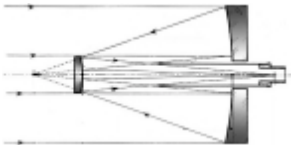
PETERBOROUGH ASTRONOMICAL ASSOCIATION

THE REFLECTOR

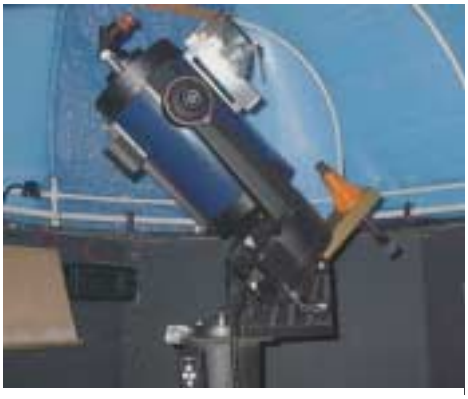


Volume 2, Issue 1 November 2002

Editorial

Happy Anniversary—It has been a full year since "The Reflector" made it's debut. Many thanks to those who have contributed over the last year.

Has anyone been observing much this last month? It looks like the grim skies of November came early this year. I am still waiting for a decent night, just to polar align my scope in the new location using the Tuthill Polar aligner. This neat device clamps on the bottom of a typical Schmidt-Cassegrain wedge and has a polar scope that you set to Polaris according to the time and date. Perhaps the astronomical gods have seen this and are trying to thwart this attempt at a quick polar align.



My Meade LX-10 with the Tuthill Polar alignment scope installed—just waiting for a clear night.

This month brings with it another opportunity to view the Leonid Shower. Last year this was totally spectacular. This year also promises to be good, but the moon will almost be full so only the brighter meteors will be seen.

I will still be accepting orders for RASC Handbooks and Calendars until the November 15 Meeting. Order Forms are at the back of this issue.

Clear Skies,

Charles W. Baetsen
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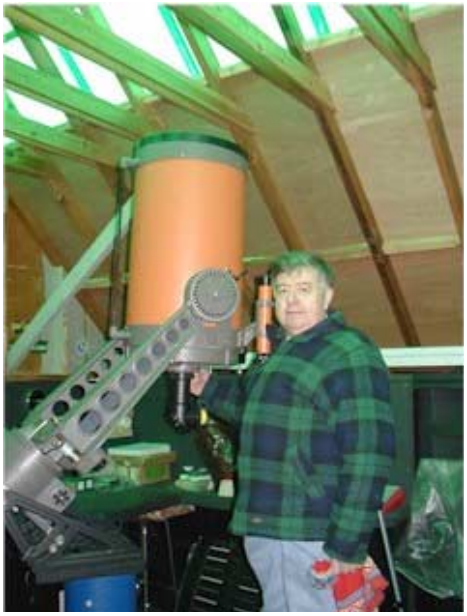
Leo Enright Uses Astrophotography To Do Science

Friday, October 18th will be a night PAA members won't soon forget. That night we all enjoyed a superb presentation that focused on Leo Enright's lengthy career as an observer, a carousel tray filled with very enlightening astrophotos, and an impromptu discussion on the Holleford impact site.

Mr. Enright is a model of observing precision. During the course of his talk, he discussed the value of keeping an accurate log of each night's observing. As examples he brought along copies of his own logs, complete with codes he has developed to speed the recording process.

Leo is also an avid solar observer. In fact, he has recorded two complete solar cycles via with his 8-inch SCT and full-aperture solar filter. That's about 22 years of counting sunspots all told. He also lists a pair of 20X100 binoculars as one of his favorite observing tools. And there's always the C-14 beneath the roof of his observatory.

During the course of his presentation, Mr. Enright showed us a number of



Leo Enright

Inside This Issue

An Ariel view of the Holleford Crater near Kingston. Even after half a billion years and being buried under 100s of meters it is still quite obvious from above.

slides that not only served to highlight his skills as an astrophotographer, but also his belief that a photograph can underscore an astronomical concept. To that end he showed us sun spots moving across the surface of old Sol, some fascinating conjunctions that demonstrated planetary motion and an intriguing example of how visible details in a crater change as the sun sweeps over the lunar surface in just a 45 minute period. Towards the end of his presentation the discussion swung around to meteor impacts. Leo just happens to be and expert on the Holleford crater, just east of us. At that point, the discussion opened up and we found ourselves immersed in a fascinating discussion that kept everyone going until about 11:00 p. m. It's a good thing Dave made an extra pot of coffee and brought two boxes of doughnuts. I'll also bet we have a trip to Holleford coming up this spring.

