Winter 2013–14
Issue 104

Quarterly

www.bpastro.org Bainbridge Island, WA

Events Calendar

(unless otherwise noted, planetarium shows and classes are at the Edwin Ritchie Observatory, Battle Point Park)

DECEMBER 2013

December 2 ●
New Moon

December 11
Annie Jump Cannon's 150th birthday

December 14 7:00 p.m.
Planetarium Show and Stargazing
Geminid meteor shower peak

December 17 ○
Full Moon (1:28 a.m.)

December 21
Winter Solstice (9:11 a.m.)

December 22
Comet Lovejoy (C/2013 R1) at opposition

JANUARY 2014

January 1 ●
New Moon

January 3
Quadrantid Meteor shower peak

January 4
Earth at perihelion (0.983 AU)

January 5
Jupiter at opposition

January 11 7:00 p.m.
Planetarium Show and Stargazing

January 15 ○
Full Moon (8:52 p.m.)

January 30 ●
New Moon

January 31
Mercury at greatest eastern elongation

FEBRUARY

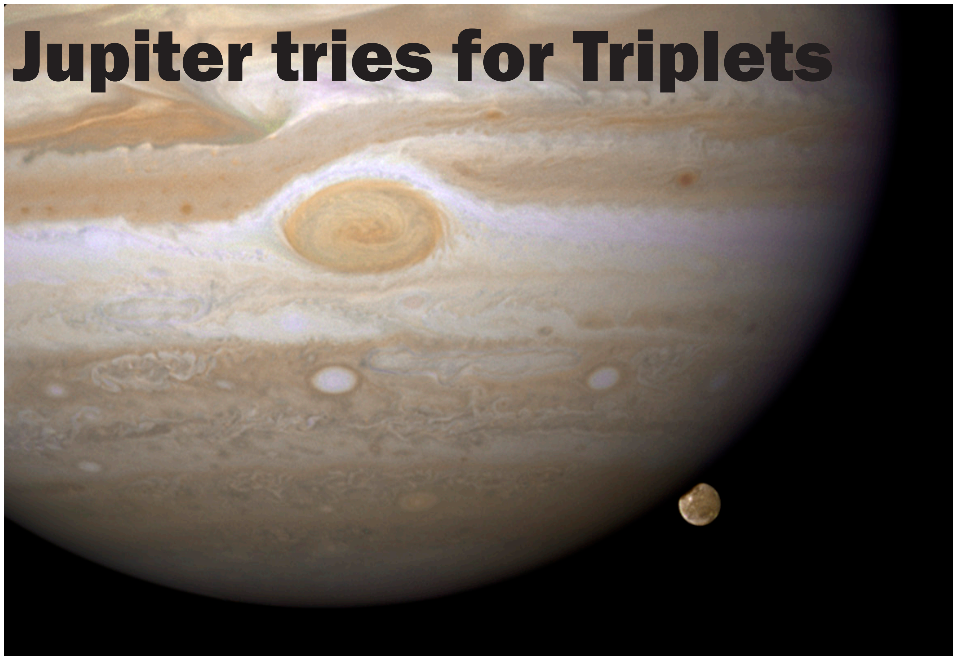
February 8 7:00 p.m.
Planetarium Show and Stargazing

February 14 ○
Full Moon (3:53 p.m.)

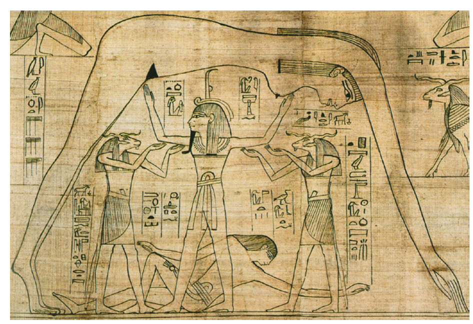
February 15
Galileo Galilei's 450th birthday (1564)

Calendar *con't on page 2*

Jupiter tries for Triplets



The length of the year, 365 days plus a fraction, is wholly inconvenient. 360 would have been ever so much better. Man has fretted about this problem a lot. In ancient Egyptian mythology the Sun god Re, warned that his rival, the sky goddess Nut, would give birth to a son who would depose him, decreed, "Nut shall not give birth any day of the year." Nut's advisor, Thoth, god of wisdom, cleverly schemed to gamble with the moon and eventually won five days worth of extra moonlight. Guess when Nut's children were born.

