Nova Notes

The Newsletter of the Halifax Centre of the Royal Astronomical Society of Canada

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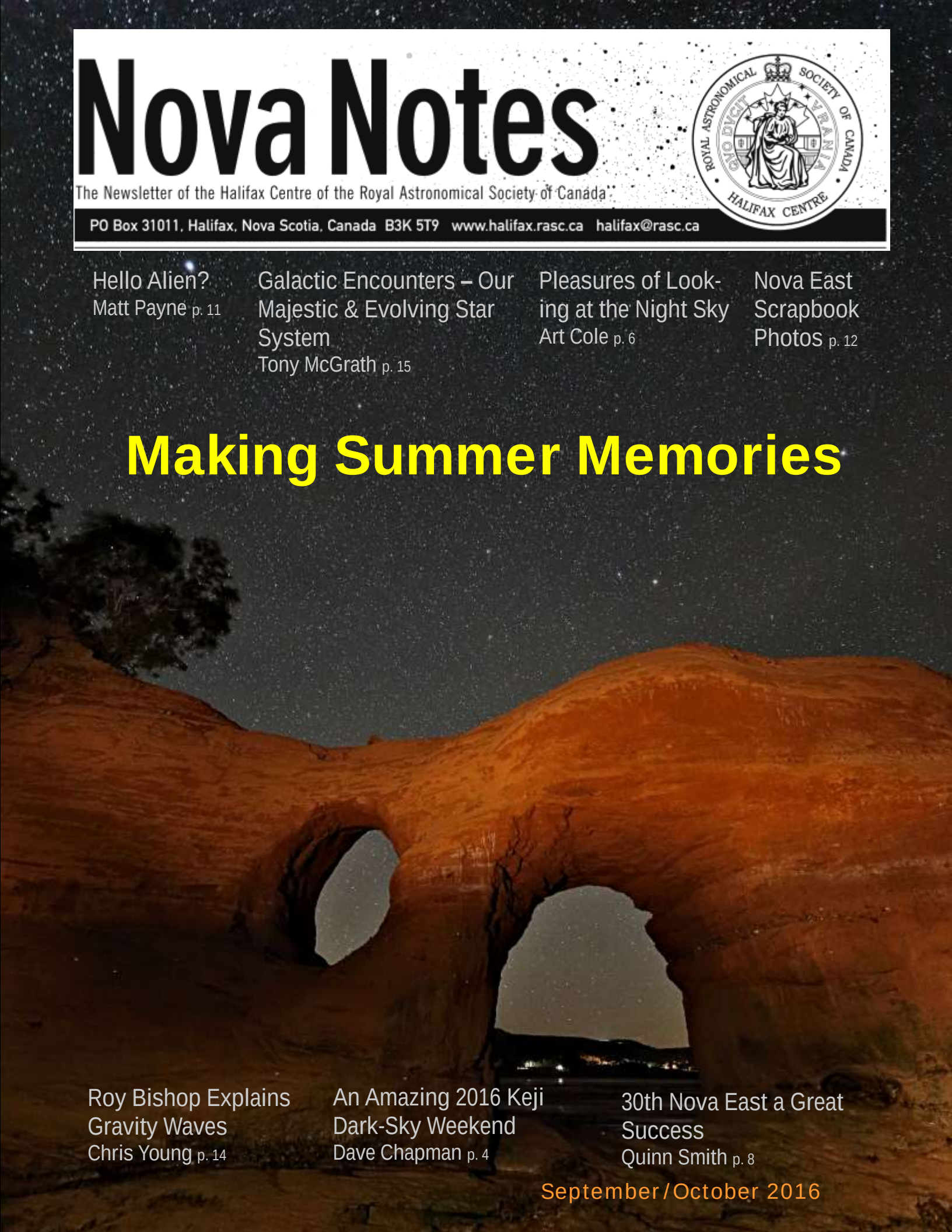
Making Summer Memories



September/October 2016

St. Croix Observatory

Part of your membership in the Halifax RASC includes access to our observatory, located in the community of St. Croix, NS. The site has expanded over the last few years and includes a roll-off roof observatory with electrical outlets, use of the Centre's new Go-To 400-mm Dobsonian telescope and 100-mm binoculars, a warm-room, and washroom facilities.

Enjoy dark pristine skies far away from city lights and the company of like minded observers searching out those faint "fuzzies" in the night. Observing nights (Fridays close to the New Moon or Saturday backup) are open to both members and their guests. If you are not a key holder and would like to become one, or need more information, please contact the SCO Manager, Tony McGrath.

Upcoming Observing Nights:

October 28 (alt 29)
November 26 (alt 27)
December 17 (alt 18)

Meetings usually begin at 7:30 p.m. at Saint Mary's University in Room 101 of the Atrium Building (AT).

All meeting locations and presentations subject to change

The October RASC Meeting will not take place in its usual location. Instead, members and guests are encouraged to attend the lecture listed below.

