible as streaks of light in long-exposure pictures. Many of the constellation patterns contain stars bright enough to capture with a short time exposure. But taking an image of the sky or celestial objects, day or night, requires some planning, the right equipment, and an understanding of how to use a digital camera in manual mode.

## Equipment

Typical equipment for digital astrophotography obviously includes a digital camera, preferably one with manual settings for shutter speed, aperture, and ISO. My primary camera is an 18-megapixel digital single-lens reflect (DSLR), a digital version of a 35 mm single-lens reflex (SLR) camera. An advantage that a DSLR camera has over other digital cameras is the ability to change lenses or use filters, much like what is done with film-based SLRs. However, as long as manual settings are available on a camera, lens interchangeability is not as significant.

A sturdy tripod should be used, as many pictures require exposure times, or shutter speeds, of several seconds—even one second is too long to be able to hold a

camera steady. A cable release, which allows the shutter-release button to be “pressed” electronically rather than by finger touch, also minimizes the chances of taking a shaky picture. There are even some electronic shutter releases that have the capability to be set or programmed for taking a sequence of pictures at specified intervals. Without a cable release, the delay timer on the camera could be set for several seconds, which allows the shutter release to be manually pressed but the picture not taken for some seconds afterward, giving the camera time to stop shaking or at least minimizing camera shakes. This method takes some practice with the timing of moving objects, but for time exposures of the Moon or star patterns, it works quite well.

## Software

Many digital cameras come with a graphics-editing program, and there are also online and downloadable graphics programs available, so editing and making touch-ups to pictures should not pose a problem. Software programs that can pre-edit pictures could be used to introduce students to techniques commonly employed by astrophotographers. For example, the Startrails computer application (available at no cost; see Resources) allows photographers to stack or merge a series of pictures of the same part of the sky into one image that shows star trails (see Figure 1). The free DeepSkyStacker program (see Resources) takes a series of pictures of the same part of the sky and stacks them into the equivalent of a time exposure equal to the combined exposure times of all the pictures used. The resulting image looks as if it were taken using one long time exposure and shows star trails. Figure 2 was created using a series of pictures taken at regular intervals as the International Space Station (ISS) traveled across the constellation of Orion the Hunter.

## Planning

Deciding what to take a picture of and then knowing when and where to look is always a good starting

point. Two of my astrophotography pastimes are to capture a sequence of pictures showing the ISS as it orbits above the Midwest and to catch an Iridium flare. In order to photograph a moving object such as the International Space Station, the Hubble Space Telescope, or an Iridium satellite, I use a variety of resources to help me determine where and when to look. These include software on my tablet and desktop computer, as well as several websites, such as NASA's Spot the Station (see Resources for software and websites with sighting information).

One of the programs I use, ISS Detector, is available as a free or paid version from Amazon. The program is designed to graphically display the location of an Iridium flare or the path the ISS will follow, as well as other information about a flyover (see Figure 3). Using this information or similar data from online sources, I then use an astronomy program capable of simulating the flyover path or satellite location relative to the horizon. By comparing the simulated view with my various observing locations, I know how to position my camera and tripod. Once everything is set, I take a series of test pictures, looking for the right combination of camera settings.

### Camera controls

Taking pictures with a digital camera, regardless of the time of day or night, requires some familiarity with the camera. Astrophotographers need even more knowledge, because the camera should be used in manual mode to allow more control over how it captures an image. Becoming proficient in digital astrophotography means becoming familiar with three important camera settings: ISO or ASA, aperture, and shutter speed (or exposure time). Each of these has a direct impact on the other two.

ISO and ASA refer to the International Organization for Standardization and American National Standards Institute (formerly the American Standards Association), respectively, organizations that have developed standards for the sensitivity of either print film or the sensor in a digital camera. On older print film cam-

**FIGURE 1**

Star trails created using the Startrails software



eras, film is purchased by the film speed, or its ASA/ISO number, and then the camera is set to match the film speed. With digital cameras, one may adjust the ISO setting, in effect replicating the different speeds available in print film. The typical automatic ISO setting in a digital camera is 100, with a higher number indicating greater sensitivity. When the sensitivity is increased, more light is collected by the camera, thus allowing for a slower shutter speed or a reduction in the aperture size. One drawback to increasing the ISO setting value is that pictures become grainier; at lower ISO settings, pictures appear sharper. For pictures with darker backgrounds of satellites and star patterns, the image quality does not appear to be affected when high ISO settings are used.

