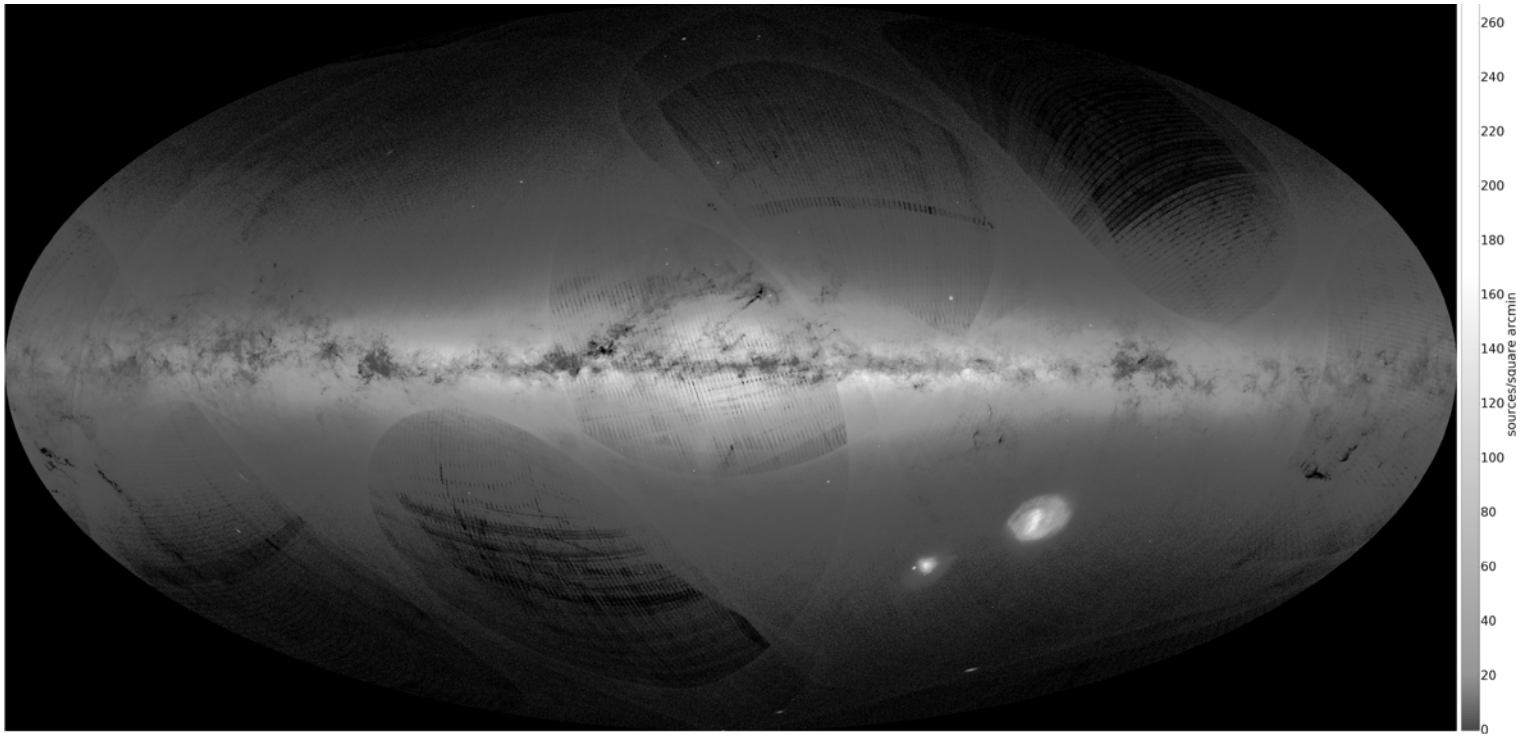
ROYAL ASTRONOMICAL SOCIETY OF CANADA - VICTORIA CENTRE

SKYNEWS



The Spatial Density of Stars Using One Billion Star Positions Measured By The Gaia Space Telescope

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NEXT MEETING

Annual General Meeting
Sunday Nov 27th 2016
At 6:00 PM
Cedar Hill Golf Course
1400 Derby Rd

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On the Cover
The Spatial Density of Stars *By Gaia*

What looks to be a composite image of the night sky in galactic coordinates actually displays the number of stars per square arc minute. This census of the night sky was obtained by the Gaia space telescope which made it's initial data release in September 2016. This remarkable image is based on the position information of over 1.1 billion stars gathered by the European Space Agency Gaia Mission. Learn more about this mind blowing endeavour on page 4.

