How to pick a camera for astroimaging

Sky-shooting has never been easier. Stunning results may be just a click away with off-the-shelf digital SLRs. **by Michael A. Covington**

Once upon a time, photographers who wanted to capture the sky used the same basic equipment for everything: a 35mm film single-lens reflex (SLR) camera. What it did well, we did well. What it did poorly, we did poorly. But those days are no more. Today, amateur astroimagers have a wide range of imaging devices to choose from. Each has its strengths and weaknesses.

Camera basics

All modern cameras use electronic image sensors. It no longer matters whether the sensor is CCD (charge-coupled device) or CMOS (complementary metal-oxide semiconductor); after years of competition, the two technologies perform much alike. Either way, you get an array of tiny photocells, called pixels, and the circuitry to control the exposure and read out the image. The number of pixels can range from 640×480 for tiny planet images to millions of pixels (megapixels) for star-studded deep-sky shots.

Some sensors produce color images while others are monochrome. The color sensors use a "Bayer matrix" (pronounced BY-er), in which alternate pixels are filtered red, green, and blue. A computer interpolates the information to smooth the image. Monochrome sensors yield sharper images, but creating color photos becomes more awkward — you have to take red, green, and blue exposures through separate filters and then combine them in a computer.

You should ask yourself two more practical questions before choosing a camera: Can you use it for daytime photography, and can you use it for astroimaging without connecting a computer? The answer to both questions is "yes" for digital single-lens reflex (DSLR) cameras and "no" for most other astrocameras.

DSLR cameras

Manufacturers build DSLR cameras like film SLRs. Both have a mirror, a focusing screen, and a viewfinder that lets you view and focus through the lens optically whether the camera is turned on or not. DSLRs are cost-effective and easy to use, and you can take daytime photos with them. They work well for deep-sky imaging — especially for wide-field shots when the camera "piggybacks" on a telescope — and are ideal for full-face shots of the Moon, the Sun, and lunar and solar eclipses. What I like most about DSLRs is that I don't have to bring a computer along, although you can computer-control a DSLR if you prefer.

Choose a DSLR carefully because you'll have to live with it a long time — you can't simply change brands of film. For instance, many Nikon cameras have a built-in noise removal algorithm that tends to "eat" tiny star images, and you can't turn it off. Many DSLR brands have controls that astroimagers will find hard to use, with too many buttons to press or, conversely, lacking a button that does what you need.

For these and other reasons, many astroimagers prefer Canon EOS DSLRs. Canons produce good astronomical images and have controls well suited for the job. Canon has shown a continuing commitment to astronomy. At one time, they even made a special astronomical DSLR, the EOS 20Da, and their later EOS 40D and 50D models have features requested by astroimagers. Thanks to the compact size of the camera body, Canon EOS cameras also can accept Nikon, Pentax, and other lenses using adapters.

If you're deeply into Nikon gear, you might also consider Fuji DSLRs, which are built around Nikon bodies but optimized for scientific photography.

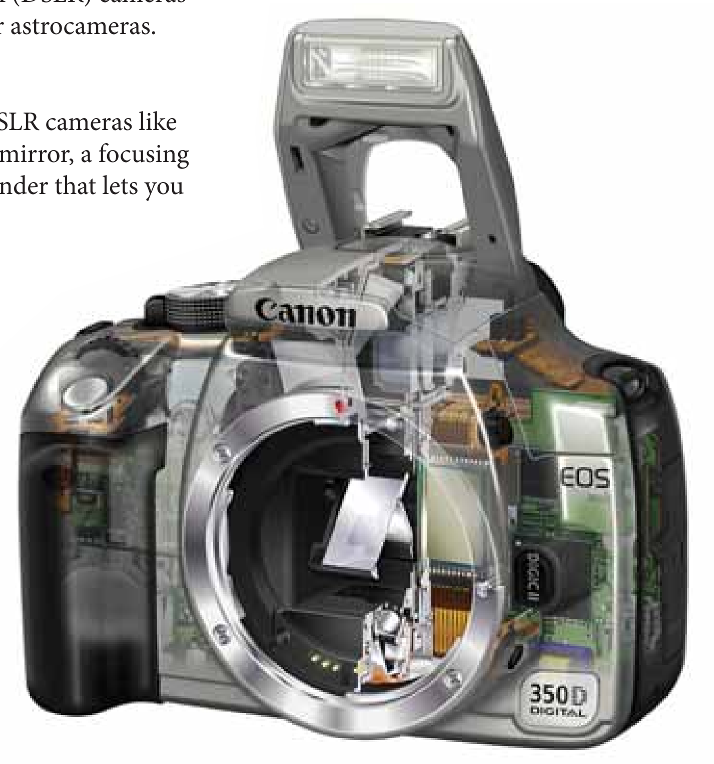
What DSLR features do you need? You'll want a camera with live focusing ("Live View" in Canon-speak). This means you can focus by viewing, on the camera's display screen, a greatly enlarged portion of the image actually falling on the sensor. It's by far the best way to focus on stars. (Autofocus is useless; an autofocuser can't even see stars most of the time.) And on many DSLRs, live focusing lets you start an exposure electronically, which means no shutter movement and thus no vibration.