The aperture setting adjusts the amount of light that can pass into the camera system. Think of it as an opening that can be partially to fully open. Numerical values for aperture settings are prefaced with the letter *f* and typically referred to as *f-stops*. The lower the *f-stop* number, the greater the opening and the amount of light the camera sensor receives. Changing the *f-stop* also has an interesting and more obvious effect on daylight pictures in that changing the aperture alters the depth of field. Lower *f-stops* will cause the background to be less in focus than the central part of the picture, while higher *f-stop* values result in the entire scene being in focus.

The shutter speed, or exposure time, is the amount

**FIGURE 2**

Ten stacked pictures and the International Space Station's path across Orion



of time the shutter is left open. The longer the shutter is open, the more time there will be for the camera to collect light. Brighter objects need relatively short exposure times, or fast shutter speeds, while dimmer objects would need a longer exposure time, or a slower shutter speed.

### Camera targets

There are many easily photographed objects in the night sky that could be captured with a digital camera. Pictures of bright objects such as the Moon at sunrise or sunset can usually be taken without a tripod and present opportunities for composing scenic pictures of the Moon and the horizon below. Check the monthly calendar in this column, as often there will

be a conjunction between the Moon and a bright planet such as Venus or Jupiter. Star patterns forming a constellation or an asterism such as the Big Dipper are made up of stars bright enough to capture with the camera on a tripod, set to a shutter speed of a few seconds, and with a high ISO setting.

Taking pictures of a moving object such as the International Space Station requires mounting the camera on a tripod so that the camera is aimed toward where the ISS will be the highest above the horizon. Make adjustments to the camera settings for a shutter speed of anywhere from two to six seconds, along with whatever f-stop and ISO settings take the best picture of the stars in the background. Watch for the ISS and, as it traverses your camera's field of view, take as many pictures as possible

starting with the seconds before its calculated appearance above the horizon. With a several-second shutter speed, the ISS will appear as a bright line. With some planning and, of course, luck, there may be times when the ISS path takes it past an interesting part of the sky (see Figure 2).

Another interesting set of objects to capture in a picture are Iridium communication satellites, a series of solar-powered satellites that orbit the Earth in very regular orbital paths. As with the ISS and other satellites, this means that the position of an Iridium satellite and the angle of its solar panels may be calculated for any part of the Earth over which the satellite orbits. When the solar panels are angled toward your location on the Earth, they reflect sunlight, the amount of which is determined by the angle of

the panels. And if the angle is the correct angle, the sudden increase in reflected light from the satellite may become as bright as a full Moon, although more typically it is a few times brighter than Venus. These events are called *Iridium flares*, and capturing one requires careful timing. My method is to start hitting the shutter release button about 30 seconds before the calculated time and keep doing so until after the Iridium flare fades from view.

Because the Earth continually rotates and celestial objects move in apparent paths across the sky, there is a time limit for shutter-speed length. Stars will appear as lines of varying brightness called *star trails* in a picture taken with a long shutter speed. ■

## Visible planets

**Mercury** will start the month visible over the western horizon, setting after sunset, but will move into inferior conjunction at mid-month.