Presidents Report
by Sherry Buttnor

Good grief. Anyone want to start an ark-building club? We can only hope November brings us better observing weather…it can't get much worse than October. Somehow, we did manage a couple of VCO sessions, but other than that….yikes! At least we have the warmth, good food, and terrific companionship of the upcoming Annual General Meeting to look forward to on Sunday, November 27th. If you haven't already done so, have a look here: https://victoria.rasc.ca/2016-agm/
Our Centre AGMs are really quite special and a lot of fun, so please consider attending. Spouses/partners welcome, too! Just call or email Nelson with the number in your party and your entrée choice(s).

Also, just a reminder of **our pizza party on -Saturday December 3rd, 6pm-10pm** in the Garry Oak room, Fairfield Community Centre,1341 Thurlow Road, Victoria, as a way of saying thanks! for all your hard work as volunteers. If you're a Vic Centre member and have volunteered at one of our events in the last two years, you're invited. Spouses/partners, too!
Please email me at popokinui@shaw.ca no later than Monday, November 28th if you'd like to attend. (also let me know if you have any food allergies and/or preferences) Let's let our hair down, stuff our faces, and reminisce about all the fun we've had at the various Victoria Centre activities!

For other Centre activities and events coming up, just place your cursor over the Events tab on our website for a list.

All Good Things.
For me, this final monthly president's message is a bittersweet one. I don't like long goodbyes:
you, the members of RASC-Victoria, are an amazing, wonderful, and immensely talented group of people, and it has been my sincere honour and pleasure to have served as Centre president for the past two years. Thank you for that opportunity, and for all for the support you've given the Victoria Centre with your knowledge, enthusiasm, and hard work. My best wishes to the new Council; I know you will continue the Victoria Centre's tradition of excellence in all things astronomical and educational.

Clear (and dry) skies.
Sherry.

Upcoming Speakers
Sunday Nov 27th AGM: Paolo Turri (UVIC)
The Secret of Adaptive Optics .
Saturday Dec 3rd Pizza Party: Short Talks by Michel Michaud, Dan Posey & Reg Dunkley
The following are yet to be confirmed
Wednesday Jan 11th 2017 at UVic:
John Blackeslee; The Massive Galaxy Survey
Wednesday Feb 8th 2017 at UVic:
Lisa Locke; Microwave Instrumentation

AGM Speaker: Sunday Nov 27 7:30PM

The Secret of Adaptive Optics
Paolo Turri (UVic Astronomy)

Since the dawn of optical telescopes, astronomers have been struggling against a serious problem: Earth's atmosphere. The turbulence in the atmosphere degrades the quality of astronomical images by reducing the spatial resolution that they could achieve theoretically. For centuries astronomers had to live with this limitation, until space flight allowed them to put telescopes in orbit, avoiding the issue entirely. But for the larger telescopes here on the ground, the problem persisted. This was until a technical solution was finally found during the Cold War (but kept secret until few decades ago…).

Adaptive optics is a relatively new technology that allows a telescope to "manipulate" the light distorted by the atmosphere and to restore a clear vision of the skies. I will discuss the tricks that adaptive optics uses to achieve the result, as well as some of its scientific accomplishments. I will also tell the story of how we ended up acquiring this technology in astronomy. It's a plot made of secrets, spies and mutually assured destruction.

Bio: Paolo is from Italy and he graduated in Padua and Trieste for his degree in Astronomy. He is currently a PhD student in Astronomy at the University of Victoria and his field of research is in adaptive optics. He has observed at the Gemini South telescope to study the stellar populations of Galactic globular clusters. At NRC Herzberg he is also studying the performance of the adaptive optics system that will be built in Victoria for the future Thirty Meter Telescope.