John Crossen
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Astrophotographer Gord Rife To Speak At Nov. 15th PAA Meeting

Gord Rife of the South Simcoe Amateur Astronomers will be the star of the PAA's November 15th meeting. Gord is an experienced astrophotographer who does his work from scratch.

For starters he built his own telescope. Actually telescopes. The primary scope is an 8-inch Newtonian for which he ground his own mirror. The guide scope is a 4.5 incher on which he simply adjusts the primary mirror to capture a guide star. After all, its only the guide star, you don't need perfect star images.

Gord shoots much of his work on slide film and will have an excellent presentation on the big screen for us. He also has become accomplished at enhancing the shots via computer and can give us some tips on that front, too.

Astrophotographer Gord Rife with his unique Multi-scope. The two Newtonians and the 70 mm refractor ride on a Losmandy G11 mount. So why didn't Gord paint the optical tubes of his home crafted Newts? Ask him at the November 15th meeting. You'll be surprised.

Join us to meet Gord and admire his work at the November 15th meeting. If you're just getting started in Astrophotography, Gord has plenty of suggestions you'll find useful - even if you're a digital dude.

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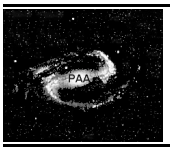

Peterborough Astronomical Association

The Reflector is a publication of the Peterborough Astronomical Association (PAA). Founded in 1970, the PAA is your local group for astronomy in Peterborough and the Kawarthas.

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Off the Beaten Path

Fall is upon us, which means its galaxy season again! To help maximize your observing sessions, I have prepared the following list of interesting and often overlooked objects to observe this month.

NGC 404 - Located within the same field of view as β-And. This small round galaxy can be easily spotted if one places β-And just outside the field of view.

NGC7640 in Andromeda

NGC 7640 - Also located in Andromeda, this 12.5 magnitude edge-on spiral is a good challenge for a 4" scope. An 8" scope will reveal a slender, even nebulosity with a bright bulge in the centre.

NGC 772—One of the few objects in Aries

NGC 772 - At magnitude 10.3, this is the largest and brightest galaxy in Aries. It is located in a rather bland part of the sky 2 degrees ESE of γ-Ari.

NGC 877 - This is another easy target in Aries. In an 8" scope it appears as a small round patch.

NGC 821 - Located 4 degrees south of NGC 877, this bright elliptical galaxy is visible in as small a scope as a 4".

G1—A globular from another galaxy

G1 - The challenge object of the month. This 13.7 magnitude globular is actually a member of the Andromeda system. A 10" or larger scope is required to see the brightest globular in the local group. It appears as a tiny but obviously non-stellar object.

With any luck you will be able to find most of these objects on that next clear cold night. Be adventuresome and go off the beaten track. Enjoy the new scenery.

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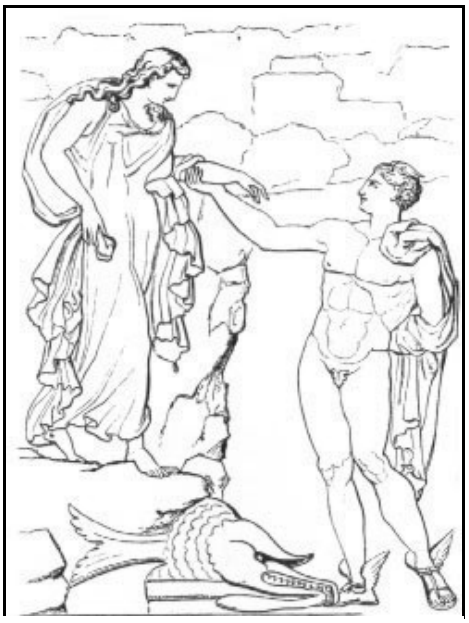
Look! Up In The Sky! It's A Bird. It's A Plane. It's A Celestial Soap Opera!