**Venus** will be very visible above the eastern horizon at sunrise.

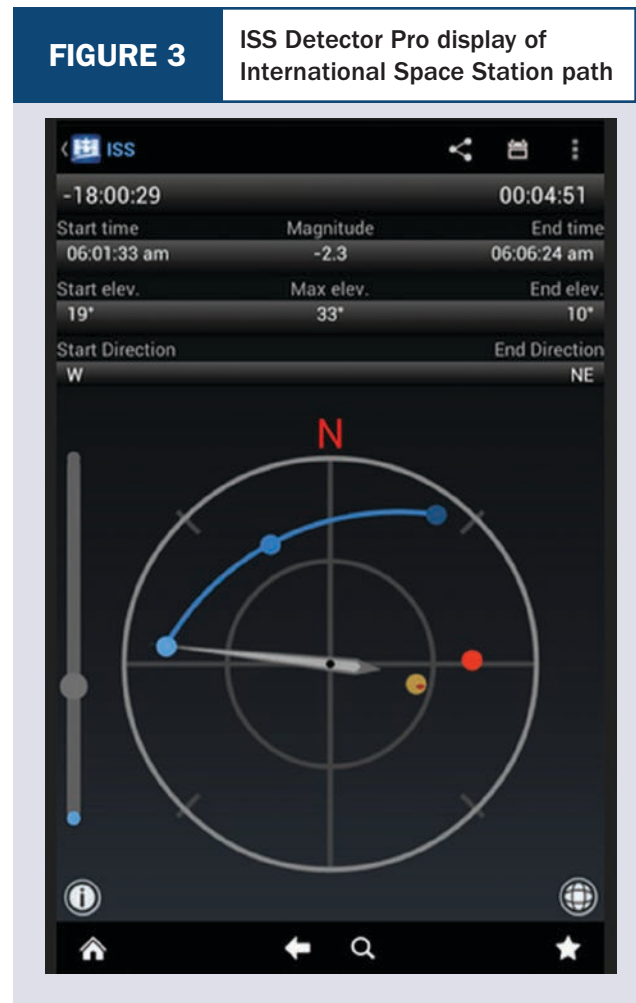
**Mars** will rise at around midnight local time and by sunrise will be over the southern horizon.

**Jupiter** will rise after sunset local time and will be visible all night, setting just before sunrise.

**Saturn** will rise a few hours before the Sun and will be visible over the southeastern horizon at sunset.

## February

- 2 Mars near Spica  
*Cassini* flyby of Titan
- 3 Mercury at perihelion
- 6 First quarter Moon
- 8 Waxing gibbous Moon near Aldebaran
- 11 Waxing gibbous Moon near Jupiter  
Moon at apogee: 406,232 km (252,421 mi.)
- 14 Full Moon
- 15 Waning gibbous Moon near Regulus  
Mercury at inferior conjunction  
Martian summer solstice
- 19 Waning gibbous Moon near Mars and Spica



- 21 Waning gibbous Moon near Saturn
- 22 Last quarter Moon
- 23 Neptune in conjunction with Sun
- 25–26 Waning crescent Moon near Venus
- 27 Moon at perigee: 360,439 km (223,966 mi.)  
Thin waning crescent Moon near Mercury

## Resources

### Image-editing software

DeepSkyStacker—<http://deepskystacker.free.fr/english>  
Startrails—[www.startrails.de/html/software.html](http://www.startrails.de/html/software.html)

### Sighting information

Heavens Above—<http://heavens-above.com>  
ISS Detector (search for “ISS Detector”)—[www.amazon.com](http://www.amazon.com)

## For students

1. What camera settings would work best for a picture of the full Moon?
2. How long can the shutter speed, or exposure time, be without showing star trails?
3. Take a star trail picture of the Big and Little Dippers to demonstrate Earth rotation.

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Satview—[www.satview.org](http://www.satview.org)

Spot the Station—<http://spotthestation.nasa.gov/home.cfm>

## Other resources

Cassini mission—<http://saturn.jpl.nasa.gov>

Iridium Everywhere—[www.iridium.com/](http://www.iridium.com/)

ISS and Iridium flares (pictures of satellites)—<http://bobs-spaces.net/comets/sky-shots/iss-and-iridium-flares>

Sky pictures by NSTA member Rob Sparks—[www.flickr.com/photos/halfastro](http://www.flickr.com/photos/halfastro)

Stephen F. Austin State University star charts—<http://observe.phy.sfasu.edu/SFAStarCharts/PDFCharts/SFAStarCharts.zip>

**Bob Riddle** ([bob-riddle@currentsky.com](mailto:bob-riddle@currentsky.com)) is a science educator in Lee's Summit, Missouri. Visit his astronomy website at [www.currentsky.com](http://www.currentsky.com).