Peterborough Astronomical Association

The Reflector

Volume 12, Issue 3 ISSN 1712-4425 March 2013

Right: Clusters of galaxies collide in this composite image of "Pandora's Cluster." Data (in red) from NASA's Chandra X-ray Observatory show gas with temperatures of millions of degrees. Blue maps the total mass concentration (mostly dark matter) based on data from the Hubble Space Telescope (HST), the European Southern Observatory's Very Large Telescope (VLT), and the Japanese Subaru telescope. Optical data from HST and VLT also show the constituent galaxies of the clusters. Such images begin to reveal the relationship between concentration of dark matter and the overall structure of the universe.

Tackling the Really BIG Questions

by Diane K. Fisher

How does NASA get its ideas for new astronomy and astrophysics missions? It starts with a Decadal Survey by the National Research Council, sponsored by NASA, the National Science Foundation, and the Department of Energy. The last one, New Worlds, New Horizons in Astronomy and Astrophysics was completed in 2010. It defines the highest-priority research activities in the next decade for astronomy and astrophysics that will "set the nation firmly on the path to answering profound questions about the cosmos." It defines space- and ground-based research activities in the large, midsize, and small budget categories.

The recommended activities are meant to advance three science objectives:

1. Deepening understanding of how the first stars, galaxies, and black holes formed,
2. Locating the closest habitable Earth-like planets beyond the solar system for detailed study, and
3. Using astronomical measurements to unravel the mysteries of gravity and probe fundamental physics.

For the 2012-2021 period, the highest-priority large mission recommended is the Wide-field Infrared Survey Telescope (WFIRST). It would orbit the second Lagrange point and perform wide-field imaging and slitless spectroscopic surveys of the near-infrared sky for the community. It would settle essential questions in both exoplanet and dark energy research and would advance topics ranging from galaxy evolution to the study of objects within the galaxy and within the solar system.

Naturally, NASA's strategic response to the recommendations in the Decadal Survey must take budget constraints and uncertainties into account.

The goal is to begin building this mission in 2017, after the launch of the James Webb Space Telescope. But this timeframe is not assured. Alternatively, a different, less ambitious mission that also address the Decadal Survey science objectives for WFIRST would remain a high priority.

The Astrophysics Division is also doing studies of moderate-sized missions, including: gravitational wave mission concepts that would

see "WFIRST" on page 16

President's Message

A Great Start to The Year

This year promises to be a good one astronomically speaking. We are only in the second month and we've had a close fly-by of an asteroid and a brilliant meteor show over Russia both within a 24 hour period. While we were not blessed with the ability to witness these first hand, it shows an activity increase that is quite rare. It's probably a good thing we didn't witness the meteor first hand. The asteroid came close. Was it too close for comfort? As we look forward into this year we are promised to have two comets for our viewing pleasure, again, something rare. Comet PANSTARRS may fizzle out but if not we will have something extra for the public during our Earth Hour session on Armour Hill, March 23rd. Comet ISON may be quite spectacular. There are predictions that it could even become a bright daytime viewable comet. What a treat that would be. I believe that this kind of activity can only raise awareness of astronomy and ramp up public interest in organizations like the P.A.A. There is a big opportunity for publicity here. Don't forget to be "on the hill" March 23rd for Earth Hour.

Once again a reminder that it is membership renewal time. The deadline is April 1st.

I hope to see you at the March meeting. Boy Wood will be discussing the world of astronomy through binoculars. As we suggested at the last meeting, if you have binoculars, bring them along. Let's see what the members have out there.

Rodger Forsyth
PAA President

Letter from the Editor

Look Up, Look Way Up

Spring looks to be a busy month if all goes according to plan. Comet PANSTARRS should make it's northern hemisphere debut around March 9. I recently saw some photographs taken from Australia. It is magnitude 5, just naked-eye and sports a tail. Should it survive it's trip around the Sun we may have quite a show. Then again, it may fizzle out.

We also have a bevy of articles to get you in the mood. John Crossen begins the comet coverage with what to expect from Comet PANSTARRS. John Chumak provides us a report on the progress of Comet ISON, expected to grace our sky in late October into November. Look out for future articles from Mr. Chumak, a well-known astrophotographer from Dayton, Ohio. His friend Rick Stankiewicz has made arrangements.

Kenneth Sunderland continues with his Starting Out series with another look at the Galilean Moons. Mike McCarthy sends us some fine photos from his Mallincam.

Please enjoy this issue and cross your fingers for clear skies this month.

Phillip Chee
Editor, The Reflector

Peterborough Astronomical Association

The Reflector is a publication of the Peterborough Astronomical Association (P.A.A.) Founded in 1970, the P.A.A. is your local group for astronomy in Peterborough and the Kawarthas.
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Spend Boys' Night with The Gemini Twins

M35 AND NGC 2156. At a distance of 2,800 light years open star cluster M35 is an explosion of sparks while its more distant companion tucks in neatly to its right. Photo by NASA.

JOHN CROSSEN

UNLIKE SOME CONSTELLATIONS which require a lot of imagination or a small dose of hallucinogens to mentally assemble, Gemini the Twins look pretty much as advertised.