Here's a tale that links most of fall's major constellations together. Our story opens in the mythical African Kingdom of Æthiopia (not to be confused with modern Ethiopia). First upon our celestial stage are the constellations Cepheus, the King of Æthiopia, and his Queen, Cassiopeia.

It seems that Cassiopeia, in a moment of great vanity, declared that she was the most beautiful woman in the Kingdom of Æthiopia. This greatly annoyed the sea nymphs who complained to the god Poseidon (also known as Neptune to the Romans). As punishment for Cassiopeia's vanity, Poseidon sent Cetus the sea monster to ravage the shoreline of Æthiopia.

Cepheus, the King, was most dismayed at the destruction the sea monster was causing and asked a friendly local oracle what he should do. The oracle instructed him to chain his beautiful daughter, the princess Andromeda, to a rock near the sea where she would become an offering to Cetus. The King, being a major whimp, did exactly as instructed



Perseus saving Andromeda from the Sea Monster Cetus.

Thankfully handsome Perseus rode past on his way home from slaying Medusa and the hideous Gorgons. Looking down from his winged horse Pegasus, Perseus spied Andromeda about to be devoured by Cetus. Ever the helpful lad, he swooped down and pulled the head of Medusa out of a bag so that Cetus would see it.

One glance at Medusa's head and Cetus turned to stone, whereupon he made like a rock and sank to the bottom of the sea. Thus, Perseus rescued the beautiful princess Andromeda.

An alternate ending claims that Queen Cassiopeia was further punished by being chained to her throne and condemned to forever circle the northern sky - sometimes in an upside down position. Most indignant for a Queen!

As a challenge, grab your star charts on a clear autumn evening and go out to see if you can spot all the characters from this mythological soap opera. Some of the constellations, like Cassiopeia, Perseus, Andromeda and Cepheus are easy to find. The others are a bit more difficult. So here are some hints:

Where Andromeda ends, the great square of Pegasus begins. And by the way, the winged horse, is upside down in the sky. Cetus is a long, large and very dim constellation south of Pisces. It is near the horizon in the early evening at the beginning of fall.

Happy constellation hunting.

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The Sky This Month

MERCURY:

Mercury will be in the glare of the sun and will not be visible this month..

VENUS:

Venus will be in the glare of the sun and will not be visible for most of this month, but will become visible in the morning sky by month's end.

MARS:

Mars will be visible this month in the early morning hours.

JUPITER:

Jupiter will be in Cancer and appears as the second brightest object at night. It will visible in the late evening hours.

SATURN:

Saturn will be visible near the Taurus-Gemini boundary, not far away from the Crab Nebula (M1).

URANUS & NEPTUNE:

Uranus and Neptune will be visible in the constellation Capricornus.

PLUTO:

Pluto will not be visible this month.

METEOR SHOWERS:

Southern Taurids: Peak on November 3rd

Northern Taurids: Peak on November 13th.

Leonids: Peak from November 18th-19th, but there will be interference from the moon.

There are several minor meteor showers this summer. For details on these see *http://comets.amsmeteors.org/meteors/calendar.html.*

Magnification

Hey, mister, how powerful is that telescope of yours? Anyone who has ever shown the sky to the public has been greeted with this question. I used to launch into a great and lengthy description about how we astronomers were more interested in light gathering powers of a telescope and not mundane magnification. This was answered by a blank stare that inevitably was followed by "Yea, but ... how powerful is it?"

To us amateur astronomers this should be a relevant question. We have all used the rule of "twenty times the diameter of the objective in centimeters" and have probably never thought where this rule came from. We should know about the restrictions imposed upon us by our equipment. When I talk about equipment as regards magnification, I am referring to our telescope *and* our eyes. Let us assume that both work at the limit of their ability.

The magnification of a telescope with a given eyepiece is determined by dividing the focal length of the objective by the focal length of the ocular. For example, a 15 cm f/8 (focal length = 15*8=1200 mm) telescope with a 25 mm eyepiece will yield 48 power. However, we can't increase or decrease the power of our telescopes without bounds simply by changing eyepieces—there are limits.