Our weekly **Astronomy Cafe** is an excellent, informal, way to meet us. New comers are especially encouraged. http://victoria.rasc.ca/events/astro-cafe/

Fairfield Community Centre - 1330 Fairfield Rd. Victoria.7:30pm

Contact: Chris Purse for further details
vp2@victoria.rasc.ca
Every Monday at 7:30 PM

Email Lists

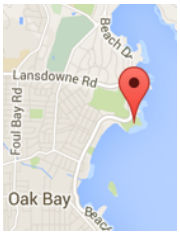
Observer / CU Volunteers / Members

Contact Chris Purse to subscribe

vp2@victoria.rasc.ca

New Observers Group

Hosted by Sid Sidhu - 1642 Davies Road, Highlands. Call 250.391-0540 for information and directions.



Cattle Point observing in Victoria's own Urban Dark Sky Park:
http://victoria.rasc.ca/events/rascals-cattle-point/
Next Sessions : *Weather Permitting*
Friday December 9th at 7PM

Victoria Centre Observatory: Every Saturday Evening.
*Open to those on **the Active Observers list only***
Weather permitting. Dress warmly, and see you out there.

Membership Report - November 2016

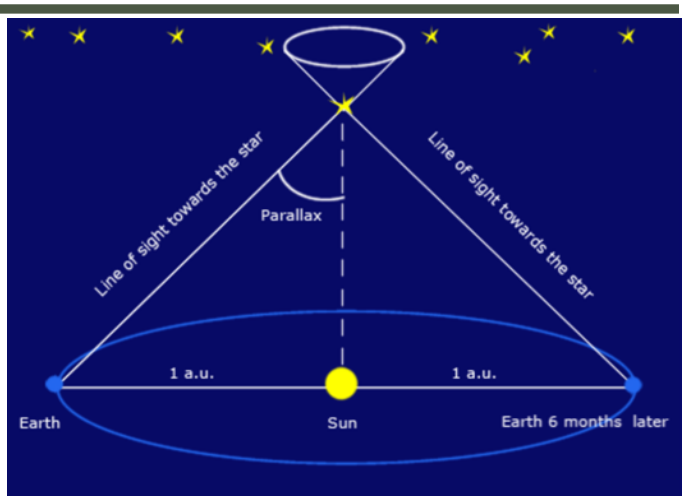
Total membership is currently **238.** There are 18 members in the grace period which means their membership has expired in the past 2 months. Please contact Chris Purse (membership@victoria.rasc.ca) if you would like to check the status of your membership.

Astronomy on an Industrial Scale
by Reg Dunkley

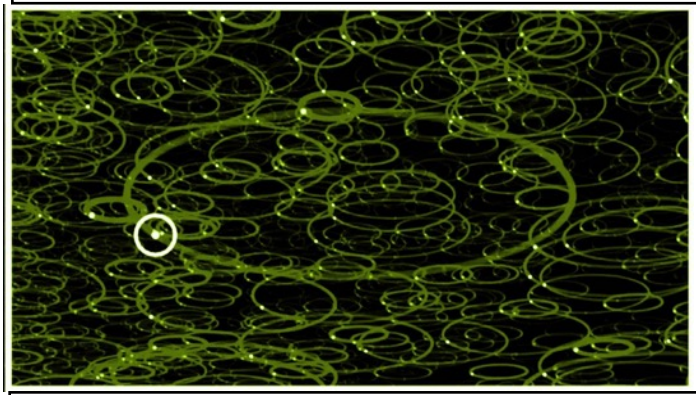
In the September 2016 issue of Sky and Telescope Peter Tyson wrote the article *Astronomy and Big Big Data.* He discussed the challenges presented by the looming tsunami of raw data from major astronomical sky surveys including the Solar Dynamic Observatory, The Sloan Digital Sky Survey, The Large Synoptic Sky Survey and the Square Kilometer Array. He did not , however, mention the European Space Agency **Gaia Space Telescope**. On September 14, 2016 the initial release of Gaia data was published. It included the precise positions and magnitudes of over **1 billion star**s as well as the parallax and proper motions of over 2 million stars. These are staggering quantities and to better appreciate these achievements let's revisit a quainter period when stars were measured one at a time.