The two bright stars that mark the heads of the twins, Castor and Pollux, are an easy find on a clear night. Just draw a diagonal line from Rigel, the blue-white star in Orion's foot up through Betelgeuse the orange star that represents his armpit and up. The two brightest stars you come to next will be the heads of our celestial duo. Cascading out from the head-stars are two lines of dimmer stars that represent their bodies side-by-side.

Ancient drawings show the two with Castor's arm around his brother's shoulder. No sibling rivalry here! But there is a bizarre tale to hatch—literally.

It seems the two lads were the sons of a lovely lady named Leda. But the two weren't born, instead emerged from an egg not long after Leda had been seduced by Zeus who disguised himself as a swan. Zeus was indeed, a dirty bird.

Later on the Romans confused the boys with Romulus and Remus, the legendary founders of Rome. Hence they appear on some ancient Roman coins as two males, each with half an egg shell around him.

According to mythology, the boys accompanied Jason in his pursuit of the Golden Fleece and are credited with calming the sea during a terrible storm. Today they are considered the patrons of mariners and are associated with St. Elmo's fire, an electrical discharge that can take place around a ship's mast during a storm. In some cul-

See "Gemini" on page 16

Here's What Will Keep You Up All Night in March

Comet C2009 P1 glides past star cluster M71. Photo by Brian McGaffney of Nutwood Observatory www.nutwood-observatory.com in Apsley.

John Crossen

The big question this month is can comets be trusted? Like cats, they have tails. But also like their feline counterparts, you never know what they'll do. Such is the case with Comet PanSTARRS.

Comet PanSTARRS is named after the telescope and observing program that discovered it in 2011. As the comet nears our Sun, it is expected to become naked-eye visible. Look in the western sky during mid-March just after sunset. Each evening it will rise slightly higher and further to the north from the previous position. Here in the Northern Hemisphere we will see the comet after it completes its journey around the Sun and is hurtling back out of our solar system.

To the best of our knowledge this is the comet's first fly-by of Earth, so astronomers have no idea whether it will fizzle or flare as it rounds the Sun. If it flares, it will be our first naked-eye comet since 2009. If not ... well, it's a comet after all.

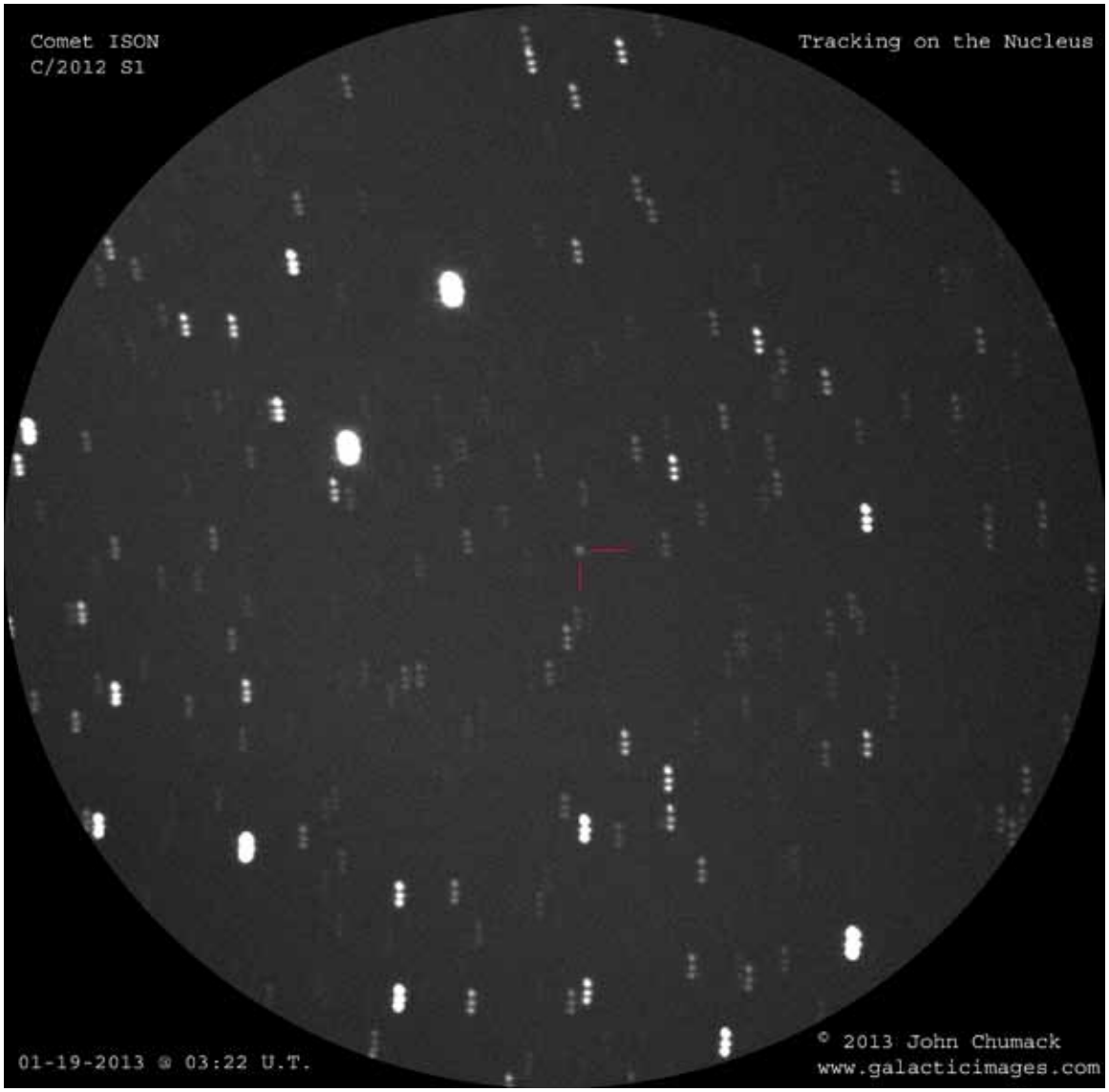
The planets will be far more predictable in the messy month of March.