The lowest power that a telescope can produce is directly related to the diameter of the dark-adapted eye. The exit pupil of a telescope is found by dividing the objectives diameter by the magnification of the telescope. If the fully dark-adapted eye has a smaller opening than the exit pupil of the telescope, the eye will in effect restrict the size of the telescope being used. Dark-adapted eyes vary between people, but for sake of argument let's assume an aperture of 7.5 mm for the average. This yields a bottom limit of 1.3 times the diameter of the objective in centimeters.

The upper limit of a telescope is also determined by the eye. When the exit pupil drops below 1 mm there is a marked degeneration of the image quality. The minimal allowable size of an exit pupil is 0.75 mm; below this, the quality really starts to suffer. Using the same formula as we did in finding the lower limit the upper limit is found to be 13 times the diameter of the objective in centimeters. If we are only interested in separating doubles and not on image quality then we can increase this value to 20 or 30 times the objective's diameter.

The laws of physics are such that a telescope has a limit to which it can resolve. No matter how much magnification you give the telescope, if it

is not resolved at the focal plane of the telescope it will not be resolved at all. The empirical value for this limit is known as the Dawes Limit. The human eye can resolve about 1' at the very best. When we combines these two facts, we come up with a magnification of maximum resolution to be 10 times the diameter of the objective in centimeters. Any magnification above will not yield any more detail but it might just make it easier to see the detail that exists.

This article does not take into effect the psychological aspects of observing. People feel more comfortable observing a larger object than a smaller object; therefore smaller telescopes are more pleasing at their higher power levels. Lines are easier to resolve than points: Cassini's division (0.5") was first seen in a 6.5 cm telescope, even though theory tells us that it requires a 23 cm telescope. Strongly contrasting objects are easier to resolve than low contrast objects making planetary observation even more difficult. For working with double stars, the Lewis Formula takes better account of the size of the telescope

So what do you say when you get the Dreaded Question about power? Well, you now have the facts - do with them as you must. For my part, I mumble a lot.

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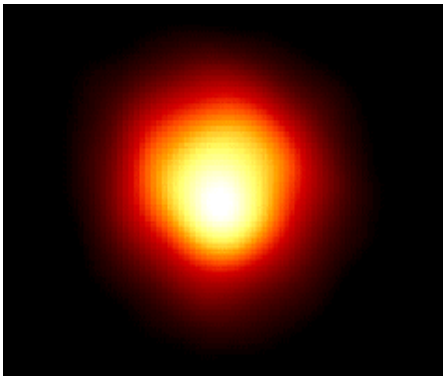
Amazing Space

Talk about hefty stars, a typical white dwarf would make Rita McNeil seem like a total lightweight. One teaspoon of a white dwarf weighs as much as the average family sedan. That's about 3,500 lbs. Our own Sun will eventually become a white dwarf, as will any star that equals its mass or is 1.4 times it.

In its latter years the Sun will become a red giant - like Betelgeuse. At that stage it will have converted all its helium to hydrogen, then burned the hydrogen and converted it to carbon and oxygen. The Sun will also have expanded to engulf Mercury, Venus, Earth and Mars.



Betelgeuse—This red giant is the only star large enough to see it's disk

As the Sun grows during its hydrogen-to-carbon conversion phase, radiation from within it will blast massive layers of gas off from its outer shell. Eventually these gasses will form a planetary nebula - like the *Ring Nebula* or *The Dumbbell*. At the centre of this nebula will be a white dwarf star - very high in mass, but only as about as large as the Earth is today. Eventually that white dwarf will cool to become a giant crystal-like object drifting through the blackness of space.

But who's to worry. All this nastiness won't happen for about 4 billion years. And by then we'll either have World-Trade-Centered ourselves out existence or evolved into something more intelligent than we now seem to be.

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Theoretical Basis for Determining the Speed of Light Using Jupiter

Warning - The following article should not be read by those with an aversion to complex math!

Have you ever wondered how the speed of light was first measured? Galileo attempted to do this with two lanterns, but was unsuccessful because the speed of light was much faster than he thought. Later in 1676, Ole Romer noticed discrepancies in the timings of the Galilean moons, which he interpreted as being a result of the finite speed of light. Why could he say this? Read on and you shall be "enlightened".

