

# POLARIS



## Newsletter of the London Centre, RASC

October 2019

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### **NOTICE! November OGM!**

**Saturday Nov 16 19:30**

**Location: 173 Gatineau Road, in Byron.**

**Tel: 519-657-6825**

**Cell: 519-200-6577**

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## **The Very Odd Neutron Star**

We know that eventually our star will evolve and enter its end-of-life as a white dwarf, fated to cool over many billions of years until it blinks out as a cold cinder of a star. A solar-mass white dwarf will be about the size of the earth and will be very dense with a teaspoon of matter having a mass of around five tonnes. With this amount of mass the star cannot collapse further as electron degeneracy pressure holds it 'up'. This pressure is due to Pauli's Exclusion principle which forbids two leptons (quantum particles) from occupying the same state.

What about stars more massive than the sun? With the original star having over about 10 solar masses end-of-life comes with a Type II (core collapse) supernova. This type of explosion leaves a compressed core of about 1.4 solar masses. This core is compressed enough that electrons and protons are squeezed together to form neutrons (analogies are always suspect but it works) through inverse beta decay/electron capture. The lack of remaining electrons means that the only thing holding a neutron star up is neutron degeneracy pressure. There's no Pauli Exclusion principle at work here, the neutrons are so close to each other that the repulsive nature of the strong nuclear force keeps them apart.

Neutron stars generally have a radius of about 10km. While white dwarfs have densities of around 5

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tonnes/teaspoon (sorry Peter) neutron stars have a density of more than  $10^{10}$  tonnes/teaspoon (or more). This makes them very odd objects indeed. Thor's hammer is made from neutron star material and is supposed to be able to be set down on a table... that's one very strong table.

Neutron stars, being very small, display huge gravitational forces at their surface. Enough so that light deflection allows us to see more than 1/2 of the surface at any one time. Some neutron stars, with very small radii may even keep photons trapped in orbit just above the surface which would make the entire surface visible. Gravitational time dilation would show 8 years passing on a neutron star as being 10 years on earth.

Neutron stars are differentiated like rocky planets, but there are no rocks or magma involved. The outer crust of a neutron star may consist of ions and electrons and could be 300-500m thick. An inner crust of electrons, neutrons and nuclei about 1-2km thick is below that, then things get strange. The outer core of a neutron star, about 9km in diameter may consist of a neutron-proton Fermi liquid with a small percentage of electron Fermi gas. The remainder, the inner core could be a quark/gluon plasma.

*A Fermi gas consists of non-interacting fermions occupying all momentum states. When interactions are 'turned on' they become a Landau-Fermi liquid.*

In between some layers in a neutron star is thought to be a type of degenerate matter known as *Nuclear Pasta*. At densities around  $10^8$  tonnes/teaspoon nuclear attraction and Coulomb repulsion are roughly equal. The two forces fighting each other can lead to the formation of a range of structures that look like gnocchi, spaghetti and lasagna; hence, Nuclear Pasta.

Neutron stars generally don't 'shine' brightly in visible light. Their thermal signature is mostly neutrino emission. However, they do shine in other parts of the electromagnetic spectrum. Many have very strong magnetic fields and therefore jets of material form at the magnetic poles of the star. If the poles are offset from the stars rotational pole then these jets may sweep across us and we will see a pulsar. The fastest pulsar we've found is PSR J11748-2446ad which pulses 716 times per second. The Crab Nebula pulsar was discovered in 1968 and was the first to be connected with a supernova remnant. The supernova was seen in 1054AD. Neutron stars 'spin down' over time with older neutron stars spinning less rapidly than young ones.

Some neutron stars can actually spin UP. This is generally due to the star absorbing material in-falling onto its surface from a companion star.

Magnetars are types of neutron stars with extremely powerful magnetic fields, up to  $10^9$  to  $10^{11}$  Tesla (the superconducting magnets at the Large Hadron Collider are 8 Tesla). Gamma ray bursts thought to come from magnetars were detected in 1979 and since then magnetars have become accepted as the explanation for *soft gamma repeaters* and *anomalous x-ray pulsars*. Their magnetic field is thought to be a result of a magnetohydrodynamic dynamo effect (there's a mouthful) due to turbulence that existed before the neutron star settled down.

### **Some famous neutron stars**

- LGM1. This was the first pulsar was seen as some 'scruff' on a readout found by Jocelyn Bell Burnell in 1967. This is pulsar PSR B1919+B21 and has a period of 1.3373 seconds with a pulse width of 0.04 seconds. LGM stands for Little Green Men as it was first thought to be a beacon from aliens.

