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Astrophotography in the City:

Capturing Cosmic Wonders Amidst Urban Light Pollution

by Robert G. Lyons

City lights may dim our view of the night sky, but that doesn't mean we have to miss out on the magic of astrophotography. With the right techniques and equipment, urban stargazers can still uncover the celestial wonders that lie beyond the cityscape. In this article, we explore the art of astrophotography in the city, focusing on strategies like battling light pollution with narrowband filters, optimizing your camera's position by shooting at the zenith, harnessing fast aperture telescopes for swift data collection, and the power of short exposures combined with data accumulation to achieve awe-inspiring results.

Conquering Light Pollution with Filters

One of the most significant challenges faced by city-based astrophotographers is light pollution. The artificial glow from streetlights and buildings can wash out the faint celestial objects you're trying to capture. Even the moon, as beautiful as it is, is a source of light pollution. To combat this, light pollution and narrowband filters come to the rescue. These specialized filters isolate specific wavelengths of light, such as hydrogen-alpha (Hα), oxygen-III (OIII), and sulfur-II (SII), emitted by celestial objects while blocking out much of the unwanted artificial light. By utilizing light pollution and narrowband filters, you can enhance contrast and reveal the hidden beauty of nebulae and other deep-sky targets. This technology allows you to capture breathtaking images even from light-polluted city locations. Since using these fil-

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SEPTEMBER 14 **SFU**
SFU student Marcus Cowan on using the IllustrisTNG simulation to study the role of gas momentum in galaxy formation. Room AQ3159

OCTOBER 12 **SFU**
Max Rakhimov from NightSkyCamera will talk about astrophotography in an urban setting. Watch Meetup for room location.

NOVEMBER 9 **SFU**
Dr. Robin Catchpole of Cambridge University. Details of his topic will be posted on Meetup closer to the date.

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ters has the most significant impact on urban astrophotography, we will do a deep dive into filters, and I will provide specific recommendations (no brand affiliations here).

NGC 7822 is a young star-forming region in the constellation Cepheus. This image was made using a colour astronomy camera and the Optolong L-Ultimate duo narrowband filter over four nights in July. With a faster telescope, it could have been done in less than half of that time and displayed here in the HOO palette, with hydrogen in red and oxygen in blue and green.

Let's begin with light pollution filters. These are best used on colour cameras and work even better on full-spectrum modified DSLR and mirrorless cameras and colour, dedicated astronomy cameras to shoot broadband targets such as galaxies, star clusters, and comets. Here's how they work:

1. Selective Wavelength Blocking: Light pollution filters are designed to selectively block or reduce the transmission of specific wavelengths of light associated with common sources of artificial light pollution, such as streetlights, city illumination, and urban skyglow. These filters typically target the wavelengths of light emitted by sodium-vapour lamps (which produce strong yellow/orange light at around 589 nanometers) and mercury-vapour lamps (emitting a range of wavelengths, including strong green and blue lines). By reducing the transmission of these specific wavelengths, light pollution filters help darken the background sky.

2. Enhanced Contrast: Light pollution filters enhance the contrast between celestial objects and the sky background by effectively reducing the contribution of artificial light sources. This improved contrast allows astrophotographers to capture fainter objects and details in the night sky that would otherwise be overwhelmed or obscured by the glow of city lights.

3. Broadband Blocking: In addition to targeting specific wavelengths of light pollution, many light pollution filters also incorporate broadband blocking. This means they reduce the overall transmission of light across a broader range of wavelengths, including both visible and near-infrared light. This can help further darken the sky background, making it easier to capture deep-sky objects.

4. Minimal Impact on Celestial Objects: Light pollution filters are designed to minimize the impact on the light from celestial objects you want to photograph. They usually have high transmission in the wavelengths associated with astronomical targets, such as hydrogen-alpha (Hα) and oxygen-III (OIII), ensuring that the desired emissions from nebulae and galaxies can pass through the filter with minimal attenuation.