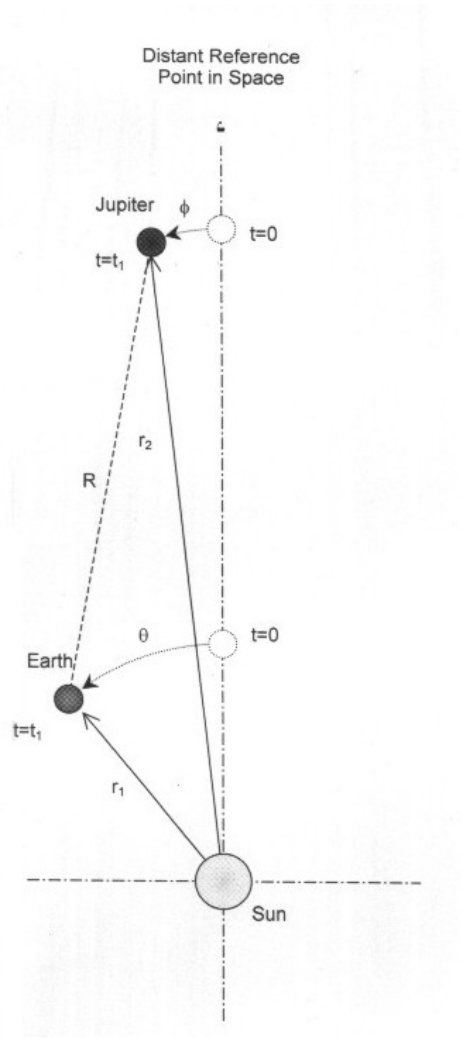

Figure 1: Sun-Earth-Jupiter Geometry

Figure 1 shows the relative positions of Earth and Jupiter at opposition ($t=0$) and at some later time ($t=t_1$).

We will first define r_1 to be the distance between the Sun and Earth and r_2 be the distance between the Sun and Jupiter.

At time $t=0$, Jupiter is at opposition with

Earth (i.e., $\theta = \phi = 0$). After some time ($t=t_1$), Earth has moved θ radians and Jupiter has moved ϕ radians in their orbits from their opposition positions.

NOTE: a radian is approximately 57.29 degrees (or 360/2π) and is the natural unit of angular measurement (as opposed to degrees, which is an arbitrary manmade unit).

From the cosine law, the distance between Earth and Jupiter, *R* is:

$$R = \sqrt{r_1^2 + r_2^2 - 2r_1 r_2 \cos(\theta - \phi)}$$

The angular speed (ω_1) at which the earth moves is given by:

$$\omega_1 = \frac{2\pi}{T_1} \text{ , in radians/day}$$

Similarly the angular speed (ω_2) at which Jupiter moves at is given by:

$$\omega_2 = \frac{2\pi}{T_2} \text{ , in radians/day}$$

T_1 is the period of the earth's orbit (365.24 days) and T_2 is the period of Jupiter's orbit (11.8*365.24 days).

If we assume that the ω_1 and ω_2 speeds are constant throughout their orbits (they are not, but are close), then we can predict what angles Earth and Jupiter will be from the opposition line at a given time (t) using $\theta=\omega_1 t$ and $\phi=\omega_2 t$.

Substituting these in the first equation we get the following expression for *R* as a function of time:

$$R(t) = \sqrt{r_1^2 + r_2^2 - 2r_1 r_2 \cos(2\pi t(\frac{1}{T_1} - \frac{1}{T_2}))}$$

Clearly from the diagram, the closest Earth is to Jupiter is when we are at opposition or when $\theta = \phi = 0$. Substituting this in the above equation, we get the minimum Earth-Jupiter separation to be:

$$R_{\min} = \sqrt{r_1^2 + r_2^2 - 2r_1 r_2}$$
$$= r_2 - r_1$$

Of course you could have guessed that from the diagram, but it is nice to see that the math works.

