Peterborough Astronomical Association

The Reflector

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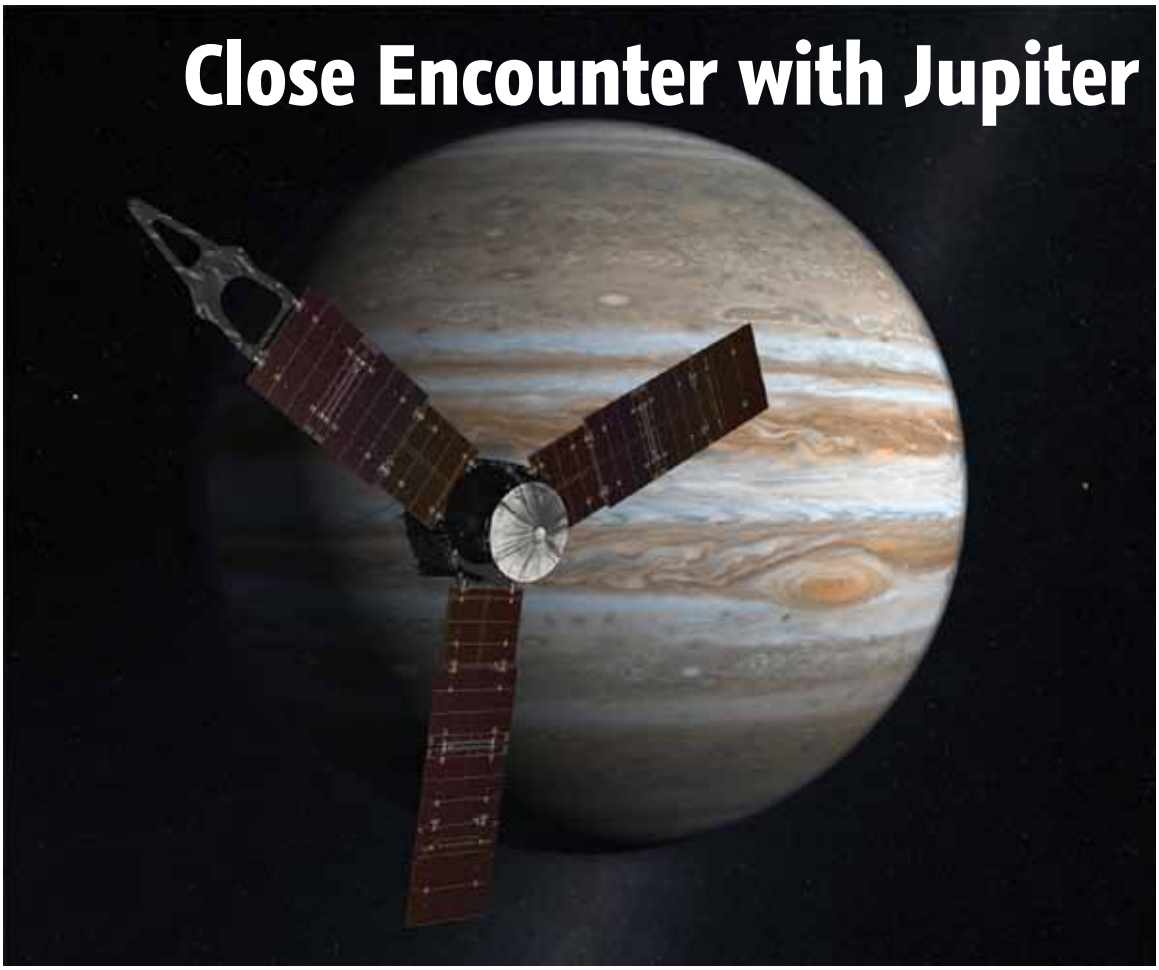
Close Encounter with Jupiter



The Juno mission, arriving at Jupiter in July 2016, will help to solve the mystery of what's inside the giant planet's core.

By Dr. Tony Phillips

Jupiter and Earth just had a close encounter—and it was a good one. In late September 2010, the two worlds were 31 million km (about 19 million miles) closer than at any time in the past 11 years. Soaring high in the midnight sky, Jupiter shone six times brighter than Sirius and looked absolutely dynamite through a backyard telescope.

Planetary scientist Scott Bolton of the Southwest Research Institute isn't satisfied. "I'd like to get even closer," he says.

Bolton will get his wish in July 2016. That's when a NASA spacecraft named "Juno" arrives at Jupiter for a truly close-up look at the giant planet. Swooping as low as 5,000 km (about 3,000 miles) above the cloud tops, Juno will spend a full year orbiting nearer to Jupiter than any previous spacecraft.

The goal of the mission is to learn what lies inside the planet.

Astronomers have been studying Jupiter since the invention of the telescope 400 years ago, but in all that time the planet's vast interior has remained hidden from view. Even the Galileo probe, which dived into the clouds in 1995, penetrated no more than about 0.1% of Jupiter's radius.

