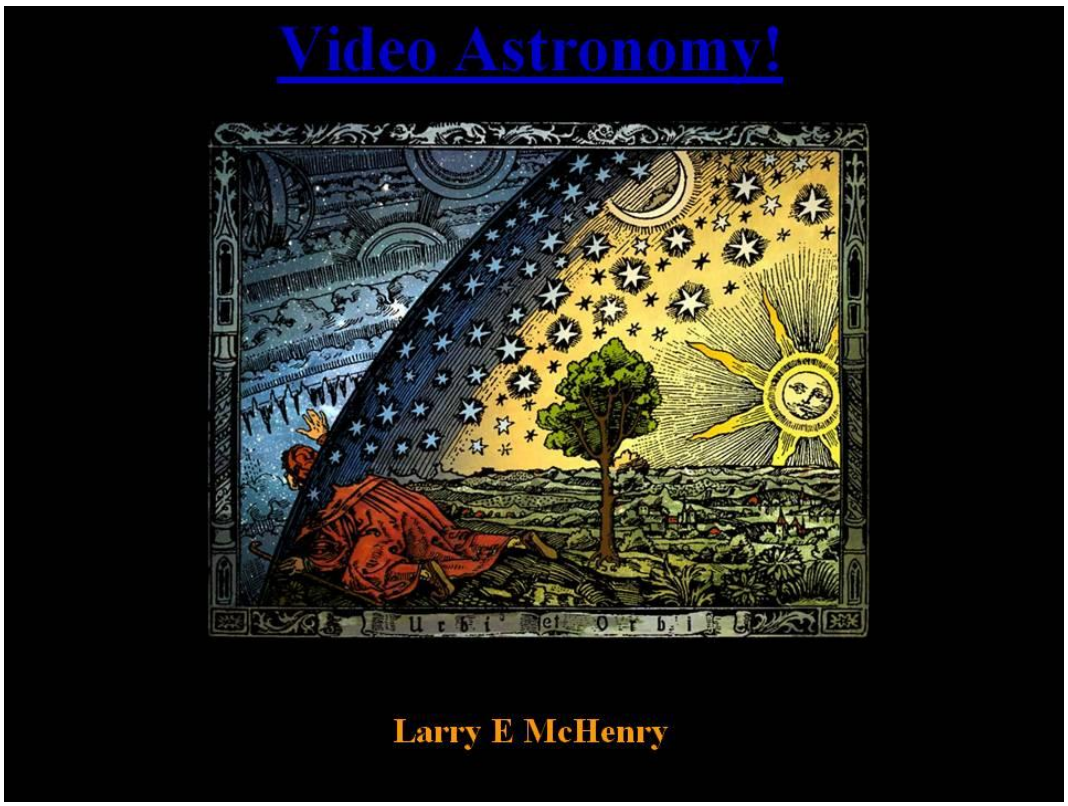
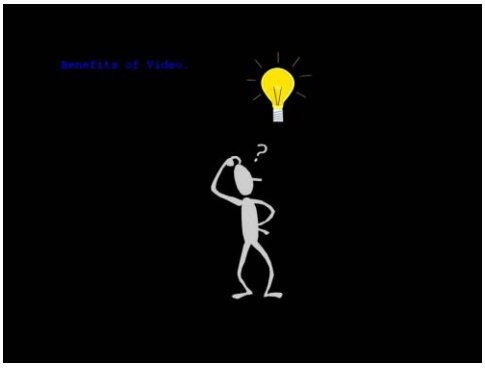


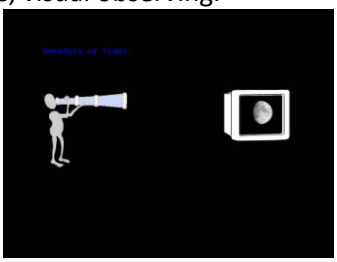
Good Afternoon. Today we are going to review an introduction to video astronomy.
It's the first clear night of Summer, a young waxing Moon shines in the Western sky.
The planets Jupiter and Saturn appear brilliant to the naked-eye.
The Milky-Way flows overhead, Messier objects appear to the naked-eye.
Your telescope hops from one spectacular solar system or deep-sky view to the next.
You would love to somehow capture this evening. . . .

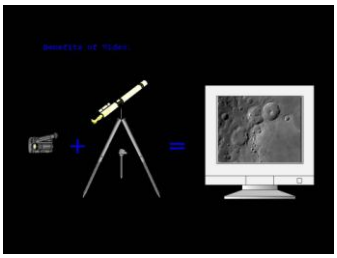
And you can,,,,,,, by Video Astronomy!!!



So, what are the benefits of using video?
It allows you to observe in comfort and reduces eyestrain. Eliminates problems with Floaters.
Great for group observing and sharing astronomy with friends or those with handicap challenges.
It allows you to manipulate images in real-time, via your monitor's brightness and contrast controls.
Displays deep-sky images in breath-taking detail not observable visually through the same telescope.

Most video cameras capture and display about 30 images every second.
This short exposure time of video tends to overcome many of the rippling and churning effects of our atmosphere. Video mimics the capability of the human eye-brain combination to cope with the effects of atmospheric turbulence. It can actually increase your visual acuity, particularly in older observers! Viewing images on a monitor can allow more detail to be seen when observing the Moon, Sun, Planets and Deep-Sky, as opposed to direct, thru the eyepiece, visual observing.





Most people already have the basic video equipment needed to get started. *(camcorder, DVR, and small TV).*
If the camcorder is small and light enough, it can be mounted directly to the telescope. The image can then be either recorded directly by the camcorder or output to a DVR or computer. Add a TV or Monitor for real-time viewing. More advanced video equipment would consist of a security type of video camera or webcam that can be attached to the telescope replacing the eyepiece.

Now, we're going to briefly run thru a short list of equipment needed for video Astronomy: Telescopes, cameras, monitors, and computers.

Telescopes:
Video cameras can be used with any type of telescope. (refractors, reflectors, SCT's , dobs, even finder scopes). The telescope can on an alt-az mount, polar aligned, or GOTO. Since video at the prime focus of a telescope will result in very high magnifications, an equatorial mount driven electronically with a hand controller for adjustments is preferable. You will also need an accurately aligned finder scope with crosshairs, or a flip-mirror to help in finding and centering the object. You will want a Barlow for increasing the image scale of the planets, and a focal reducer for use on wide-field deep-sky objects. And finally, filters to enhance faint surface detail.
Below are several examples of a video-astronomy setup using a video camera at the prime focus of the telescope, replacing the eyepiece.

The video image can then be fed into a DVR recording device, or directly into a computer for image capture, or straight to a monitor for visual observing.
Your camera will need to have an eyepiece adapter to fit your telescope's drawtube or diagonal.

Cameras:

Many people are getting good results from home-made astro video cameras. These are usually made from home security type cameras. Security camera features to look for are removable lens which allows the camera to be used at a telescope's prime focus, low lux numbers, high resolution, and manual shutter speed and gain control.

Being able to manually control the cameras shutter speed and gain is quite useful. Camera's that have these as auto-features can suffer from overexposed images from large bright objects, like the Moon or Sun which fills the image frame, or smaller very bright objects like Jupiter and Saturn where there's too large amount of dark sky surrounding the planet, both of which tends to swamp the auto shutter speed and burn out the object's image. By being able to manually adjust these camera settings, you can control the amount of incoming light and bring out low contrast planetary features.

Having a color camera is nice, and the color Mallicams give great views of bright objects in their natural color. But generally, Black & White cameras may be more preferable because they have better resolution, contrast, and light-sensitivity on small low-surface brightness objects than color cameras.

Resolution *(which is referred to as TV line resolution)* is the ability of the camera to record and display fine detail in an image. The higher the number, the more fine planetary detail that will be visible.

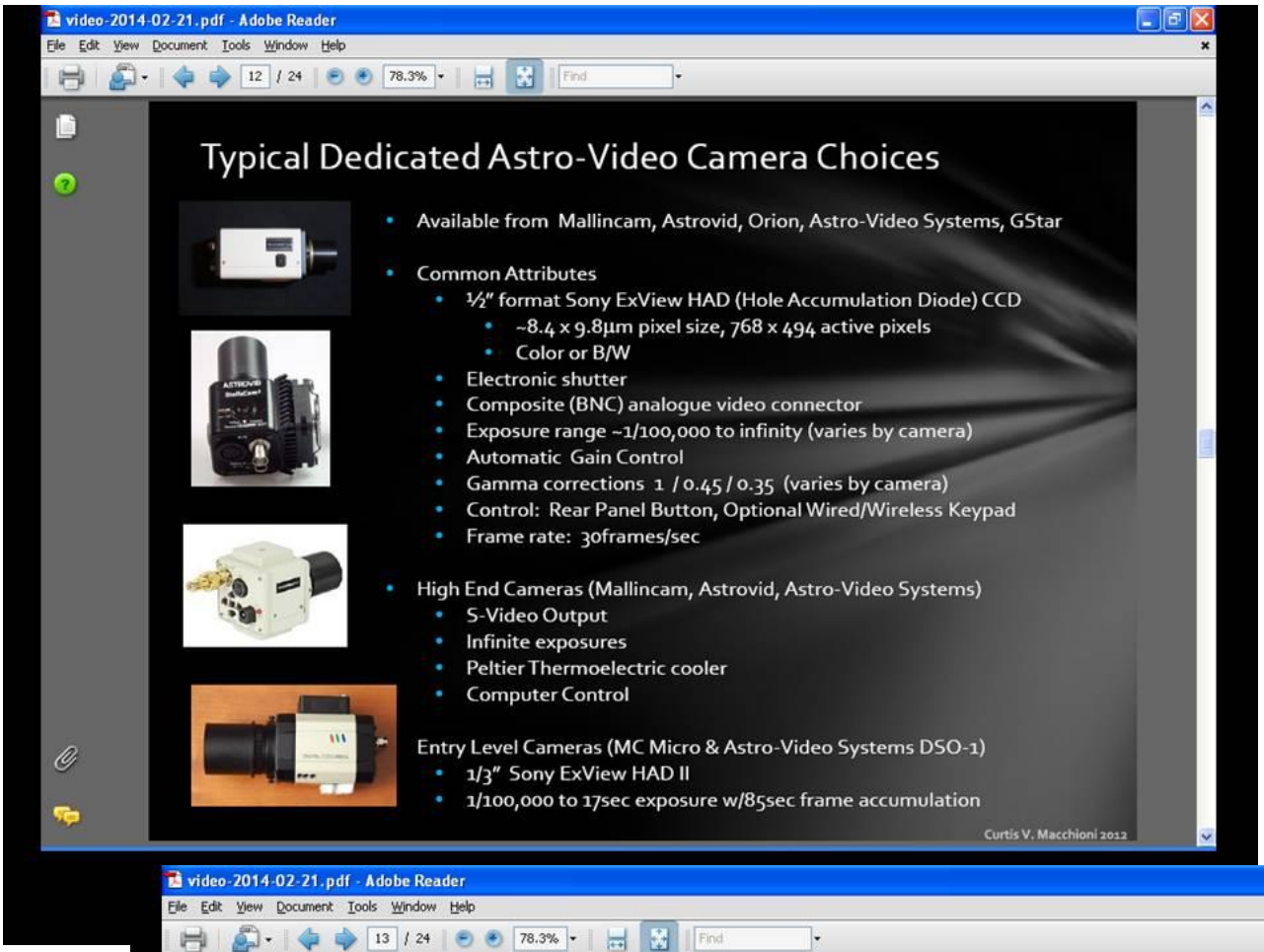
Look for a line resolution of 600 and higher**.** The StellaCam camera line is known for their fine resolution.