5. Benefits for Urban Stargazers: For astrophotographers in urban or light-polluted areas, light pollution filters are valuable tools. They allow

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President's Message

by Alan Jones

2023 So Far

Our primary Vancouver Centre of RASC goal is to stimulate our member—and public—curiosity about astronomy and share the excitement of learning with each other. The astronomy discipline for us includes: observing, astrophotography, astrophysics, optics, automation, night sky navigation, observatories, space, and solar system exploration. How do we satisfy so many areas of interest? We live in a time of ready access to information. Yet often the best learning is while sharing with others.

Our Centre monthly meetings are open to the public and we host or co-host more than twenty public events in a year. We accomplish this through the generosity of our membership. Generosity in volunteer time and membership fees that fund our activities. Anyone wishing to support us is invited to join as a member. Our members volunteer their time to run our club and share knowledge with each other and the public at outreach events. Anyone—member or public—can support us with a charitable donation for which

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About RASC

The RASC Vancouver Centre meets at 7:30 PM on the second Thursday of every month at SFU's Burnaby campus (see map on page 4). Guests are always welcome. In addition, the Centre has an observing site where star parties are regularly scheduled.

Membership is currently $104.00 per year ($61.10 for persons under 21 years of age; family memberships also available) and can be obtained online, at a meeting, or by writing to the Treasurer at the address below. Annual membership includes the invaluable Observer's Handbook, six issues of the RASC Journal, and, of course, access to all of the club events and projects.

For more information regarding the Centre and its activities, please contact our P.R. Director.

NOVA, the newsletter of the Vancouver Centre, RASC, is published on odd-numbered months. Opinions expressed herein are not necessarily those of the Vancouver Centre.

Material on any aspect of astronomy should be e-mailed to the editor or mailed to the address below.

Remember, you are always welcome to attend meetings of Council, held on the first Thursday of every month at 7:30pm in the Trottier Studio in the Chemistry wing of the Shrum Science Centre at SFU. Please contact a council member for directions.

2023 Vancouver Centre Officers

President	Alan Jones president@rasc-vancouver.com
Vice-President	Robert Conrad vp@rasc-vancouver.com
Secretary	Suzanna Nagy secretary@rasc-vancouver.com
Treasurer	Phil Lobo treasurer@rasc-vancouver.com
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Library

The centre has a large library of books, magazines and old NOVAs for your enjoyment. Please take advantage of this club service and visit often to check out the new purchases. Suggestions for future library acquisitions are appreciated.

On the Internet

rasc-vancouver.com
astronomy.meetup.com/131/
www.facebook.com/RASC.Van
www.instagram.com/rascvancouver/
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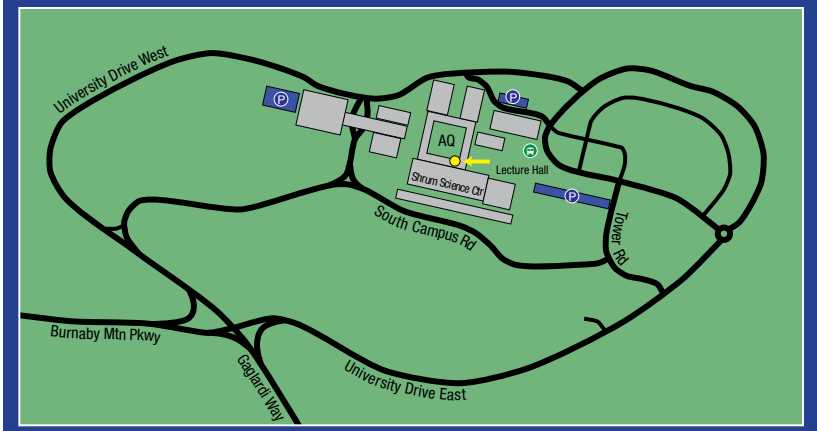
Map to Meeting Site



Our September meeting is in room AQ 3159 of the Academic Quadrangle, in the south concourse near the southeast corner, as indicated by the arrow on the map.