"Our knowledge of Jupiter is truly skin deep," says Bolton, Juno's principal investigator. "There are many basic things we just don't know—like how far down does the Great Red Spot go? And does Jupiter have a heavy core?"

see *Astro2010* on page 16

President's Message

Fall Excitement

What a great stretch of weather we have been having this last month. Jupiter is putting on quite the show for us. Comet Hartley 2 has been a special treat and a few extra meteors with the Draconids too.

For those that missed our last monthly meeting in October, just look at the cover and feature article in the current issue (Nov/Dec) of *SkyNews* magazine. Our Skype presentation by world-renowned astrophotographer Yuichi Takasaka is the "real star!"

We saw all these same images and more and got the inside scoop on how and where they were taken too! We have PAA member Peter McMahon to thank for not only the idea and inspiration for such a thing to happen at our club, but he has taken on this project with great zeal and we all benefit because of it. Hats off to Peter and the other members that make the magic of Skype come alive. Maybe we will get Stephen Hawking by the end of next year? ;)

Stay involved in the club, as we get ready for our last meeting of the calendar year in December. Our club is what you make it and you only get out of it what you put into it.

We have a vacancy for our Light Pollution Abatement Director and we will be needing a new Treasurer too, so if you are interested in helping out your club in one of these positions, let us know.

Enjoy this issue of your newsletter too; it truly is one of the benefits of membership.

Rick Stankiewicz
President

Letter to the Editor

Of Hope and Change

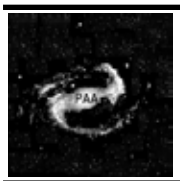
November can sometimes be forgiven for raising hope and expectations. With that theme in mind we have John Crossen's ultimately successful glimpse of Comet Hartley 2 accompanied by the wonderful photo taken by club member Brian McGaffney. The popular astronomy media raised many high expectations for the apparition of Comet Hartley 2 as a naked-eye comet in October which it failed to attain.

Late in September media outlets reported on the discovery of a planet around the star Gliese 581, raising many hopes that we'd found an Earth-like planet in the "Goldilocks" zone of a solar system. Ben Morgan gives us some sobering facts about this discovery that should make you postpone your vacation plans for an extraterrestrial voyage.

And of course, meteor showers always raise expectation of spectacular showings. November has five of them, but only the Leonids, peaking on the 17th, could be classified as dependable.

With the goal of managing expectations let's hope for clear skies this month.

Phillip Chee,
Editor



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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I eat crow with a side order of humble pie—almost

Comet Hartley 2. Comet Hartley 2 as revealed by the CCD camera of astro-imager Brian McCaffney of Nutwood Observatory near Apsley, Ontario.

Ok I admidt as of this writing (October 15) I have yet to spot Comet Hartley 2. It hasn't been because of a lack of clear nights, we've had a couple of week's worth of them. And it certainly hasn't been for a lack of trying on my part. Every night that I've been out giving a sky tour I've taken a few moments to try to spot the elusive little tusker.

Ultimately it's because the comet hasn't performed up to expectations—mine or those of the experts. Let's just call it the astronomical equivalent of lunch bag let down. I was expecting a Twinkie and Mom slipped in some broccoli instead. Being a short-term comet it will make another orbital pass between Earth and the outer regions of Jupiter every 6.46 years, so better luck next time, or so I thought.

A number of my friends have managed to image the comet using highly-sensitive, wide-field gear. This was especially true when the little bugger was passing near the Double Cluster between Cassiopeia and Perseus. It was quite a photo opportunity for the digital generation. But those of us in the binocular brigade didn't have as much luck.

According to all the reading I had done, Hartley 2 was supposed to be visible to the naked eye in early October. The dark sky at Buckhorn Observatory is more than up to the task of revealing the

see "Hartley" on page 11

What's Up in November?
Plenty if it Ever Clears

Orion Nebula. Not sure how to find the winter constellations? Visit Happenstance Books in Lakefield and ask for a copy of Terence Dickinson's *NightWatch*. Or pick up a copy of the magazine *NightSky* at Chapter's in Peterborough.

For astronomy buffs held captive in southern Ontario, November is traditionally the cloudiest month of the year. A friend of mine once said it was like a giant gray Tupperware bowl was placed over the bottom half of the province on November First.

But during the last couple of years traditional weather patterns seem to have broken pace with the norm. Blame it on global warming, Stephen Harper or whatever, things seem to have changed. So maybe November will cast off its grey cloak and give us a few clear and starry nights. If so, there's a lot to see.

Winter's constellations are sneaking up on us. By sunset the Taurus and Auriga are well up in the eastern sky. The binocular brigade will not only have the Pleiades and the Hyades in Taurus to examine, but the open star clusters M36, M37 and M38 in the constellation Auriga, the Charioteer.