Jupiter will be bidding us farewell as it slides down the western sky. I think Saturn must be attached to Jupiter by a string because as the Jovian giant drops beneath the western horizon the ringed thing pops up slightly later in the east.

Saturn and its rings will be tilted to give us an excellent view this year. A few years ago they were edge-on and the planet looked like an olive with a tooth-

See "Comets" on page 14

Comet ISON



Comet ISON C/2012 S1 in Gemini on 01-19-2013 at 03:22 U.T. Twenty minute exposure tracking on the comet's nucleus. QHY 8 Cooled CCD Camera. Binned 3 × 3 in monochrome mode. Homemade 16" *f*4.5 Diameter Telescope. Photo by John Chumak, www.galacticimages.com.

John Chumak

The possible "Comet of the Century" may not look like much now, but it has brightened a little since my last shot, and is now at magnitude 15.6. Comet ISON is currently out about 400 million miles from Earth, but come early Fall it will be visible in Binoculars and by late October into November and December it should become naked eye, even visible in the city for a couple of months, some say even in broad daylight!! Well we will just have to wait and see. I will be following and photographing the comet every few weeks all the way through its perihelion passage, as it will get very close to the Sun. This Comet is a "Sungrazer" type, and should get very bright, hence why there is so much hope for a fantastic show!

Starting Out

The Galilean Moons

Kenneth Sunderland

What follows is a continuation of last month's article about Jupiter (♃) and its Galilean satellites in which I discussed some early observations.

Neils Bohr famously quipped "Prediction is very difficult, especially about the future." I made a prediction in last month's article that ♃'s moons would be parallel to the horizon at my local transit. Check … a small victory. Still, it felt good because it means that the model I'm building-up in my imagination passed a test.

A priori I assumed that the four moons would share a common orbital plane projected out from ♃'s equator. That implies that they would always be aligned in a straight line and indeed my first observations confirmed it. They were nicely lined-up, pointing the way where ♃ should go next. Soon followed a surprise when one of the moons appeared to be displaced just a little. Doubt. Then on January 8, 2013 at 02:10 UTC three of the moons were stacked one atop the other making for a striking configuration. No doubt about it — my assumption was wrong. The orbital planes of the moons (and probably ♃ itself) must have a variety of inclinations so that any moon can appear above or below an imaginary straight line through ♃'s equator.

In last month's article it was explained that distances were judged in ♃ diameters (Dia.) Measurement error increases as one moves away from ♃ since the comparison is with ♃ itself. For example, at 12 Dia. distance I allow for ±2 Dia. while at a distance of ¾ Dia. I'm more confident although ♃'s halo becomes a factor. Converting from absolute to a percentage gives about ±20% error for any measurement. The closest moon never gets further than about 2 Dia. away. The next one reaches a maximum of 4 Dia. followed by one at 6 Dia. Finally there is a moon that roams some 12 Dia. This is the greatest elongation, and by far. Their names respectively are Io (I), Europa (II), Ganymede (III) and Callisto (IV). (The Roman numeral tag is due to Galileo.)

Can an observer unscramble the moons from a single look? It would be convenient if the moons carried their own tag in the form of different sizes or colours. Alas, in my little refractor, they do not. It needs to be done by recording the changing positions over time to understand the orbital geometry.

If at least three of the moons are at a point in their orbit unique to them then they can be easily sorted. For example, (IV) can range from 0-12 Dia. but if we see a moon at 9 Dia. then it can only be (IV). And so on. Figure 1 is a scaled model of such a situation. The view is looking down from above ♃'s north pole. The projection of the moons' positions along the orbital plane toward Earth shows where the moons would appear.

