Fall 2011
Issue 95

Quarterly

www.bpastro.org Bainbridge Island, WA

Events Calendar

(unless otherwise noted, all events are at the Edwin Ritchie Observatory, Battle Point Park)

September

September 4 ◐

September 7
7 p.m. BPAA Board Meeting

September 12 ○

September 20 ◑

September 23
Autumnal Equinox 2:05 PDT

September 24
7:30 p.m. Planetarium Show and Star Party

September 25
Uranus at opposition

September 27 ●

September 29
7 p.m. Fall Introduction to Amateur Astronomy Class begins

September 29–October 2
Camp Delany Star Party, Sun Lakes State Park

October

October 3 ◐

October 5
7 p.m. BPAA Board Meeting

October 6
7 p.m. Introduction to Amateur Astronomy 2nd class

October 9
Draconids Meteor Shower Peak

October 11 ○

October 13
7 p.m. Introduction to Amateur Astronomy 3rd Class

October 19 ◑

October 20
7 p.m. Introduction to Amateur Astronomy 4th Class

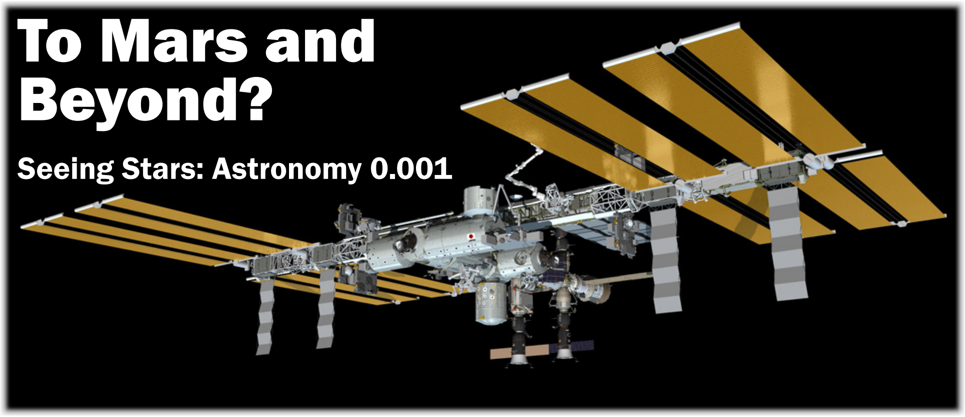
October 22
7 p.m. Planetarium Show and Star Party

October 26 ●

Calendar con't page 2

To Mars and Beyond?

Seeing Stars: Astronomy 0.001



International Space Station, August 2011 courtesy NASA

A moving twinkle in the early evening sky? A realized dream of space exploration? A platform for an amateur's telescope? What has the International Space Station (ISS) been? And what comes next?

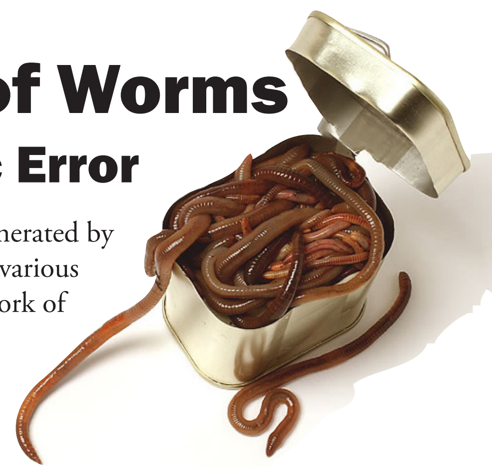
The successful return of the final space shuttle flight on July 21 raises questions about what the ISS has done. As far as the US cooperation in the program, NASA has flown 135 missions and had 356 astronauts and cosmonauts participating over these 11 years, plus a number of animals. The Station goes around the Earth every 91 minutes, about 15 revolutions each Earth day. (Such circling has been a bit of a problem for the Muslim astronauts who are supposed to pray facing Mecca five times a day. They've solved the times of prayer by conforming to Earth time, not space, but facing Mecca has been problematic.)

Five space agencies have been involved in the project: NASA for the Americans, the Russian Federal Space Agency, the Japan Aerospace Exploration Agency, the Canadian Space Agency, and the European Space Agency. Crewmembers have represented 15 nations. (At one time part of the test to judge how well a Japanese

Mars con't page 7

Closing a Can of Worms

Eliminating Periodic Error



Periodic error (PE) is the systematic error generated by a telescope's right ascension (RA) drive. The various physical components comprising the clockwork of a RA drive contribute to periodic error. The conventional mechanism to correct this is to record the error and train the electronics to speed up and slow down appropriately. This approach is called Periodic Error Correction (PEC). While PEC is helpful, it is not a precise solution and can be cumbersome to initiate. PEC requires exact synchronization of the physical and electronic components. This can be problematic as things change and get banged around. The correction needs to be recalculated frequently to ensure accuracy. There is a better

Worms con't page 4

October 27
7 p.m. Introduction to Amateur Astronomy 5th Class

October 29
Jupiter at opposition

NOVEMBER

November 2
7 p.m. BPAA Board Meeting

November 2 ◐

November 3
Taurids Meteor Shower Peak;
7 p.m. Introduction to Amateur Astronomy final class

November 6
Daylight Saving Time ends

November 10 ○
7 p.m. Advanced Amateur Astronomy Class begins
Deadline for Winter issue of BPAA Newsletter

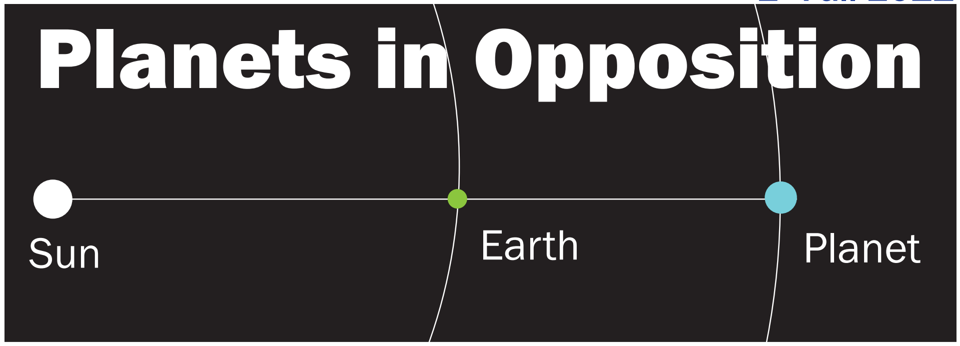
November 17
Leonids Meteor Shower Peak;
7 p.m. Advanced Amateur Astronomy 2nd Class