As far as planets go, things don't get much bigger than Jupiter which is well up in the southeast when the Sun dips beneath the western horizon. On September 21st the Jovian Giant was at opposition and shined at its brightest. It is dimming now, but is still the brightest star-like object in that section of the night sky.

Near Jupiter, and visible in binoculars, is Uranus. It appears as a blue-green dot and resolves into a distinctly round—though small—object in a small telescope. Its name may have a high "snicker factor" but the "wow factor" is almost nil.

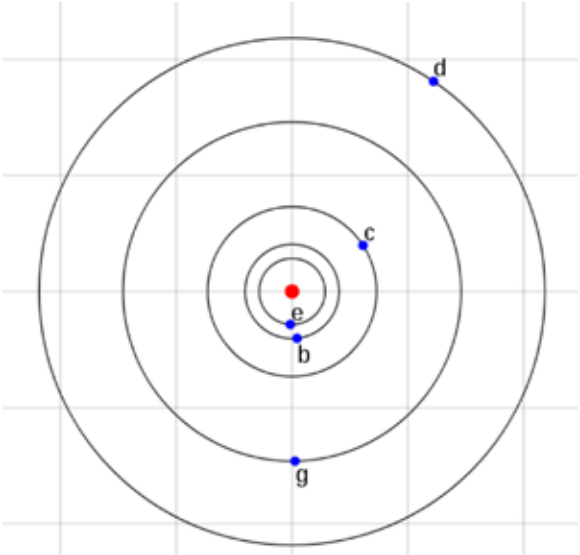
see "November" on page 11

Gliese 581
Where Hope May Go False

On September 29th, it was announced that Gliese 581 had two more planets; Gliese 581f and Gliese 581g. Gliese 581f has a minimum mass of 7 times that of the Earth and orbits 0.758 AU from Gliese 581 with an orbital period of 433 days. Gliese 581g has a minimum mass of 3.1 times that of the Earth and orbits 0.146 AU with an orbital period of 36.6 days while being tidally locked. Gliese 581g's temperature at equilibrium is 228 K, making it habitable for life.

Gliese 581 has also been known to host another planet that has potential for life, Gliese 581d, but further studeies and observations have had scientist trash their hope of life on Gliese 581d. With the discovery of Gliese 581g, it should be now known that life must, with the maximum certainty, exist on this planet. The only worries planet hunters are having is whether it may turn to be a bust and Gliese 581g is a Venusian or Martian made planet.

On September 24th, 2005, it was announced that Gliese 581 had one planet



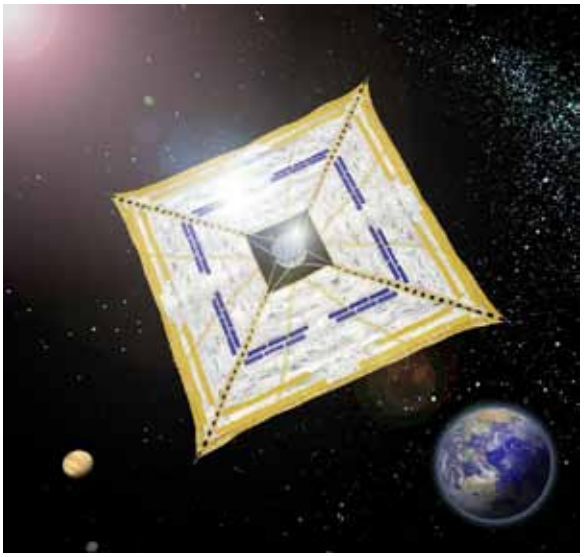
JD 2451409.762 (19 Aug 1999CE, 06:17:16.8 UT)
Each grid square = 0.1 AU × 0.1 AU
Planets and star not drawn to scale

orbiting called Gliese 581b. Gliese 581b was a Neptunian-sized planet with a mass of 0.97 that of Neptune. Gliese 581b's orbital period was measured to be 5.366 days at the speed of 13.2m/second. Research in 2007 has many believing that moons may have life, yet this is argumentative since it may lie too close to Gliese 581 to have moons. Later in 2007, Gliese 581c was discovered and was said to harbour life, unfortunately, new research has had planet hunters trash that idea. Again, in 2007, the discovery of Gliese 581d with a mass of about 7 times that of the Earth, leads to another belief that it may harbour life. Later research was conducted and found that it was too far away to have liquid water. Luckily, in 2009, a recalculation had them say "whoops" and announced that it lied closer to Gliese 581 than previously believed making new research conclude that it may be an ocean planet. Finally, at the end of April 2009, it was announced that Gliese 581 had another additional planet called Gliese 581e. It resided the closest to Gliese 581 at just 0.03AU with a minimum mass of 1.9 that of the Earth; Gliese 581e was too hot for it to be a candidate in having life.

Gliese 581 lies 20.5 light years away in the constellation Libra with it being the 87th closest star to the Sun. Gliese 581 is a red dwarf star with a mass of 0.31 times that of the Sun. Gliese 581 is calculated to be 7,000,000,000–11,000,000,000 years old and is suppose to be around for a lot, lot, lot longer, so no worries on it leaving.