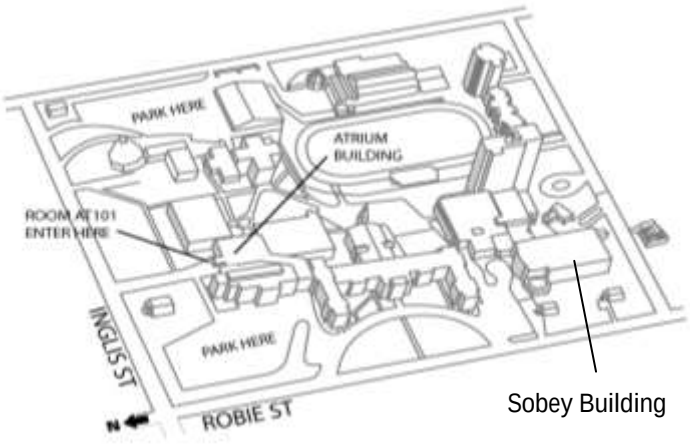
The 2016 MacLennan Memorial Lecturer will be Nobel Laureate Dr. Art McDonald, Friday 21st of October, 7:30pm at the McNally Theatre Auditorium, Saint Mary's University. The event will be ticketed, but tickets will be free. See ap.smu.ca and click on resources for ticketing information.

There will be no council meeting prior to this event.

Meeting Location:

Saint Mary's University

Atrium Building (AT)
Room AT 101
The Atrium is located in front of the Patrick Power Library, between the Burke Building and Science Building.



Meetings are usually held on the third Friday of the month, except for the months of July and August, when there are no meetings.

Executive meetings begin at 6:30 p.m., usually in room AT306, and all members are welcome.

Halifax RASC Executive, 2016:

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Councillor	**Paul Heath**	**pheath@eastlink.ca**

In this issue:

Cover Photo
Barry Burgess

The photograph was taken in Medford, Nova Scotia on Sept 21, 2016 at 10:38 P.M. Barry used a Canon 6D with a 15 -mm, f2.8. He exposed for 30 sec at ISO 5000 and light painted the rocks during the exposure with a small flash-light.

The Fundy shoreline is ever changing due to tidal erosion. These sandstone arches were carved by the Fundy tides. The arches will enlarge as the tides flow through until they collapse and then new arches may form as the coast continues to erode.

From the editor ***Tony Schellinck***

What a great summer it was. By my reckoning we had far more clear nights than usual and I was able to take advantage of those nights to work on my Explore the Universe certificate. Matt Payne in his article "Hello Aliens?" says he observed more this summer than in the past ten years. Art Cole's column describes how he rediscovered the pleasures of viewing while at Nova East. In his Keji Dark-Sky Weekend report Dave Chapman points out that not a single RASC event was cancelled. And, as Quinn Smith reports, we had some wonderful weather and night viewing during the 30th Nova East Star Party. I sincerely hope all of you were also able to take advantage of the clear skies this summer.

I captured the good times experienced during this summer's activities by photographing RASC members "doing their thing" during the day. See pages 12, 13 and 16 as well as excerpts from Blair McDonald's AstroBlog on page 7. Unfortunately I don't have room to put all the photographs I took into this issue so some very active members are not included here.

The cool evenings have arrived along with an early sunset, so the good viewing times will continue for several months. I hope you all will enjoy them as much as I plan to.

Moose-Calling Moon (Ninth Moon – Micmac)
Joseph Bruchac and Jonathan London
Read by Dave Chapman at the September meeting

In this season when leaves
begin to turn color,
we go down to the lakes
and with birch-bark horns
make that sound which echoes
through the spruce trees,
the call of a moose
looking for a mate:
Mooo-ahhh-ahhh
Mooo-ahhh-ahhh.

If we wait there,
Patient in our canoes,
The Moose will come.
His great horns are flat
Because, long ago,
before people came,
Gloos-kap asked the Moose
what he would do
when he saw human beings.
"I will throw them up high
on my sharp horns," Moose said.

So Gloos-kap pushed his horns
Flatter and made him smaller.
"Now, Moose," he said, "you
will not
want to harm my people."
So the Moose comes and stands,
Strong as the northeast wind.
He looks at us, then
we watch him disappear
back into the willows again.

Nova Notes: The Newsletter of the Halifax Centre of the RASC

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Nova Notes is published five times a year, in February, April, June/July, September/October and December.
The deadline for the next edition is November 10, 2016

Keji Dark-Sky Weekend 2016
Dave Chapman

The 7th annual Dark-Sky Weekend was a cosmic success. The two observing nights involved a wide range of eyes, binoculars, and telescopes (from 6-mm eyes to a 635-mm Obsession). These drew large crowds and for the entire weekend we estimate 900+ "Galileo Moments" (Parks Canada calls these "Visitor Experiences.")

The Jerry Black shows how to use the camera for astro photos.

On Friday, we had a good afternoon by the Tuck Shoppe and a great night at the Sky Circle, a beautiful clear sky with a crescent Moon and Jupiter in the twilight to start, and a few lovely meteors and a couple of ISS passes to spice things up. We paired the Centre's wireless mikes to a rented battery-powered PA system, which helped a lot with projecting Chris Young's voice into the field of a dozen RASCals and 300+ visitors.

Our keynote speaker Tim Doucette explains how he can see more than the average person.