November 18 ◑

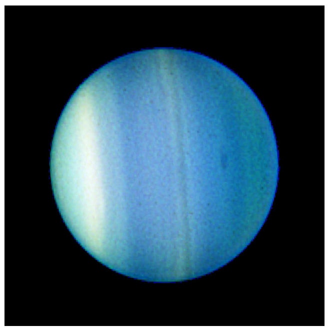
November 19
7 p.m. Planetarium Show and Star Party

November 25: ●

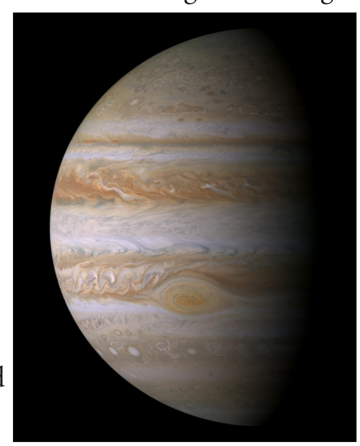
Any member who is planning to observe can invite others to join in by sending an email to *bpaa@yahoogroups.com*. To join our email group, send an email with your name to *bpaa-owner@yahoogroups.com* and we can en-roll you. If you want to have web access to the messages and files, you can join the Yahoogroups 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.



CALENDAR NOTES: Fall? Autumn? How can summer possibly be ending, when it's only just begun? Summer, such as it was, offered fewer viewing opportunities than in most years. The coming season, while not known for its clear skies, will at least offer extra evening hours of darkness. Look for the 'W' shape of Cassiopeia, which dominates the autumn sky. Autumn is also a good time to view the zodiacal light, or "false dawn." *Sky and Telescope* advises looking to the east 120–80 minutes before sunrise from a dark location during a two-week period starting on September 25 and ending October 10. Also on September 25, Uranus is at opposition. When a planet is in opposition, it is visible all night, rising around sunset and setting around sunrise. A planet in opposition is also closest to the Earth, making it appear bigger. So opposition makes for great viewing, especially around midnight. But wait, there's more. On October 29 Jupiter will be very close and very bright.



Uranus by Hubble



Jupiter by Cassini

If you want to see the zodiacal light or Uranus from a dark location this fall, the Olympic Astronomical Society of Bremerton is offering us a wonderful opportunity. Its annual Camp Delany Star Party is scheduled for September 29–October 2. It's held at Sun Lakes State Park near Ephrata. The park features Dry Falls, carved by Ice Age floods, and one of the geological wonders of the world. We've attended in the past and enjoyed the event both by day and by night. Meals are provided and the accommodations include bunk houses and tent and RV sites. More information is available on the society's website *www.olympicastronomicalsociety.org*.

The Olympic Astronomical Society is also holding a Hurricane Ridge Star Party in Olympic National Park on September 3 at 7:00 p.m. If clear, this would be great viewing from an altitude of over 5,000 feet. More information at the website above. The Park also offers additional viewing from Hurricane Ridge through their astronomy programs. The programs last one hour and offer viewing with telescopes. They run only through September 3rd, but will probably be continued next year. The programs are canceled if the skies are cloudy. Program status is available at 360 565-3131 after 5:00 p.m. the day of the program.

Our monthly planetarium showtimes are 7:30 p.m. in September and 7:00 p.m. in October and November. Check our website *www.bpastro.org* and the local newspapers for information on topics. BPAA is also offering two classes for amateur astronomers this fall, a six-session introductory course and a four-session advanced class. Again, see the website for details. —*Diane Colvin, BPAA Events Manager*

Launch Pad and Beyond

"Space is big. You just won't believe how vastly, hugely, mind-bogglingly big it is."—Douglas Adams, *The Hitchhikers Guide to the Galaxy*

A week-long "crash course" in astronomy funded by the National Science Foundation, the Launch Pad Workshop's mission is simple: educate writers of all types about modern science, specifically astronomy, and in turn reach their readers. In this way, organizers hope to educate the public and to reach the next generation of scientists.

This past July, I had the good fortune to attend the Workshop (*http://www.launchpadworkshop.org/*) in Laramie, Wyoming. Professor Mike Brotherton, PhD, one of the world's foremost experts on quasars, heads the program. He is assisted by Professor Jim Verley, PhD, who specializes in how to teach science-based curricula. This year's guest instructors included Stanley Schmidt—the long-time editor of *Analog Science Fiction* magazine; Jerry Oltion—a well-known SF writer and avid amateur astronomer whose home-built telescopes have been featured in several *Sky and Telescope* articles; and Dr. Henry Stratmann—writer and cardiologist, who provided insights into the biological processes of humans in space.

As you might imagine, absorbing a semester's worth of astronomy in one week was somewhat challenging. Fortunately, Mike, Jim, and all of the guest instructors presented their materials in a lively manner with plenty of enthusiasm and visual aids. Lectures, labs, and field trips covered the fundamentals. Specific topics included: the scale and measurement of the universe, spectroscopy (ed. note, see spectroscopy article p. 9), observation across the electromagnetic spectrum, the lifespan of stars, the classification of stars, and the various structures of the universe—including galaxies, black holes, and quasars. Additional

Inside WIRO

topics ranged from cosmology, to biological hazards of space flight, to world-building in science fiction. Yes, it was an action-packed, neuron-busting extravaganza.

Although the week's weather was less than ideal for stargazing, two evenings with telescopes bracketed the labs and lectures. On the first such night, Jerry Oltion and his 18" Dobsonian performed admirably in an ad hoc, enthusiastic, parking-lot star party. Amidst pitiful viewing conditions, it was amazing to watch Jerry work his way around the mostly-cloudy sky without benefit of a star chart or a computer to guide his scope. We saw the Moon, Saturn, Titan, Albireo (a double star with two different colors), Polaris (the North Star, a double star with two different magnitudes), M3 (a globular cluster), M11, also called the Wild Duck cluster (an open cluster), the Ring Nebula (a planetary nebula), and M82 (an edge-on spiral galaxy)—all spotted during momentary breaks in the clouds. It was also fun to watch students who had never looked through a telescope before. Gasps of delight reinforced the wonder of it all.

Later in the week we visited the Wyoming Infrared Observatory, WIRO (*http://www.physics.uwyo.edu/~mpierce/WIRO/*), an hour's drive from Laramie. Once again, weather played a role. Although the sky was clear overhead, a supercell thunderstorm had parked itself over Laramie. It provided a spectacular show, but standing next to a large telescope, cradled in a steel superstructure, atop of a ten-thousand-foot high mountain, is problematic when lightning is dancing across the sky. Thus, we had to wait a few hours before the dome could be opened. In the meantime, we toured the facility, had a close up look at the 2.3 meter scope, and watched the loading of liquid nitrogen into a dewar—a thermos-like container at the base of the telescope, which houses an infrared camera. The camera operates at 77 K (-321 Fahrenheit). Unfortunately, due to the delay caused by the storm, and a couple of technical glitches, we had to leave before any observations took place. Nevertheless, the visit provided valuable insight. As a writer, I found the behind-the-scenes tour fascinating. Science is a mesh of long hours held together with coffee, stale donuts, duct tape, jury-rigged wires, and patient grad students explaining their research to anyone willing to listen.