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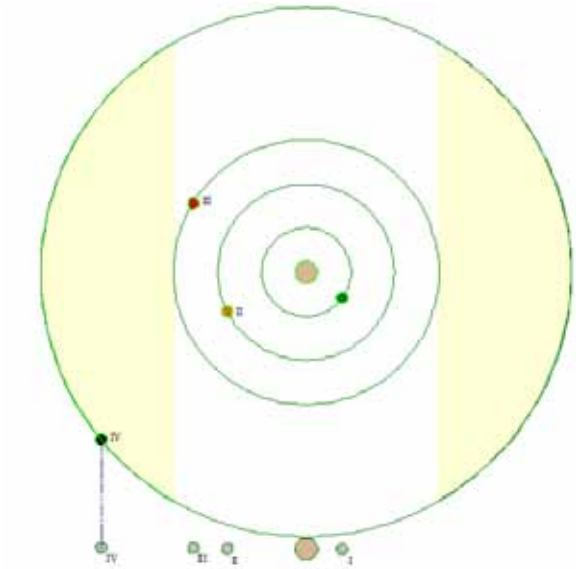

Figure 1. Moons in their orbits and how they appear from Earth.

The example above is ideal, but sadly there is generally overlap. The moons, as seen edge-on, oscillate back and forth, forever criss-crossing each other. For example, consider the situation in Figure 2 where (IV) is between the orbits of (II) and (III), and (II) is inside the orbit of (I). As viewed from Earth, what's what? I am approaching this more challenging situation with probability in order to make a best guess. Let me explain.

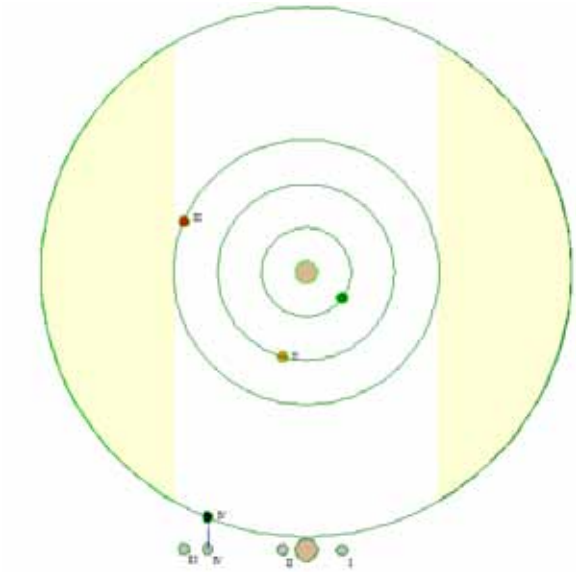

Figure 2. (II) & (IV) inside the orbit of an adjacent moon.

Consider the geometry of Figure 3. The yellow sectors swept out by (IV) uniquely belong to (IV) and represent 240° of the 360° total. That means (IV) spends 2/3 of its time between 6 and 12 Dia. away. Before even looking I can expect to see (IV) in this unique position two times out of three.

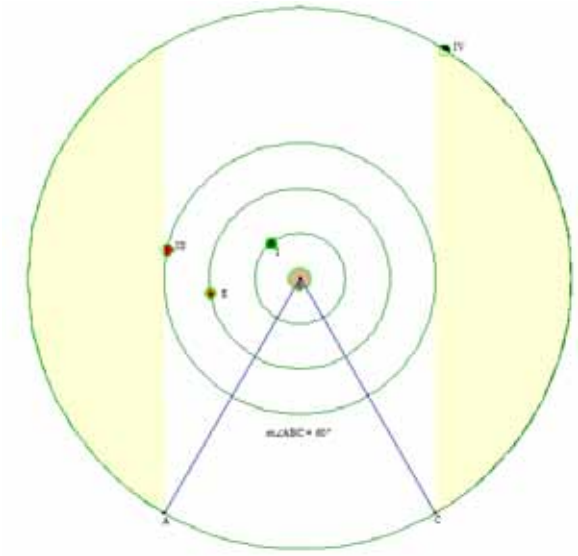

Figure 3. Calculating the odds of where to find (IV).

This same analysis can be repeated for each moon to determine the chances of where one might expect to see it. The results are (III) should be between 4 and 6 Dia. a little more than half the time and (II) will be found between 2 and 4 Dia. two times out of three. Obviously (I) stays bounded within 2 Dia. all the time. Then there are the refinements of finding say (IV) between the orbits of (I) & (II) and so on. The interested reader can make these calculations for themselves using Figure 3.

Rick Stankiewicz's article "Close Call" in February's *The Reflector* included a photo of 21 and moons (his Figure 3) taken the night of January 21, 2013. I wondered if I could disentangle the moons using my own model—a process that can involve certainty, elimination and best guessing. The original has been cropped and made into a negative. The

see "Off by one hour" on page 15

PHOTO GALLERY

Some Recent Images from Fairview Observatory

Hi Phil,

If it's not too late, can you add these to this month's *Reflector*. Telescope is a C14 *f*/1.9 on a Celestron/Losmandy G11 mount with a Mallincam Extreme video camera.

Thanks,
Mike McCarthy

Images clockwise from top-left: Comet C/2012 K5 (LINEAR); Horsehead Nebula; Pinwheel Galaxy; Thor's Helmet; Running Man Nebula.