Vital DSLR accessories include a cable release (preferably one with a built-in timer) and spare batteries. Batteries run down quickly on chilly nights; keep the spares in your pocket so they'll stay warm.

Don't get hung up on a huge number of megapixels or a large sensor. Extra megapixels don't necessarily help. Fewer pixels will be larger, more sensitive to light, and less subject to noise caused by stray electrons. And there is nothing sacrosanct about a "full-size" sensor that matches a 35mm film frame. In fact, such sensors are bigger than an eyepiece tube, and the more common 15x22mm sensor actually fits telescopes better.

If you want to photograph emission nebulae, you should know that DSLRs do not record deep-red light well. And such nebulae emit much of their radiation in the deep red, at a wavelength of 656 nanometers. Inherently, DSLR sensors are sensitive to red light, but manufacturers include an infrared-blocking filter so that daytime color photographs look realistic. Serious astroimagers often pay to have this filter replaced with one that transmits deep-red light. Because this modification makes the camera less suited for daytime photography and it only affects hydrogen nebulae (not stars

Canon's Digital Rebel introduced many astrophotographers to the wonders of digital imaging. Canon U.S.A.



A cutaway view shows the inner workings of an early Digital Rebel. The EOS 350D (Digital Rebel XT) model came out in early 2005. Canon U.S.A.

The North America Nebula (NGC 7000) stands out amid a panorama of star clouds in the northern Milky Way. The author took this photo with a Canon Digital Rebel and Sigma 105mm lens at f/4.5, piggybacked on an 8-inch SCT. Michael A. Covington

Longtime astrophotographer **Michael A. Covington** *is senior research scientist and associate director of the Institute for Artificial Intelligence at the University of Georgia.*

Jupiter's banded atmosphere shows plenty of detail in this image, which the author took through an 8-inch SCT and a 3x Barlow. He recorded 2,000 video frames with a modified webcam, then aligned, stacked, and sharpened them with *Registax*. Michael A. Covington

Live focusing lets you focus on an enlarged portion of the image that falls on the camera's CCD sensor. Nikolai Sorokin/Dreamstime.com

or galaxies), many astrophotographers, myself included, choose not to do it.

What about lenses? A zoom lens that typically comes with a camera is generally too slow because of its small aperture and not sharp enough for astroimaging. Instead, consider a 50mm f/1.8 lens, the lens that was standard on film SLRs. Such lenses are sharp, fast, and inexpensive.

If you plan to try piggybacking, you'll also want other non-zoom telephoto lenses. Better yet, get a lens mount adapter so you can use Nikon, Pentax, Zeiss, or another telephoto lens on your Canon DSLR. Don't worry about being unable to autofocus through an adapter because you should always manually focus astroimages anyway.

Astronomical CCD cameras

Cooled CCD astrocameras have long been a mainstay for serious deep-sky photographers, or at least for well-heeled amateurs, and those who work at observatories. Such cameras have come down in price to the point where manufacturers are mass-producing suitable sensors for DSLRs and high-end video equipment. Thermoelectric cooling reduces electronic noise, which lets you record fainter objects. Leading makers of these cameras include Apogee, SBIG, Meade, and Orion.

Using a CCD astrocamera requires connecting it to a computer and power source, so you'll need a laptop with suitable software and a red filter for the screen to preserve your dark adaptation. Compared to a DSLR, images from a CCD astrocamera are better but require much more effort.