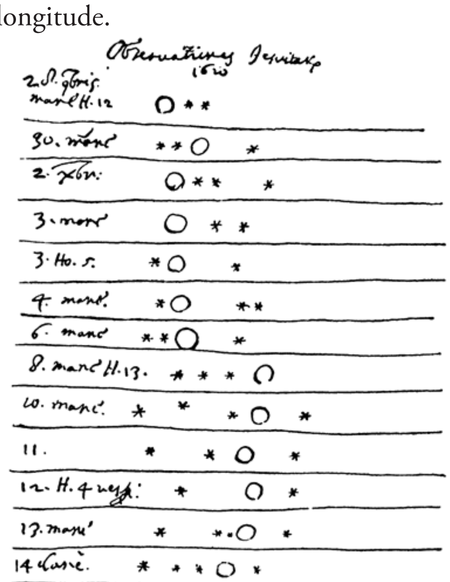


Detail from the Greenfield Papyrus (Book of the Dead of Nesitanebtashru*). The air god Shu, assisted by ram-headed Heh deities, supports the sky goddess Nut as the earth god Geb reclines beneath.*

In modern "civilization" we still acknowledge the special character of those leftover days by filling out the calendar with year-end holidays. This winter, Christmas and New Years Day both fall on Wednesday, creating multiple opportunities for extended weekends. Some revelers may still be in party mode when the Quadrantids fireworks light up this year's perfectly moonless early January. But which night? The peak is predicted for noon on Friday, January 3. Although the Quadrantids are one of the three strongest annual showers (the other two: Perseids and Geminids), they are the least observed, partly because of the nasty nature of Northern Hemisphere's winter weather and partly because of the intense sharpness of the Quadrantid's peak, lasting only a few hours. For most showers a noon peak would mean good viewing both the night before and the night after. For the Quads it may mean we've missed out again. Nonetheless early Thursday morning might be a bit closer to the peak than Friday night; and both are certainly worth a try.

Two days later Jupiter reaches opposition, essentially meaning it's visible all night. This is one event where timing doesn't matter. This year Jupiter dominates our sky all winter long. You'll find Jupiter cruising Gemini, very near The Twins, Castor and Pollux. Surprisingly its fly-by does not change the character of the constellation from twins into triplets. Jupiter doesn't really blend in. Jupiter is so much brighter that, at least to my eyes, he does nothing to disrupt the visual linkage of the famous pair.

Finding companions for Jupiter was amongst Galileo's greatest accomplishments. In 1610 he published his humbling discovery: four unsuspected moons found orbiting Jupiter. In honor of his 450th birthday this February it's well worth hefting a pair of binoculars toward Jupiter and marveling at his moons, Io, Ganymede, Europa, and Callisto. That these names were bestowed by an observational nemesis, Simon Marius, who claimed to have discovered the moons a few weeks earlier, should not dissuade one from admiring Galileo's accomplishment. Not only did Galileo actually publish, he also turned Jupiter into the world's first GPS. Man had long known how to determine latitude by watching the stars; but determining longitude was not so easy. Galileo realized that by observing the ever-shifting alignments of Jupiter's moons, it was possible to precisely determine time and thereby longitude.



Galileo's notes on the alignments of Jupiter's moons.

Although Gemini is clearly a pair, the zodiacal constellation most resembling its namesake is Leo the Lion. On March 20, Regulus, Leo's brightest star, will be occulted for 14 seconds by asteroid 163 Erigone. In Greek mythology, Erigone hanged herself after discovering her father's dead body, and was subsequently immortalized in the heavens as the constellation Virgo. This spring Erigone exacts her own revenge by jumping back one sign to temporarily disfigure Leo. This event won't be visible from Bainbridge. You'll have to travel to the East Coast. Remarkably the narrow path of this occultation travels right over New York City. It is likely this will be the most observed minor planet occultation of all time.

Whether or not you make it to NYC, that same date marks the return of spring, always a cause for celebration. In particular, aurora seem to inexplicably increase around the equinoxes. We haven't had much activity yet from the remarkably anemic Solar Cycle 24. Its peak should be now. But there's almost nothing happening, and a lot of speculation that future cycles may be even quieter. The show may already be over. I like the theory that there could be a double peak, just now starting. If so, hope remains for a few more months of sunspots and aurora. Regardless, early 2014 is likely our last best chance for a good many years to come.