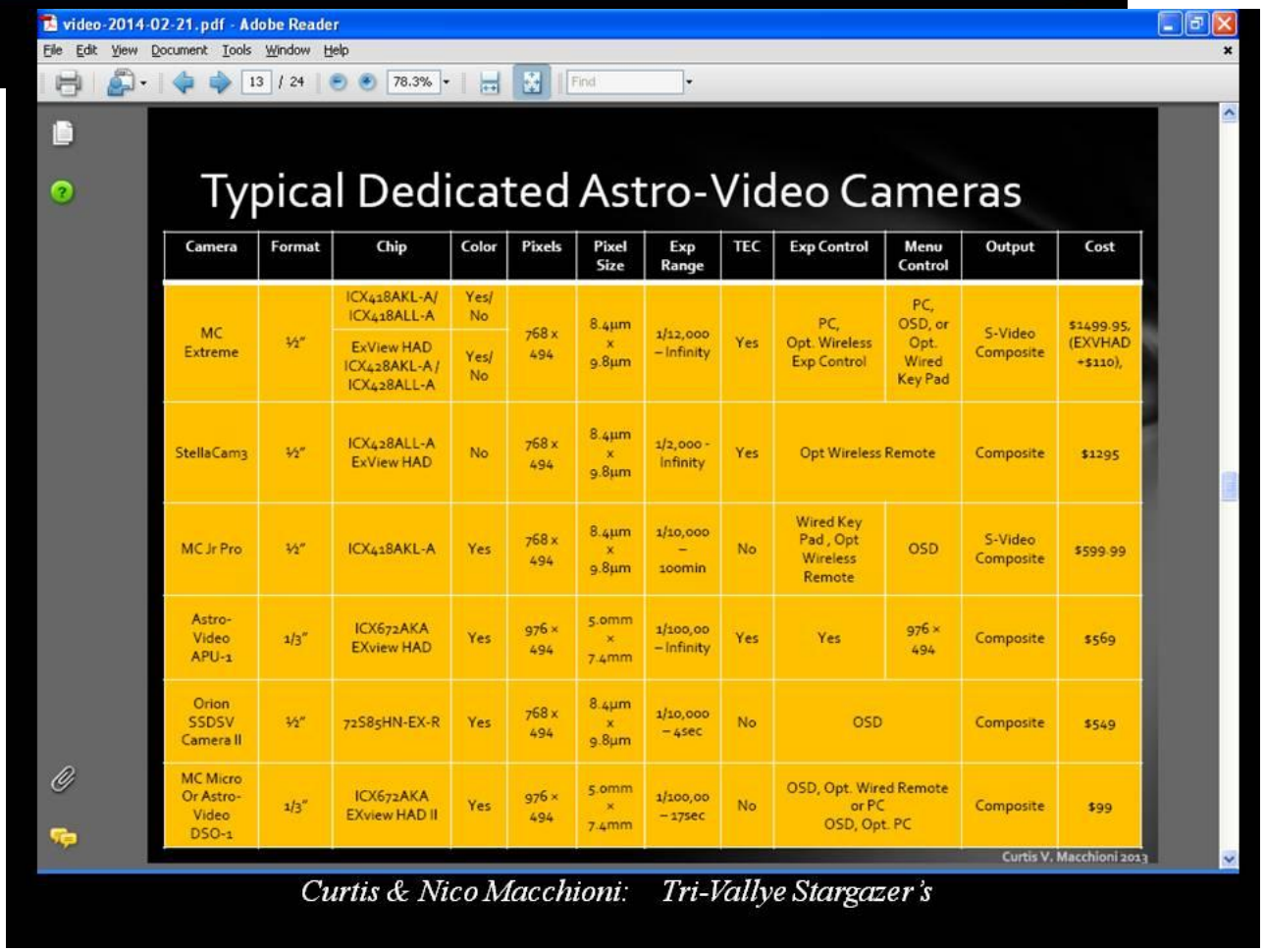
Finally, look for a camera that has a large CCD chip, such as ½".

The larger the chip, the wider video field you will have. There are several commercial models available, (Mallincams, GStar, Astro-Video Systems, Stellacams, and even Orion Telescopes – which are either color or B&W and have 1/3" to ½" CCD, and some even come with remote control or Peltier coolers).

Pixel size of the CCD chip is important, with the smaller the size, the better for planetary observing.

Here are a couple of great slides From *Curtis & Nico Macchioni of the Tri-Valley Stargazer's* that details commercially available Deep-Sky camera specifics:





Camera	Format	Chip	Color	Pixels	Pixel Size	Exp Range	TEC	Exp Control	Menu Control	Output	Cost
MC Extreme	½"	ICX418AKL-A/ ICX418ALL-A ExView HAD ICX428AKL-A / ICX428ALL-A	Yes/ No Yes/ No	768 x 494	8.4µm x 9.8µm	1/12,000 – Infinity	Yes	PC, Opt. Wireless Exp Control	PC, OSD, or Opt. Wired Key Pad	S-Video Composite	$1499.95; (EXVHAD +$110),
StellaCam3	½"	ICX428ALL-A ExView HAD	No	768 x 494	8.4µm x 9.8µm	1/2,000 - Infinity	Yes	Opt Wireless Remote		Composite	$1295
MC Jr Pro	½"	ICX418AKL-A	Yes	768 x 494	8.4µm x 9.8µm	1/10,000 – 100min	No	Wired Key Pad , Opt Wireless Remote	OSD	S-Video Composite	$599.99
Astro-Video APU-1	1/3"	ICX672AKA EXview HAD	Yes	976 x 494	5.0mm x 7.4mm	1/100,00 – Infinity	Yes	Yes	976 x 494	Composite	$569
Orion SSDSV Camera II	½"	72S85HN-EX-R	Yes	768 x 494	8.4µm x 9.8µm	1/10,000 – 4sec	No	OSD		Composite	$549
MC Micro Or Astro-Video DSO-1	1/3"	ICX672AKA EXview HAD II	Yes	976 x 494	5.0mm x 7.4mm	1/100,00 – 17sec	No	OSD, Opt. Wired Remote or PC OSD, Opt. PC		Composite	$99

Monitors/ TV's:

Security Monitors and Televisions are basically the same type of analog display machine (NTSC format), with the difference being that security monitors don't have a channel selector or tuner. *(can't watch TV)*

Over the last decade, LCD and Plasma flat panel HD TV's have become the standard, replacing the older traditional cathode ray tube sets. But, one of the nice features on the older models is manual brightness and contrast controls on the front. There's no need to have to navigate thru an OSD menu to make a tweak to the display screen image. The resolution ability of a Monitor/TV is called 'TV Line Resolution'.

Older tube style home TV's have a resolution of about 340 lines. *(HDTV's are over 1080 lines and higher).*

Dedicated B&W security monitors have around 400 - 600 TV lines.

In the traditional tube set world, B&W sets usually have better resolution, brightness/contrast than color models. Also, you want to use a monitor/TV that has the same or higher rated line resolution that your video camera.

If your video camera is rated at over 600 TV line resolution, and you're using it with an old conventional tube home TV, *(rated at 340 TV lines), y*ou are losing resolution, which tends to make fine planetary detail blur on the displayed image.

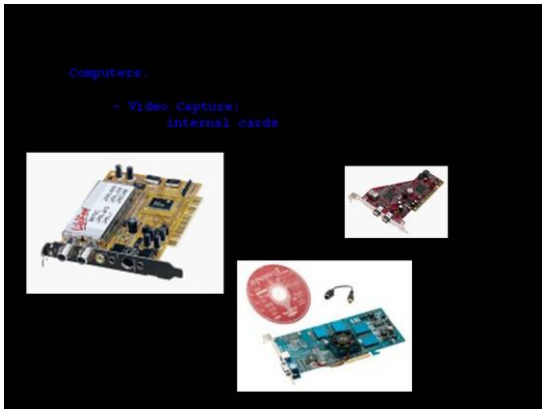
Computers:

You can use almost any computer to 'grap' or acquire video images.

Of course it helps to have a computer with a fast processor chip, lots of memory, and a large hard-drive. You don't want to waste video observing time waiting for individual frame captures to load, or worry about running out of storage and crashing the computer.

Video capture cards, internal or external:

There are many different models to choose: from a basic WinTV card for about $20, all the way to a deluxe Digital Video editing card used for making home DVD's for maybe $100. The one thing that they all have in common is that you have to access the inside of your computer and install the card in an open I/O adapter slot. Then you have to install the driver software for your computer's operating system to be able to recognize and use the new hardware. If you are not inclined to tinker with the insides of your computer, you can also get external capture devices. They work just like internal cards, except that they just plug into an open USB port.