Ben Morgan

Solar Sails



Artist's rendition of Ikaros Solar Sail.

A solar sail, simply put, is a spacecraft propelled solely by sunlight rather than with conventional rocket or ion engines. A solar sail is pushed forward simply by light from the Sun made possible because light is made up of packets of energy known as "photons," that act like atomic particles, but with more energy. When a beam of light is pointed at a bright mirror-like surface, its photons reflect right back, just like a ball bouncing off a wall. In the process the photons transmit their momentum to the surface twice—once by the initial impact, and again by reflecting back from it. Ever so slightly, propelled by a steady stream of reflecting photons, the bright surface is pushed forward.

A solar sail is made up of just such a reflective surface, or several surfaces, depending on the sail's design. When the bright sails face the Sun directly, they are subjected to a steady barrage of photons that reflect off the shiny surfaces and impel the spacecraft forward, away from the Sun. By changing the angle of the sail relative to the Sun it is possible to affect the direction in which the sail is propelled —just as a sailboat changes the angle of its sails to affect its course. It is even possible to direct the spacecraft towards the Sun, rather than away from it, by using the photon's pressure on the sails to slow down the spacecraft's speed and bring its orbit closer to the Sun.

In order for sunlight to provide sufficient pressure to propel a spacecraft forward, a solar sail must capture as much Sunlight as possible. This means that the surface of the sail must be big—very big. Cosmos 1, currently in development by the Planetary Society, is a small solar sail intended only for a short mission. Nevertheless, once it spreads its sails even this small spacecraft will be 10 stories tall, as high as the rocket that will launch it. Its eight triangular blades are 15 metres (49 feet) in length, and have a total surface area of 600 square meters (6,500 square feet). This is about one and a half times the size of a basketball court.

For a true exploration mission the requirements are far greater: when a NASA team in the 1970s, headed by Louis Friedman, suggested using a solar sail spacecraft for a rendezvous with Halley's Comet, they proposed a sail with a surface area of 600,000 square meters (6.5 million square feet). This is equivalent to a square of 800 metres (half-mile) by 800 metres—the size of 10 square blocks in New York City!

Even with such a gigantic surface, a solar sail spacecraft will accelerate very slowly when compared to a conventional rocket. Under optimal conditions, a solar sail on an interplanetary mission would

see "Ikaros" on page 15

So Much Space News
So Little Space

There has been so much going on lately that I don't have room to write about it all. So here's what I've been reading about lately in digest form. Call it the *Cole's Notes* from outer space.

The exoplanet count is exploding. We're now up to 473 and the Kepler Space Telescope recently discovered one distant sun with two planets orbiting it.

So far we've nailed lots of gigantic "Super Jupiters" and even some Jupiter-sized planets, but no Earth-sized dirt balls yet. They're smaller and harder to find. Even now we have the technology and techniques for analysing the atmospheres of some of the exoplanets. So it shouldn't be long before we'll be discovering smaller worlds out there.

We're all familiar with the idea that when we look at a distant object through a telescope we are really looking back in time. Look at the Moon and the image is as it was 1.5 seconds ago. Look at the Sun (with a proper filter) and it appears as it did 8.5 minutes ago. But when we see something like the Hubble Ultra Deep image we're looking more than ten billion years back in time.

Science writer Francis Reddy brought the Hubble Ultra Deep Field image down to a more easily comprehended human scale with this statement. "It would be the same as a 70 year-old woman looking through a telescope and seeing herself as a 30-year old.

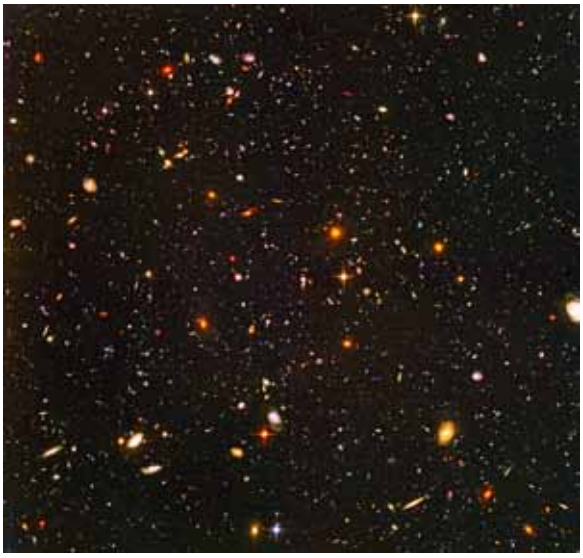
According to a panel of 41 international experts who reviewed 20 years' worth of research, it was an asteroid impact not runaway volcanic activity that ended the reign of the dinosaurs 65 million years ago. The impact not only did a lot of instant damage with tsunami and fire storms, but the materials thrown into the atmosphere from the impact blocked out the Sun. As a result, plants couldn't grow and many large land and sea reptiles simply starved to death, clearing the way for mammals to become the dominant species on Earth. Hooray for us!