The Snow Moon

The February full moon is called the Snow Moon, as this time of year usually signals the deepest snows of winter. This year the full moon fell on February 25th and on this evening I was fortunate to be in an opportune location to see the moon rising in the eastern sky. I had not planned it, but this particular evening I was fishing for walleye with some friends on the Bay of Quinte (Lake Ontario) near Belleville, Ontario, when the moon appeared through the clouds on the horizon. A pale pastel pink disc appeared initially, but as the minutes wore on and the lunar disk rose higher above the horizon it grew brighter and transformed from pink, then red, then orange as it evaded more and more of the earth's atmosphere along the horizon.

What a wonderful sight and this made the whole trip worth the effort. Our fishing party caught one nice fish this trip but the rising of the Snow Moon was the "icing on the cake" for me.

Photo details: Cropped image from Panasonic, Lumix DMC-TS3 camera, 5× optical zoom, ISO 400, $f/5.9$, ⅓ sec. exp.)

Rick Stankiewicz

Star Trails

Rodger Forsyth

I'm sure you all have seen photos in Astronomy magazines of "star trails." An example is presented here.

Have you ever wondered about the technique for creating these? What equipment do I need? What is "Must Have" vs. "Nice to Have?" What technique is used, timing etc?

Well, I'm quite new to the process but I thought I'd share some fun I've had attempting to capture some trails.

OK I cheated. In my exuberance to try out a new gadget for my DSLR and write an article for *The Reflector* regardless of weather conditions, clouds snow rain or hail I took the above shot with the camera set up in front of the computer screen with the computer running Stellarium. The purpose was to experiment with technique, timing and to learn a few things. One thing I discovered there is a lot of trial and error in attempting this. The trials took time and thought, the errors came quite naturally requiring no skill whatsoever. The nice thing about the cheating method was that I could do this in the comfort of my home, middle of the day and not freeze my butt off. Presented here is a report of the process. It is not a "How to shoot star trails" it's a how I studied the process.

The must haves. There is of course some basic equipment required.

- Camera
- Wide angle lens
- Tripod
- Shutter release cable
- Clear sky (most difficult item)

The list suggests a DSLR although I'm sure some point and shoot cameras could be used as long as the shutter can be controlled for long exposures. A tripod is an absolute necessity. Armed with the above and lots of patience you're set to go. Be prepared to spend a lot of time at the camera. The process is going to take a few hours. A chair, your favorite brew, coffee etc. Will help.

The nice to haves. To free yourself up and allow the camera to do the work the next items are priceless.

- Intervalometer
- AC adapter

The intervalometer, the new gadget I mentioned earlier, can take complete control of your camera allowing you to go about your business without having to "babysit" the camera. The AC adapter is a good idea depending on your camera's appetite for battery power. Remember we are talking about a few hours of continuous shooting here.

The intervalometer. I would think available for just about any camera that supports a remote shutter release this item is very versatile and quite inexpensive. I got this one from http://fotodioxpro.com/ for $49.95 plus shipping. They ship UPS ~$20 and it arrived two days after ordering.

There's a large shutter release button that slides forward to lock the shutter open. You can set it up to be a self timer. You can set the time interval for successive shots and the exposure (shutter open time). These three time settings can be from 1 second to 99 hours, 59 minutes, 59

Continued on next page

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seconds. An exposure count can be set from 1 to 99 or unlimited. Not bad for a $50 device.

The setup.

OK. We've got the camera, wide angle lens, tripod, intervalometer and AC adapter. We're good to go.

The trials. I will admit I spent a few afternoons experimenting with exposure, camera settings, timing settings, screen brightness and Stellarium configuration. I won't detail all of these but will reveal some of it. Stellarium setup was quite easy. Set the time for around 8pm, click on and center Polaris, turn off Cardinal points, Nebulas, planet and star names. Of course when you go outside to shoot the real star trails these are all done for you. The most time was spent trying various combinations of exposure and interval times. Here's where the error factor can creep in. Two items caused the many repeated attempts. As I tried different combinations of interval and exposure times I discovered the camera/intervalometer combination were not in sync. The camera had a mind of it's own, operating the shutter at seemingly random intervals regardless of setting. As I watched the countdown on the intervalometer I realized what was happening. On long exposures the camera was taking as long to process the shot as the shot itself took. The processing time was being ignored by the timer. Bingo! In setup, the "Noise Reduction" was turned on for long exposure. The camera was shooting a dark frame, same duration, for each shot. First lesson learned. Turn off the noise reduction. It can be dealt with later as I will explain. After that brilliant discovery I still observed out of sync operation. It took me a while to realize what was happening. I had replaced the fully automatic lens that came with the camera with an older wide angle lens. This normally requires setting the camera on "M" as one will be setting aperture, focus and shutter speeds manually. Bingo! We're using an intervalometer. The camera must be set to "B" for bulb exposure, not "M". The camera can't merrily go about deciding the exposure times by itself. Thoughts like "stupid camera, I've plugged in an intervalometer, why are you ignoring it?" come to mind. As mentioned, it can take some time to figure out why things aren't happening the way they should but these were valuable lessons learned.

The final product. The photo shown at the outset of this article was taken by the cheat method with the following settings:

- Bulb setting
- *f*/22
- ISO 100
- 30 second exposures
- 20 frames
- 5 seconds apart

In the interest of saving some time I clicked once on the "Time increase" in Stellarium to give longer trails. Speeding up the earth's rotation is not an option so be prepared for a long session.