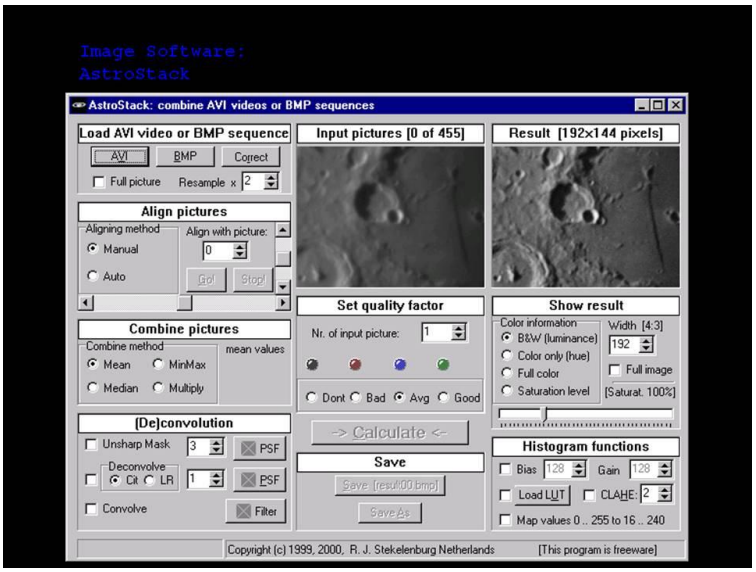


All of the capture cards will come with some type of software that allows you to control the video input interface. Basic editing programs will allow you to change and modify settings such as the video source, capture window size, and capture frame rate. They'll have setup screens that allows you to set various video capture options, such as the type of capture, single frame or continuous, the video source, capture size and quality, picture display mode, and how you want to save the capture – as a BMP, JPEG, or AVI. and adjust the brightness, contrast, and sharpness of a previewed image before capturing a final image.

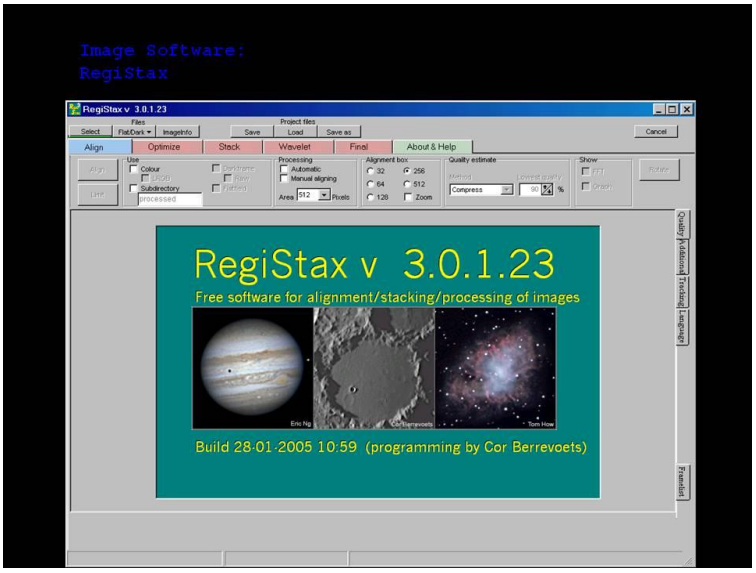
Basic Image Processing Software:

I could probably do an entire presentation on astronomical image processing software, but I just want to mention a couple of the many possible image processing programs that are available.

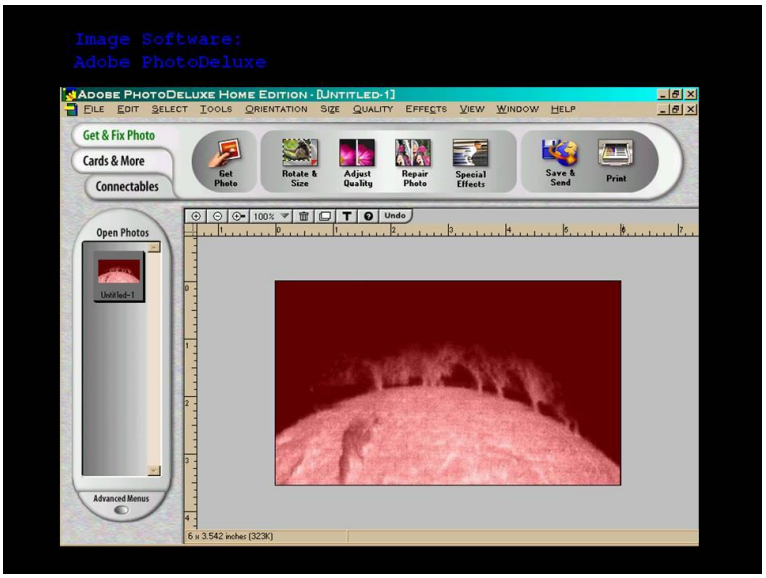
Here's a great freeware program called 'AstroStack' that allows you to stack or combine multiple images of the same object. By doing this, you end up with a combined image that has better resolution, and sharpness than a single image frame will have. Much like more advanced software used with CCD cameras, AstroStack allows you to load in Flat and Dark frame correction images, which helps get rid of dust spots and bad pixels on the CCD chip. It allows you to rate individual capture frames that you are stacking on their image quality, and will automatically stack and align the images for you. After the images have been combined, you can further adjust the brightness/contrast or apply sharp or unsharp masks and other built-in noise reduction algorithms.
And best of all, It's free!!! Just Google AstroStack, and you'll find the download links.



Also, another great free processing program is 'Registax'! It's similar to Astrostack, only Registax is used to process AVI files. You can take a short previously recorded 'movie' clip and run it thru the software to come out with a single combined, stacked image of several hundred individual frames. This will greatly improve your astro images. And again, It's free!! Just google 'Registax'.



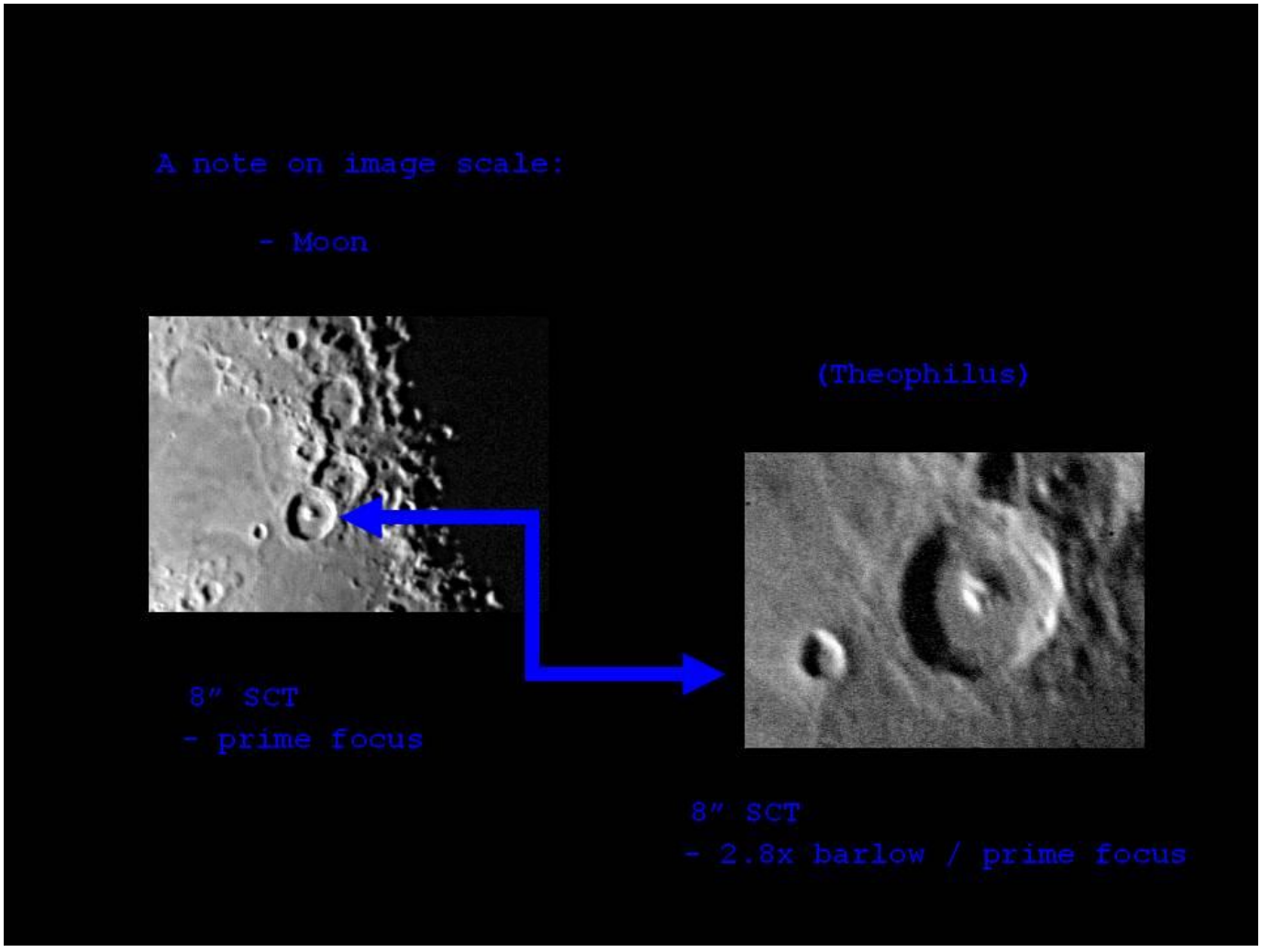
Finally, most digital cameras come bundled with image enhancement software. This particular one, Adobe PhotoDeluxe, comes bundled with a lot of older computers or digital cameras. It allows you to perform various enhancements to your captured video image, such as rotating the image, or resizing/cropping them, adjusting the brightness, contrast, or convert it to a negative image.
It is a good basic image processing package that you may already have!!