Sometimes called the Cretaceous-Tertiary (KT) extinction, it wiped out more than half of all species on the planet, including the dinosaurs and large marine reptiles. One of the materials thrown up into the atmosphere was iridium brought to Earth by the meteor itself. This blanked the globe and if you dig down you will come to a thin layer of iridium which is referred to as the KT Boundary.

Just when you thought the Moon was a dead desolate place it turns out that it may still be geologically active—and shrinking. Recent studies show that cracks in the Moon's surface have formed as our celestial dance partner cooled.

Called Lobate Scarps, they formed as the interior of the Moon cooled and the surface crust shrank. The scarps had been seen previously along the Moon's equatorial region, but it now appears that they are more "global" in their dispersal. But not to worry, dear old Luna will still be there for those who croon in June beneath the silvery spoon.

John Crossen



Hubble Deep Field. The most distant objects in the Hubble |Ultra Deep Field image are more than 10 billion light years away. The exposure took a total of 950,400 seconds spread over an 11 day period.

PHOTO GALLERY

NGC 722

This CCD image of NGC 772 was done at the Nutwood Observatory on October 11th and 12th.

NGC 772 is a spiral galaxy, approximately 130 million light-years away, in the constellation Aries. Below and slightly to the right, is the satellite galaxy NGC 770, which is probably responsible for NGC 772's peculiar shape. Also, there are a lot of dwarf galaxies visible in the immediate neighborhood that may also be interacting with NGC 772.

This galaxy is large but far far away (130 million light years from us). It has a apparent magnitude of about 11 and is difficult to image details of the galaxy due to its distance—however the large scope and clear skys did help along with a huge arsenal of post-processing techniques.

Photo by Brian McGaffeny

Fall Equinox Alignment

On September 22 of this year there was a nice alignment of our Moon and the planet Jupiter. Around midnight the high thin clouds created the near perfect conditions for a lunar halo and inside (at the 7 o'clock position) is our solar system's largest planet. I needed to overexpose our Moon to get both the halo and Jupiter to register in the image.

This image was a tripod shot with a Canon 400D camera.

Settings used were ISO 400; 8 seconds; f/4.0 with a Sigma 10 to 20mm lense at 10mm.

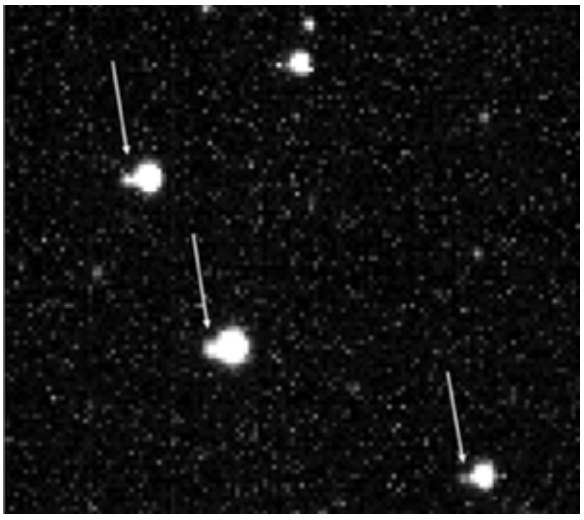
Photo by Rick Stankiewicz

Misadventures of an Aspiring Imager

Adventure #9—Backlash

At this point, if you recall, I have setup and balanced my telescope, and been able to actually focus my camera, despite the vagaries of "seeing" and miscellaneous other challenges. I have also learned to auto guide while taking long exposure images. The next task that I tackled was backlash.

When I covered the subject of autoguiding I no doubt left you with the impression that this was a fairly straightforward task, and it usually is so long as all the preparatory setup steps have been rigidly followed. However, there is one other problem (oops, challenge) that may be encountered, namely backlash. Backlash can occur with cheap mounts or ones that have been used for some time, whereby the gears get sloppy, bearings loosen, poor lubrication, etc. Also note that a certain minimum backlash will be present even in the most expensive mount, otherwise there will be excessive stiffness which will cause drag and/or overloaded drive motors.



Backlash in a mount can lead to problems when guiding during an image. (The New CCD Astronomy)

Backlash issues will become readily apparent during autoguiding. The RA axis is always rotating in the one direction, and assuming this axis is balanced slightly offset to the east, there should rarely be an issue. However, the Dec axis, unless exactly polar aligned, needs to move in both directions, and any large backlash movements will totally foul up the autoguiding. This will become evident as an inability to maintain the guide star centred, and/or overcompensated adjustments which will show up as oval star shapes.

The first step is to identify the culprit. This can be tricky. Every single component needs to be checked for sloppiness—this could be as simple as the scope not being attached to the mount securely, or a clutch not being torqued correctly. Or it could just as well be something major such as a worn bearing or worm gear. Keep in mind that backlash could be the cumulative effect of minor, seemingly insignificant, small movements.