To learn more about these and many other celestial wonders don't forget to join us at our always-open-to-the-public monthly Planetarium Show and Stargazing events, every second Saturday. See you there! — *Cheth Rowe*

February 21
Comet Linear (C/2012 X1) at opposition

MARCH

March 1 ●
New Moon

March 8 7:00 p.m.
Planetarium Show and Stargazing

March 9
Daylight "Saving" Time begins

March 16 ○
Full Moon (10:08 a.m.)

March 20
Vernal Equinox (9:57 a.m. PDT)
Regulus occulted by 163 Erigone

March 30 ●
New Moon

Any member who is planning to observe can invite others to join in by sending an email to *bpaa@yahoogroups.com*. To join our email group, send an email with your name to *bpaa-owner@yahoogroups.com* and we can enroll you. If you want to have web access to the messages and files, you can join the Yahoogroups by clicking the register link for new users on *http://groups.yahoo.com/*. Request to join at *http://groups.yahoo.com/group/bpaa/*. The system will send us a message, and we'll approve your request after we verify your membership.

BPAA Sundial Fundraising a Success!

The BPAA sundial project received $28,645 in total funding from all sources. At its November 6 meeting, the BPAA Board authorized the project to proceed to construction.

Our Indiegogo crowd-funding campaign raised $5,899, well short of its $17,000 goal. But the campaign helped raise the visibility of the project, so much so that we got a huge response from supporters who donated directly to the sundial, instead of through Indiegogo. Additional support came from the North American Sundial Society, the Bainbridge Island Parks Foundation, and donor-directed funds from the Bainbridge Community Foundation and the Seattle Foundation. All together, these contributions pushed us nearly to our overall project goal of $30,000. If you or someone you know would like to help us close that last $1,355 gap, please send a check to BPAA or make a donation on our website. Be sure to mark your donation for the sundial. Here is a summary of contributions so far:

Individual Contributions	$18,545
BPAA Board	$5,000
Bainbridge Community Foundation	$2,100
BI Parks Foundation	$1,000
Seattle Foundation	$1,000
North American Sundial Society	$1,000
TOTAL	$28,645

The Sundial Committee is thrilled at the widespread support for the sundial. The majority of contributions came from the Bainbridge Island community and the greater Puget Sound region. Support also came from far and wide, from places like Illinois, Iowa, Minnesota, Kentucky, Massachusetts, Vermont, California, and even New Zealand!

With the success of the fundraising and the Board's authorization, we are moving on to engineering and fabrication. We've selected Lee Fabricators in Silverdale to build the sundial using steel plates, precision cut and rolled into the graceful arc shapes that you see in the photos, welded together, then flame-coated with bronze. The sundial will be hoisted onto a concrete pedestal foundation on top of the north berm in the park. We expect to complete work by spring of 2014.

The Sundial Committee sends a big THANK YOU! to everyone who contributed. We look forward to seeing you at the dedication next spring. Watch for progress updates and an announcement of the dedication date.

—Frank Petrie, Sundial Committee

Russ and Dave at Dr. Who Event

photos by Elliot Swanson

The Bainbridge Public Library hosted a Doctor Who 50th Anniversary Celebration Saturday afternoon, Nov. 2. Nearly 100 Islanders stopped by. BPAA was there to help celebrate the long-running British science fiction television show and deliver a little science education. Visitors checked out a motorized, moving orrery (far end of table), sundial model, telescopes, and Mars globe, and discussed the Universe with Dave Fong, BPAA Education Officer, and Russell Heglund, BPAA secretary.

Steve Ruhl

President's Message

In this column a year ago, we were celebrating our lease extension which included official permission from our landlord, the Bainbridge Island Parks and Recreation Department, to build our sundial. This winter, I am pleased to report that we have raised enough funds to begin building the sundial. Hurray. (See article on page 3 for details.)

There are many thanks to go around. Thanks to everyone who donated to the fund. Thanks to the many people who have helped in the past, through the various fund drives that we have had over the years. And a very large thanks to Frank Petrie, for driving the fund raising, Charles Higgins, who worked tirelessly with the park district to secure permission and the extension on the lease; and to the artist, Bill Baran-Mickle, who has stuck with us for all of these years.

This has been a long process but it is getting there. Now all we have to do is build it.

I don't know what I am going to do with myself, now that I won't be writing grant requests for the sundial project.