We had a field full of telescopes, binoculars, cameras, and RASCals (Tony Schellinck, Martin Hellmich, Karl Penney, Wayne Mansfield, John McPhee, Chris Young, Andrea Misner, Paul Heath, Jerry and Judy Black, Andy Hasler and daughters, Jerry Deveau, Mark Dryden). The nearby forest fires were worrisome, but did not interfere directly with our programs, although the Highway 8 closure prevented some volunteers, staff, and visitors from getting to the park. NO RASC PROGRAMS WERE CANCELLED that weekend!

Martin Hellmich and Chris Young Solar Observing

Friday and Saturday afternoons, we had two 2–3 hour drop-ins that attracted low numbers (about 15–25 each), but resulted in genuine, in-depth interactions. They were also a good opportunity for the volunteer group to enjoy some pleasant social time. Paul Heath conducted family programs as well, one scheduled for Friday night (25 people), and several spontaneous ones during the drop-ins. I believe I saw Jerry Black conducting an impromptu astrophotography workshop Saturday afternoon.

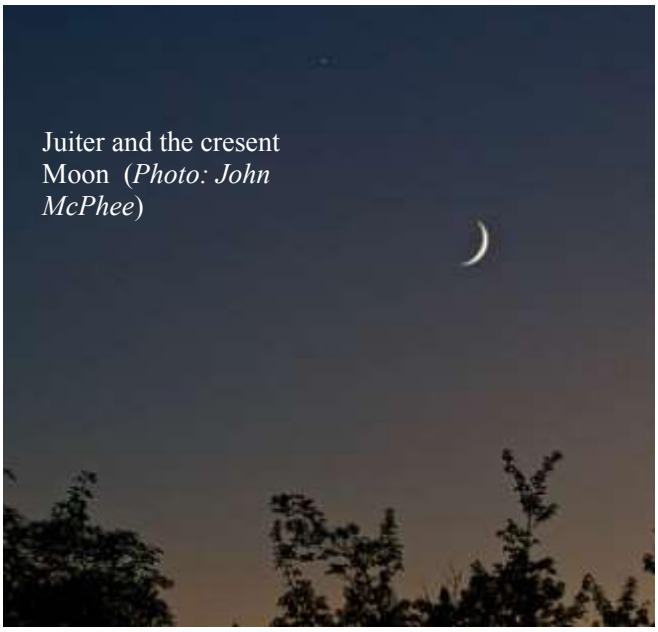
Mark Dryden's 635-mm Obsession is a popular viewing station (*Photo: Jerry Black*)

The Keji Saturday night Sky Circle program had no observing, but the Parks Canada interpreters Colleen Anderson and Lesley Rogers shared some fascinating sky stories (75 people). Tim Doucette's theatre talk on

Paul Heath recruits participants of all ages when illustrating the size of the solar system.

his Deep Sky Eye observatory was spellbinding (125 people, once it got going) and we thank him and his family for persevering in the face of forest fires to attend the event.

We did solar observing in a "pop-up" fashion, as Karl Penney, Paul Heath, and Wayne Mansfield all have their preferred spots. Over the weekend, this amounted to 110 additional Galileo Moments at the beaches and Visitor Centre.



Juiter and the cresent Moon (*Photo: John McPhee*)

Our weekend plans included three of us staying over (Tony Schellinck, Martin Hellmich, and me) and the Clear Sky Chart promised good skies! Joining us were Jerry and Judy Black, Melody and Bruce Hamilton, Wayne Mansfield, and Mark Dryden to host casual drop-in observing (no smoke, no campfires, clean air). We brought in 225+ people and eventually gave them a sky tour. Again, the PA was valuable, and I think we'll make that a fixture.

I could not be happier with the outcome. Many thanks to all who took part and volunteered. The Keji DSW dates for 2017 are August 11-13, book your campsites early, and see you there!

All photos by Andrea Misner unless otherwise noted.

Starlight and Semiconductors: The Pleasures of just Looking at the Night Sky

Art Cole

OK, I'll admit it. I haven't done a whole lot of astronomy over the summer. While others have been going to special astronomy events, doing outreach, and staying up late to catch the summer sights, I've been riding my bike, working on my patio, or sleeping. Summer is my down period for astronomy, and when the long nights of autumn return, my telescope and camera come back out of the garage. One of the nice things about astronomy is that it gives me a reason to anticipate the end of summer.

▲ Is this view of M11 better than the one I got through a telescope at Nova East? No way!

So when it was time for Nova East, I was looking forward to spending some time under the stars at a nice dark site and catching some photons from the night sky. Unfortunately, I had some family issues this year that prevented me from camping, but I did manage to make it down to Smileys Park on Saturday night for some imaging. The skies cleared right around sunset, and the view of the Milky Way was amazing, as usual. People were friendly and cheerful, and the assortment of scopes and other gear on the field was amazing. Great people and a great pastime!

My plan was to set up my gear for imaging, then to walk up the hill for some visual observing. Once I got everything working, I pointed the scope at the Witch's Broom Nebula, and started the camera. Around the same time, my buddy Geoff arrived (who only gets back to Nova Scotia from Calgary once a year) and we headed up to the field. Geoff is an astronomy enthusiast and is keen to look through any type of scope under dark skies.