But, at the end of the day, especially with cheaper or older mounts, it may be too expensive or simply not practical to correct all backlash. Herein lies the wonders of computerised backlash correction feedback loop software. For example, **CCDSoft**, the software I use for autoguiding, has a backlash compensation routine. Some GoTo mount software packages also has the same sort of thing. And analysis software, such as **PemPro**, is available to help measure and correct the backlash. But, software cannot perform miracles, so don't expect it to do everything. A well tuned mount is the best solution to backlash.

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Oh, and by the way, some backlash issues are impossible to handle. For example, severe cold weather will stiffen lubricants and cause all sorts of weird movements—in this case I suggest you go inside and relax with a nice Scotch.

Next issue I'll continue with more misadventures, including:

- what the heck is PEC
- why I am becoming a computer geek
- being color blind doesn't help
- digital developments
- and I thought curves was all about beautiful women and fast cars
- keeping things in balance and sharp
- presenting the snaps to the world
- and what makes it all worthwhile

Stay tuned, John Galle

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Hartley

rascal, but it has been a no-show in my Bausch and Lombs.

I wasn't expecting a brilliant comet like Hale Bopp in 1997 that was bright enough to be seen through the sky glow of downtown Toronto's light and air pollution. That was some comet! But if Hartley 2 just glowed a bit, like Comet Holmes two years ago, I wouldn't have feel as though I had let my readers down.

I won't give up, but the situation does highlight two annoying aspects of astronomy. The first is that comets and meteor showers seem to have minds of their own. And to compound the fracture, astronomers are an optimistic bunch. Mix the two together, then sprinkle in some media hype and we have an award-winning recipe for public disappointment.

This year's Perseid Meteor Show was supposed to deliver up to 200 "shooting stars" per hour at its peak. It said so on the cover of one of the world's most respected amateur astronomy magazines. But here at BHO we managed about 10 per hour. We saw more on the night after the peak. All of which made for a mediocre meteor shower.

But wait, hold the presses! It's now October 16 and I nailed Comet Hartley 2 last night. About 1:00 a.m. spotted a very dim blurry green glow in my binoculars. It was about the size of an aspirin held at arm's length. A close up in the telescope revealed the comet's nucleus, but no tail.

So hold that order of crow, cancel the humble pie and pass the champagne. Comet Hartley 2 may be a few fries short of a Happy Meal, but it definitely is there. Google it up and check out a map to see where it will be on the night you are trying to find it. Just remember, it doesn't look like a traditional comet. That's what fooled me

John Crossen

Stars Explode with the Awesome Power of Binomite

I'm talking about the amazing power of binoculars. They can make those misty patches in the night sky burst into starry fireworks. Single stars turn into double stars. Even the largest moons of Jupiter pop into view for those with steady hands,

Put all that together and it makes October a great season for the sweater 'n' jacket set step out with their big eyes. Never thought of binoculars as useful astronomy tools? Get ready to change your mind. It doesn't really matter what kind or size they are, they'll show you more than your bare eyes ever will.

I recommend 7x50 models. That means the magnification power is seven times and the distance across the front lenses is 50mm. Compared to the light gathering capability of an adult's dark-adapted pupil at just 5mm, 50mm is a big jump. Even if you have 8x25 birding binoculars, they'll scoop up more light and that means brighter stars and galaxies. Yes, Virginia you can see galaxies that are millions of light years away with binoculars—some with the naked eye!

So grab a copy of *SkyNews* from the local Chapters magazine rack, flip it open to the star chart and head out the door on the next clear night. Here's what's up for neck-benders this month.

Let's start in the east with an easy target, the Seven Sisters of the Pleiades. This little star cluster forms a misty patch near the constellation Taurus the Bull. The cluster bursts into a beautiful shower of diamond dust in your binoculars. Some say it looks like a miniature version of the Little Dipper. I call it the dinky dipper. And the ancient Greeks called it the Old Hen.

Move to your right and up a bit to the bright star Aldebaran and you'll pick up the Hyades cluster. This is a much larger and less compact grouping of stars. It's not as pretty as "the sisters", but is still well worth a look. Aldebaran, by the way, represents Taurus the Bull's eye.

Swing back to your left and up towards Cassiopeia—the big "W" shaped constellation and you'll stumble over another misty patch midway between the queen and Perseus below her. It is known as the Double Cluster because it shows you two gorgeous clusters of stars side-by-side. No brain-breaker to that one.

Now move towards the north to the Big Dipper. Take a look at the second star in from the end of the handle. It's actually a double star, Alcor and Mizar. Native peoples called it the horse and rider and anyone with good eyesight can split the two, naked eye.