On another note, shortly I will be writing the annual letter to the membership. As per our bylaws, this letter will go out in early December and will review our accomplishments for the year and a vision of what next year will bring. We follow this up with an annual meeting on the second Wednesday in January, the 8th. We value your input so if you can please bring some. I will bring cookies.

Our goal is to set a direction to improve member's experiences and their astronomical acumen. If you have things you would like to see or ideas about how we could function better, I would love to hear them. If you cannot make the meeting, please email your ideas to me.

Goldilocks' Story?

Seeing Stars Astronomy 0.001

The Earth's porridge is ju-u-u-ust right. It's neither too hot or too cold.

But it's not only being in the so-called "Goldilocks zone" that makes it perfect. Consider all the factors that had to come together to make Earth a life-giving planet:

It's not too small to keep its atmosphere, although it's taken millions of years to get the balance we have now of nitrogen, oxygen, water vapor, carbon dioxide, argon, neon and methane.

At the same time it's not so big that it might become a burning star in its own right. (Huge Jupiter, for instance, is on the verge of star-hood.) Likewise it's circling around the Sun with the right, slight variation in distance for the range of temperature that suits life as we know it.

While the Sun's energy that reaches Earth is only one-half of one billionth of its total dispersed energy, it's the right amount to warm our air and get it blowing in currents around us. The heat and currents influence how much water evaporates and where and when it rises to form clouds. Some of that wind pushes the clouds across the land where they discharge their water to fall on streams and rivers, lakes and oceans, and then reform to repeat the cycle. Along the way, as the water falls and runs off, it breaks up the Earth's rocky surface to make soil and release its minerals to nourish plants, which use sunlight to produce the carbohydrates that nourishes all living things.

We're lucky that the Earth is a slightly squeezed sphere and that its lumpy surface is about 30% land and 70% water; both of these factors help contribute to the changes in climate from one place to another. The heat and the water also influence the shaping of the terrain, while the clouds also act as mirrors to reflect some of the Sun's energy away from Earth and into space, and as blankets to keep warmth from radiating out into space.

The Earth has a molten interior that rotates and produces a magnetic field which helps us find our way around and shields us from the solar wind, a flow of charged particles from the Sun that vary in temperature, mass and speed. Charged particles trapped by the magnetic field collide with air molecules and make them glow, causing spectacular aurorae around our north and south poles. Violent eruptions from the Sun, called coronal mass ejections, can cause geomagnetic disturbances on Earth, including power line surges and interference with broadcast signals such as radio, TV, telephone, and GPS.

Our two most visible neighbors, the Sun and the Moon, have also had to be "just right" for life on Earth to succeed.

The Sun, a "G-1 main sequence star," is in the middle category of stars fusing hydrogen into helium at their core — which creates the energy that we know as visible and invisible light and heat. It's about halfway through its lifetime at about five billion years of age. In as many more years it will have turned all its hydrogen into helium and perhaps will swell into a red giant like Betelgeuse, engulfing all the area that includes the Earth's orbit.

But for now, it is at the right stage to sustain life here and the right size to maintain the Solar system as we know it.

The Sun keeps us in its orbit; the Moon is big enough to keep us tilted at the 23.4° angle that makes for our changing seasons. Without the Moon the Earth probably would flop over, rotating like a chicken on a spit, making days and nights the same length.

The Moon's creation — most likely the result of a collision with a Mars-sized body — also changed the rotation speed of the Earth. Before the collision, the Earth may have whirled around so fast that there would have been only four hours from sunrise to sunrise. How would you like a day that gave you two hours to eat, work and play, and two to sleep? You wouldn't find much time to regret the Moon-less sky. Over time the Moon's pull has slowed us down to the present 24-hour day — it's still putting the brakes on — adding 1.4 milliseconds a century as it drifts farther and farther off toward the Sun.

Of course there's also the daily gravitational pull these two neighbors exert on our oceans. That pull is greatest when the Moon is either directly between us and the Sun or directly behind — the New Moon and the Full Moon. That's because it and the Sun are working together then to make the high "spring" tides. At first and last quarter the Moon and the Sun compete, the Sun having about half as much pull as the Moon because of its greater distance. At that time the tides are "neap" ("spring" as in "springing forth," "neap"

as "without power of advancement"). The tides help species like salmon, gulls and algae that live near the coasts and depend for their food on the changing tides. The Moon's gravitational pull may also affect plate techtonics.(The Moon is also just the right size and in just the right relation to the Sun and the Earth so that occasionally it lines up to interfere with the Sun's light in the daytime. That produces the spectacularly eerie occurrence of a solar eclipse which has startled both animals and people for millennia.)