Less than 200 years ago we did not know the distance to the nearest stars. In 1838, Friedrich Bessel showed, through meticulous measurements, that the star 61 Cygni moved in an annual ellipse with respect to background stars that could only be explained by the motion of the Earth about the Sun. From this 0.3 arc second variation, called the annual *parallax*, Bessel calculated that the distance to 61 Cygni was 10.3 light years. The distance of only a few dozen stars were known until photographic methods were developed. By 1924 the distance to 2000 stars were determined and this number increased to 8000 by 1995. Due to atmospheric influences the precise measurement of stellar positions and motions (a field called Astrometry) was up against a wall.

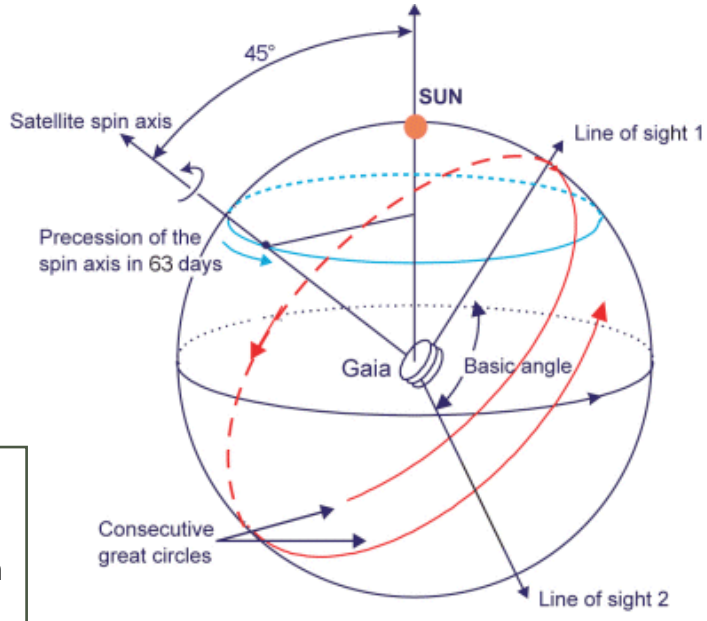
It was time to move the observing platform to outer space. This not only removes atmospheric distortion but also allows the entire sky to be observed by a single consistent stable instrument. Another source of error for Earthbound observations is that the motion of



As the Earth orbits the Sun closer stars appear to move in an ellipse with respect to neighbouring background stars. Image Source



The problem is that background stars are also moving in a similar phase which introduces error.

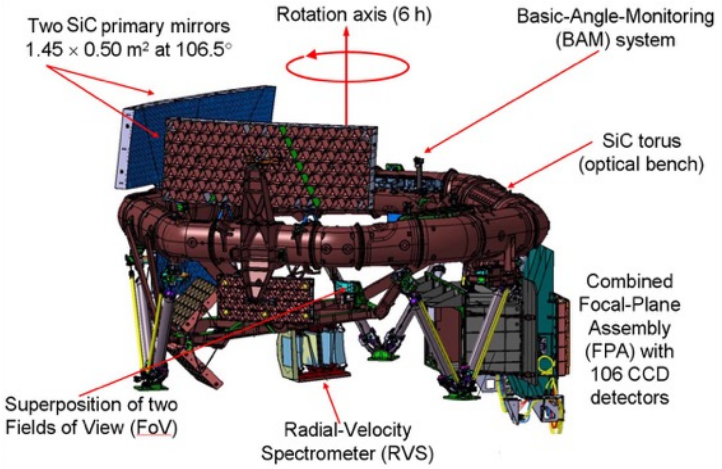


The Gaia spacecraft is equipped with two telescopes separated by a basic angle of 106.5 deg. Gaia rotates once every 6 hours (1 deg per min) and allows starlight to slowly drift across an enormous billion pixel CCD. Image Source

the star of interest is measured by comparing it to nearby background stars. These background stars, however are also moving in ovals that are in the same phase. This error can be reduced by comparing the star positions to a widely separated star field. Atmospheric refraction and turbulence prevents employing this method on the Earth. In 1966 Pierre Lacroûte suggested that this can be achieved in outer space by placing two telescopes aboard spacecraft separated by a fixed “basic angle”.