We visited a bunch of telescopes, and looked at a number of objects, including Andromeda, the Wild Duck Cluster, the Lagoon, the Hercules Cluster, Messier 92 (Hercules Cluster Jr.?), the Eagle Nebula, and the Witch's Broom. The telescopes were big and the views were bright. We had some funny conversations about John Dobson (Is it true that he slept inside his telescopes? Answer: yes.), viral YouTube videos, and who was who in the dark. And it was nice to share the experience with an old friend.

But more about the views through the eyepiece. I can't remember ever looking at deep-sky objects and seeing them so vividly. Of course, they lacked the colour I am used to capturing in my images, but they seemed so vivid, popping out of the background, and surrounded by a sea of stars. They were nothing like I'd ever seen on a computer screen.

So what did I learn from this? It's that every once in a while I should return to the eyepiece and reconnect with the Universe. While I enjoy imaging and the results I get from it, I now realise that imaging introduces a degree of separation between me and the objects I capture.

A few days after Nova East, I got around to processing the data I captured on the Witch's Broom into an image. The image showed the nebula's beautiful contrasting colours and its wispy filaments. It made me think back to my view of it at Smileys a few days before, when it appeared as a shining arc with a bright star blazing inside it. Which did I enjoy more? I can't honestly say…

P.S. – Many thanks to everyone who was involved in making Nova East happen (yet again, a great event), and thanks to everyone who let me look through their scopes.

The Universe's Symphony of Sound: Hello Alien?

Matt Payne

What a busy summer! Time flies when you're having fun: I think I observed more this summer than in the past ten years. We have had a lot of clear nights or workable skies; on the downside, the lack of clouds and rainfall has left the Boston area in a severe drought. The town where I live, Mansfield Mass. is 15 inches below normal rainfall. Many surrounding towns use ponds or lakes for their water supply and it simply amazes me that I can walk to the middle of one of these reservoir ponds or lakes, and be no more than 6-8 inches deep in water. I am also happy we did not have a tropical storm or hurricane during Nova East 2016. I tend to attract these sort of storms and Matthew is on the list this year. How ironic it would have been to show up at Nova East 2016 with Hurricane Matthew in tow! I would never be allowed to attend Nova East again!

Now onto the good stuff. What the heck is happening in the world of radio astronomy? I have been so busy this summer that I really have not paid much attention to the science news or listened to my podcasts. I must admit it is good to unplug once and a while. One story that did catch my attention was the analysis of the May 15, 2015 radio signal received by the RATAN 600 radio telescope near the Caucasus

The Universe's Symphony of Sound: Hello Alien? continued

Matt Payne

Mountain in Russia. Last year this telescope was surveying a star field in the constellation Hercules. RATAN 600 focused in on star HD164595. The Russian team partnering with SETI (Search for Extraterrestrial Intelligence) researchers determined this star was approximately 94 light-years from Earth. With a promising signal, the Russian recorded the radio waves they believed were emanating from this star for further analysis. Of course this being the 21st Century, news of this discovery went viral, especially on the internet science and astronomy blogs and websites. SETI researchers then decided to investigate further rather than jump to any immediate conclusions. The discovery appeared to be very similar to the 1977 WOW! signal detected by the Big Ear radio telescope from a star in the constellation Sagittarius. SETI affiliated telescopes from around the world pointed their dishes towards star HD164595 in Hercules, but nothing was ever heard again.

Fast forward to September 1, 2016: a year and a half later and a lot more research by a smart SETI scientist and a conclusion regarding the signal source was reached. Did we have alien life trying to say HELLO? Not exactly and I know some people are bummed out about that. The likely source of the radio transmission was from Earth, not outer space. Scientists looking at the RATAN 600 data believe the radio telescope picked up a signal emanating from Earth or possibly a military satellite down-linking a transmission back to an Earth receiving station. The frequency of the signal from star HD164595 was in a frequency range used by military and commercial satellites.

So the signal was not from aliens from outer space trying to say HELLO. One must wonder if there is someone or something out in deep space trying to contact Earth and its human inhabitants. Will we as humans ever hear from a star or galaxy far, far away? I am not sure how to answer this question myself, but it would be cool if someone or something did try to say HELLO and confirm that we as humans are not alone in this great galaxy of ours. Maybe, just maybe, one of the thousands of stars we look up at every night, has life just like we have life on Earth.

Excerpts from Blair McDonald's Summer Viewing AstroBlog Posted on August 9, 2016

The day started out normally, warm, sunny and promising to be another great summer day. Since the drive to the cottage involves some less than smooth dirt roads, I went about aligning the optics and getting all the equipment together. Things were getting very dark and it was only 6 PM! The heavens opened up with heavy rain so I ran to the shed and closed the door to protect the scope and then dashed inside the cottage just as the wind started picking up. I took a look out the window to see a small water spout rip our row boat off the wharf and send it 40 feet down river before landing with a splash! Ten minutes later it was all over and the Sun started to break through the clouds.