Since the *speed of light (c) = distance / time*, any extra time difference ($\Delta\tau$) due to light traveling any extra distance ($R(t)-R_{min}$) will be given by:

$$c\Delta\tau(t) = R(t) - R_{\min}$$

$$= \sqrt{r_1^2 + r_2^2 - 2r_1 r_2 \cos(2\pi t(\frac{1}{T_1} - \frac{1}{T_2}))} - (r_2 - r_1)$$

If we solve for *c* (the speed of light) we get,

$$c = \frac{1}{\Delta\tau(t)}(\sqrt{r_1^2 + r_2^2 - 2r_1 r_2 \cos(2\pi t(\frac{1}{T_1} - \frac{1}{T_2}))} - (r_2 - r_1))$$

Therefore if we can measure $\Delta\tau$ (the extra time it takes light to reach us because of the increased distance), we can find the speed of light (*c*). As you might of guessed, $\Delta\tau$ is measured by determining how far off the occultations of Jupiter's moons are from predicted times (calculated as if Jupiter was always the same distance away).

How big of a time difference are we talking about? If one plugs in the values for Jupiter at quadrature, and compares them to the time it took light to reach us at opposition, there is a 9:09 minute delay. This is quite noticeable and well outside normal errors. This is why Romer could attribute these discrepancies to the extra time it takes light to reach us.

Before you try a science experiment in your back yard - don't use the tables in the RASC handbook. These already are corrected for this effect and you will notice no time differences in the actual times verses the published times.

Charles W. Baetsen
va3ngc@rac.ca

Bigger Is Better - Way Better

When it comes to stargazing and big, bright images, telescope size makes a world of difference. So when Jim Kendrick rolled into Buckhorn Observatory with his 22-inch Star Master

Jim Kendrick and his 22" Star Master

Dob, the news spread fast. What was to be a regular public observing night with a dozen registered guests turned into a mini star party with local cottage owners and an ardent observing group from Bobcaygeon showing up, too. All told the giant scope accounted for about 15 additional guests - including Charles Baetsen and Mike & Ellen Ricks of the PAA.

What's it like to look through a scope with such incredible light gathering power? Almost photographic was my take-away. A low-power eyepiece combined with the scope's very fast f/4.1 focal ratio allowed the galaxies M81 and M82 to be seen in the same field of view. And, indeed, they did look just like one of the photographs from Sky & Telescope Magazine. No tiny smudges in this scope!

While I was busy giving sky tours at the eyepiece of the Observatory's seemingly "dainty" 14-incher, I also managed to slip away for a peek at M57, the ring nebula and M13 in Hercules. Again, absolutely stunning.

After the night's session we gathered at the house for coffee, cocktails and a bit of astro-chatter - mostly about the giant scope. Now, as I write this two weeks later the image of M81 & 82 is burned into my mental CD. Zowie!

By the way, Jim spent the weekend at the Observatory and gave The Reflector an interview on his years in astronomy. Read all about it in next month's issue.

John Crossen
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Time Tunnel

Let's hop into the Way-Back Machine and check out what happened over the years during the month of November. For such a cloudy month, it certainly has been a busy one.

Nov. 1 - Mars 1 launched in 1962
Nov. 2 - Harlo Shapley born in 1885 & first light for Mount Wilson scope in 1917
Nov. 3 - Sputnik 2 carries dog Laika into Earth orbit in 1957
Nov. 4 - First "stoop 'n scoop" satellite launched & Taurid meteor shower begins
Nov. 5 - Taurid meteor shower continues
Nov. 6 - Tycho Brahe records super nova in Cassiopeia
Nov. 7 - Mars global surveyer launched in 1996
Nov. 8 - Edmund Halley born in 1656
Nov. 9 - Carl Sagan born - 1934
Nov. 10 - Surveyor VI lands on Moon in 1867
Nov. 11 - Vesto Slipher born in 1876
Nov. 12 - Great Leonid shower of 1833 took place. May repeat again on Nov 17 this year
Nov. 13 - Mariner 9 becomes first space craft to orbit Mars in 1971
Nov. 14 - Apollo 12 Lunar mission launched in 1969
Nov. 15 - William Herschel born in 1738
Nov. 16 - Third Skylab crew launched in 1973
Nov. 17 - Luna 17 lands on Moon in 1970
Nov. 18 - COBE launched in 1989
Nov. 19 - Apollo 12 becomes second manned mission to land on Moon in 1969
Nov. 20 - Edwin Hubble born in 1889
Nov. 21 - Nothing spacey happened
Nov. 22 - STS-57 Endeavour launched in 1993
Nov. 24 - STS-44 Atlantis launched in 1991
Nov. 25 - First powered flight of M2-F3 lifting body in 1970
Nov. 26 - France becomes third nation to launch its own satellite in 1965
Nov. 27 - Mars 2 becomes first artificial probe to hit Mars in 1971
Nov. 28 - Mariner 4 launched in 1964
Nov. 29 - Australia becomes fourth nation to launch a satellite in 1967
Nov. 30 - Elizabeth Hodges hit by a ten-pound meteorite in Alabama

John Crossen
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Classifieds

For Sale:

Meade 1.25" 90° diagonal for Schmidt-Cassegrain Telescopes . Asking $55.