The week closed with a discussion of dark matter, cosmology, and the acceleration of the universe. And with that, they sent us on our way, with the hope that accurate science finds its way into our work, even if it's fantasy fiction, and that such stories might inspire the next generation of scientists. According

Launch Pad con't page 6


Outside WIRO

Worms con't from page 1

way. Converting your telescope's RA drive from an open control system to a closed control system can eliminate the need for PEC.

PEC as the Worm Turns

Periodic error is inherent in the design of RA drives. Minor errors in the machining of the worm gear, precision and alignment of the support bearings, alignment of the drive motor, roundness of the drive gear, and other sources all contribute to a cumulative error that repeats with every turn of the worm. For astrophotography, Periodic Error Correction attempts to record errors and use the processing power of the electronics to subtract the errors by altering the speed of the RA motor.

Problems arise since not all of the errors are periodic. Drift, wind gusts, telescope imbalance, and atmospheric turbulence can all add error components that are not periodic and should not be recorded. To overcome these multiple sources, a statistically meaningful sample needs to be collected. This involves taking data for 4 or 5 worm gear revolutions. Depending on geometry, each worm cycle is 4 minutes (360 teeth), 8 minutes (180 teeth), or something else. The data needs to be collected and recorded by the mount electronics, easily a 30 minute operation. This cuts into valuable observing time.

There are several software packages to assist with the recording of PE. PEMPro by CCDWare interfaces with most mounts. Many mount manufactures supply their own software, each one unique.

To program a mount with PEC requires the following tasks:

1. Collect raw RA data.
2. Perform an analysis on the data. If you are happy with the results, you are done.
3. Manipulate the analyzed data appropriately and load it into the mount's software. Go to step 1.

Fig. 1. Bad tracking: a sky full of Saturns (a rejected 5 minute exposure with trails of 8 to 10 arcseconds)

Of course, if you change the tension on your worm gear, fiddle with your motor, or switch telescopes, you need to redo your PEC curve.

The table at the end of this paper compares data from a standard PEC approach with the (preferable) techniques described below.

Thought Process

Astrophotography requires taking long exposures of moving targets. The sky moves 15 arc-seconds per second. While individual configurations vary, most astrophotos show 1 to 2 arcseconds per pixel. Tracking variations greater than a few arcseconds change nice round stars into a sky full of Saturns. (See Figure 1.) PE values may run 10 to 20 or more arcseconds over each rotation of the RA worm gear. These errors need to be removed.

A normal RA drive is an open control system. An open control system does not provide feedback to the controlling electronics. As the RA advances, the electronics system has no position knowledge. Only the precision of the machinery keeps the target in the same place on the focal plane. With or without PEC, the controller thinks it knows but has no verification. Auto-guiding can assist with this process; but the guiding, imaging, processing, and transmission results in delays of several seconds. Each correction perturbs the mount, which can induce oscillations into the mount. Auto-guiding does not make the RA drive a closed control system. It does not provide real-time feedback to the controller. No guiding was done in any configuration in this paper.

My dad worked as a flight guidance and control systems engineer for 40 years at Douglas Aircraft and he just despised open control systems. The alternative is called a closed control system. A closed control system allows for corrections to the RA axis in real time. For a telescope, this means that the RA position is actively monitored and adjusted several times a second.

Baseline Configuration

For this analysis, I used a secondhand 1997 Losmandy G-11. With 360 teeth on the RA worm gear the mount has a period slightly less than 4 minutes. (The "slightly less" is the difference between a solar and a sidereal day.) The G-11 is somewhat equivalent to buying a Ford or Chevy. It is not the best mount in the world but it is very functional and works well for visual applications.

The controller used for the telescope is the Sidereal Technology Servo Controller (*http://www.siderealtechnology.com/*). This controller utilizes a feature called Tick Management (TM). TM uses a "medium" resolution encoder (320,000 ticks per RA revolution) to measure the position of the axis. This resolution allows the position-calculating software on the laptop to receive position updates from the encoder (via the controller) several times a second. The software dynamically compensates for the mechanical variations internal to the encoder and provides an active closed loop for the RA axis. Details on the nature of the TM software can be found in the documentation on the Sidereal Technology website. A requirement of the controller is that Tick Management and Periodic Error Correction are mutually exclusive. You can have one or the other but not both.

Worms con't next page

Worms con't from page 4

Analysis Software

I used PEMPro (*http://www.ccdware.com/*) to analyze the periodic error. PEMPro communicates with both the mount and camera software. It images a selected star repeatedly and records movements. The position is calculated and plotted against the RA worm cycle time.

After the RA worm gear has gone through several cycles and PEMPro has gathered a statistically significant sample, the data is analyzed with Fast-Fourier Transform software to pick out the frequency components, and a PEC curve is created to counteract the natural PE in the system.

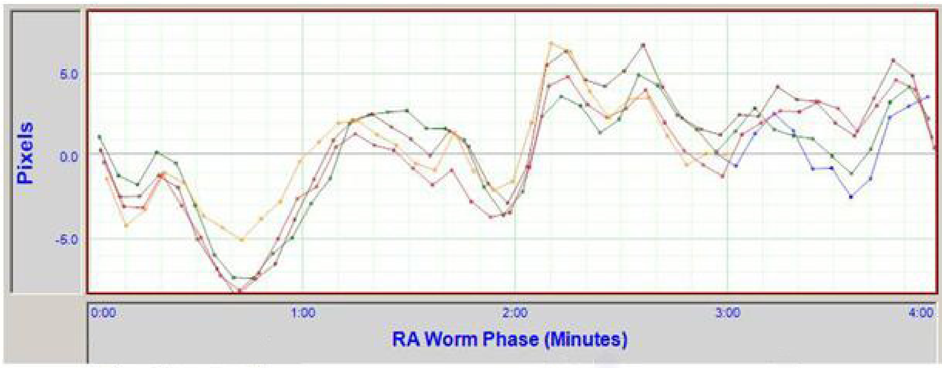


Fig. 2. Raw tracking data for baseline configuration

Figure 2 shows the raw tracking error over 4 worm cycles to provide a base configuration. PEMPro performs statistical analysis and Fast-Fourier Transforms (FFT) to pull the periodic components from the data.