▲ M20 (Trifid Nebula) RA 18:02.7 Dec +22:58, 72 minutes (24 X 3 minutes), ISO 1600, prime focus of a 200-mm SkyWatcher f/5 Newtonian reflector with Televue Paracor for a total focal length of 1150 mm, location Marion Bridge, Nova Scotia. (*Photo: Blair McDonald*)

By 9:00 PM the skies began to clear and the wind died down to zero allowing our kids to enjoy a fire by the rivers edge while I got a chance to do some nightscape work. By about 10:30 it was one of the clearest nights I had at the cottage. I hauled the scope and camera out of the shed and set up to try to capture some data from M20. This has always been a tricky target from the cottage as it skirts the trees for most of time. I managed to image it for about two hours only getting 72 minutes of data where the trees did not interfere. After a little processing it turned out reasonably well (http://www.nightanddayastrophotography.com/gallery/m20da.html.)

The 30th Nova East

Quinn Smith

Thanks to everyone who participated and helped organize the 30th Nova East, held at Smileys Provincial Park on the weekend of Aug 26th to 28th. I think everyone had a good time, reconnecting with friends and sharing the views of some excellent skies. We had a good attendance with 34 camp sites taken and a total of 54 registrants.

I would particularly like to thank the presenters: Roy Bishop, Melody Hamilton, Tony McGrath, Dave Lane, Chris Becket, Dave Chapman, Paul Evans, Jerry Black, Sherman Williams, Paul Heath and Tony Schellinck. Also I would like to mention and thank the Nova East organizing committee: Chris Young, Roy Bishop, Paul Heath, Melody Hamilton, Irene Moore, Paul Gray, Jim Millar, Judy Black, Dave Chapman and Michael Gatto.

The weather mainly co-operated this year, with clouds and occasional light showers during set-up on Friday, but it was dry by the beginning of Roy's presentation at 8 pm. It was still quite cloudy in the early part of the evening but skies partially cleared to allow some observing on Friday night. The biting insects were minimal this year, and it was a pleasant change not to have to cover ourselves with mosquito repellent!

Saturday was forecast to be sunny, but there was broken cloud for most of the day. It was warm and was a perfect temperature for the talks and events throughout the day. I must thank Mo and Chris for doing such a great job of feeding the campers with their astronomers' breakfast of delicious pancakes and bannock. New to this Nova East was a noon swap meet, and although it was not well attended, maybe we will try again next year.

The BBQ was the gastronomic highlight of the afternoon, and I think everyone was quite full (over full?) by the end. Thanks to Paul Gray for cooking the pork loins, and to everyone who brought the contributions to the "pot luck". From all of the positive accounts of the meal I received I think the BBQ is a keeper! The presentations and door prizes were held a little earlier than usual, to allow a unique observing opportunity just after sunset. This observing opportunity replaced the usual Saturday evening talk, although Tony Schellinck had a presentation ready to "go"- just in case!

I would like to thank the participants of the Nova East astro-photo contest and to thank Brian Giffin of Atlantic Photo Supply for donating the winning prize of a framed photo of the winning entry. Congratulations to Jeff Donaldson for his winning submission of M108. All the photos were great, and thank you everyone for participating. There were several great door prizes with the main prize being a fully automated Celestron Sky Prodigy 6 telescope donated by Celestron and Brian Giffin of Atlantic Photo Supply. The main door prize was won by Wilfrid Maillet who only just managed to fit it into his car for the trip home.

Although the skies were cloudy for most of the day, it looked like there was a clearing trend coming in from the west. After the presentations and door prizes, a convoy of cars headed out of the camp site to a nearby location (organized by Roy Bishop) to observe the close conjunction of Venus and Jupiter in the evening sky. The weather co-operated, and those watching saw both planets sink below the horizon just after sunset, first Jupiter and then Venus. And as a special treat for those watching, we saw a "green flash" as Venus set in the west. How about that! As Roy Bishop often says "Good fortune favours the prepared".

It was nearly dark by the time we arrived back at the camp site and many people busied themselves with out-

The 30th Nova East continued

Quinn Smith

reach, to show our guests from other parts of the Park, the celestial sights using laser pointers. Skies remained clear for the whole night and some serious observing and photography occurred after the lasers were shut off at 11 PM In my case, my dew heaters could not keep up with the heavy dew that was present, but I heard the whine of telescopes late into the night.

It was a good weekend and I hope that many of you will be able to attend the 31st Nova East, which will be held early next year in late July, again at Smileys Provincial Park.

Clear Skies

Quinn Smith
Chairperson - 2016 NE Planning Committee

▲ Brian Giffen of Atlantic Photo presents Wilfrid Maillet with the main door prize, a Celestron Sky Prodigy 6 telescope.

▲ Brian Giffen of Atlantic Photo presents Jeff Donaldson a framed print of his astro-photo contest winning photo of M108 .