Video imagers

For imaging planets, you'll want an astronomical video camera. Let the camera record thousands of video frames and then have software select and combine the sharpest frames.

Video astronomy started with modified webcams. Amateurs simply took the lens off a cheap webcam and fit an eyepiece tube adapter in its place. Today, webcams have been replaced by the Meade Lunar and Planetary Imager, Orion planetary cameras, and higher-end cameras from Imaging Source, Lumenera, and others.

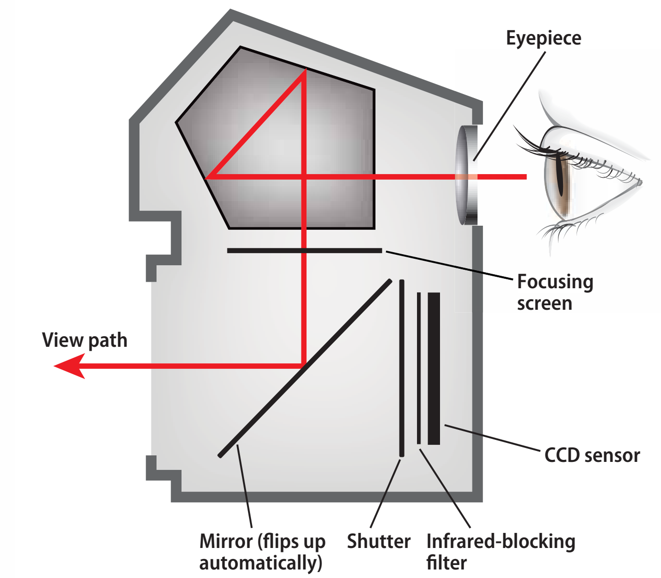
You can choose from color imagers (best for fast-rotating planets such as Jupiter) and monochrome cameras that require you to use a red-green-blue filter wheel to get color shots. A video astrocamera also can double as an autoguider to watch a star and transmit corrections to your telescope while you photograph deep-sky objects with a different camera. Like CCD astrocameras, astronomical video cameras require a connected computer. Some also will take still pictures up to a few minutes long, giving you a taste of deep-sky imaging.

Non-DSLR digital cameras

Astroimagers shy away from typical point-and-shoot digital cameras. Even cameras with the same number of megapixels have smaller, less-sensitive sensors. Aimed directly into a telescope's eyepiece, however, they can capture nice images of the Moon's full face without the vibration from an SLR's mirror and shutter.

Non-DSLR cameras can take nice astroimages and excel at shots of the Moon's face. Nikon, Inc.

Canon's EOS 50D model, which came out in 2008, has many of the features astroimagers crave. It has become a favorite of those who like to capture the sky. Canon U.S.A.



The guts of a digital SLR are quite simple. A CCD sensor records light much like film. One difference is the infrared-blocking filter, which helps make daytime color photos look realistic. *Astronomy*: Roen Kelly, after Michael A. Covington

On the horizon are interchangeable-lens, DSLR-like cameras with no mirrors. They will rely entirely on electronic viewing screens. These "mirrorless DSLRs" may replace conventional DSLRs because they are lighter and produce less vibration.

The death of film?

It may surprise you to learn that film isn't dead. In fact, good film equipment has never been cheaper, and Kodak still makes and recently improved the best color films ever, Elite Chrome 100 and 200. Be forewarned that at the same ISO speed, film picks up less light in a 5-minute exposure than a DSLR does in 2 minutes. This is one reason digital sensors have taken over.

Although a film camera and lens may cost only $20, you'll spend another $20 to acquire and process each roll of film. Processing is still available from E-Six Lab in Atlanta (www.e-sixlab.com), and they'll scan your images to digital format so you can adjust and enhance them with Adobe *Photoshop*® just as if they had come from a DSLR. So, if you've always wanted to try film astrophotography, do it now. No one knows how much longer you'll be able to do so.

This is part one of Michael Covington's imaging series. He will look at camera-on-tripod imaging in a future issue.

A colorful Moon greeted observers of the October 27, 2004, total lunar eclipse. The author snapped this image with a Nikon Coolpix 990 compact digital camera mounted on a bracket and aimed into the 25mm eyepiece of a 5-inch f/10 telescope. Michael A. Covington