Contact: Charles Baetsen
Phone: 905-983-8143
E-mail: va3ngc@rac.ca

RASC Calendars and Handbooks

RASC Calendars and Handbooks can be ordered through the club. Prices are as follows:

2003 Observer's Handbooks	$17.00 ea.
2003 Calendars	$13.00 ea.

Last day for Orders is November 15 !!

ARTICLES

Submissions for *The Reflector* must be received by the date listed below. E-mail or "sneaker-net" (i.e., floppy disk) submissions are preferred (Microsoft Word, ASCII and most graphics 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 this address:

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or via e-mail at:
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NEXT ISSUE'S DEADLINE IS

Nov. 25th, 2002

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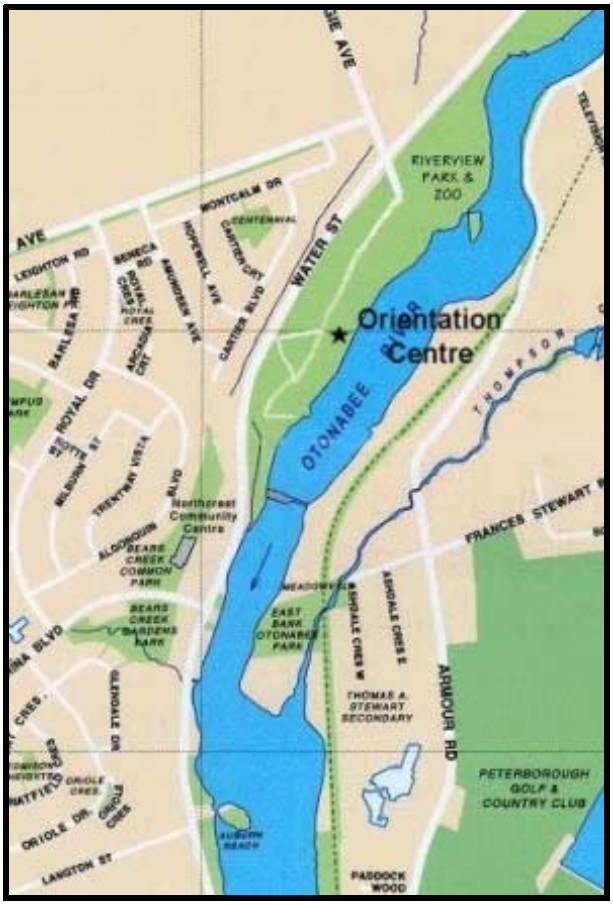
MEETINGS