▲ Paul Heath's talk on the solar system is interrupted by a comet orbiting around the sun (aided by Dave Chapman). (*Photo: Tony Schellinck*)

Nova East: The Presentations

▲ Chris Beckett presented Giovanni Battista Hodierna's "Admirable Objects of the Sky"

▲ Dave Lane presented on the use of filters when observing

▲ Dave Chapman presented Lunar Sketching for Beginners

▲ Tony McGrath presented on eye-pieces for observing

▲ Melody Hamilton presented Earning your RASC Observing Certificates

▲ Jerry Black presented Time-lapse Nightscapes for Beginners

▲ Paul Gray presents Tony Schellinck with the Messier 110 Observing certificate

▲ Paul Gray presents Bruce Hamilton with the first ever Astroimager-Wide Field certificate

May Meeting Report
Jim Millar

Paul Gray opened the meeting and welcomed all.

Paul Heath gave an update on outreach activities and asked for volunteers to give short library talks. He reminded members of the events planned for the transit of mercury. The next transit will be Nov 2019. He indicated that there may be requests for Provincial Park presentations and that he would need help for those. He will notify the list as these events are planned. He ended his presentation by reading his poem about the transit of Mercury.

Paul Gray then gave an update on future events. He reminded everyone that Nova East would be held Aug 26-28 at Smileys Park and that the website was up and running. He also mentioned that the latest issue of Nova Notes was on the Halifax RASC website. He ended his presentation by discussing the significant refresh to the library. There were 30 newly purchased books plus many donations.

Dave Lane then presented our guest speaker, Dr. Luigi Gallo. His subject was "Seeing the Universe in X-ray." He gave a brief overview of what x-ray astronomy was and his time with the Hitomi X-ray Telescope. X-rays require a different way of focusing waves. One had to use nested mirrors instead of the normal ones used for visual astronomy. Since X-rays don't penetrate the atmosphere one needs to go to space to observe them. He explained that we study X-rays to better understand the universe. Things are revealed in this spectrum that are not in others. He then showed various X-ray images and compared them with visual images of the same objects.

He then talked about his involvement with the Astro-H (Hitomi) Mission. It was a Japanese satellite with 5 main instruments; 4 focussing telescopes (2h8igh energy, hard X-ray and 2 low energy, soft X-ray) and a non-imaging gamma ray detector. Initially there was excellent data from the satellite. On March 27, 2016 communications were lost. A system failure caused the satellite to spin out of control and it was lost. The group is currently deciding what the next steps are.

His main message was "Do what you are passionate about and don't give up.

Paul Gray mentioned that RASC was planning a tour of astronomy sites in Arizona and New Mexico for the fall. Full details were on the RASC website. The President then discussed the "Explore the Universe" observing program. It is one that is open to anyone but is focussed on beginners. One has to observe 50 of 110 specific items. He then presented Mary Lou Whitehouse with her pin and diploma for completion of the program.

Dave Chapman presented Paul Heath with a book that he found while reviewing books for the library. It was titled "Sky Atlas." It was a book of poems about the constellations.

The evening ended with a slide show of images from the past month , refreshments and socialization. The next meeting will be on June 17 at SCO. It is a members-and-guest-only night of a BBQ and observing. Notice of meeting and rain date will be sent directly to the membership.

FOOD FOR THE SOUL:
Open Cluster

We gather during evenings warm,
Beneath unfettered dusty lanes.
On wind swept, treeless plains of grass, and mountain meadow terraces.
In forest clearings, or nearby open fields.

Our Silvery shrouded secrets, begin to spiral out
Gravity bound to a mocking Sun.
And Sages speak and pace about, acclaiming wonders, are all about!

As the brightest lantern fades away, our shrouds unfold
Their secrets begin to swing, and glowing fingers stretch forth to search
And show, the wonders spoken of, to all of those who've drifted by.

Yet this we've done in days gone by,
For have the Sages not spoke of drifting dust, and Gravities not so gentle touch.
And are not a few shiny, Silvery shrouds, new formed upon the field?

But KNOW now, our secret is but a mirror.
For we do not gather to wonder at the sky,
But hope the Stars on looking down,
Will plot a numbered letter down, and claim *OUR* open cluster found!

By Paul Heath

Nova East Scrapbook Photos 1. David Hoskin looking at the sun, 2. Gerry Brosky and Janet Murphy with their new scope, 3. Tony McGrath with his beautiful tripod, 4. James (Jim) Combie with his masterpiece, 5. Paul Gray dishes out pork loin at the Nova East BBQ, 6. Well-fed Nova East attendees, 7. Andrea Misner and Chris Beckett (*Photos: Tony Schellinck*)