In 1989 the European Space Agency launched the astrometric satellite Hipparcos which used a combination of mirrors and a 29 cm Schmidt telescope to merge two beams separated by a basic angle of 58 degrees. The mission ended in 1993 and the resultant Hipparcos Catalogue contained over 118,000 high precision values of position, proper motion and parallax to an accuracy nearly 200 times better than most Earthbound measurements. 2 million entries of lesser precision were published in the Tycho 2 catalogue. These data were used in the Millennial Star Atlas, Sky Atlas 2000 and Uranometria 2000. This high resolution Hipparcos data has made a significant impact in many different fields of astronomy.

The success and lessons learned from the Hipparcos Mission motivated the European Space Agency to embark on the follow up **Gaia Mission.** There were an number of improvement opportunities available since Hipparcos was designed. For instance, charged coupled devices had not yet arrived on the scene when Hipparcos was built. Gaia however was equipped with the largest CCD device yet launched, containing a massive 1 billion pixels in an array 1.04 m by 0.42 m. In order to fit within the narrow confines of the launch rocket Gaia contained two innovative triple-mirror folded telescopes with a rectangular aperture of 1.45m X 0.5m and focal lengths of 35 m. The field of view was 1.7 deg by 0.6 deg. An excellent video shows how this intricate and most ingenious system works. Hipparcos was intended to go into a geosynchronous orbit but when the booster rocket failed it ended up in a highly eccentric orbit which introduced numerous challenges. Instead of orbiting the Earth like Hipparcos, the Gaia spacecraft was



Layout of Gaia Observing Payload Image Source

placed at the Lagrangian 2 point located 1.5 million km from the Earth on the side opposite from the Sun. (the James Webb Telescope will also use this “parking lot”). This has a much more stable gravitational and thermal environment.

Gaia also contains prisms to obtain blue and red photometric readings as well as a grating spectrograph to measure radial velocities. Gaia rotates once every 6 hours. As a star reaches the CCD an entourage of nearby pixels are assigned to accompany it on its journey across the focal plane. A “time delayed” method is used to integrate these pixel values, resulting in very precise measurements of the position of each star centroid and magnitude. The starlight from the second telescope is also combined in the scan to allow wide field inter comparisons and detect minute changes in stellar positions.

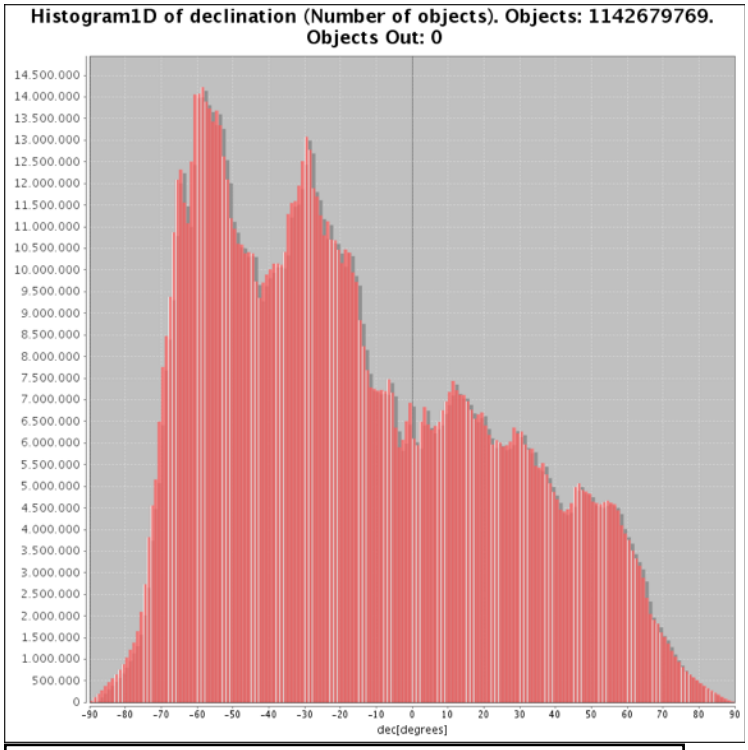
Did this extremely complex and ambitious project actually work? Well Gaia was successfully launched on December 19th 2013. Gaia Data Release 1 contains 14 months of observations taken between July 2014 and September 2015. Initial indications are that **Gaia is working very well indeed!** The first data release contains the positions, parallaxes, mean proper motions and magnitudes for about **2 million of the brightest stars** in common with the Hipparcos and Tycho catalogues (the primary astrometric data set). Also included are the positions and magnitudes for **an additional 1.1 billion sources!** The typical standard error