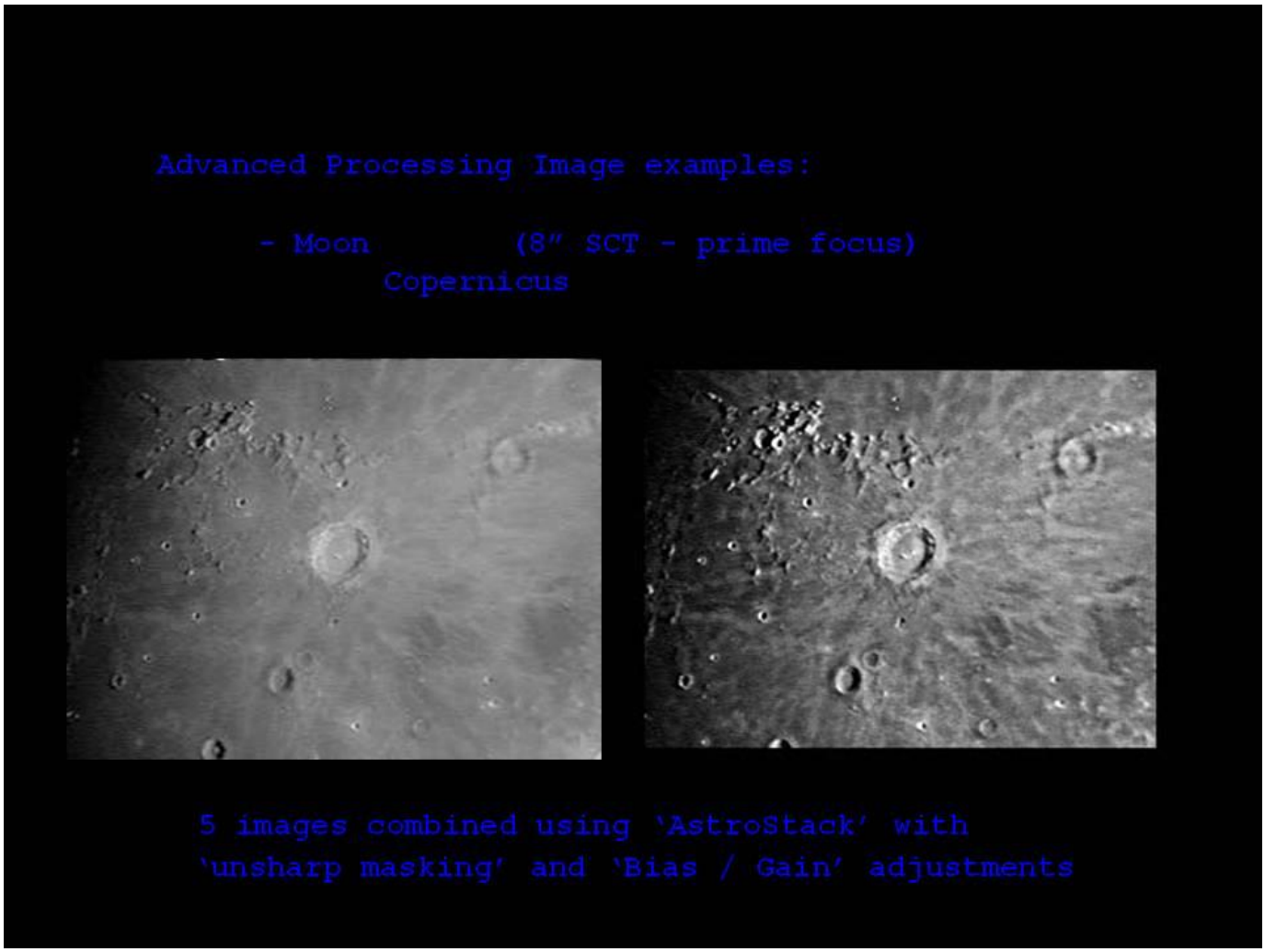
Now, let's move into some **basic** video astronomy **tips** using a security style video camera and show some examples of single frame capture and stacking. **The Moon** makes a great easy target for your first attempts. Whether you're using a small refractor telescope, or something larger like an 8" SCT, there's plenty of detail visible on the monitor. For an image scale comparison, if you were still using conventional film, at the prime focus of an 8" SCT, the Moon easily fits into the entire frame with plenty of room to spare. But, when using a video security camera with a smaller CCD chip of ¼" or 1/3" in size, the lunar surface features will fill the monitor.

Earlier I mentioned that a good feature to have on your video cameras manual shutter speed and gain controls. Otherwise you will have problems with overexposure. You can control overexposure on the auto-shutter video camera models by stopping down the aperture of the telescope, or by using eyepiece filters on large bright objects such as the Moon.

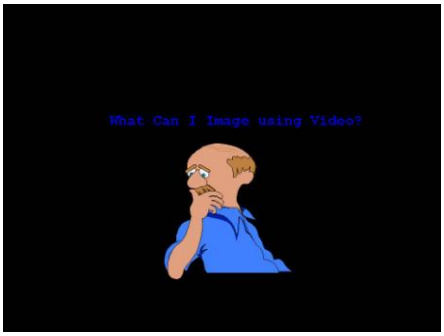
A few more notes on image scale: If you are using a video security camera with a 1/3" video CCD array (average size) mounted at the prime focus of an 8" SCT, it will display a magnified image about equal to using a 5mm eyepiece visually. Adding a Barlow further increase the image scale. This can make locating objects difficult, unless you're using a larger finder, such as an 80mm, equipped with crosshairs. An alternative to having a larger finder scope is to use a 'flip mirror' style diagonal and center the object in the primary telescope, then 'flip' to the camera. These are actually quite handy, not only in finding objects, but in focusing when using an eyepiece that is parfocal with the video camera. I highly recommend you get one.



Now that you've seen some examples of basic single frame captures, let me show you what you can do when applying a little **post processing** using either AstroStack or Registax.
On the left of the below slide a single image of the lunar crater **Copernicus.**
To the right of that is a processed image using 5 single images combined using 'AstroStack' with 'unsharp masking' and 'Bias / Gain' adjustments.
You can achieve a similar real-time effect on your monitor just by using its brightness and contrast controls.

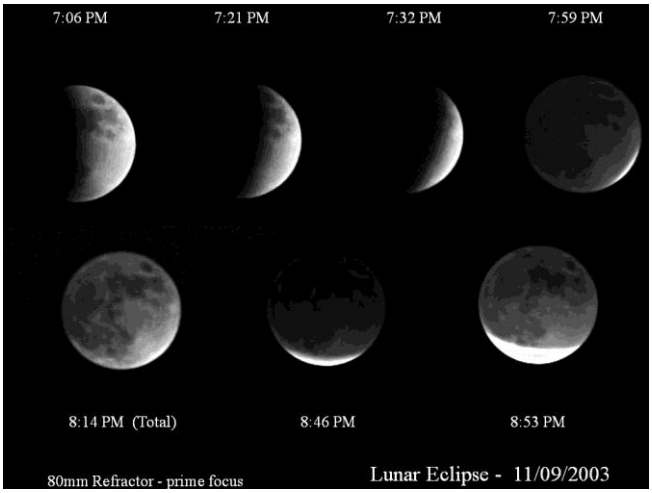


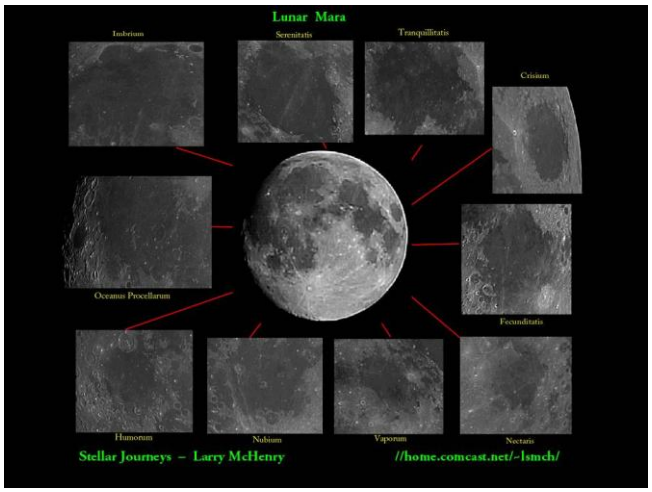
So, now that we've talked about the types of equipment needed, telescopes, video cameras, recording devices, computers, and basic image processing,,,,, **So, What can 'I' do with Video Astronomy!!**
Let's run thru some of my examples of the various video observing projects that I've done over the years.

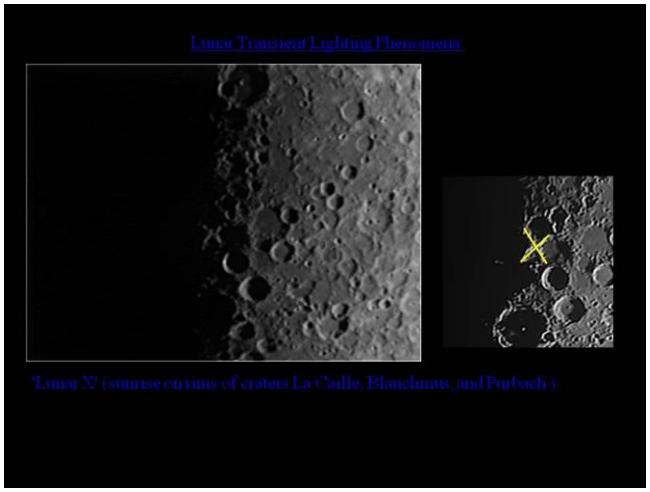


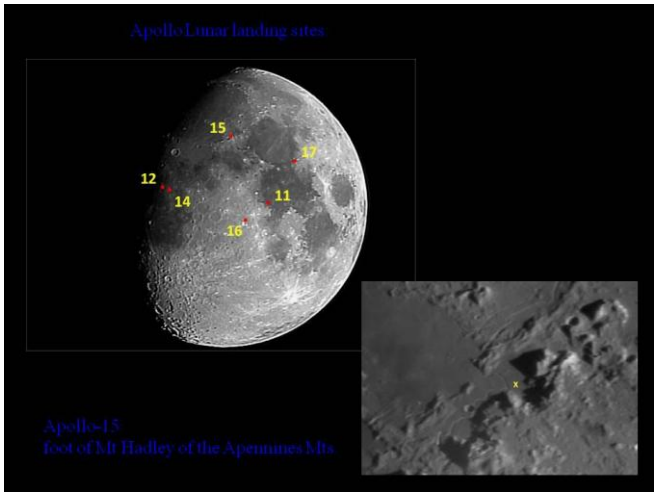
Lunar Projects:

Phases, Eclipses, Mara, craters, transient lighting phenomena, Apollo landing sites!!