Pay parking is available at several locations located around campus (indicated as "P" on the map).

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we can issue a tax receipt.

We enjoy a productive and special relationship with Simon Fraser University, specifically the Department of Science. The Dean of Science hosts a weekly Starry Nights event on clear Friday evenings. The event is led and organized by Astrophysicist Dr. Joanna Woo. Our members set up telescopes on Trottier Observatory grounds for the public to enjoy viewing. Most of these scopes are owned by our members. This is an ideal opportunity for the public to catch our excitement. I cannot adequately describe how wonderful it feels to hear someone gasp, "Oh Wow" when they look through one of our telescopes and see Saturn's rings and several moons, or Jupiter's Galilean moons, or view a nebula or star cluster or even a galaxy for the first time through a fine portable telescope. Many of us 'old timers' see new people bring telescopes and we know it is in part because it is so fun to share our views of the celestial objects.

I am sometimes told that new people may feel intimidated and am sometimes asked how to get started in astronomy? The best way I have found to start something new is to start it! Lower your expectations of instant success and instead enjoy the journey of discovery. Make some mistakes. We learn through trying. Make some new friends. Reach out and meet people that are doing what you seek to learn. Read about it. BC also has many published authors. I met both Gary Seronik and Ken Hewitt-White at star parties, several times. I recently ran across Gary's website while exploring and learning about meniscus mirrors. He was an editor of *Night Sky* and has returned as editor of *Sky & Telescope*. Both authors wrote excellent get started books that survive the learning enjoyment curve of astronomy. Books are still a wonderful way to learn. They don't run out of power at a remote observing location either.

I am so proud to be Canadian and to have met so many interesting amateur and professional astronomers in the time I have been a RASC member of our Centre. One of our members put a telescope satellite in space! A UBC researcher built a liquid mirror telescope larger in diameter than the Hale 200-inch telescope. A local company designed and built parts of the Canadarm. We have had lectures by physicists describing leading research about Neutrinos. We have had a Nobel Prize winner address our club. When I think about the many exciting presentations, I am just amazed. September's presentation by Marcus Cowan is exciting because we will learn from a young researcher, working with astrophysicist Dr. Woo, exploring sophisticated computer models of galaxies to learn about their evolution. We live in exciting times of exploration and discovery happening around us and we can speak to the people doing the work! How much better can it get than that?

My own lifetime interest in astronomy was likely sparked when I was less than four years old and my parents took me to a public outreach at an observatory. I still remember seeing Saturn. It was cold waiting a long time before my turn to look and I had trouble finding Saturn in the eyepiece. When I finally "got it," the view took my breath away. I couldn't believe it... Just stunningly

beautiful. That is why I think it is so important for us to share the views through our telescopes with the public and especially help young people, or just anyone, get their first in-person view of light from space besides our moon or sun.

I encourage members to reach out and introduce yourselves to our council at our monthly meetings. It is one of the ways to "get started." It is usual for half or more of council to attend our meetings in person. At least one council member attends all our public events. Many of us are seasoned observers and many of us are new. Our interests are diverse. Most of our volunteer time is at events. Our council meetings are short but well attended and business is taken care of efficiently. We value each other's opinions and have great discussions that help set our direction. We encourage young members to consider joining council, which includes positions where you can observe and learn while still expressing your opinion while you determine how you can best help with the more specific council duties. If you are a member, consider volunteering at events or joining council. Members can reach out to council to enquire how to get started volunteering. Please do this at one of our monthly meetings or events. Emails are ok but much better to meet you in person.

2023 Fall

Recent Starry Nights are very well attended. Saturn is back and Jupiter is returning in the evening. Planets are great for "sidewalk" astronomy or city viewing where the sky is not as dark as remote sites. We also view the brighter deep-sky objects.