The red curve in Figure 3 shows the completed PEMPro analysis for this base

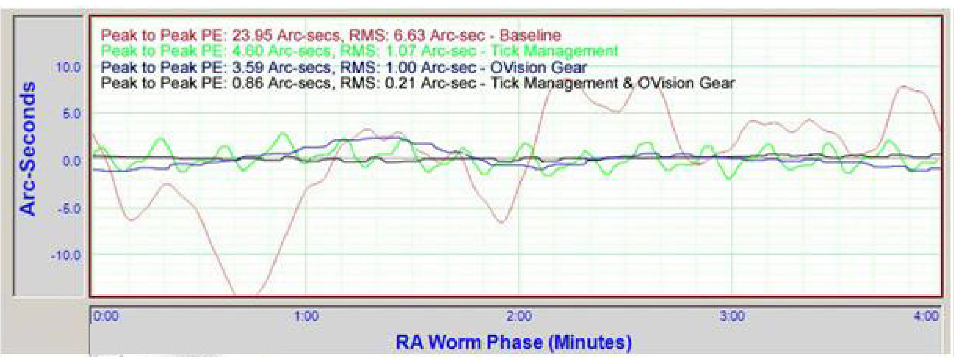


Fig. 3. PEMPro Analyzed Periodic Error curve for all configurations

configuration. If you were programming your mount for PEC, you would load this curve into your mount. For this paper, we are using it as a metric to quantify the amount of periodic error.

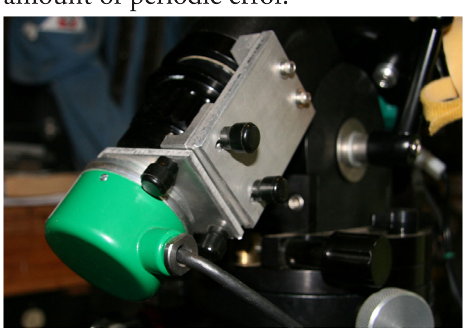


Fig. 4. Gurley encoder mounted on Losmandy G-11

The end result is about 24 arc-seconds of PE over one worm cycle. This is a typical value for this class of mount. Higher-end mounts can reduce this value by a factor of 3 to 4; but as the mechanics of the mount are perfected, the cost of the mount goes (way) up.

Tick Management

This configuration adds a Gurley (*http://www.gpi-encoders.com/*) R158 encoder with a resolution of 320,000 ticks per revolution. Sidereal Technology's Tick Management manages the RA drive by monitoring the encoder. See the Setup Manual on the Sidereal Technology website for details. Figure 4 shows the Gurley encoder mounted on the G-11 mount. The PEMPro analyzed periodic error curve is shown as the green curve in Figure 3. Adding TM essentially closes the loop on the control of the RA axis.

The encoder is placed directly onto the center of the RA axis. There are no gears or belts. This simplicity increases accuracy, as every additional component introduces additional errors. The goal of the encoder is to get the most accurate reading possible.

The peak to peak performance of the TM curve is much better (8 vs 24 arcseconds), but it has a very nasty characteristic. The high frequency of its remaining errors would be very difficult for auto-guiding to remove. Because of the inherent delays in auto-guiding, this frequency would likely induce oscillations into the mount. By the time a correction is made on one peak, the correction is likely to be made on the top of the next inverted peak throwing the telescope further off target and inducing a larger correction.

Precision Gearing

In this configuration, the encoder is temporarily removed and the original equipment worm gear is replaced with the G-11 NS precision gear from Ovision (*http://ovision.com/*). The original Losmandy worm has several notorious flaws that Ovision's aftermarket replacement corrects. Each individual gear is tested. The test report for my gear showed a peak-to-peak error of about 2 arcseconds. Figure 5 is a photo of the worm gear installed on the G-11. The blue curve in Figure 3 shows the PEMPro analyzed improvement: the Ovision test report is accurate.

Losmandy recently offered a precision gear with a one-piece block but the author selected the Ovision for several reasons. Ovision has been making these for about a decade and the reviews I have seen on them are

Worms con't next page

Worms con't from page 5

glowing. Another consideration is that the Losmandy gear has an adjustment feature that would likely interfere with the servo motors on my particular mount. (On a standard G-11, this would not have been an issue.)

I was also steered away from the Losmandy version by a more esoteric reasoning. Losmandy has been making these mounts since the early 1990s. Yet they have chosen not to improve the RA in spite of well-documented deficiencies. The standard Losmandy RA worm gear comes with two blocks holding the bearings. It is very easy for these blocks to become misaligned and induce a PE whose frequency is not a multiple of the period of the worm. This error is referred to in the various blogs as the "76-second error" and it cannot be removed with PEC. The Losmandy precision gear still uses two blocks (whereas the Ovision block is milled from a single block of aluminum). Losmandy should have fixed these problems many years ago.

The Ovision worm gives a very nice result. The size of the curve is small and the frequency is very low. The residual error could easily be removed by auto-guiding. This result is comparable to mounts costing much more than a Losmandy.

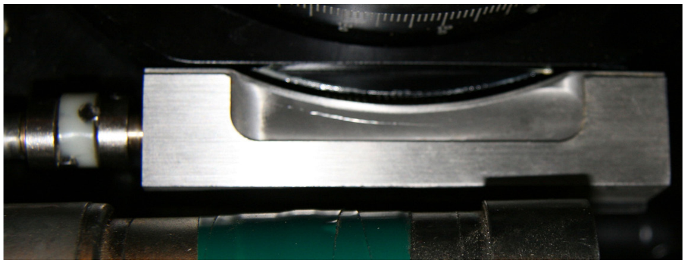


Fig. 5. The Ovision one piece precision worm block installed on the G-11

TM & Precision Gears

Combining TM and the G-11 NS precision gear from Ovision produces excellent results. The black curve in Figure 3 shows the analyzed periodic error curve.

Who needs PEC?

The residual error is about half the size of a pixel on my camera. Further improvement is really beyond what I would expect from the capabilities of this mount.

Summary

Periodic Error Correction is the most common type of periodic error reduction. While improvement is seen with this correction, PEC requires synchronization between electronic and physical components, introduces its own errors, and needs to be repeatedly programmed when things change. By converting an open system to a closed system, Periodic Error can be essentially eliminated.

The combined improvements of Tick Management and precision RA gearing reduce the periodic error to significantly less than the pixel size. This result exceeds any that I have seen for a system utilizing a PEC curve loaded into a controller. With this combined system, the aggressiveness of the auto-guider can be reduced so that the auto-guider solely corrects drift issues; and best of all, it just works. You plug it in and verify it is working. Then you get sub-arcsecond tracking. There is no programming of PEC curves. My dad would approve. —*Stephen Ruhl*

Table 1. Comparison of standard PEC approach with TM and precision RA gearing.