Without the Moon, the Earth might still have the one continent, Pangaea, instead of the several we know. Seperated in island-continents, it was more likely that species would diverge, as Darwin showed, using orchids to illustrate what differing locations did to flowers that started out the same.

The place where life started may have also been influenced by the Moon. If life wasn't spun off by some passing comet, or if all men didn't march in from Mars and all women shake and shimmy here from Venus, there are two serious possibilities. One comes from the discoveries about 35 years ago of the life in the deep dark 350° C waters around the "black smokers" of the ocean. The other possibility is the shallow, relatively warm tidal pools where minerals in the water plus the runoff from the land were repeatedly stirred up and could offer a fertile nursery for multiple attempts at life.

The Sun and the Moon are embedded in our speach: In English we talk about moonshine meaning foolish talk or smuggled whisky; about moony meaning both round or crescent-shaped and dreamy; moonlighting as taking a second job; moonstruck as mentally afflicted or loony; and moonwort as a plant sometimes called honesty (Lunaria annua). Sunstruck is also an affliction, but sunwise is not; sundaes are ice cream dressed in their Sunday best; sunset, besides being when the sun goes down, also refers to a declining industry, as opposed to sunrise which is a growing industry; sunshine is both the light

Image of Mayan calendar courtesy the Dumbarton Oaks Research Library.

coming from the Sun and an adjective meaning that certain meetings must be open to the public; and a sundowner in England is an alcoholic drink at sunset.

We pay largely unconscious tribute to the cycles of the Sun and Moon as we mark the passing months (moons) and seasons of the year. Whatever our racial or religious background, our calendars are adjusted to what the Sun and the Moon are telling us: The Jewish calendar is lunar-solar, the Muslim strictly lunar, and the Western is solar. The Hindu calendar is geared to the phases of the Moon; the Buddhist used to be a lunisolar calendar including the Metonic cycle, since replaced with the Western Gregorian. The Mayan-Mesoamerican was a complex mixture of solar, lunar and 584-day Venus cycles.

Nor should we ignore other aspects of the Sun's and the Moon's powers in the rainbows and moonbows, and in the shafts of sunlight through the clouds to inspire poetry, our wonder at nature and our curiosity about what's "out there."

The Sun and the Moon were also instrumental in our being able to make scientific measurements way out there without actually running a tape measure to them. Eratosthenes's well in Aswan, plus Aristarchus' measurements of a lunar eclipse have pushed us on the way to the Moon and now beyond our solar system.

Sizes, relations in locations, gravity, climate variations and length of days, winds, erosion, tides, magnetism — we're sitting pretty, aren't we? Well, of course there are more hazards around than coronal mass ejections. But with all the gifts from our neighbors to support life as we know it, and then the gifts to inspire math, sciences, art, music and imagination that have come with human life, no wonder that the Goldilocks in all of us is happy to settle down here. — *Anna Edmonds*

With thanks to Susan Eyre for editorial help.

Astronomical Image Workflow

Our eyes are incredible sense organs that decipher electromagnetic energy. But the eye is not the most sensitive or accurate scientific instrument for interpreting this energy. When you view an image on a computer, each little point (or pixel) is represented by 256 levels (or 8 bits) of data (Red, Green, Blue, or Gray). This is near the limit of contrast detection by the human eye.

In its native mode, a typical camera takes an image with 65,535 levels (or 16 bits) of data. When an astronomical image is generated, multiple images are added with a calibrated sensor, and the range of levels can go into the millions.

My workflow is a process of combining and transforming this huge range of contrast data to an image suitable for human vision.

As I process each image, I translate this wealth of data to produce a "real" color astronomical image. Here I report my current techniques. Note that I'm not endorsing any particular software product.

Calibration

Calibration normalizes all of the pixels in the camera. You self-calibrate the images you see. Within your eye you have a collection of biological pixels called rods and cones that vary in sensitivity to light. And you have a blind spot where the optic nerve passes through the retina. If you look at a uniform surface, you see a uniform surface, not all of the perturbations that are in your eye. Your brain is calibrating your image.