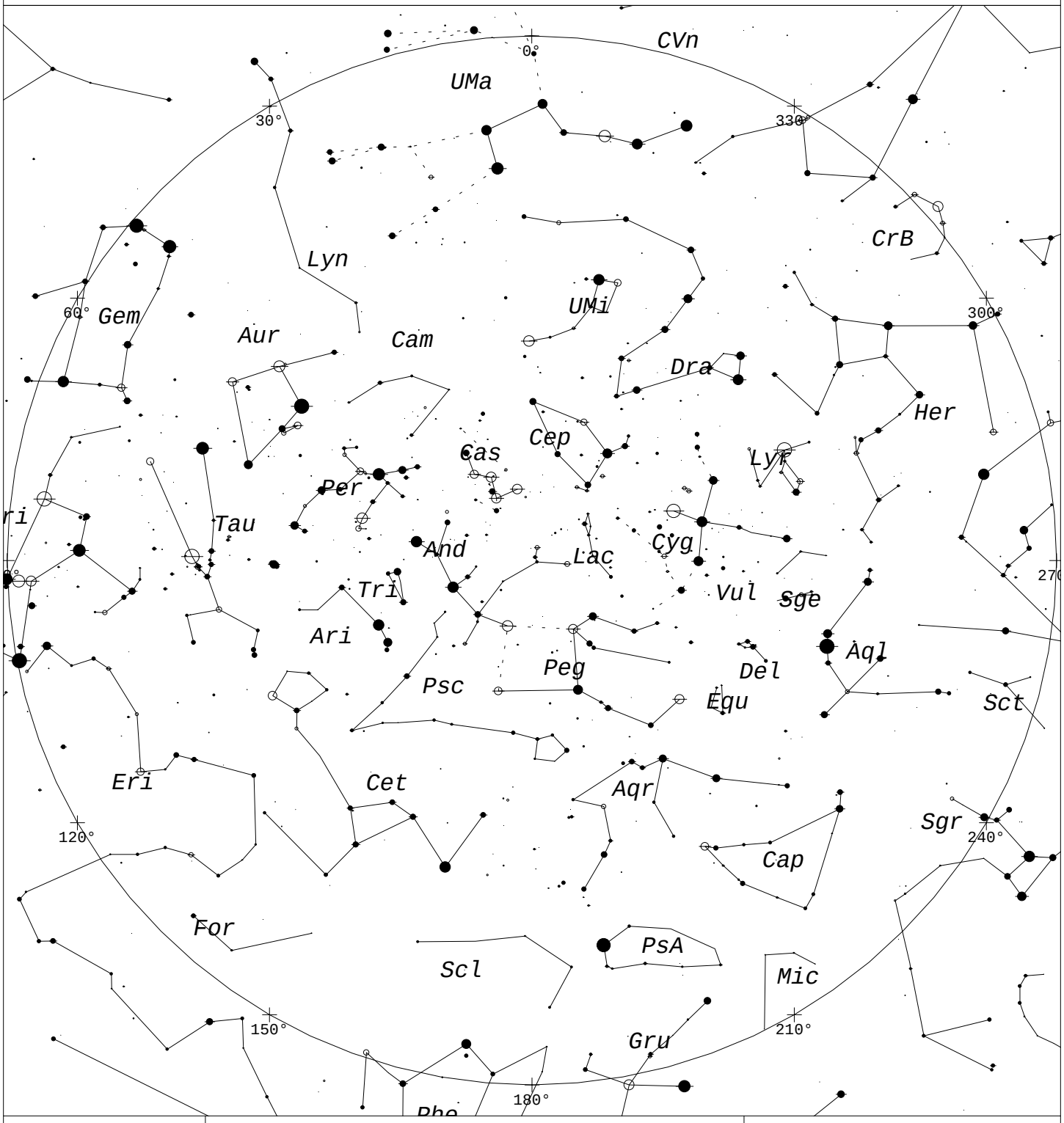
The Peterborough Astronomical Association meets every second Friday at the Peterborough **Zoo Orientation Centre** (Next to the PUC Water Treatment Plant) at **7:30 pm**.



CALENDAR OF EVENTS

November 1, 2002, 7:30 pm	**General Meeting** — Meeting at Don McDonald's Observatory near Hastings
November 4, 2002	**New Moon (●)**
November 11, 2002	**First Quarter (◑)**
November 15, 2002, 7:30 pm	**General Meeting** — Gord Rife—Astrophotography
November 19, 2002	**Full Moon (○)**
November 27, 2002	**Last Quarter (◐)**
November 29, 2002	**General Meeting** — Rene Bowe—Building a 10" Reflector Telescope. Weather permitting we will have an observing session afterward at Armour Hill

November Skies



STARS			
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1.5	4
2	4.5
2.5	>5
3	

SYMBOLS		
Multiple star	Dark nebula	Radio source
Variable star	Globular cluster	X-ray source
Comet	Open cluster	Other object
Galaxy	Planetary nebula	
Bright nebula	Quasar	

Local Time: 21:00:00 1-Nov-2002
Location: 43° 39' 0" N 75° 0' 0" W

UTC: 02:00:00 2-Nov-2002
RA: 23h44m42s Dec: +43° 38' Field: 182.0°

Sidereal Time: 23:44:42
Julian Day: 2452580.5833