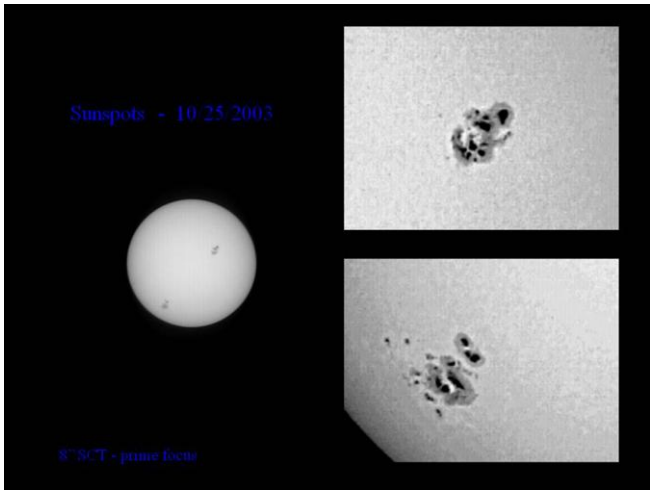


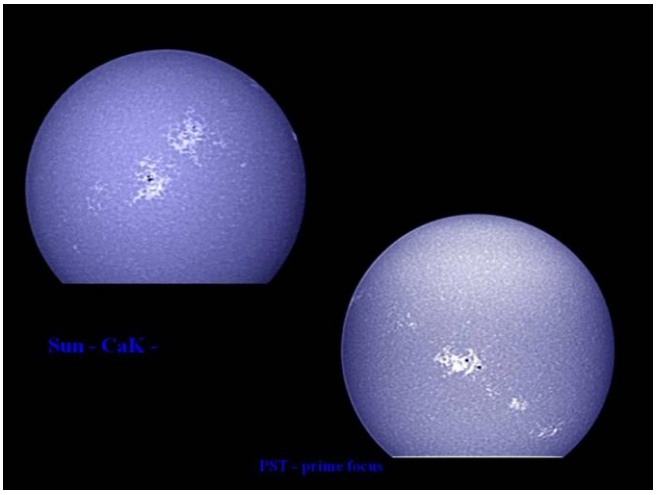


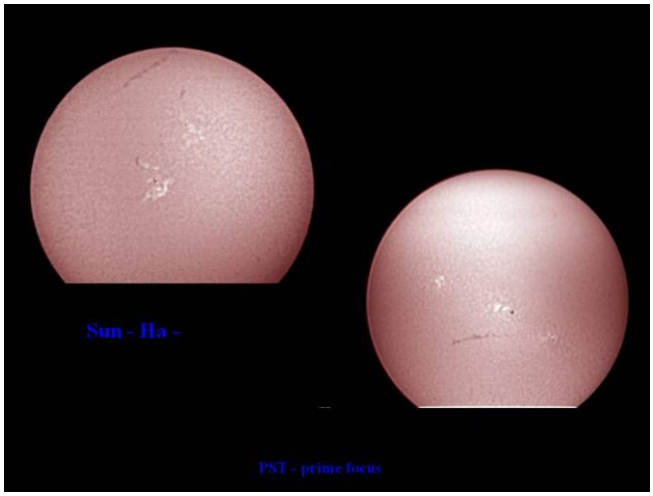


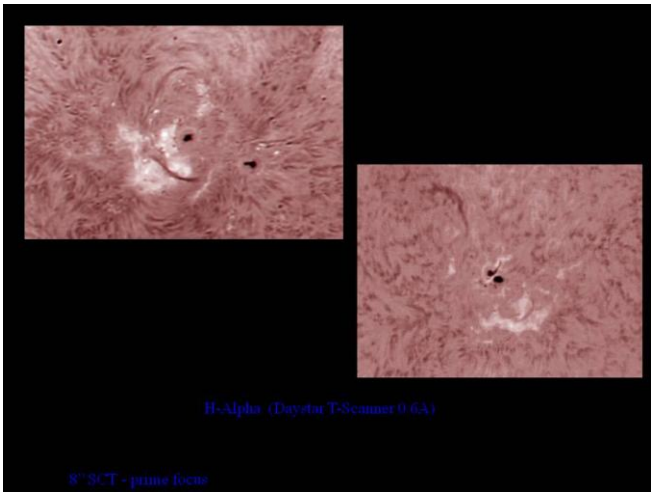
Solar Projects:

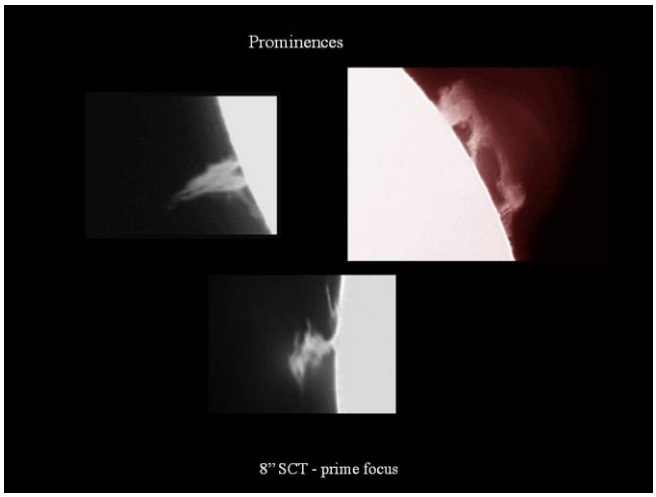
Sunspots in WL, Coronado CaK, Coronado PST, Sunspots in HA, prominences, flares.

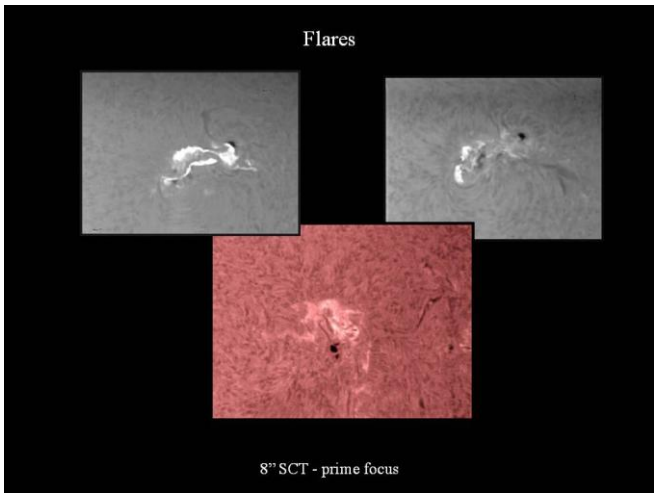






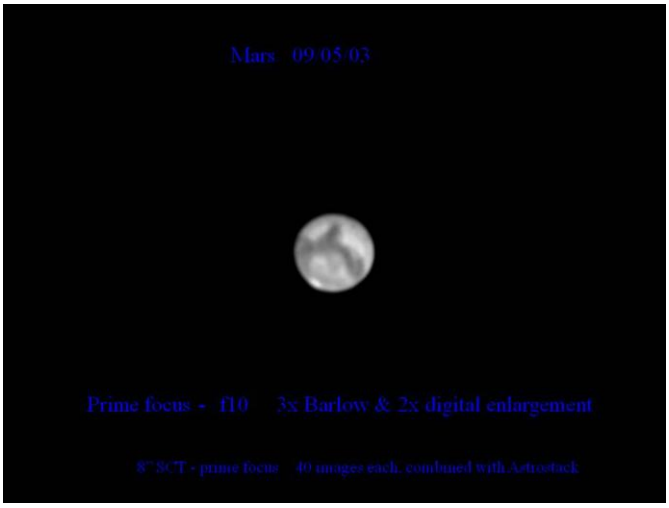


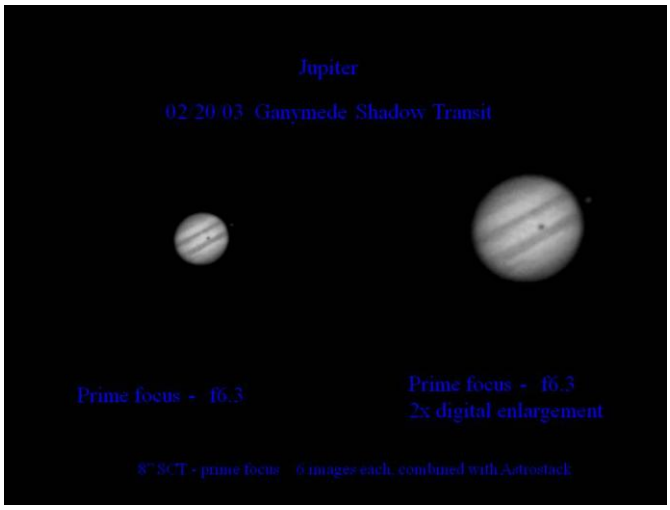


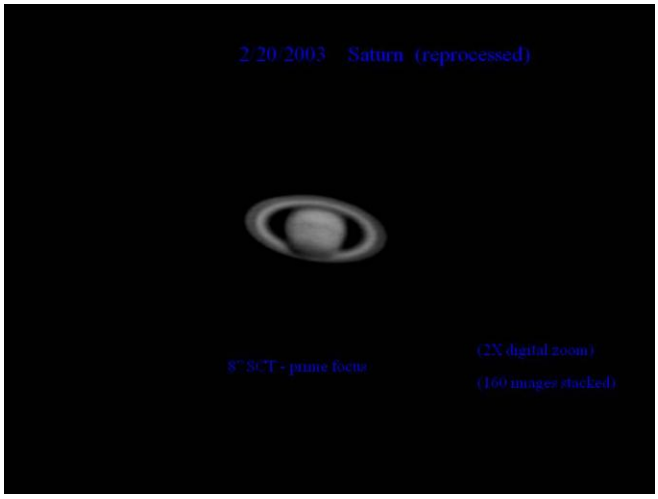


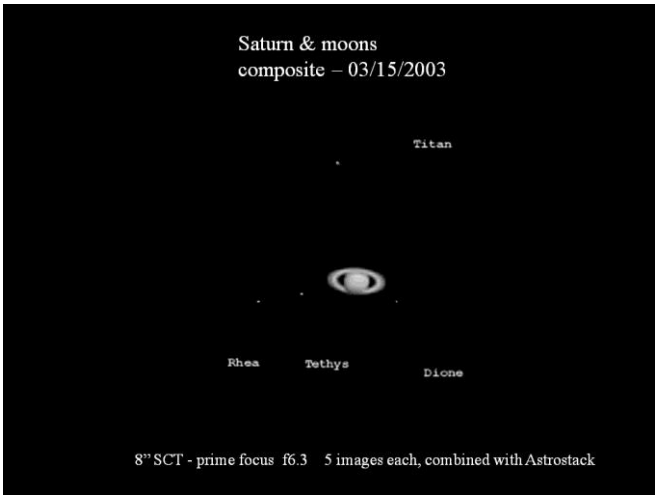
Planetary Projects:

Venus in daytime, Venus transit, Mars, Jupiter, Jupiter's Moons, transits, Saturn, occultation, bands, moons,



