Chapter 14

Astroimaging

The subject of *astroimaging* is a popular and fascinating one—but also one that is vast and in many aspects technically complex. Springer itself has published a number of entire volumes on the topic, several of which are referenced in this chapter. Here we provide mainly an overview of this modern instrumentation of interest to backyard observers, along with some general comments about various techniques used. Those wishing to go deeper into the subject should consult one or more of the references given below.

Astrophotography

Astrophotography has always been a major part of amateur astronomy. Indeed, many "stargazers" hardly ever actually look at the sky through their telescopes, using them only as glorified "telephoto lenses." The major change in imaging today has been that conventional film photography of the heavens is all but extinct—both at professional observatories and with amateur instruments. This is due to the amazing new electronic and digital imaging technology (especially affordable charged-coupled-devices or "CCD" imagers) that make possible taking ultra-short exposures in rapid succession ready to view and/or process instantly on computer monitors. Indeed, amateur astronomers today are routinely taking pictures of celestial objects that rival those of the major observatories!

J. Mullaney, *A Buyer's and User's Guide to Astronomical Telescopes and Binoculars*, The Patrick Moore Practical Astronomy Series, DOI 10.1007/978-1-4614-8733-3_14,

But first, however, the author would like to offer a word of advice to readers. If you are new to astronomy, before plunging into astroimaging of whatever type, spend the better part of a year *seeing the real sky*—the wonders of all four seasons—with your own eyes (and preferably also with binoculars and/or a telescope as well) rather than that of a camera! No photograph however spectacular it may be can match the impact of seeing the "real thing" in person. To experience this for yourself, just compare an image of Saturn from the Hubble Space Telescope to the "live" view in even the smallest of telescopes. The former appears "flat" while the latter looks like some exquisite tiny piece of cosmic jewelry suspended three-dimensionally in space! (And in this regard, see the discussion concerning the "photon connection" in Chap. 16.)

Conventional Film Astrocameras

Astrocameras come in many different types and varieties, ranging from common 35 mm film cameras riding piggyback on telescopes for wide-angle shots of the sky to special cameras designed for prime-focus or eyepiece-projection photography through the telescope itself. (Unitron in its early days offered a superb astrocamera for these latter forms, which can still occasionally be found on the used market.) Conventional astrophotography can be very rewarding given lots of patience and practice shooting many rolls of film to get a good picture! While some amateur astronomers today are still routinely taking spectacular color images of celestial targets this traditional way, film photography has rapidly declined in favor of CCD and video imaging (see below). A plethora of practical guides covering both conventional and electronic astroimaging are available for the amateur astronomer. Some of these resources are listed below while others can be found in the advertisements in *Sky & Telescope* magazine.

Pricing for astrocameras themselves employed for sky-shooting (film or electronic) is about the same as for ones used in conventional terrestrial photography, since they are essentially the same piece of equipment. (Such is the imaging craze today that some hobbyists are even using the cameras in their iPhones and those tiny eyeball-looking security web-cams to take pictures of the Moon and brighter planets! As would be expected, however, the image quality leaves something to be desired.) (Figs. 14.1 and 14.2)

Digital and Video Astrophotography

The widespread availability and use of *DSLR* (Digital Single-Lens Reflex) *Cameras* has revolutionized astrophotography by amateur astronomers, both for shooting the sky with attached telephoto lenses or connected to telescopes. (Two very helpful Springer publications here are *Digital Astrophotography* by David Ratledge, and *How to Photograph the Moon and Planets with Your Digital Camera* by Tony

Fig. 14.1 Electronic eyepiece cameras (both black & white, and color) like that seen here make video imaging easy and affordable today. The camera output can be displayed in real time on a monitor, or recorded on a VCR or camcorder for viewing later. Courtesy of Orion Telescopes & Binoculars

Fig. 14.2 An excellent and inexpensive little color imager designed for shooting the Moon and planets in sharp detail. Its nosepiece fits into standard eyepiece focuser drawtubes and displays its output on any PC. Courtesy of Orion Telescopes & Binoculars

Fig. 14.3 Shown here is a CCD color imaging camera attached to the focuser of a Newtonian reflector. This one is intended primarily for use on deep-sky objects while other models are available for imaging solar system targets like the Moon and planets. In either case, the output is fed into a PC for viewing and processing. These state-of-the-art devices make it possible for amateur astronomers to routinely take pictures rivaling those of the professional observatories! Courtesy of Orion Telescopes & Binoculars

Buick.) One of the many advantages of these is being able to view what's taken immediately. *Video* and *CCD Imagers* are also part of this revolution in the form of eyepiece video and full-fledged CCD cameras to "photograph" the heavens through telescopes. As already mentioned, CCD imaging in particular has virtually replaced conventional film photography at most of the world's major research observatories today due to its immensely faster speed (or "quantum efficiency") and dynamic range (levels of brightness). There's also the fact that the images collected can be immediately viewed—and processed later electronically using sophisticated computer software. Exposure times of minutes or even seconds routinely show striking images of what previously took hours employing the fastest films! And these devices have now become widely used by amateur astronomers as well. One comprehensive Springer publication on the subject is *The Art and Science of CCD Astronomy* edited by David Ratledge. Another helpful volume is *Electronic Imaging in Astronomy* by Ian McLean (Fig. 14.3).