for the positions and parallaxes for the primary dataset is 0.0003 arc-seconds while the position error for the "additional billion" is 0.01 arc-seconds. Keep in mind that the planned duration of the Gaia mission is five years and by the end of the project each of the 1 billion sources will have transited the focal plane at least 70 times. Photometric and radial velocity measurements are also on the way. As the volume of the data grows it will be scrutinized by the Data Processing and Analysis Consortium and the quality is expected to improve significantly.

So lets take a step back and think about this. The number of stars for which the parallax is known has risen from 8000 in 1995 to 2 million today! This increase is astonishing and **validates the industrial assembly line approach** of data acquisition. This data has an immediate impact on the study of open clusters (March 2016 SkyNews). Most of the local clusters lie beyond the reach of Earth based parallaxes (300 light years). With Gaia's first data release, however, it is now possible to measure the distances and motions of stars in about 400 open clusters up to 4800 light-years away. This is certain to refine lower rungs of the cosmic distance ladder with the promise of further improvement when the Gaia mission ends. It will take time for the Astronomical Community to digest this massive dataset but since astrometric measurements serve as the bedrock for so many areas, the influence of Gaia will be felt for years to come.

How do we contend with this avalanche of measurements? The ESA is actively promoting the access and use of this new data set. Workshops were conducted in the UK in October and the presentation slides are available on line. The professional community will be employing astrostatistics to explore this information.

As an example of astrostatistics, Gaia is providing a detailed census of about one percent of the Milky Way. One summary graph in particular confirms the glowing reports, often shared at Astro Cafe, about skies seen from "down under". Although the Gaia survey is not complete, the chart displays the number of objects per degree of declination and clearly shows that southern latitudes win hands down! Maybe I will put a trip to Oz on my bucket list.



The number of objects observed by Gaia (so far) versus Declination. It suggests slimmer pickings in northern skies. From Figure 7.64

Accessing Online Astronomical Surveys

Amateur astronomers can access the Gaia database. In fact it is only **one of many industrial scale astronomical sky surveys** that are available on line. Diving in to these data sets head first can be overwhelming. The Sloan Digital Sky Survey has developed an excellent educational component of it's SkyServer website. It is an enjoyable, entertaining and informative way to learn how to access and use the SDSS. It also has a section that shows you how to access other sky surveys.

So the leading edge of the *Big Data* tsunami has already arrived. ***Tomorrow is Here Today*!** Amateur astronomers with the knowledge and skills to access and manipulate these data sets will be well positioned to contribute to the analysis and interpretation of this fresh wave of data. It is a *discovery opportunity* … that can be explored on cloudy nights!

An Observer's Conversations
by *Diane Bell*

Do you recall the conversations you had with family and friends about your passion that is astronomy? I have been "star-struck" since I was a little girl, and have remembered the variety of reactions - and moments of joy - from my own friends and acquaintances as I shared my hobby, pointing up to the night sky....