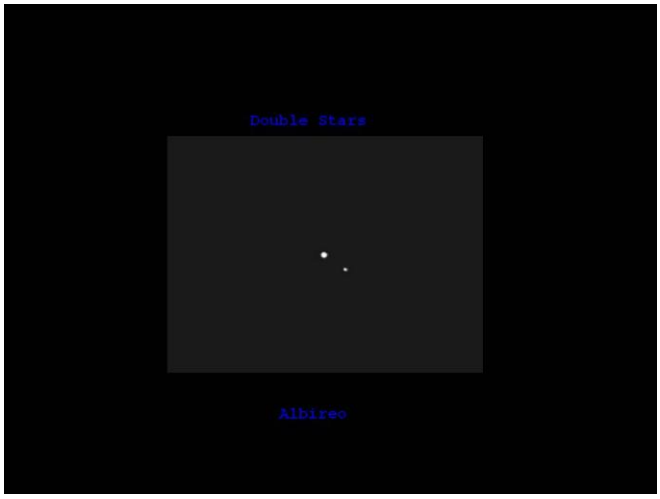




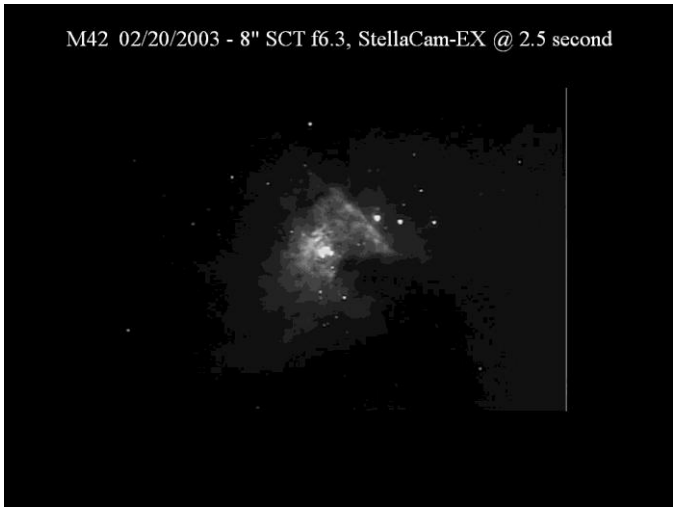


Deep-Sky Projects:

Most unmodified security style Video cameras can only reach down to about 8 to 9th magnitude.
While this is good for things like double-stars and a few bright clusters, generally, you can't do much with other deep-sky objects. But, If you gave one of the Deep-Sky integrating cameras, such as this StellaCam EX that came out in 2001, you can do some really interesting near real-time video observing.

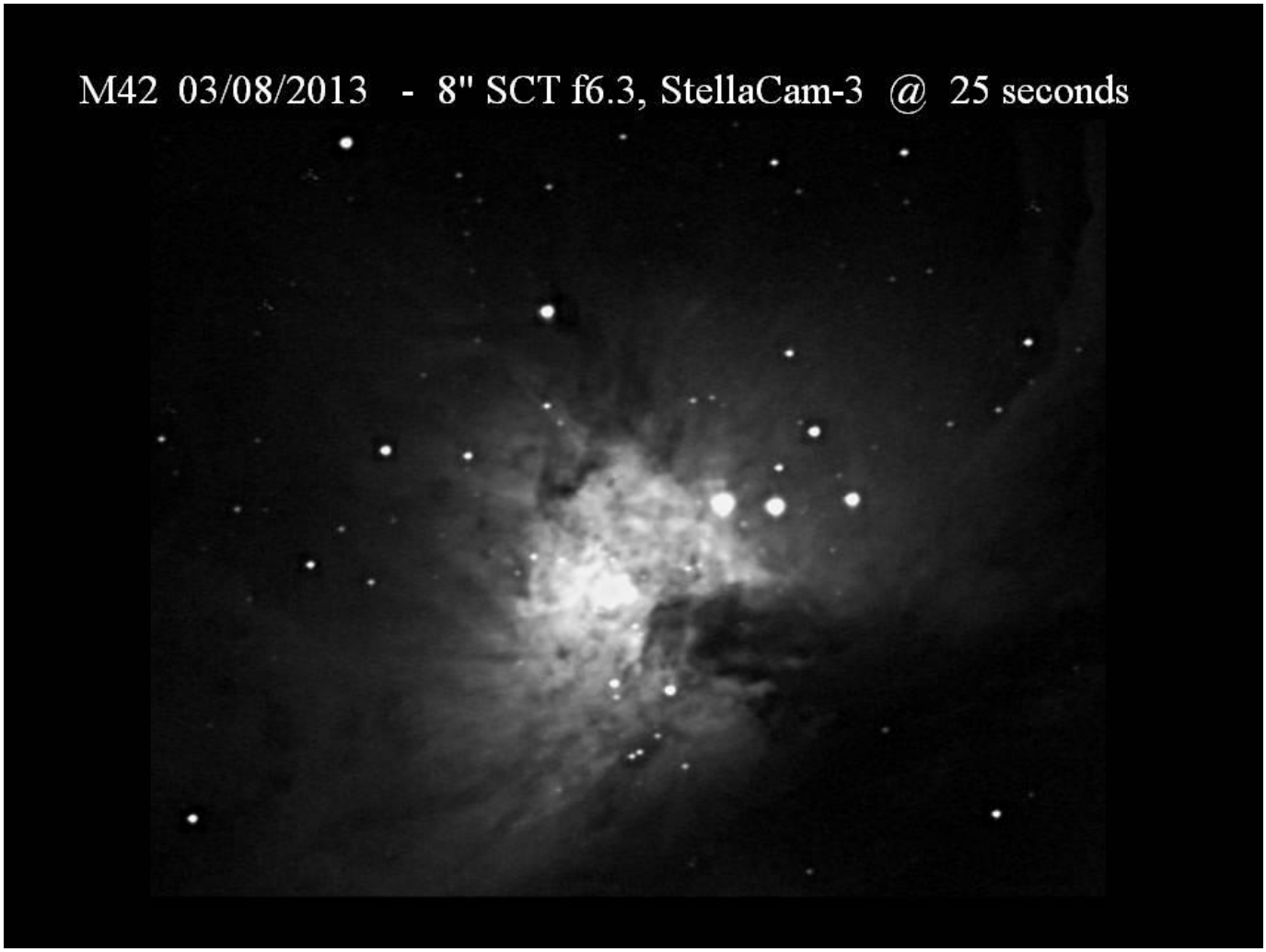


For example, here on the left is an average exposure of M42, the Orion Nebua, using a standard security style video camera. Not much to see. Now, here on the right is what it looks like with a 2.5 second integrated exposure using the older model StellaCam EX: Lots of great visual detail, as if you had a large telescope.



StellaCam II and 3 Cameras:

Newer model Deep-Sky integrating cameras, such as the Stellacam-II with up to 8 seconds integrated exposure and the top-of-the-line Stellacam-3 with basically unlimited exposure, (only limited by your polar alignment and sky conditions), and peltier cooled, opens up truly amazing video observing.



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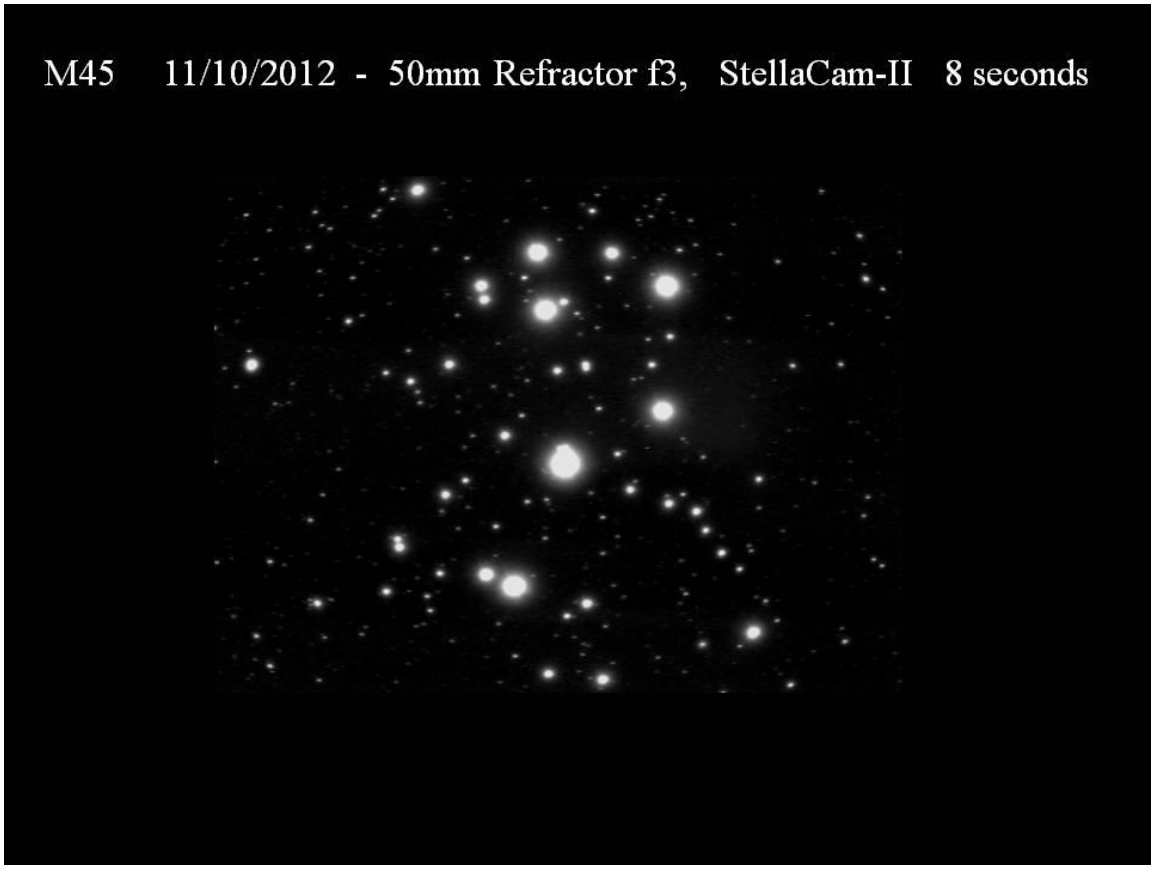
open clusters, globular clusters, planetary nebula, emission nebula, galaxies, dark nebula,