Calculated PEC curves	Peak-to-Peak Error (Arc-seconds)	RMS (Arc-seconds)
Base Losmandy Gemini G-11, 2004 model	7.54	1.83
PEC Correction to 2004 Gemini	2.85	0.71
After Multiple Iterations of PEC Correction to 2004 Gemini	1.45	0.41
Base Losmandy G-11 (1997 model)	23.95	6.63
Tick Management (1997 model)	7.79	1.56
Precision RA Gearing (1997 model)	3.59	1.00
Tick Management & Precision Gearing (1997 model)	0.86	0.21

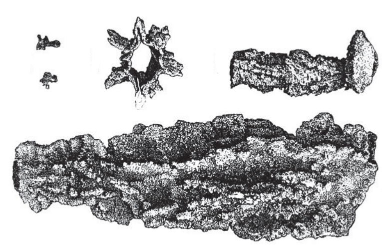
Launch Pad con't from page 3

to Jim Verley, they'll know that Launch Pad has been a success when a past student writes a best-selling werewolf novel in which the phases of the moon have been described correctly.

Although I have no plans to write a werewolf novel, I can state for a fact that Launch Pad fulfilled its mission. What a great experience. I wish that all science education, at all levels, was infused with such enthusiasm and clarity. I encourage anyone who creates anything for an audience to take a look at the program if you have any interest in astronomy, and perhaps more so if you don't!

The application period for next summer will open in March, 2012. Admission is competitive, with only twelve to fifteen students selected from each year's sizable applicant pool. Consideration is provided to minorities and women, who have been traditionally underrepresented in science education. Visit Launch Pad's website (*http://www.launchpadworkshop.org/*) or Mike Brotherton's blog (*http://www.mikebrotherton.com/*) for more information.—*Todd Vandemark*

Todd Vandemark, a volunteer at BPAA, is the editor of the Science Fiction Writers of America (*www.sfwa.org*). He writes speculative fiction, chases storms, and prospects for fulgurites.



Fulgurites, natural hollow glass tubes formed in quartzose sand, silica, or soil by lightning strikes.

Mars con't from page 1

applicant would do under the stresses of weeks-long dully repetitive tasks was to fold 1,000 origami cranes. The quality of the last ones was compared against those they'd folded first.)

The ISS was launched with the hope that it would provide a space laboratory, observatory, factory, and educational facility to study future, possibly manned, space trips, especially those to Mars. Recent projects range from a middle school study of the Earth as seen from the ISS to hurricane detection for ground-based monitoring. The astronauts have worked on developing methods from space to determine the carbon dioxide and methane content in the Earth's atmosphere, and on the effects of space flight on the automatic regulation of circulatory, respiratory, and cardiac functions over time.

One of the ongoing series of ISS experiments is on how flames, fluids and metals react in space. The lack of gravity means, for instance, that the normal convection currents on Earth such as hot air rising don't exist, so flames have a different shape. Water and other fluids do not stay in an open container; they float around even more freely than do the astronauts. Molten metals mix more easily. And how do you hold onto something that has no gravity to make it stay put?

They've studied the problems and solutions of diagnosing and treating medical conditions without a doctor handy (which also could help in rural Africa as well as backwoods America), including the early detection of osteoporosis in space (an ever-present problem for astronauts). They have gotten practice in repairing damage to the ISS way out there, and in extinguishing fires. They have an amateur radio (ARISS) that makes scheduled contacts between the astronauts and cosmonauts aboard and classrooms and communities. The ground-based Mars-500 project looks towards the manned mission to the Red Planet. All of this is in accord


View of hurricane eye from ISS, courtesy NASA

with the international agreement, of which the US is a signatory, that no space object may be claimed by any one country. In these, and hundreds of other similar projects, the ISS has been active. (Although the amateur telescope proposed by BPAA's founder, Mac Gardiner, is still earth-bound.)

There had been several other space station projects prior to the ISS: the Soviets had *Salyut* and *Mir* in the 1980s and the US was planning to send *Freedom* into space. During *Mir's* 15-year lifespan, it was visited by astronauts from 12 different countries. Economic problems and the end of the Cold War helped US president George H. W. Bush and Russian president Boris Yeltsin come to an agreement to cooperate in the space program in 1992. The next year vice president Al Gore and Russian prime minister Viktor Chemomyrdin planned what became the ISS, combining Russian, Japanese and US modules.

The ISS is made of 15 pressurized modules plus a number of external, mostly non-pressurized additions. Segments of the ISS have come from Russia, Europe, Japan and the US. The Russian Multipurpose Laboratory Module Nauka and several more external pieces including the European Robotic Arm are expected to be in place and working by 2012. At that time the whole station will have a mass of over 400 metric tons with 16 pressurized modules of laboratories, docking compartments, airlocks, nodes and living quarters, with a volume of about 1,000 cubic meters. Further plans include help from NASA's Commercial Orbital Transportation Services and Commercial Resupply Services contracts lasting through at least 2015, with the hope that the ISS will continue to function into 2020. NASA is still active in space exploration: the Juno rocket to Jupiter was launched on August 5th.

Beyond ISS

A most readable book by Mary Roach, *Packing for Mars*, details many of the mundane (earthy?) situations of space flight from the crews' schedules and sleeping arrangements to toilet facilities and the astronauts' initial nausea. (One reason crew interviews are rare during the first days of their mission.) The recycling of water is also an important function on board. All these issues will also be important on any Mars missions that include human explorers.

In addition to all these, one has to acknowledge the psychological problems of a small group of people confined in a cabin for—how many weeks? months?— that it will take to get to Mars, work there, and return to Earth. Two years (they think) with no possibility of escape and few ways to vent one's frustrations. And during a long trip, boredom becomes a serious problem.

After the relatively short terms of the astronauts' stints on the ISS they report that even those companions with whom they were the most congenial at first became, for their very congeniality, the ones they could least tolerate. When there is no possibility of escape and no door you can slam, when your life depends upon the one you hate, what do you do?

Without question the space station has given scientists and governments specific information on the probable requirements for getting human beings to Mars. Obviously astronauts will need a continuing supply of air, food, water and a safe retreat, and they must be protected from the heat and cold and

Mars con't next page

Mars con't from page 7

the intense radiation of space. Because Mars has less mass than the Earth, the pull of gravity is less; therefore everyone loses bone density and some immunity to disease. Those with good cholesterol, no history of kidney stones and a high radiation tolerance are better risks. Maintaining contact with the Earth from Mars is desirable; but immediate, direct contact is not possible, even at the speed of light. Then there's the expense of the project, including the techniques and power to return to Earth.