On October 14th, Saturday morning at sunrise, a solar eclipse begins just after 8 am. If the weather is clear, we will set up solar telescopes at Simon Fraser near the Trottier Observatory. The eclipse is an annular eclipse across North America. Our view is partial but it is very good and will be a better view from Vancouver than the total eclipse next April. During the October 14th eclipse, the moon will appear to work its way around the sun and most of the moon will block the sun. It will end after 10 am.

We have a great series of lecture presentations for our fall monthly members' meetings. Mark your calendars for the second Thursday of each month at Simon Fraser University in person. When the weather permits, we will open the Trottier Observatory after our meeting for observing. Our library will be open for members to borrow books and members can reserve and borrow from our telescope collection on the same evening. See our Librarian and our Director of Telescopes at the meeting. We also have a growing astro imaging group which uses the Trottier Observatory to collect data and learns from each other how to process and in some cases take our own images with our own equipment. We have completed an incredible journey restoring and improving our Vancouver RASC Observatory in Maple Ridge. Interested members should contact the observatory chair. We intend to make the grounds available to members for darker sky visual observing. ✸

Membership has its Privileges!

Are you tired of looking at the same objects again and again (planets, moon, etc.)? Is your telescope collecting dust because it's hard to locate deep sky objects? Would you like to bring your observing to a stellar level? Robert Conrad, our observing director, leads the Vancouver RASC observing group and invites you to join by sending him an email at observing@rasc-vancouver.com. Some of the benefits of belonging to this group include:

- Hands on training on how to operate the SFU Trottier observatory
- Weekly observing sessions at the observatory or at dark sky locations
- One-one-one coaching on how to locate thousands of objects in the night sky
- Attend small interactive seminars delivered by Robert on a range of topics including failsafe star-hopping, charting challenging objects and understanding the motions of the cosmos
- Learn to make your telescope dance by locating objects such as asteroids, nova, and supernovae
- Spectroscopy and imaging training from Howard Trottier and an opportunity to collaborate on observatory research projects
- Updates on observable sky events happening during the week like asteroid/comet/deep sky conjunctions
- Access to observing guides and lists that Robert created that took hundreds of hours to create and will help with planning observing sessions
- Knowledge and expertise from other observing group members
- Learn how to quickly and efficiently find and star-hop to deep sky objects using a range of binoculars and telescopes

Upcoming Events

December
14 – AGM

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for longer exposure times, which can reveal more details and improve the signal-to-noise ratio in astrophotographs. These filters are particularly effective when capturing wide-field shots of constellations, star clusters, and certain deep-sky objects.

6. Limitations: It's essential to note that while light pollution filters can significantly improve astrophotography in urban settings, they have limitations. They are most effective when used in combination with other techniques like narrowband filters for specific wavelengths (e.g., Hα and OIII) to capture nebulae and emission nebulae. Additionally, they may not completely eliminate light pollution but can mitigate its impact to a significant extent.

In summary, a light pollution filter works by selectively blocking specific wavelengths of artificial light associated with light pollution sources, thus enhancing the contrast between celestial objects and the sky background in astrophotography. These filters are indispensable tools for urban stargazers seeking to capture the beauty of the night sky despite the challenges posed by city lights.

For light pollution filters, I recommend the Optolong L-Pro filter. It cuts out most common light pollution and is affordable. If you live right in the city and want something even more powerful, I would choose the Antlia RGB Ultra filter. It is far more aggressive than the Optolong, and has a nicer colour balance. The downside is that it is so aggressive it can clip into some of the wavelengths of light given off by the celestial objects you are trying to capture, particularly the dark, dusty nebulae. I use both for different targets and I even use the Optolong filter in place of a luminance filter in my monochrome cameras.

Let's step things up and further restrict the light that is allowed to pass through our filters. Light pollution filters are considered broadband filters, and now we will dive into the world of narrowband filters.