The aperture and ISO settings will have to be adjusted when you go outside. The computer screen is much brighter than our sky. A wide open *f*/2.8 aperture and ISO 200-400 would be good starting points.

Processing. OK. We've got ourselves a bunch of images that we now need to stack to get the final picture. While reading up on this on the internet I found a great piece of free software called StarStax. You select all your images and add them to the software. With one click of the mouse they are stacked with blazing speed and you've got your result. I mentioned earlier about the dark frame. If you've taken all your shots at say 30 sec. you then put the lens cap on and take one more at 30 sec. You include this with your images and in StarStax you select it as the dark frame. StarStax will then do the noise reduction by subtracting the dark frame. You may not need to do this. It depends on your camera, the ISO setting and the exposure duration.

This was fun, and I hope the lessons learned will help me and you take some "real" star trails. When it warms up a bit, it's a clear night and there's no moon I'm going to give it a try. I'll report on my efforts at that time.

BOOK REVIEW

Exploring Space
Journeys to the Edge of the Universe

Rick Stankiewicz

This past year was certainly a year to remember for the achievements in space and the study of the universe. I picked up this magazine while grocery shopping last year because it appealed to me a little more than *The National Enquirer*. As you would expect from the National Geographic Society (NGS) they have done a wonderful job of compiling an array of images and short stories that capture the discoveries and achievements in humankind's knowledge of space and how we got there. The 128-page glossy "magazine" format that the NGS has become known for is used successfully here. A nice fusion of rarely seen historic images of early space travel to artists concepts of alien worlds that we can only imagine, even with today's technological advances. I really liked the eight page "space-time continuum" listing the milestones in exploration from the 1543 publishing of Nicolaus Copernicus' *De Revolutionibus Orbium Coelestium* to 2012 as the number of Exoplanets discovered fast approaches a thousand.

I have never been disappointed by a NGS publication yet and this one is no exception. I am always amazed at how the NGS can take complex information and produce a graph, table or illustration to make sense of it all and they do it several times in this publication too. If you would like a good overview of some unforgettable moments, astonishing photographs and recent discoveries of our solar system and universe, then you will enjoy this magazine.

Quirks & Quarks

Dean Shewring

I remember delivering rural mail in the 1970s with my father and getting to listen to a new CBC radio program devoted to the sciences. *Quirks and Quarks*, hosted by David Suzuki, launched on October 8, 1975. The show was created to fill a perceived knowledge gap in the media representation of science, particularly science news. However, instead of a show that focussed on demonstrating one or two aspects of science at a simple level, *Quirks and Quarks* presumed its listeners had a basic understanding of science and presents news on the latest discoveries from all over the world.

An article in the Ryerson Review of Journalism by Paige Magarrey quotes *Quirks and Quarks'* Senior Producer Jim Handman contrasting the way the show presents science, "…the mainstream media focuses on how science might affect their audience…Meanwhile, *Quirks* is doing something different—it's putting the wonder back into science…"

Quirks and Quarks has had three hosts in its 38-year history. David Suzuki led the charge from 1975 to 1979, before devoting himself fully to television with The Nature of Things. Jay Ingram was the replacement host with the most until 1991, when off he went to join the new cable channel Discovery Canada. Bob McDonald is the current host, celebrating his 20th anniversary with the show in 2012. *Quirks* has won more than 80 national and international awards for science journalism; including from the Canadian Science Writers Association for "Asteroid Impact" in 1999, the Passport to World Band Radio "2002 Top Ten Shortwave Shows in the World", The American Institute of Physics 2007 Science Writing Award for the documentary 'Multiple Worlds, Multiple Universes', and the Canadian Science Writers Association Science-in-Society Award for "Before the Big Bang" in 2008.

The first "Question from Listeners" ever posed to *Quirks and Quarks* came in its very first program on that Wednesday afternoon in 1975; "Why does it get dark at night?" The given answer was rather surprising, as it involved The Big Bang. It does, however, demonstrate how important astronomy has been to the success of the show—right from the very beginning. *Quirks* was there (November 2008) when Canadian astronomers reported imaging three exoplanets orbiting a nearby star. *Quirks* was there (January 2012) reporting on Canadian scientists looking for a cold, clear, dry High Arctic site for a new telescope. *Quirks* was also there (September 2012) when we celebrated the 50th anniversary of the **Alouette 1**, Canada's first artificial satellite. Today, *Quirks* is following the travels of astronaut Chris Hadfield, soon to be the first Canadian Commander of the International Space Station.

Recent shows on *Quirks and Quarks* have had important astronomical segments:

- ***Earth Two***—on finding an Earth-sized planet orbiting close to Alpha Centauri B
- ***Planets Go Rogue***—A planet bigger than Jupiter was diacovered 100 light years away travelling through space unattached to any star
- ***Hubble's Universe***—Terence Dickinson is interviewed about his newest book
- ***Dwarf Galaxy Puzzle***—The discovery that small galaxies are orbiting the Andromeda galaxy in a disk-shaped orbit

All of these stories, and more, can be found by checking out the *Quirks'* website podcasts at www.cbc.ca/quirks.