The value of going to Mars? The hopes are that Mars will provide minerals for Earth that are worth mining and transporting, a stable location for observations of Earth and space, and perhaps a place of refuge from Earth's problems. More and more it looks like there is water on Mars. Does that mean life as we know it? It could be a staging place for further exploration of space. Certainly it will

Dunes on floor of Samara Valles, Mars. Image: NASA/JPL/Texas A&M/Cornell

present challenges and possibilities still undreamed of. And even more certainly, it promises the lasting thrill of space flight; a thrill beyond words in anyone's language.

Mars is there. Do we need any greater motivation to go? What's on beyond?

—*Anna Edmonds*

Sources:
http.//en.wikipedia.org/wiki/International Space Station
Roach, Mary, *Packing for Mars*, W.W. Norton & Company, New York, 2011
www.shuttlepresskit.com

President's Message

In the last newsletter, Diane spent a couple of paragraphs disparaging GOTO telescopes. I also have some strong feelings about this.

If you are looking to buy a "first" telescope to learn astronomy, you will do yourself a huge disservice by getting a GOTO telescope. These telescopes create a barrier to learning the basics of the night sky. Instead of learning astronomy, you are forced to learn a user interface to make the telescope move. Then you will need to align the telescope with an unfamiliar sky. You will likely chuck the whole thing out of frustration.

If you are interested in astronomy, grab a star map, go outside and find some constellations. Find Polaris via the Big Dipper, then go down the meridian and identify each constellation. Spread out in each direction and find a few more. After that, your sky map may have a couple of Messier objects (designated with the letter M) on it. These may be visible with the naked eye or a pair of binoculars. Find them and see if you can identify them. A simple entry level push-pull telescope can replace the binoculars to give you a much better view. Check out a telescope from the club to help. Do this every month, and you will know the sky after one spin of the stars.

After that, there are more detailed star maps. I find that the researching and hunting for new objects visible at dark sites is a challenge and very enjoyable. Asking deeper questions, like "why is that thing shaped like that?" will teach you astronomy. If you simply go from one object to the next down a list, it is analogous to playing video games and teaches nothing.

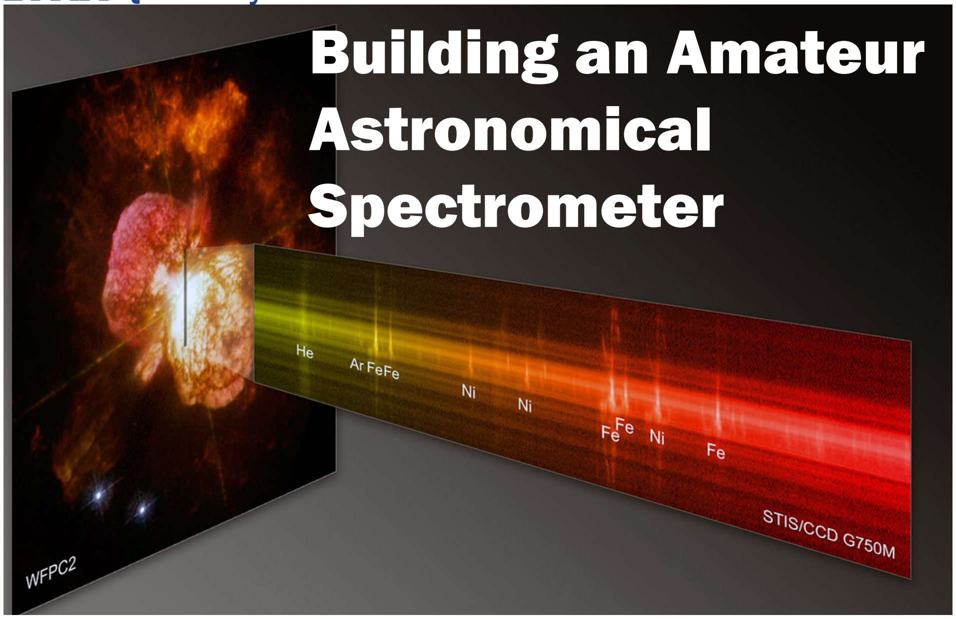
Both non-GOTO and GOTO telescopes have their places. For my astrophotography, I use GOTO exclusively. Having a mount that can GOTO and track accurately is almost required for photography. But when your telescope gets lost, do you have the sky knowledge and telescope interface knowledge to correct it? Trying to navigate with a set of buttons is non-trivial.

When I am showing people objects at a star party, a simple push-pull Dobsonian telescope works better than a GOTO scope. With a simple Dob, I can move about at will and go from object to object in a heartbeat. With a little examination of a sky chart, I can put my telescope on an object or close enough that I can find it quickly. I have removed the GOTO electronics from my Dob for this reason.

Late Breaking News

Congratulations to Vicki, BPAA newsletter editor, and all the folks who contribute to the newsletter. We just received word that it won 4th place in the Astronomical League's Mabel Stern Newsletter contest. —*Steve Ruhl*

Building an Amateur Astronomical Spectrometer



Spectral Signature of Eta Carinae — NASA, ESA and the Hubble SM4 ERO Team

Amateur astronomers can make real contributions to our knowledge of the cosmos by characterizing spectral signatures of celestial objects. The use of charge-coupled devices, such as CCD cameras, has all but done away with the use of photographic film for astrophotography. The same technology makes it possible to do away with photographic film for recording spectral data. With CCDs easily available to be incorporated in spectrometers it is possible for do-it-yourselfers to practice spectrometry with homemade instruments. I have recently decided to step gingerly into the field of amateur astronomical spectrometry, using home-built equipment.

I'd been doing basic physics experiments with light for a couple of years, and was between projects when Harry Colvin off-handedly asked me if I might be interested in trying to build a spectrometer. He had a book for amateur builders that he loaned me. I originally was hesitant, but the more I looked into it the more the subject intrigued me.

I did not use a CCD as a light detector. I didn't have a CCD. Instead I used a photon detector I had on hand, capable of recording and counting single photons. This device depends on an avalanche photodiode and is on loan to me from Sensl Corporation. The device is the equivalent of one pixel in a CCD. That means that in order to record a spectrum, I have to rotate the diffraction grating, thereby presenting the detector with a scan of the spectrum. In effect, I look at slices of wavelength sequentially and record the intensity of each slice. Intensity is represented by a count of the photons received per unit of time at each discrete wavelength.