Narrowband wavelengths refer to precise, limited sections of the electromagnetic spectrum, particularly crucial in the realm of astrophotography. These wavelengths correspond to the specific emission lines of atoms and molecules found within celestial objects. The two primary narrowband wavelengths of interest to astrophotographers are:

1. Hydrogen-alpha (Hα): Hα falls around 656.3 nanometers (nm) within the red part of the spectrum. This wavelength is characteristic of ionized hydrogen gas emissions, frequently observed in nebulae, star-forming regions, and the outer atmospheres of stars.

2. Oxygen-III (OIII): OIII wavelengths exist at approximately 496 nm and 501 nm, residing in the blue-green region of the spectrum. They are prominent in the emissions of planetary nebulae, supernova remnants, and various other astronomical phenomena.

Additionally, astrophotographers also frequently utilize a third narrowband wavelength:

3. Sulfur-II (SII): SII wavelengths typically fall around 672.4 nm in the red part of the spectrum. SII emission lines are encountered in various astrophysical contexts, including nebulae and star-forming regions.

Narrowband filters. A complete set of narrow and broadband filters in a filter wheel makes it easy to switch on a busy night of astrophotography.

Narrowband filters work in the same manner as light pollution filters by suppressing unwanted light, enhancing contrast, and improving signal-to-noise ratio. The key difference is that they only allow one or two very narrow wavelengths of light through, whereas light pollution filters are broadband, meaning many wavelengths, and lots of each wavelength. Traditionally, narrowband filters were exclusive to monochrome astronomy cameras, but since we are in the astrophotography renaissance, there are excellent options available for colour cameras as well. One caveat is that to use narrowband filters, you need either a dedicated astronomy camera or a modified mirrorless or DSLR because a regular camera has filters over the sensor which block the specific wavelengths of light we want to capture.

For a great set of affordable (a relative term in astrophotography) narrowband filters, I recommend the Antlia 3nm Pro filters for use with a monochrome astronomy camera. They have very tight bandpasses and excellent contrast. Bright stars do not produce halos in images with these filters. For a duo band filter for colour cameras (hydrogen/oxygen combined), I recommend the Optolong L-Ultimate (3nm). It has very tight bandpasses and produces great results. There is also the Antlia Alp-T (5nm) filter which is very popular, and Altair makes a set of duo band filters: one captures the traditional hydrogen/oxygen pairing, and the second filter captures oxygen/sulphur, allowing imagers to capture the full Hubble colour palette. Be warned! All of these filters are expensive!

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Zenith: A Prime Shooting Location

One secret weapon for urban astrophotographers is shooting targets near the zenith, the point in the sky directly above you. This technique minimizes the impact of light pollution since it's the region closest to the observer, reducing the atmospheric and light pollution interference. Shooting near the zenith also avoids capturing the often brighter and more obstructive light pollution on the horizon. By positioning your camera or telescope to capture objects near the zenith, you can maximize your chances of obtaining clean and detailed astrophotos in a city setting.

I have a saying: "Plan the shoot, shoot the plan." With a little planning, we can always shoot our astro targets when they are at the zenith and there are some tools to make it a lot easier. The free app, Stellarium (desktop, website, and mobile) uses our location to show us the night sky and allows us to change the time so we can visualize where things will be on any given night, specifically when celestial object will be at the zenith! We can expand on this concept by shooting one object at the beginning of the night while it is at zenith and then switch to a second target at the zenith as the first descends towards the horizon and back into the thicker atmosphere and light pollution. Software like NINA or a piece of hardware like the ZWO ASIAIR can provide a fully-automated solution so that this all happens in the background while you sleep. Like I said, we're in a renaissance!

The Cygnus wall in the Cygnus Constellation. This image was made using three narrowband images and mapping them to the traditional Hubble palette: hydrogen is green, oxygen is blue, and sulphur is red. This image was made over six evenings when the constellation Cygnus was high in the sky at the zenith, where it is less susceptible to light pollution.