These conversations have carried on into my retired life - but with some folks over the years, there had to be some clarification of sorts! "Astrology? How fascinating," some would say. "I follow astrology, too. By the way, what's your sign?" "Well," I replied, "my horoscope tells me I'm a Pisces but really, I'm an Aquarius. And my younger brother? He's an Ophiuchus!" "An Ophi....WHAT?" As I try to point out the science behind the movement of the 13 (Yes, 13!) zodiacal constellations in our night sky - not to mention the Earth's precession throughout the millennia, the explanation is lost on my friends. But there are other conversations I've had that were memorable as well.

Recently I participated in a women's weekend at Shawnigan Lake with other participants from all over Vancouver Island. As we shared dinner in the evening, one of my friends told her story about a retreat she attended at a Franciscan monastery in Alberta, many years ago. The retreat director was also an amateur astronomer, and offered to take his participants out to the grounds to look at the dark sky. As my friend related her tale, she mentioned that he had showed them his recent discovery through his telescope with a low-powered eyepiece, pointed near the constellation of Cassiopeia. "It was a long and beautiful star cluster," she remarked. I asked her if the director's name was Father Kemble. "Yes, Father Lucian Kemble!" she said, rather excitedly. She was introduced to the beautiful but gentle asterism of Kemble's Cascade - by Kemble himself....

Another profound moment I had under a dark night sky was on a study tour of Israel, and the Sinai Peninsula in Egypt. We were travelling in early May of 2008 with the students and faculty of Trinity College, affiliated with the University of Toronto. One of our nights in the Sinai Desert was spent at the Monastery of St. Catherine, at the foot of Jebel Musa (Mt. Sinai). An adventurous trip up Mt. Sinai was on the itinerary for the next morning. Our guides wakened us at 3:00 AM and we started our 30 minute hike up to the camel station, as our flashlights braided a lit path along the trail. From there, we would make the hour-long trip up the mountain on the backs of our camels....

I walked with the Dean of the college up to the camel compound. He looked up at the pristine Milky Way at that latitude of 28 degrees north. As he remarked on the brightness of the starry sky, I pointed out some of the familiar constellations. David knew some of them but as we looked southward, we could see the elevated curve of the Scorpion's tail embedded in our Galaxy's star fields, as well as the Teapot in Sagittarius. And - the intensity of the Milky Way's centre, as it "freed" itself out the celestial spout. He was speechless, to say the least. So was I. "I will remember that for a long time", he finally remarked. And, as we sat high on our camels, zig-zagging up the side of the mountain for the hour-long trip, the Milky Way shone above us to light the way. Our guides led us up the east side of the mountain to a plateau near the summit. We arrived at 5:00 AM, shared breakfast, watched the sun rise, and climbed the 700+ steps to the summit. It was the best travel experience I've had in my life. And one of the nicest dark skies I've ever seen....

Memories of conversations past - and the sharing continues. Enjoy the encounter.

The VCO Astro Planner has Vanished

Instead of the VCO Astro Planner we recommend **Larry McNish's Night Time Planner V1.2** (see page 7 of September issue for details). While it does not show a month at a glance it lists a wide variety of objects that are visible on a particular night**.** Check it out at: http://members.shaw.ca/rlmcnish/darksky/nightplanner.htm

RASC Victoria Centre Council 2015 / 2016

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First Vice President	Michel Michaud	vp@victoria.rasc.ca
Second Vice President	Chris Purse	vp2@victoria.rasc.ca
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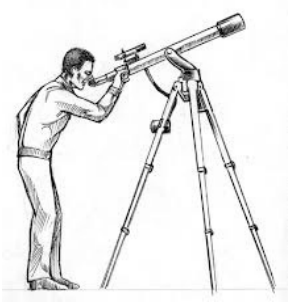
NRC Liaison	James di Francesco	
UVic Liaison	Alex Schmid	
Member at Large	David Lee	

Online Resources

Magazines

SkyNews Our National RASC Newsletter
Sky & Telescope Magazine
Astronomy Magazine
Astronomy Now Astronomy in the UK
Amateur Astronomy Magazine
Astrophotography Magazine

Borrowing Telescopes



The centre has telescopes for new and seasoned observers that members can use. Contact Sid Sidhu from the email list above.