At the diffraction grating, I have a beam of light that contains a mixture of all wavelengths. The diffraction grating is on a rotating stage. Rotation of the diffraction grating is accomplished by a lead screw turned by a stepping motor. The screw is a 3 millimeter diameter bolt with 50 threads per centimeter, approximately 25 centimeters from the axis of rotation. As the stepping motor rotates, the diffraction grating rotates so that different parts of the diffracted spectrum are presented to the detector. The diffracted light coming off the grating enters a lens which focuses an image of the entrance slit onto the detector, which has a sensitive area of about 10 microns width. A scan of the spectrum from about 400 nanometers wavelength to 600 nm takes about three minutes.

I will couple the spectrometer to a telescope with an optical fiber about 3 meters in length. The input will be centered on the focal plane of the telescope, over the star image. Keeping the fiber centered over a moving image will be a problem. I'll have to leave that up to the astronomer.

The other end of the optical fiber butts up against a 40 micron entrance slit made out of two razor blades. A collimating lens collects the light from the slit and presents it to the diffraction grating.

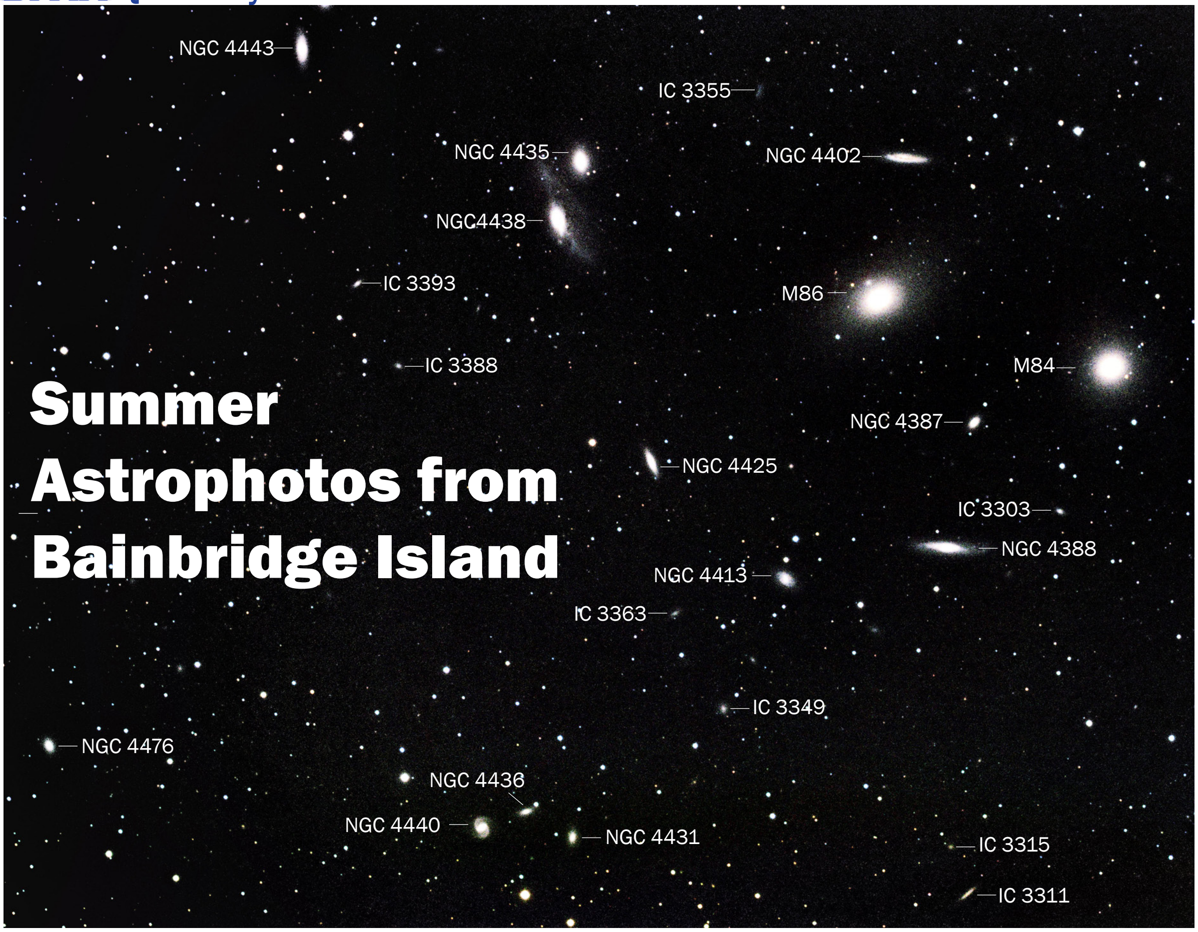
I am currently working on software in collaboration with Nathan Rosenberg, a high school student, in a mentor-student relationship. Our immediate goal is to combine control of the stepping motor and data acquisition on the same computer.

I'm also working on software with which to analyze the data. The critical items of data are the wavelengths of the spectral lines and the ratios of intensity of the various spectral lines. These I am now extracting from the data set; by hand, you might say. Making that process more automatic is not really holding us up. I'll be very happy to just get a raw data file that, when plotted, shows spectral lines from any celestial object. Our own blue sky first; then the moon, and then, hopefully, a bright star.

This spectrometer will be "done" when I can show that the detector on loan from Sensl is useable in this context. That's not been done before. If it doesn't work—if the scanning of the spectrum into a single pixel fails—I'll rework the spectrometer to incorporate a CCD camera.—*Mauri Pelto*

Ed. note: Astronomical spectroscopy is the analysis of the light (electromagnetic radiation) from celestial objects. The wavelengths of light (which includes radio waves, visible light, infrared, and so on) an object emits can reveal its chemical composition as well as its distance, motion, age, brightness, and rate of mass loss, and disclose nearby black holes and exoplanets.

Summer Astrophotos from Bainbridge Island



(1) 22 Galaxies, Including M84 and M86
June 4, 2011
Telescope: AT106 Refractor with field flattener
Exposure—
Luminosity: 7x300s,
Red: 6x300s,
Green: 6x300s,
Blue: 6x300s
(7500 seconds)

After being shut out during the spring due to weather, I wanted to get something from the Virgo Cluster before it faded into the twilight for the year. I selected this target because of the quantity of galaxies around the two brightest objects. In the photo above, (Photo 1) I have labeled all of the Messier, NGC, & IC galaxies. There are 22. Additionally, there are many more faint galactic smudges in the photo if one looks closely. (Faint stellar objects will be small and round whereas faint galactic objects are extended and likely oblong.)