Fast Aperture Telescopes for Swift Data Collection

In urban astrophotography, speed matters. Fast aperture telescopes with low f-ratios (e.g., *f*/2 or *f*/3), are invaluable for collecting data quickly. Their wider openings allow more light to enter the camera sensor in a shorter time, reducing the risk of blurring due to Earth's rotation and minimizing the effects of light pollution. These telescopes enable you to gather more data in less time, making it possible to capture remarkable images of celestial targets even from within a light-polluted city. It is hard to imagine, but the practical difference between a fast telescope and an average one can be up to 4 or 5 times faster. That means that it would take four or five nights on an average telescope to match the amount of photons that a fast telescope can collect in one night. This is a big deal, especially when we take a look at the next topic.

Like all things astrophotography-related, fast telescopes do not come cheap. The faster the aperture on a lens or a telescope, the harder it is to produce a clean image from corner to corner of the frame. For a fast telescope that can laugh at light pollution and make dazzling images in a single night, I recommend either the RASA by Celestron, an 8" aperture with a 400mm focal length giving it a jaw-dropping aperture of *f*/2. Very similar is the Celestron Edge HD 8" with a third party accessory called the Starizona Hyperstar, which is essentially the same things as the RASA except that without the Hyperstar attached, you have yourself a 2032mm focal length at *f*/10, so a slightly more expensive, but much more versatile option. For a more beginner and budget-friendly choice, the Samyang or Rokinon (same lens, different branding) 135mm *f*/2 lens is great for ultra-wide field imaging. I am going to throw the Canon 200mm f2.8 in there as well (older version) as a lower-cost, fast optic to get the job done in a hurry.

M51 Whirlpool Galaxy. Galaxies can be very difficult to capture from the city. Still, it is possible by combining a light pollution filter, a narrow 3nm hydrogen alpha narrowband filter, and collecting over 20 hours of data.

Short Exposures and Data Integration

While long-exposure astrophotography is ideal for dark-sky locations, it can be challenging in urban settings due to light pollution and atmospheric instability. Instead, urban astrophotographers often opt for shorter exposures, typically ranging from 30 seconds to a few minutes. These shorter exposures help mitigate the adverse effects of light pollution and atmospheric turbulence. To achieve optimal results, capture numerous short exposures over an extended period, totalling several hours' worth of data. During post-processing, these individual frames can be stacked and combined, reducing noise and enhancing the signal-to-noise ratio, resulting in sharper and more detailed astrophotos. It takes a lot more exposure time in light pollution to produce a similar image to one taken under pristine dark skies, so this is where my last point about fast optics comes into play. By taking hundreds of images over several nights, it is possible to produce images that will have your friends thinking you have the Hubble Space Telescope in your backyard. By using an optic with a fast aperture, what would normally require 5 nights of acquisition can be done in a single night.

Conclusion

Astrophotography in the city presents unique challenges, but with the right techniques and equipment, urban stargazers can capture stunning cosmic wonders. By using narrowband filters, shooting near the zenith, planning targets in advance, employing fast aperture telescopes, and combining short exposures with extensive data accumulation, you can unlock the beauty of the universe from the heart of the urban jungle. Don't let the city lights deter you—embrace the challenge, and you'll discover that the cosmos has much to offer even amidst the glow of the metropolis. ✸

VRO Hosts Event for UBC Forestry Group

by Marla Daskis

On Wednesday, August 17, 2023, the newly renovated Vancouver RASC Observatory successfully hosted an event for the UBC Research Forest's "Wild and Immersive" outreach team, called "Lower Mainland Wonders of the Night Sky." The VRO site is located within UBC's Malcolm Knapp Research Forest, and RASC has always worked closely with UBC Forestry for access and management of the land the observatory is located on.

Since this was the inaugural event, a rehearsal was held on August 2nd to see if the plans we had made were sound. Fortunately, nothing major was identified and there were only a few minor improvements to add to the list. We thought we were good to go for August 11, but the weather had other ideas and we had to reschedule for August 17th.