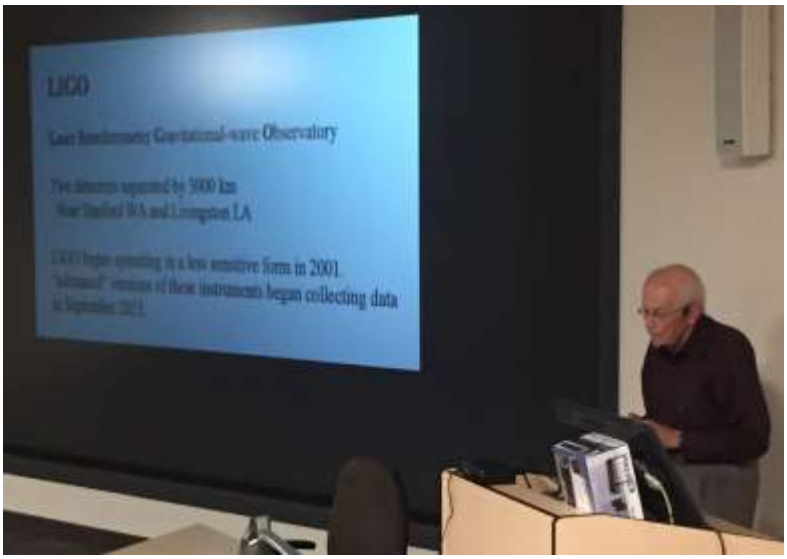
Nova East Scrapbook Photos: 8. Matt Payne, Kevin Collins (builder of this fine scope), Mary Berrigan, Garth, Adam and Kolbe Arsenault, Carl Hudson and Tony McGrath admire Kevin's portable dob, 9. Jeff Donaldson, 10. Dave Griffith. 11. Dan and Kathy Zylenko with their 10-inch LX200, 12. Quinn Smith, 13. Karl Hudson, 14. Andy Hasler

September 2016 Meeting Report

Chris Young

Vice-President Dave Chapman welcomed fifty members and guests, including two new members, a graduate student from Brazil who is an accomplished variable star observer, and an author from California who has published books on astronomy and science fiction.

Paul Heath kicked off the meeting with one of his "Food for the Soul" poems, then Dave read the Mi'kmaw poem "The Moose-Calling Moon" (both poems are to be found in this edition of NN). Paul Heath then provided an update on outreach activities and noted there are opportunities for volunteers if any members are interested.



Roy Bishop talks about detecting gravity waves at the September RASC meeting (*Photo: Dave Chapman*).

Dave Lane made a brief announcement on the upcoming Dan MacLennan Memorial Lecture (to be presented by Nobel Laureate Art McDonald) and advised that tickets will be available (free) for RASC members. Information will be posted to the email list soon. A call for nominations for next year's Council was made by Paul Gray inviting members to volunteer and warning them to be wary of the prowling nominations committee.

The evening's presentation was by Dr. Roy Bishop, titled "A Matter of Some Gravity", providing context and information on the recent gravitational wave discoveries. Roy started with Newton and his contributions to classical mechanics, which provided explanation and tools to study the effects of gravity and planetary movement. Newton's laws were powerful tools but did not fully explain all planetary movement such as the precession of Mercury's orbit, which led to astronomers speculating there might be another planet (suggested name Vulcan) inside the orbit of Mercury.

Einstein's General Theory of Relativity (GTR) of 1916 offered a different way of looking at space and time and one of its initial successful applications was that it fully explained the precession of Mercury. GTR and also the Special Theory of Relativity form the basis of our understanding of the modern universe. The predictions of relativity were gradually tested and confirmed, such as the bending of light by gravity and the effects of gravity and motion on time—our GPS systems rely on the adjustments for satellites having their clocks run faster on the one hand as they experience less gravity and run slower as they are moving faster relative to clocks on earth. Einstein's theories predicted these effects and allow the GPS to make allowance for them.

All the information we have about the cosmos, from our solar system out to the extremes of the universe, comes to us in the form of light, from the infrared through optical on through the ultraviolet, gathered by our telescopes and sensors on Earth and in orbit. We have one additional source, the rocks collected from the moon. These have been our only way, until the measurement of gravitational waves, to receive information about the universe.

Einstein's theories predicted gravitational waves, ripples in the curvature of space-time generated in certain large gravitational interactions which propagate outward at the speed of light. Experiments began in the 1960s attempting to measure these predicted ripples, but it was only in the last year that the technology matured enough to measure the minute physical changes that occur when a "ripple" passes through our planet and ourselves. There are two LIGO detectors (Laser Interferometer Gravitational-Wave Observatory) that recorded gravitational waves, one in Washington State and the other in Louisiana. There are three other detectors in the world, one in Italy near Pisa, one in Germany and one under construction in Japan.

The two US detectors consist of two perpendicular tunnels, 4 km long. These contain an ultrahigh vacuum and have passive and active vibration isolation. A light beam is split and is reflected back and forth in each tunnel and then the light rays are re-combined. Any disturbance is picked up in the difference in travel time of the light rays travelling in the two tunnels. The sensitivity required to record events can measure differences of 1/1000 of the diameter of proton.

Announced in 2016, the first observation of gravitational waves showed up on 14 September 2015. It matched the predictions of General Relativity for the inward spiral and merger of a pair of black holes. A second gravitational wave event was recorded on December 26, 2015. Analysis of the observed signal indicated that the event was caused by the merger of two black holes with masses of 14.2 and 7.5 solar masses, at a distance of 1.4 billion light years. The energy released in this merger was the equivalent of two solar masses, which caused the disturbance in space-time. The source of the wave is estimated using the difference in the arrival time of the signals between the two US observatories, 3000 km apart, through the use of trilateration.

The LIGO is under upgrade at this time to increase sensitivity, and is expected to measure events on a more frequent basis.