On May 31, 2011, astronomers discovered supernova SN2011DB in M51, the Whirlpool Galaxy. This supernova was studied extensively and reported widely in the astronomical press. It remained bright unusually long. The upper right photo shows the supernova a month after its discovery. The inset, taken earlier with my AT 106, shows M51 sans SN2011DB. (Photo 2)

While my observing site is declinationally challenged (too many trees), I do get a great view of the constellation Cygnus. Since Cygnus has the Milky Way going right though the middle, it is a target-rich environment. The Cocoon Nebula, IC 5146, is an emission nebula with a lot of dust surrounding it. It makes a fine target.(Photo 3)

The Crescent Nebula (NGC688) is another target in Cygnus that I have shot several times. The Crescent is a challenge: difficult and faint. Most people shoot it with narrow-band filters which I do not have. I had shot it with my AT106 and C8 but was not satisfied. I recently refurbished my first real telescope and put it on my Losmandy and this is the result—my best effort yet. At the core of NGC6888 is a Wolf-Rayet star WR136. Wolf-Rayet stars are very large stars in the process of ejecting material as they die. It is likely that this will eventually be a supernova. (Photo 4)

While waiting for a target to cross the meridian, I shot M13, the Great Globular Cluster in Hercules, the brightest globular cluster in the northern hemisphere and a textbook example of the 158 or so globular clusters we have in our galaxy. (Photo 5)

IC 1396 is a very large but faint emission nebula in Cepheus, very near Cygnus. The full nebula is approximately 3 degrees across. The Elephant Trunk is in the upper left quadrant of the picture. The dark nebula is actually dense material that absorbs visible light and then emits infrared. In photos from the infrared Spitzer Space Telescope, the Elephant Trunk out-shines the rest of the nebula. (Photo 6)

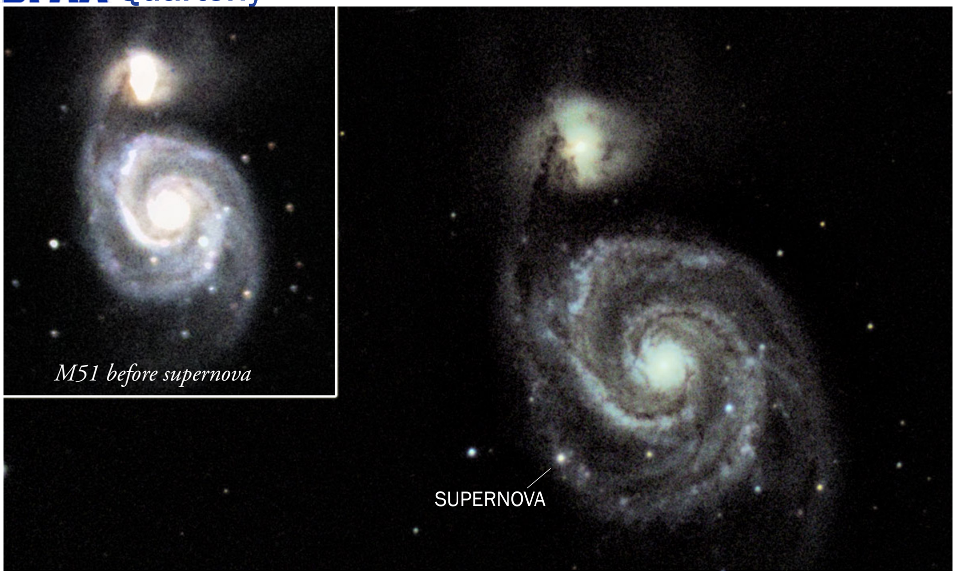
I had some spare time prior to another object crossing the meridian so I shot M27, the Dumbbell Nebula, once again. Not only is the star field beautiful but the fine detail of the nebula is in the picture as you zoom in. (Photo 7)

Base Equipment for all Photographs

Mount: Losmandy G-11 with Sidereal Technology servo controller and Ovision NS gearing

Camera: SBIG ST-8300M w/ LRGB color filter wheel

Guidescope: Celestron 500mm f5.6 lens with Orion SSAG guider and PHD guiding software



M51 before supernova

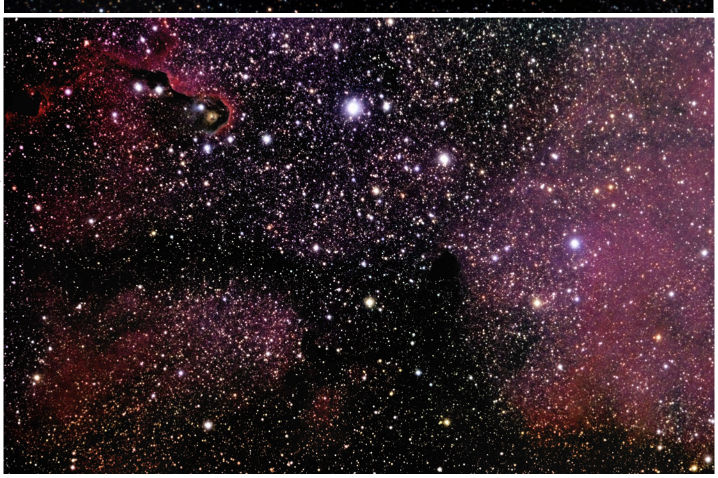
(2) M 51—The Whirlpool Galaxy with SN2011DB July 1, 2011 Telescope: Celestron C8 @ f 6.3 with focus reducer Exposure—Luminosity: 5x300s, Red: 5x300s, Green: 4x300s, Blue: 6x300s (6000 seconds)

(6) M13—The Great Globular Cluster in Hercules July 29, 2011 Telescope: 1958 Cave 8"f7 Newtonian Reflector (Mount updated with Tick Manangement) Exposure:—Luminosity: 4x120s, Red: 4x120s, Green: 4x120s, Blue: 4x120s (1920 seconds)

(3) IC 5146—The Cocoon Nebula July 6, 2011 Telescope: Celestron C8 @ f 6.3 with focus reducer Exposure—Luminosity: 6x300s, Red: 6x300s, Green: 6x300s, Blue: 5x300s (6900 seconds)

(4) NGC 6888—The Crescent Nebula July 22, 2011 Telescope: 1958 Cave 8"f7 Newtonian Reflector (Mount updated with Tick Manangement) Exposure—Luminosity: 8x300s, Red: 7x300s, Green: 7x300s, Blue: 7x300s (8700 seconds)

(5) IC 1396—The Elephant Trunk Nebula August 1, 2011 Telescope: AT106 Refractor with field flattener (Mount updated with Tick Manangement) Exposure—Luminosity: 8x300s, Red: 8x300s, Green: 8x300s, Blue: 8x300s (9600 seconds)



(7) M 27—The Dumbbell Nebula. August 3, 2011 Telescope: AT106 Refractor with field flattener (Mount updated with Tick Manangement) Exposure—Luminosity: 5x300s, Red: 4x300s, Green: 4x300s, Blue: 4x300s (5100 seconds)

In this Issue

Articles

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