Meade Instruments (www.meade.com/) years ago pioneered an affordable CCD imaging system for their telescopes in the form of the very popular and easy-to-use "Deep-Sky Imager" with "Auto Star Suite" processing software. It sold for just $300 and promised successful images the first night out! While this product is no

longer available, its introduction to the amateur astronomy market motivated others companies to enter the imaging field and many have done so since that time. This includes not only telescope manufacturers themselves, but also firms specializing in both imaging hardware and software. Again, see the ads in astronomy magazines like *Sky & Telescope*.

Among these has been Orion Telescopes & Binoculars (www.oriontelescopes.com). Its current offerings include a series of "StarShoot" video imaging cameras that display real-time pictures from the telescope directly onto a TV screen or computer monitor beginning at only $60 and ranging up to $500 for their sophisticated Deep Space Video Camera. Another is Celestron (www.celestron.com), which offers an affordable NextImage 5 Solar System Video Imager for $200 and their sophisticated CCD imaging camera series called "NightScape" starts at $1,500. More expensive, professional-level CCD cameras are also available from Finger Lakes Instrumentation (www.flicamera.com), Santa Barbara Instrument Group (www.sbig.com), Apogee Imaging System (www.ccd.com), and Quantum Scientific Imaging (www.qsimaging.com) among others. Here again, consult the advertisements in *Sky & Telescope* for these and other sources, including companies specializing in image-processing software. Willmann-Bell (www.willbell.com) publishes an excellent selection of books on this subject, ranging from introductory to advanced level.

Here are some additional facts worth knowing. Video cameras are best for imaging the Moon and planets where high resolution is desired. They make possible shooting many hundreds of frames during which at least some of them will capture rare moments of good seeing (steady atmospheric conditions). Accompanying computer software then selects and combines (or "stacks") the best of them into razor-sharp images. In the case of CCD imagers, most are monochrome (black and white), color being achieved by shooting through various color filters and then combining them using computer software. Also, to reduce "noise" in the system, most of the high-end CCD imagers are cooled with built-in fans. These are a bit expensive, with prices typically starting around $500 for the camera itself and another $500 for the filters (Fig. 14.4).

A valuable Internet site where anyone can communicate with fellow "video astronomers" worldwide is www.nightskiesnetwork.com. Here you can watch the viewing sessions of other observers in real time or even broadcast your own there for others to see. The still images posted to the site will also give you a good idea of what's possible using various types of equipment.

As we'll learn in the next chapter, the above electronic marvels have made it possible for amateur astronomers to do professional-level work—in fact, to actually join ranks with professional astronomers in cooperative research programs conducted from their own backyards.

And as an example of the sophistication of some imaging setups in the hands of "amateurs" today, see the amazing instrument cluster shown in Fig. 16.2 in the final chapter of this book. It consists of a 16-in. Cassegrain reflector with a multi-color photoelectric photometer attached, together with an 8-in. Schmidt-Cassegrain equipped for electronic CCD imaging and a 4-in. refractor for automated guiding riding "piggyback" on it! Such an optical assembly as this would have been the envy

Fig. 14.4 This sophisticated color video camera allows viewing the brighter deep-sky wonders in real-time on a TV, or to view and capture images directly onto a PC or laptop for further processing. Courtesy of Orion Telescopes & Binoculars

of any professional astronomer just a few generations ago. Indeed, the associated electronics didn't even exist back then!

Remote Imaging and Telescope Control

The bane of both amateur and professional astronomy is cloudy nights. (The author is found of saying at lecture presentations that "clouds follow astronomers around wherever they go." And based on the number of times over the years that overcast skies have spoiled planned telescope viewing following the formal programs, it definitely appears to be true!) But it's always dark and clear somewhere on the planet! And thanks to both the imaging and computer revolutions, it's now possible for amateur astronomers to rent telescope time at various facilities around the globe and operate these instruments "live" in real time using home computers and the Internet.

There are currently more than half a dozen providers of this amazing service and others are surely to follow in the future. Pioneering this field in 2002 and best-known is *SLOOH* (www.slooh.com), which operates telescopes in the Canary Islands and Chile. Slooh sets itself apart from most other scopes-for-hire companies in that it doesn't charge per viewing session. Rather, observers pay a flat fee for unlimited use—$60 for 3 months or $250 for up to 2 years. Another provider is *iTelescope* (www.itelescope.net), which operates automated instruments in New Mexico, Spain and Australia. The availability of these various services means that in addition to (or instead of) using your personal telescope to conduct professional-level astronomical research, you can now observe with world-class telescopes located in pristine, clear sites from the comfort of your own home!