In a non-astronomical photo, these effects are small. With an astronomical image, we want to enhance the image to bring out detail. Without calibration, this data would be overwhelmed by noise.

An astronomical camera uses pixels where each pixel is an individual capacitor within a Charged Coupled Device (CCD). Each CCD pixel is a little bit different from each other. One might be noisy, one might be more efficient. The calibration process puts them all on an equal footing so that the contrast indicated in the image is an accurate representation.

In an electronic photographic image there are three sources of noise to remove by calibration: electronic, thermal, and optical.

Electronic noise is generated by the electric currents flowing inside the chip during the imaging process. It is removed with what is called the **bias frame**. A bias frame is just an image taken by the camera with the lens cap on at its fastest speed. This frame identifies differences in how the electronics are processed.

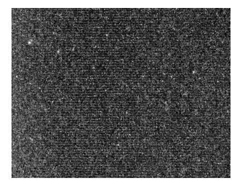
Thermal noise, or dark current, is noise generated by each CCD element during each exposure. It is removed with what is called the **dark frame**. Since thermal noise varies with temperature a dark frame is taken at the same temperature as the data, or light, frame — the actual photo. Dark frames are also the same duration as the light frames.

Optical noise comes from non-uniform illumination (vignetting) and dust on optical surfaces such as a filters or the sensor itself. Dust casts a characteristic circular shadow. In fact, several online CCD related calculators will tell you how far away the dust is from your sensor by plugging in your focal length and the size of the shadow.

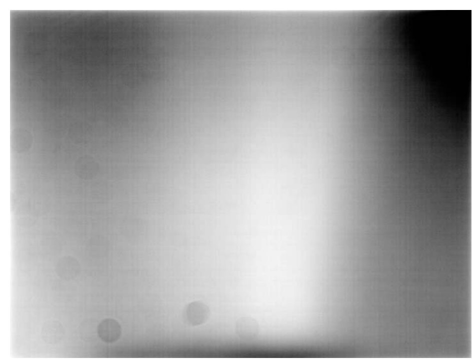
Optical noise is removed with what is called a **flat frame**. You create an image with the optical train uniformly illuminated. Astrophotographers do this in many ways — by imaging the sky at twilight, putting a t-shirt over the end of the telescope, or imaging an old LED monitor. I use a box that has a series of evenly distributed LEDs behind three layers of frosted plexiglass to spread the light uniformly, adjusting the exposure so the average pixel is illuminated to about 25000 of its 65535 levels of contrast. I choose this level because it is in the middle of my CCD sensor linear range.

A flat frame is generated for each version of the optical train that you will use — one flat frame for each filter.

Small section of a contrast enhanced bias master calibration frame



Small section of a contrast enhanced dark master calibration frame



Full frame contrast enhanced filtered master flat frame

For each type of calibration, I take twenty-five images to create a master calibration frame. This removes most statistical fluctuations. I update the dark and bias frames every few months. These do not change frequently. The flat frames, on the other hand, are updated every time the optical train is touched. If I rotate the camera to get a better framing, I take a new set of flat images. Many astrophotographers take a fresh set of flats for each image.

Imaging

Next comes the fun part, actually taking a picture. For this article, my target was M13, a very bright globular cluster that resides in Hercules. I used a 10" telescope with a 2000mm focal length to take the images. I wanted a straight up, full color image so I took texposures through red (R), green (G), blue (B) and luminosity (L) filters. The luminosity is clear but cuts out low level infrared and high end ultraviolet light.

Exposure varies by object. I might shoot something extremely bright for less than 300 seconds. A longer duration increases the chances of something spoiling the image, such as stars appearing out of round due to polar misalignment, a wind gust moving the scope, or an airplane or satellite flying through the image.

I do not want my highest values to be overexposed or clipped. As a general rule, for broadband filters, my maximum exposure is 300 seconds.

More frames are always better but there is a point of diminishing returns. Sky quality and time constraints limit how many frames actually improve your image. For this image, I used five 300 second frames for each filter.

The L frames are binned 1x1 (3352 x 2532 pixels). This is the maximum resolution my camera can give. The L images are 8 megapixels.

The RGB frames are binned 2x2. Binning is combining pixels to make 'super-pixels.' For every pixel in the image, 4 adjacent CCD pixels are gathered together to form 1 pixel. The camera becomes equivalent to a higher ASA film. These images are 2 megapixels (1676 x 1266 pixels).