Quirks' producers have had some books published, including The Quirks and Quarks Guide to Space in 2008, which is still available from Amazon.ca.

If you check out recent scribblings on Bob McDonald's Blog on the Quirks website, you will soon see that his main science concerns are divided between the environmental (why are we still wrecking the planet) and the astronomical (the great successes we've had exploring our universe and how proud Canadians should be about astronaut and friend Chris Hadfield). His informed opinion pieces are definitely worth checking out.

I no longer listen to *Quirks and Quarks* while delivering mail, but you, I or anyone can still listen to editions of *Quirks and Quarks* anytime after broadcast on their podcast site or hear *Quirks and Quarks* on CBC Radio One after the news on Saturdays at Noon, with repeats on Mondays at 11 pm and Wednesdays at 3 pm. It's also available on Sirius Satellite Radio Channel 159.

continued from page 4

Comets

pick shoved through it. Not an impressive sight, but a rare one nonetheless.

Mars will be lost in the twilight's glow and Venus will be at superior conjunction which places it directly opposite the Earth, but behind and just below the Sun. If you have a computerized telescope with a proper solar filter you can spot Venus in the day.

The spring constellations Cancer, Leo and Virgo will own the sky in March. Cancer is home to the famous open star cluster M44 which is a beautiful target in binoculars. Messier Object M68 also resides in Cancer, but much lower down in the crabby fellow and is best seen in a telescope.

Leo and Virgo are favourites of galaxy gawkers, with 6 Messier-listed galaxies in The Lion alone and 16 more in Virgo. But that's not counting the dimmer galaxies of which there are hundreds whose visibility is dependent on the size of your telescope. I'll have more on them in next week's column.

Moon-atics can enjoy crater watching at its best on March 19 when the Moon is in it's First Quarter phase. Sometimes called the Half Moon, the long shadows created by the Sun at this phase really make lunar surface details stand out. Binoculars or a small telescope are all that's needed, though a lunar map will tell you what's where.

As mentioned earlier, Comet PANSTARRS may be a hit or a miss. Our brothers in the Southern Hemisphere will be the first to know. So keep your fingers crossed.

Until we meet again by the backyard scope, please keep your lights aimed and dimmed down. Your neighbours, energy budget and we astronomer will appreciate it.

The Sky this Month

Mercury is at inferior conjunction on the 4th and re-appears mid-month in the early morning sky. Reaches greatest elongation west (28°) on the 31st.

Venus is lost in the solar glare and is at superior conjunction on the 28th.

Mars is not visible. Approaching superior conjunction with the Sun.

Jupiter is in the western evening sky north of the Hyades. Sets near midnight. Waxing crescent Moon passes 1.5° S on the 17/18th.

Saturn is retrograding in Libra and rises in the late evening.

Vernal Equinox arrives at 7:02 a.m. on the 20th.

Daylight Savings Time begins on the 10th.

Moon Phases

Last Quarter	**4:53PM**	**March 4**
New Moon	**2:51 PM**	**March 11**
First Quarter	**12:27 PM**	**March 19**
Full Moon	**4:27 PM**	**March 27**

continued from page 7

Off by one hour

star Omega2 Tauri directly below 21 provides a convenient reference point. It is my Figure 4.

Figure 4. Original photo courtesy of Rick Stankiewicz.

In his accompanying text Rick identified the moons so I had to pretend I didn't know! Using a ruler, the upper (east) moon is 2.2 Dia. away, and the west moon is at 6.7 Dia. The remaining two are ... well, really close. Note the obscuring halo effect. Where is the real edge of things? This is a tough one. The westerly moon is (IV) because it is at a distance beyond the range of the others. A near certainty. This also supports the probability argument as described above. The moon at 2.2 Dia. is not (I) so it could be (II) or (III). Can probability help? I should expect to see (III) at this distance one time in every four and (II) two times out of three. The best guess is (II) and therefore the closest moons are (I) and (III). Sorting two moons within the orbit of (I) is a coin toss, so I tossed a coin! Tails ... the closest one is (III). How did I do? Half right on one trial. Given that there are 192 basic linear patterns in this moon dance, maybe that's not so bad.

Figure 5 recreates Rick's photo to show how things might actually have been out at 21.

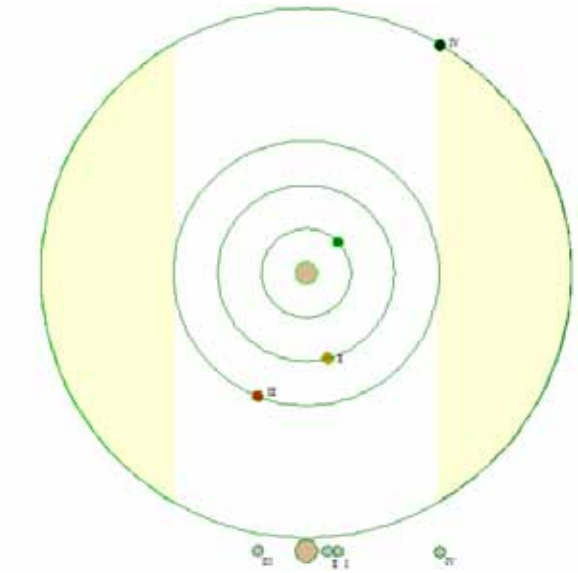


Figure 5. Re-creation of Figure 4.