Meeting Minutes 16 September 2016 continued

Chris Young

These LIGO observatories are an entirely new astronomical tool with great potential in collecting information with which to study the universe.

There were a number of questions by members throughout the talk. Dr. Bishop presented a very clear explanation of the physics involved and although a number of us are still struggling with the concept of space-time, we received insight into the workings of this new type of observation and its importance in astronomy and astrophysics.

Dr. Bishop did provide some lightness and humor in the talk by sharing a letter he had written to a physics journal, which they published, entitled "Nova S-1, A Black Hole Confirmed" where Roy reports the discovery of a black hole (i.e. "Black Hole" NS) in a scholarly manner. And just when we thought it couldn't get any better Roy showed a picture of physicist John Archibald Wheeler (who established the term"black hole") in a T-shirt stating "I Have Experienced Black Hole Nova Scotia" taken when he visited the area with Roy.

It was an excellent talk and if Roy presents it again elsewhere, it is well worth travelling for it!

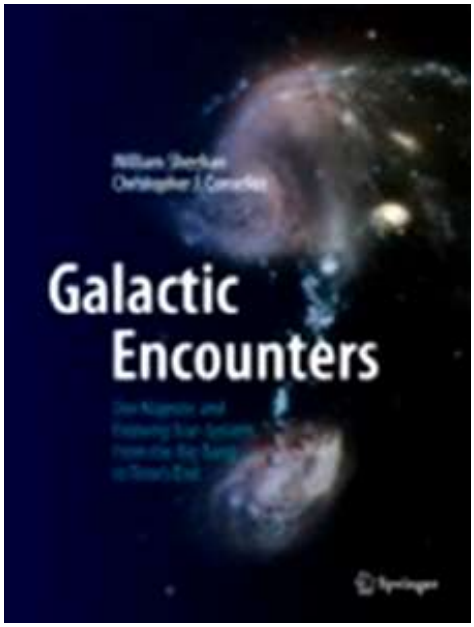
The meeting ended, as always, with a social gathering with refreshments.

PS. Dr. Bishop's article "Nova S-1, A Black Hole Confirmed" is available from JRASC 1977 through adabs.harvard.edu

Galactic Encounters

Tony McGrath

Galactic Encounters – Our Majestic & Evolving Star System
William Sheehan & Christopher Conselice
Springer
377 pages, ISBN 978-0-387-85346-8



For those who have an interest in both the science and history of astronomy, this well researched book takes you on a journey that weaves together the people, the history and the science. William Sheehan is a noted historian of astronomy and Christopher Conselice a professional astronomer specializing in galaxies in the early universe. Following an essentially linear timeline, the book opens with Charles Messier and ends with a discussion of our present knowledge of dark matter and dark energy. It is between these bookends that the tale is told.

Sheehan and Conselice spend the early part of the book setting up the problem of the nebula. Prior to the invention of the telescope, very few nebula were known, it was not until 1610 that Peiresc recorded the great nebula in Orion. This remained the case until late 18th century. Astronomy was essentially a science of the solar system, the stars being a backdrop against which all the action took place. Astronomers were principally gentlemen scientists, men of wealth and leisure pursuing science. Those observing stellar targets were pre-occupied with cataloging positions, searching for parallax and trying to determine the scale of things. Astronomers funded by public sources were in general trying to solve problems of navigation, such as the determination of longitude at sea. The other great occupation of these early observers was the discovery of comets. It was this occupation that led Messier to produce his catalogs of "faux comets".

With the work of William and Caroline Herschel in the late 18th and early 19th century, we began to look beyond the solar system in earnest, and the number of known nebula increased exponentially. This exceptional duo did more to catalog interesting objects, ask high yield questions and propose new ideas and theories than any previous astronomer. It was with the Herschel's that the nebula began to enter the attention of a wider pool of observers and scientists. There were questions which would not yield, such as what were these nebulous objects that floated through the eyepiece and was there an edge to this backdrop of stars. The pioneering work of William was in fact a family affair, and William's son John continued the legacy into the next generation.

The book outlines the development of spectroscopy and photography, and its application to discerning the nature of nebula. Early practitioners in both these areas, such as Huggins and Barnard, get their share of attention. Matters then turn to the physics of stars, and the development of the great telescopes of the late 19th and early 20th centuries. In all cases the players are developed not only as scientists, but as people. Hale, Hubble, Baade and Morgan all receive significant treatment.

The story concludes with a high level treatment of galaxy formation and the problem of the missing mass. In this portion of the book, the people begin to take a back seat to the science, as the authors try and summarize our current state of knowledge. Despite a few serious errors in editing, the book is a very worthwhile read and a welcome addition to anyone's library.

Tony McGrath

Keji Dark Sky Weekend Volunteers in the Daylight: 1. Judy and Jerry Black, 2. Paul Heath, Andrea Misner and Chris Young, 3. Karl Penney and family, 4. Tony Schellinck's cool binocular table transporter, 5. Dave Chapman and Christine Hanham , 6. Andy Hasler and daughters, 7. Pam and Wayne Mansfield (*Photos: Tony Schellinck*)