As the site has relatively dark skies, the rehearsal was a good opportunity to test some rechargeable solar pathway lights, to ensure guests didn't stray from the safety of the pathways into the brush. The attached photo shows the pathway lights and the red light in the dome during the rehearsal. August 2nd still had a great deal of moonlight so not much dark sky to explore at that time, but August 17 was much better, with clear skies and still air. Mosquitoes, plentiful at times, were a minor distraction, and many participants brought and used bug spray.

The UBC team bussed participants up from the main gate in a small shuttle van to a parking area down the hill from the observatory and clearing. Each van-load of about 12 people walked up the road, where Nolan met them and gave them a brief orientation to the event. Most people went into the observatory to watch Alan operating the telescope and demonstrating live stacking. Once finished there, they were able to view an automated slideshow at a table outside, and then discuss light pollution with Leigh. Leigh was also handing out star wheels and explaining their use. Once away from the lights inside the observatory, participants were able to come down to the observing pad and wander among the telescopes, looking at objects like the Hercules cluster, Ring and Dumbbell nebulas, Saturn, and double stars like Albireo. At 11pm, Robert and Andrew, our Education Co-chairs, gave a demonstration and presentation about finding objects in the night sky. The 36 participants were very engaged, asking lots of questions, interacting with the presentations, and enjoying their night sky adventure. The feedback was very positive from both participants and UBC, which made for an enjoyable night for the RASC volunteers. In addition, we added a few more items to our to-do list to improve telescope operations and to make hosting future events even smoother.

Thank you to the volunteers for the event: Carl Bandura, Robert Conrad, Marla and Ron Daskis, Alan Jones, Leigh Cummings, Andrew Krysa, Phil Lobo, and Nolan Smith. The following volunteers were unable to attend the night of the event but we wouldn't have been able to do it without them: Michael Levy (event design), Suzanna Nagy (powerpoint), Rick Schneider (livestack processes) and Gordon Bosch (signboards for observing pad).

Stay tuned for more information on future RASC members-only events at the VRO! ✸

Public Events

Carl Bandura grabbed an image from our trail camera at the Vancouver Research Observatory (VRO) that captured the crowd at the public event described in the article on the preceding page.

Below is an picture from the Perseid Meteor shower event held at Aldergrove Park on August 12. Image by Suzanna Nagy.

The Owl Nebula by Phil Lobo

The Owl Nebula (Messier 97) is a planetary nebula in the constellation Ursa Major and located near the bottom end of the bowl of the Big Dipper. M97 is about 2200 light years (l.y.) away and about 2 l.y. in diameter. It is estimated to be about 6000 years old.The nebula was discovered in 1781 by Pierre Méchain, who was Charles Messier's observing partner. The 'Owl' name was started based on a sketch by Lord Rosse in 1848.

M97 is one of the fainter Messier objects at magnitude 9.9. The angular diameter is 3.3 arcminutes, which is around five times that of Jupiter. It is visible through smaller scopes or large binoculars under good conditions. A nebula (i.e. UHC) filter will increase the chances of seeing it. The *RASC Observer's Handbook* describes it as a 'distinct grey oval.' Seeing the Owl's 'eyes' however requires larger telescopes and good conditions. M97 can be challenging to see. This September, the author was unable to see it in heavily light-polluted skies through a 6-inch scope using a UHC filter. Currently, this circumpolar object is low in the northern sky but in January it will begin to rise higher in the sky in the early evening and become easier to see.

The central, 14th-magnitude white dwarf has about 60% the mass of the Sun, but with a surface temperature of 120,000 degrees K (compared to the Sun's surface temperature of 5,800 K) it is about 100 times more luminous than the Sun. The high temperature produces a large amount of ultraviolet light which causes the nebula to glow. The nebula contains approximately 0.13 solar masses of matter.

(200mm f/3.9 Newtonian, QHY 163M, 60 min Ha, 60 min Oiii)