Your treat for the night will be a galaxy in the constellation Andromeda. It is a close cousin to our home galaxy, the Milky Way (if you can call 2.5 million light years close) Andromeda can actually be seen with the naked eye from a good dark sky location on an exceptionally crisp clear night. You can spot the galaxy from Buckhorn Observatory, but if it's a hazy summer night finding the lovely lady becomes a bit of a challenge.

Until we meet again by the back yard telescope, discover the amazing power of binomite. I guarantee you'll have a blast.

John Crossen

The Andromeda Galaxy appears as a misty smudge in binoculars.

Leland Melvin
from Toronto Argonaut to NASA Astronaut

Leland Melvin with a group of students. Kids couldn't ask for a more exciting or diversified role model. Leland Melvin has been an outstanding scholar, high-scoring football player in college and the pro leagues, and now he's a sucessful astronaut.

Some kids dream of being a football player. Some dream of becoming an astronaut. Leland Melvin has done both, and at 39 he's still carrying the ball for NASA.

Leland's career has supplied him with a rotating wardrobe of uniforms. His athletic and scholarly abilities earned him a scholarship to the University of Richmond where he took a degree in Chemistry. Then he was off to the University of Virginia for his Master of Science Degree in Materials Science Engineering. But before settling into a career, he wanted to try the professional leagues of the sport that had help put him through college—football.

Shortly after graduating from the University of Virginia he wore the colours of the Detroit Lions as a wide-receiver. Unfortunately a hamstring injury laid him up and Leland shifted to the Dallas Cowboys. Again his hamstring let him down and he moved to the Toronto Argonauts for a short stay at training camp. But don't count him out.

This guy had set yardage and scoring records during his college career and made the University of Richmond's Hall of Fame—and there was one more uniform he wanted to wear—that of a NASA astronaut.

See "Astronaut" on page 15

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November

Night hawks have a real treat to keep their peepers propped open for—mighty Orion. In November the Great Hunter is just crawling out of bed and rising over the eastern horizon around midnight. Later, in the still of the night, he is well up and moving towards the south.

Again, the binocular brigade can scoop up another piece of celestial eye candy, the Orion Nebula. Also known as M42 from the Messier catalogue of deep sky objects, this huge expanse of gas and dust is one of the Milky Way Galaxy's largest star birthing regions. Despite glowing from a distance of 1,500 light years, the Orion Nebula is visible to the naked eye. In binoculars it really shines. But in a telescope you can not only make out the stars that cause it to glow so brightly, you can see how their radiated energy has sculptured the nearby gas clouds into marvellous curtains and wings.

To find M42 look beneath the line of three stars that make up Orion's belt. Hanging from the belt is Orion's sword and M42 is the jewel in the hand of the big guy's toad sticker.

Until we meet again by the backyard telescope, keep your yard lights dimmed and pointed down. You'll save energy, money and the night sky.

John Crossen

The Sky this Month

Mercury is in the western evening sky. Passes 1.7° south of Mars on the 21st. Reaches greatest elongation east on the 30th.

Venus reappears in eastern morning twilight early in the month.

Mars is low in the early evening sky in the southwest in Scorpius. Passes into Ophiuchus on the 8th. Passes 4° north of Antares on the 10 than and 1.7° north of Mercury on the 21st.

Jupiter visible most of the night and just past opposition. Returns to direct eastward motion against the background stars on the 19th.

Saturn is low in the pre-dawn sky in Virgo.

Moon 1.6° south of Mars on the 7th and 1.3° south of the Pleiades on the 21st.

Daylight Savings Time ends on the 7th at 2 a.m.

S. Taurid Meteors peak on the morning of the 5th.

N. Taurid Meteors peak on the morning of the 12th.

Leonid Meteors peak on the evening of the 17th.

Moon Phases

New Moon	12:52 AM	November 6
First Quarter	11:38 AM	November 13
Full Moon	12:27 PM	November 21
Last Quarter	3:36 PM	November 28

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Ikaros

gain only 1 millimetre per second in speed every second it is pushed along by Solar radiation whereas a conventional Delta II rocket accelerates by as much as 59 metres per second. But the incomparable advantage of a solar sail is that it accelerates CONSTANTLY. A rocket only burns for a few minutes, before releasing its payload and letting it cruise at a constant speed the rest of the way. A solar sail, in contrast, keeps on accelerating, and can ultimately reach speeds much greater than those of a rocket-launched craft. At an acceleration rate of 1 millimeter per second per second a solar sail would increase its speed by approximately 310 kilometres per hour (195 mph) after one day, moving 7500 kilometres (4,700 miles) in the process. After 12 days it will have increased its speed 3700 kilometres per hour (2,300 mph).

While these speeds and distances are already substantial for interplanetary travel, they are insignificant when compared to the requirements of a journey to the stars. Given time, however, with small but constant acceleration, a solar sail spacecraft can reach any desired speed. If the acceleration diminishes due to an increasing distance from the Sun, some scientists have proposed pointing powerful laser beams at the spacecraft to propel it forward. Although such a strategy is not practicable with current technology and resources, solar sailing is nevertheless the only known technology that could someday be used for interstellar travel.