M13 04/05/2013 - 6" RC f9, StellaCam-3 25 seconds

M22 08/23/2011 - 6" RC f5, StellaCam-3 30 seconds

M27 09/10/2010 - 8" SCT f6.3, StellaCam-3 60 seconds

M57 09/05/2010 - 8" SCT f6.3, StellaCam-3 30 seconds

M8 06/15/2012 - 6" RC f5, StellaCam-3 90 seconds

M16 06/15/2012 - 6" RC f5, StellaCam-3 90 seconds

M33 06/15/2011 - 6" RC f5, StellaCam-3 45 seconds

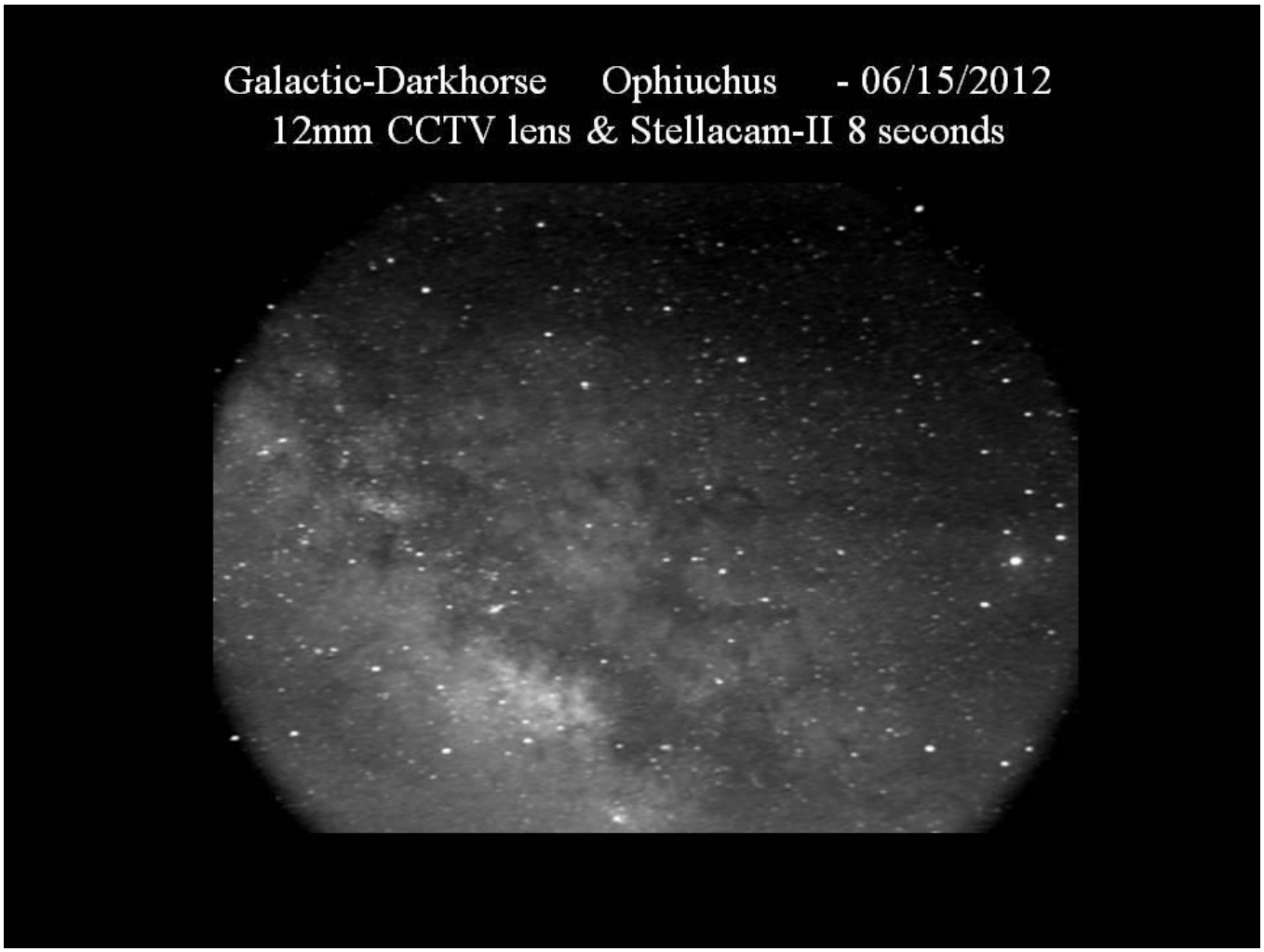
M51 06/15/2012 - 6" RC f5, StellaCam-3 90 seconds

B86 (Ink Spot nebula) 6" RC f5 & Stellacam-3 30 seconds

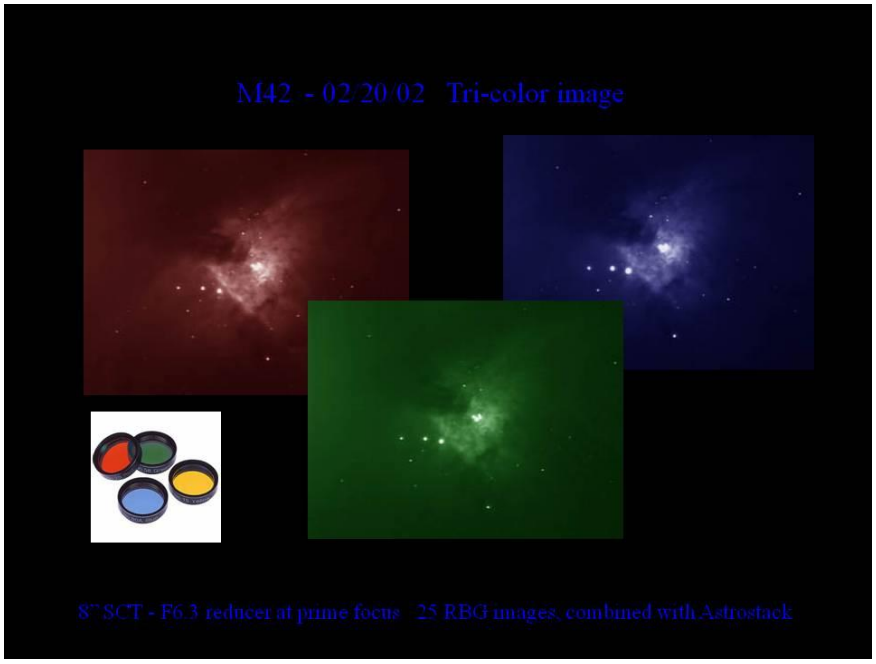
B33 (Horse Head nebula) 6" RC f5 & Stellacam-3 45 seconds

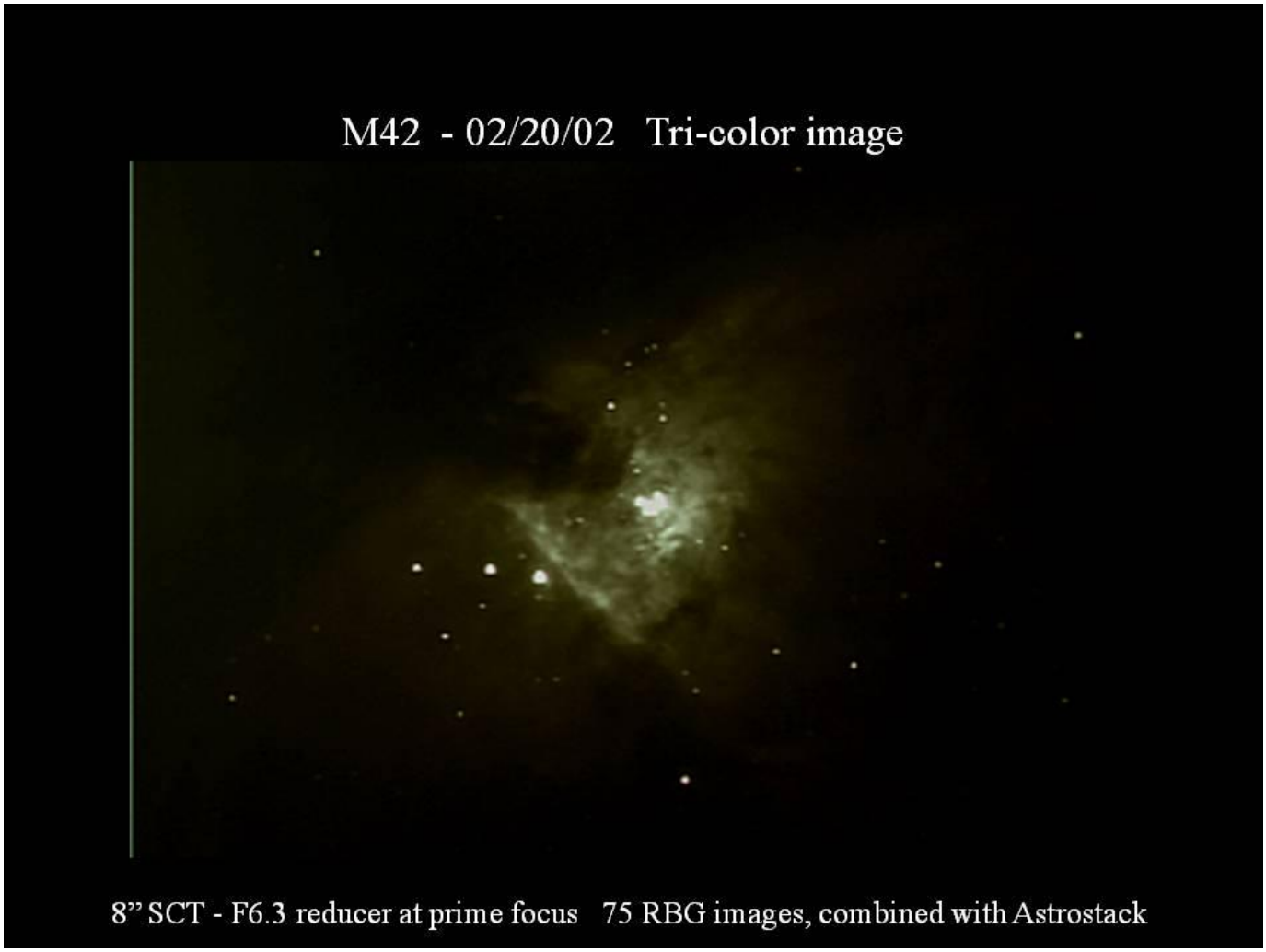
CCTV Lens - Tripod Mounted Projects:

You don’t even need a telescope with these types of deep-sky cameras! Just attach a wide-field CCTV lens and mount on a tripod.