These figures may remind you of a clock face. Here is a clockwork writ large with the moons playing the role of hands. In fact, from analyzing Rick's photo I was able to predict that he had forgotten to adjust his camera's internal clock from DST. In a private communication he confirmed "You are right on with the time and my date stamp. Off by one hour." To which I might have replied (and with apologies to Neils Bohr) "Postdiction is very easy, especially about the past."

Your comments and questions are welcome. Send them to kenneth.james.sunderland@gmail.com.

continued from page 1

WFIRST

advance some or all of the science objectives of the Laser Interferometer Space Antenna (LISA), but at lower cost; X-ray mission concepts to advance the science objectives of the International X-ray Observatory (IXO), but at lower cost; and mission concept studies of probe-class missions to advance the science of a planet characterization and imaging mission.

For a summary of NASA's plans for seeking answers to the big astrophysics questions and to read the complete Astrophysics Implementation Plan (dated December 2012), see http://science.nasa.gov/astrophysics/. For kids, find lots of astrophysics fun facts and games on The Space Place, http://spaceplace.nasa.gov/menu/space/.

This article was provided by the Jet Propulsion Laboratory, California Institute of Technology, under a contract with the National Aeronautics and Space Administration.

continued from page 3

Gemini

tures the boys are also associated with the yin and yang forces of nature.

In addition to their colourful mythological pasts, the two brothers hold some fascinating sights for stargazers with binoculars or a small telescope.

Castor appears as a single star to the naked eye, but with a telescope the single splits into a nice double star. Crank up the power and the double star turns out to be a triple star. But we're not done yet. Each of the three stars is also a double star but you'll need some fancy equipment for that. The sextuplet lies at a distance of 46 light years from Earth. That works out to about 460 billion kilometres if you're planning a trip.

Moving from Castor's head to his tootsies, we come to Messier Object M35 which can be seen in binoculars. In a telescope M35 bursts into a glorious blaze of stars that are accompanied by yet a dimmer star cluster NGC 2156.

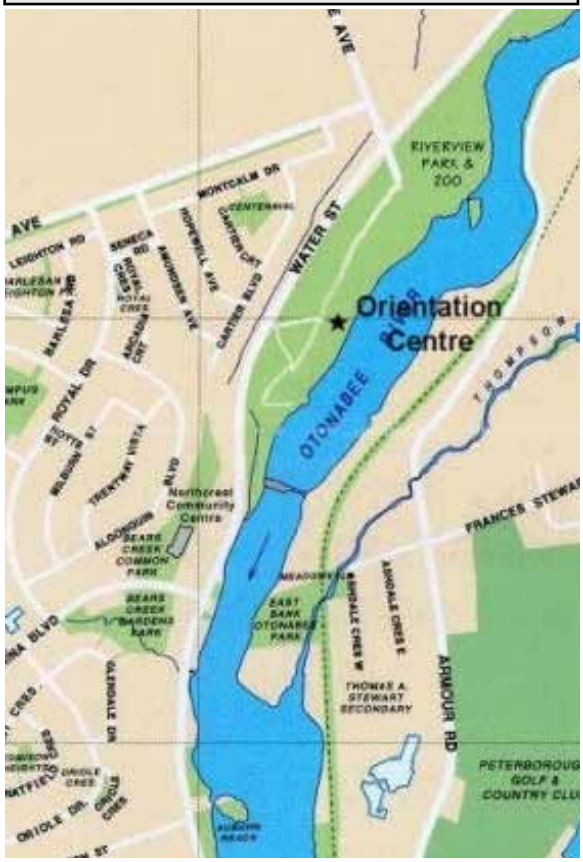
Until we meet again by the backyard telescope, please keep your outdoor lights dimmed down and aimed down. The darkness will be reflected in our energy bill.

Articles

Submissions for *The Reflector* must be received by the date listed below. E-mail submissions are preferred (Microsoft Word, OpenDoc, ASCII and most common graphic formats are acceptable). If your article contains photso or graphics, please provide a separate file for each. Typed or handwritten submissions are acceptable provided they are legible (and not too long.) Copyrighted materials will not be published without written permission from the copyright holder. Submissions may be edited for grammar, brevity, or clarity. Submissions will be published at the editor's sole discretion. Depending on the volume of submissions, some articles may be published at a later date. Please submit any articles, thoughts, or ideas to:

phillip.chee@gmail.com

NEXT SUBMISSION DEADLINE:
MARCH 25, 2013



Meetings

The Peterborough Astronomical Association meets every first Friday of most months at the **Peterborough Zoo Orientation Centre** (Next to the PUC Water Treatment Plant) at 8 p.m. P.A.A. executive business will be conducted starting at 7:30 p.m. Members and the public are welcome to attend the earlier time.