The technology is currently being tested by the Ikaros solar sail that was launched along with the Akatsuki probe on May 20th of this year by JAXA, the Japanese Space Agency. As you read this Ikaros is slowly gaining speed as it follows Akatsuki to Venus.

***Mark Coady with help from T*he Planetary Society**

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Astronaut

Leland's science achievements landed him a job with NASA at the Langley Research Centre in 1989. He worked in the Fibre Optic Sensors Group. By 1994 he was selected to head the Vehicle Health monitoring Team for the Lockheed/NASA x-33 Reusable Launch Vehicle. And in 1996 his rocketing career lead to his co-designing and monitoring construction of a Non Destructive Evaluation facility for fibre optics. But the big move was yet to come.

Leland Melvin was selected by NASA in 1998 to report for Astronaut Candidate Training. Having successfully completed his training he put on the most coveted uniform of his career—that of a NASA astronaut.

Today he is the veteran of two space flights and has logged over 565 hours in space aboard Space Shuttles on missions to the International Space Station. Leland's first mission to the ISS involved delivering the Columbus Science Module and installing it. His next flight was in 2009 and involved delivering about 30,000 pounds of replacement parts along with two Express Logistics Carriers. Altogether he has racked up nearly 16 million kilometres orbiting the Earth.

Leland Melvin has had an inspiring career and he's still making the most of it—but not for himself. As co-manager of NASA's Educator Astronaut Program, Leland Melvin traveled across the country, engaging thousands of students and teachers in the excitement of space exploration, and inspiring them to pursue careers in science, technology, engineering and mathematics.

Whether racking up yardage on the football field or millions of kilometres traveling through space, Leland Melvin just keeps on scoring.

John Crossen

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Jupiter

Juno will improve the situation without actually diving into the clouds. Bolton explains how. "Juno will spend a full year in close polar orbit around Jupiter, flying over all latitudes and longitudes. We will thus be able to fully map Jupiter's gravitational field and figure out how the interior is structured."

But that's not all. Researchers have good reason to believe that much of Jupiter's interior is filled with liquid metallic hydrogen, an exotic metal that could form only in the high-pressure, hydrogen-rich core of a giant planet. Jupiter's powerful magnetic field almost certainly springs from dynamo action inside this vast realm of electrically conducting metal.

"Juno's magnetometers will precisely map Jupiter's magnetic field," says Bolton. "This map will tell us a great deal about planet's inner magnetic dynamo—what it's made of and how it works."

Finally, Juno will probe Jupiter's atmosphere using a set of microwave radiometers. "Our sensors can measure the temperature 50 times deeper than ever before," says Bolton. Researchers will use that information to figure out how much water is underneath Jupiter's clouds. "Microwave measurements of Jupiter's water content are particularly exciting because they will help discriminate among competing theories of the planet's origin."

Now that's a close encounter. Stay tuned for Juno.

Find out more about the Juno mission at `http://www.nasa.gov/mission_pages/juno`. Play the new Solar System Explorer super game, which includes the Juno Recall mini-game at `http://spaceplace.nasa.gov/en/kids/solar-system`. It's not just for kids!

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

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). Typed or hand-written 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:

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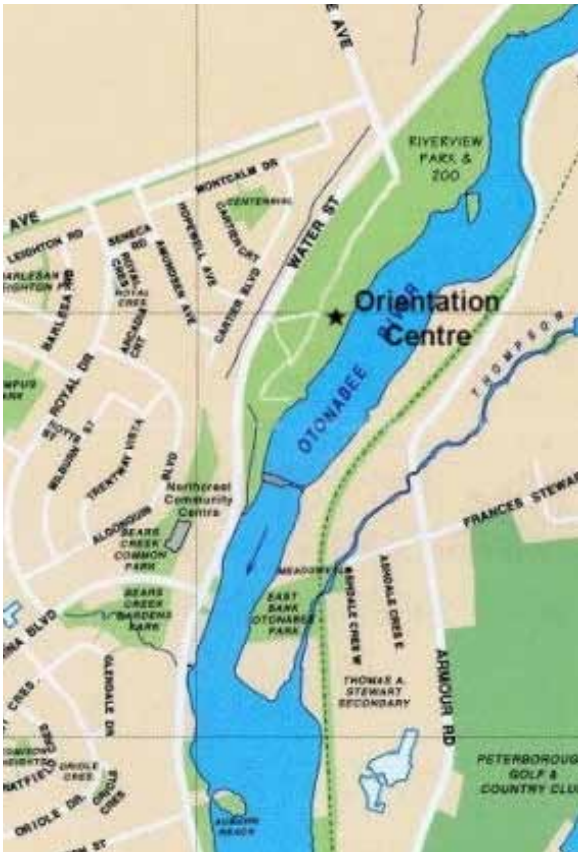
Next submission deadline:
November 27, 2010



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 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.