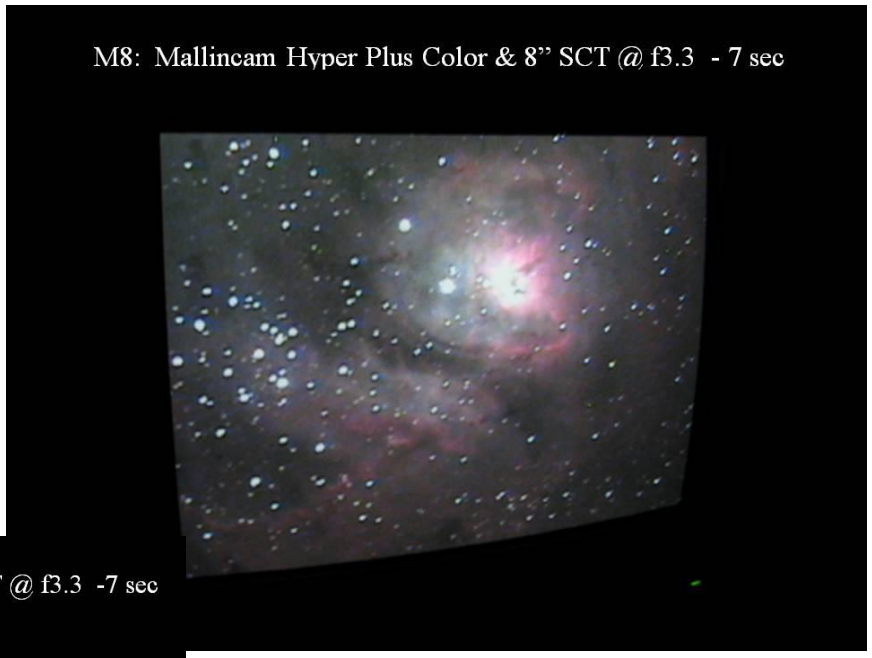
Even though the StellaCam are B&W video cameras, you can dabble in tri-color imaging using filters and create decent looking color image.

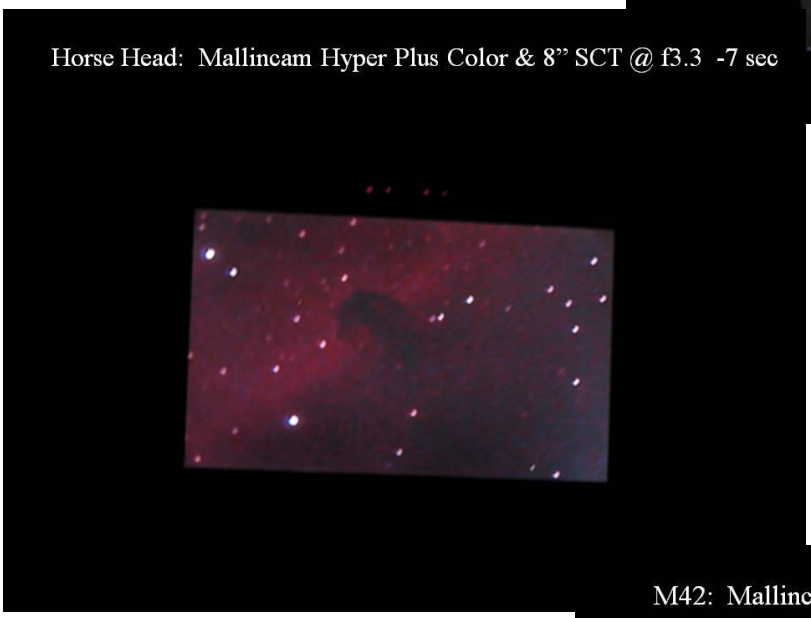


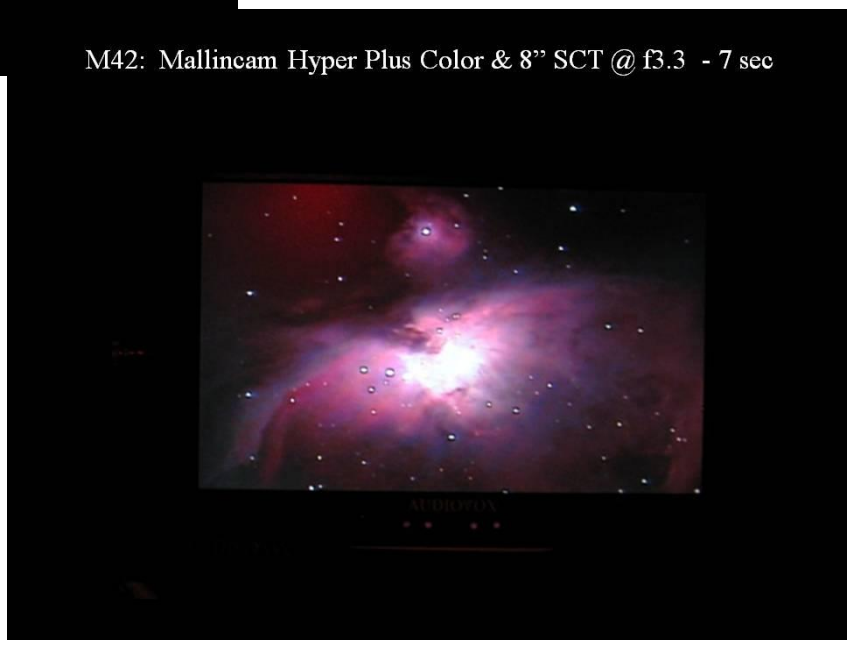


Color camera - Mallincam:

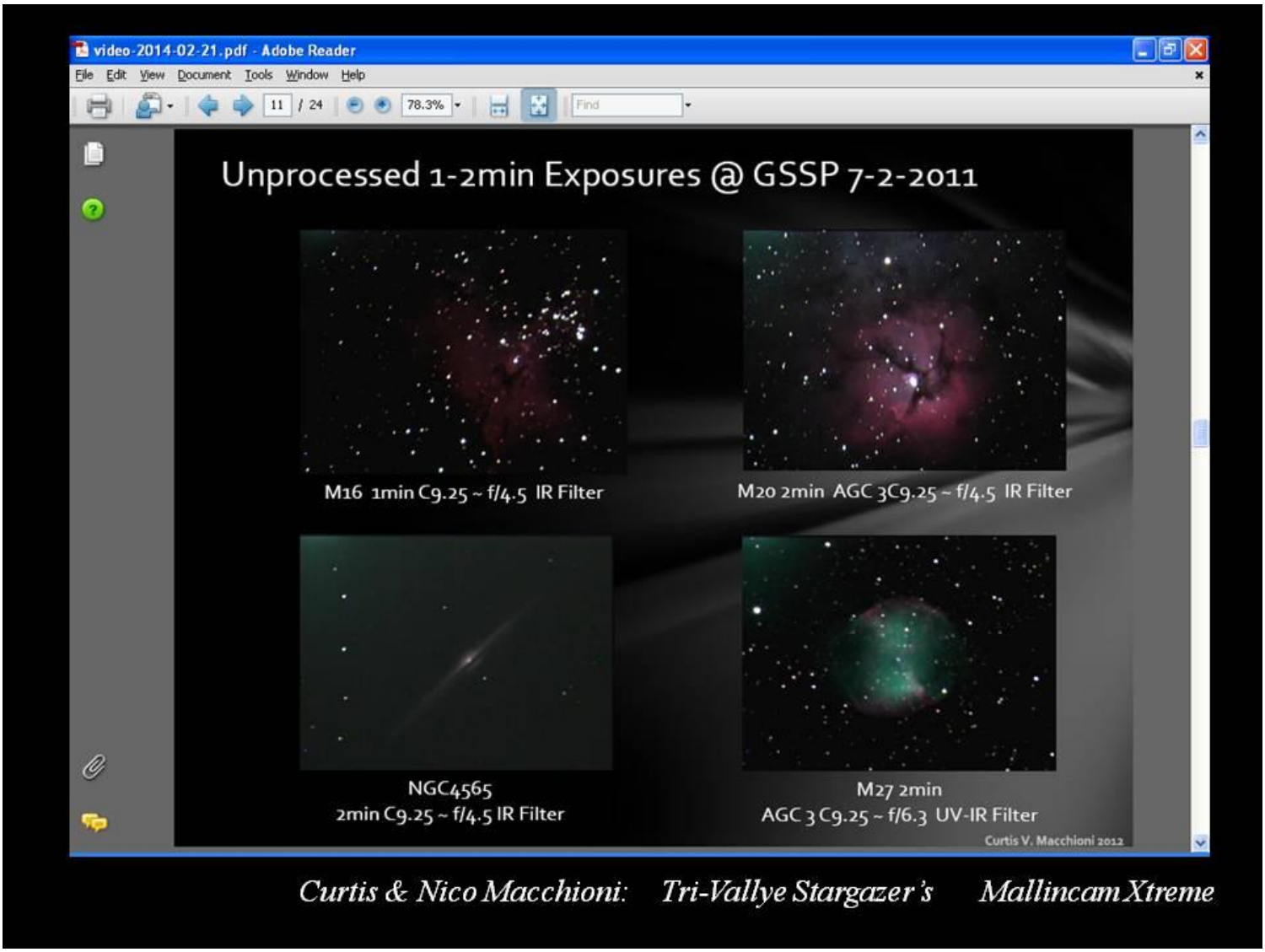
A good friend of mine from the Kiski Astronomers, Gary Shannon, owns one of the new Mallincam Hyper color video cameras. Here's his home setup. Gary gave me a few images to share today, all of them were 'captured' using a hand held digital camera and taking a picture of the monitor screen. M8- lagoon, Horse, M42 Orion neb.







Also fellow video-astronomers Curtis and Nico Macchioni *of the Tri-Valley Stargazer have* allowed me to share a few of their awesome Mallincam Xtreme color images.



People ask me all the time which camera is better.
My reply is any video-astronomy camera would be very nice to have.
It's really just a matter of preferences, like whether you buy an 8" SCT from Celestron or from Meade.
All the various models work very well, and a person would be happy to own any of them!

Books:
"Video Astronomy", by Steve Massey and Tom Dobbins
"Deep-Sky Video Astronomy", also by Steve Massey
Equipment: listed below, and don't forget, Astromart, Cloudynights, and eBay for used equipment.
Internet Websites: listed below

Conclusion:
The future of video in amateur astronomy is quite bright.

I've demonstrated today that great results can be had with basic video equipment and any type of telescope.

In the past few years, particularly with the Stellacam and Mallincam cameras coming onto the market making real time deep-sky video imaging practical, we've seen video astronomy starting to become very popular, with amateurs replacing their glass eyepieces with electronic video eyes.

This concludes my introduction to video astronomy.
Thank You