At the end of the imaging session — taking five images through each filter — L,R,G, and B —I have twenty total images. Total exposure time is 100 minutes. (I won't go into the intricacies of tracking a target moving 15 arc-seconds per second with a 0.5 arc-second resolution in this article.)

Stacking

Stacking is the process of combining the gathered images into a single image that has the full contrast range available.

The software package I use to stack is CCDStack by CCDWare. Each stacking software package available has a unique method of processing images. The process should be well documented; there are likely to be tutorials to get you started.

Stacking also removes any geometrical differences between the images. With an exposure of 100 minutes you might expect some small deviations. We actually induce deviations. After each exposure, the image is slightly moved. This is called dithering. Dithering makes sure that a pixel-unique artifact is blurred by being spread among many pixels.

One more thing happens as we enter stacking. Up to this point, each pixel is represented by 16 bits of data or 65535 levels. As we stack, each pixel is represented by a 32 bit real (or floating point) number. This means that the number of unique contrast levels goes up to about four billion with a much larger range.

The following steps are repeated for each filter:

- Each frame is calibrated with the appropriate bias, dark and flat calibration masters. All frames have a minimum of systemic noise.
- All of the frames are aligned or registered based on the location of the brightest stars. They are fitted together via a statistical function. We now have a set of images with all of the stars aligned for each filter.
- The images are then normalized. This removes statistical deviations across images. Since these images are long duration, things like sky glow and atmospheric turbulence affect the background levels in the image. After this step, ideally, all of the images look the same.
- The images now go through a round of data rejection. This process minimizes noise, looking at all locations across all of the images and eliminating outliers. For this image, one pixel across five images would have values of 78, 81, 86, 75, and 121. The 121 value would be thrown out if its deviation meets a defined threshold.
- The images are combined via a simple mean. Each point becomes a mean of all acceptable values of all of the captured images for that filter.

At the end of this exercise, the three images for RGB are then stepped up in size from the two megapixel to the eight megapixel size of the luminosity image. This gives us four stacked images, one for each filter.

Contrast unenhanced stacked luminosity image of M13

All four of these images are again re-registered so that all of the different images are aligned. Additionally, a deconvolution is performed on the luminosity to enhance detail. (Deconvolution is a statistical manipulation that sharpens the image). And all of these aligned images are saved in their own directory. The remaining work is done in this directory.

Up to this point all of the work has been done in the Flexible Image Transport System (FITS) format where the images are represented by 32 bit floating point numbers. Most photo-manipulation software does not accept this format. To use this software, we need to throw out some detail and go back to a 16 bit integer representation in the TIFF format. Prior to this transition, I insure any detail I need is captured in a contrast-enhanced version of the image. I then save all versions (LGRB and L-Deconvoluted) in a scaled 16 bit TIFF file. I can now work on the image in photo manipulation software.

Enhanced contrast of the same stacked luminosity image of M13

Photo-manipulation Software

I use Photoshop CS5, with several plugins — Astronomy Tools from ProDigital Software, Gradient Xterminator from RC-Astro, and Focus Magic — to put all of this data together into a reasonable representation of what the eye could view if it were sensitive enough. There are many photo-manipulation software packages. Among astrophotographers, preference seems to be split between Photoshop and Pixinsight, with a trend toward to Pixinsight.

My first step is to assemble a base color image from the RGB images. Astronomy Tools makes this simple. When I open the three files, it adds the different layers together to yield a RGB image, and it makes a good guess on the color balance. If I have a known G2V (sun equivalent) star in the field, I can adjust that star to be white. If not, the color balance is adjusted to provide the best representation. But this color image does not have the best resolution.

I then add Luminosity to the image, opening the Luminosity and the deconvoluted Luminosity images, combining them to provide the most

Base Color Image

detailed image with the least noise. I add this image as a new layer into the base color image and blend with the "Luminosity" option.

So what I have done is taken the 3 RGB images and generated a color image. Now I merge the image using a brightness value in the most accurate image I have. My result is below. Depending on the image, I may make small modifications or touch up obvious errors.

M13 color image with best resolution

The key is that what I present is in the data I have collected. It may not be directly visible by the human eye but it is an accurate, calibrated and deep measurement of the light emitted by the objects. That is what I am after. — *Steve Ruhl*

In this Issue

Articles

BPAA Quarterly is a publication of the Battle Point Astronomical Association.
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