- Black Widow Pulsar in Sagitta. An eclipsing binary found in 1988 it was the first of these known. It's called Black Widow as its companion is being 'eaten' as it overflows its Roche Limit. It orbits its companion with a period of 9.2 hours and has a pulse period of 1.60734 milliseconds.
- PSR J0348+0432. The most massive neutron star known at  $2.01 \pm .04$  solar masses. It is another pulsar in a binary system in Taurus. It has an orbital period of 2h 27m and is short enough that orbital decay due to emission of gravitational waves has been observed. It rotates every 39.123ms.
- PSR J0108-1431. The closest neutron star/pulsar that we know of. It is not a member of a binary pair and is approximately 425ly away in the Constellation Cetus. It is estimated to be 166 million years old and rotates every .8 seconds.

## Heart and Soul

This shot was taken at the 2019 Black Forest Star Party in Pennsylvania. It was shot through an AstroTech 65mm f/6.5 quadruplet. 14 subs each 10 minutes long at ISO1600 using a Nikon D810A and BackyardNikon. Guided by PHD2 using an Orion SSAG. Celeston CGE.



**RASC London Centre Library**  
**Books of the Month**  
**October 2019**  
**By Robert Duff**

As always, these “Books of the Month” are available for loan to members, to be returned at the following monthly meeting. The books for October 2019 are as follows:

*The Backyard Astronomer's Guide*, [by] Terence Dickinson & Alan Dyer. Revised Edition. – Willowdale, Ont.: Firefly Books, 2002.

*A Nightwatchman's Journey: The Road Not Taken*, [by] David He. Levy. – Toronto: The Royal Astronomical Society of Canada, c2019.

*The Planet Factory: Exoplanets and the Search for a Second Earth*, [by] Elizabeth Tasker. – London, England: Bloomsbury Sigma, 2019, c2017.

For a complete listing of our RASC London Centre Library collection please click on the **Library** menu at the top of the RASC London Centre main Web page: <http://rasclondon.ca/>

If there is anything you wish to borrow from the Library, please feel free to contact me by telephone at (519) 439-7504 or by e-mail at [rduff@sympatico.ca](mailto:rduff@sympatico.ca)

## **Doors Open London at London Life / Canada Life, Sunday, September 15<sup>th</sup>, 2019**

*By Robert Duff*

RASC London Centre member Mark Tovey arranged an extensive exhibit, “*Astronomical Stories*,” highlighting contributions to astronomy by prominent figures in London’s history, including Master John Harris, London’s second mayor, William Barker; and astronomical model-maker W. G. Colgrove. Mark was assisted by RASC London member Peter Jedicke. The event took place in the auditorium on the 4<sup>th</sup> floor of the London Life / Canada Life building at 255 Dufferin Avenue, London, Ontario. The exhibit took place on Sunday, September 15<sup>th</sup>, 2019, 10:00 a.m.—4:00 p.m. with Peter Jedicke and Mark Tovey giving presentations or otherwise talking to visitors the entire time. Edith Tovey was also there and Dale Armstrong took pictures earlier in the day. Bob Duff arrived later in the afternoon. There was an official count done, using a hand tally counter by a London Life / Canada Life employee, with 352 people coming in the door, including 60 youth.

The displays included the *Sotellunium*—a mechanical eclipse demonstration model built by W. G. Colgrove—as well as his other mechanical models, including a the *Midget Planetarium* and *Moons of Mars*, along with his 1/40<sup>th</sup> scale model of the *200-inch Hale Telescope* at Mount Palomar. The 3D printer replica of the Dresden meteorite was also on display along with posters and a continuous slide presentation featuring astronomy and space related themes.



## Star Night at Tweedsmuir Public School, Tuesday, October 8<sup>th</sup>, 2019

*Written by Robert Duff, as Reported by Peter Jedicke*

Mostly clear skies and very good seeing conditions made for an excellent Star Night at Tweedsmuir Public School in London on Tuesday, October 8<sup>th</sup>, 2019, 7:00—8:30 p.m. There were 56 people (25 children and 31 adults—including 4 teachers from the school) who showed up for the event. The Star Night was requested by the Grade 6 teacher. RASC London Centre volunteers included Peter Jedicke, Norm McCall, Mohammed Mubeen and Mark Pickett.

Peter gave a 15 minute digital slide presentation "*Today's Solar System*" outdoors on a tripod screen. Norm brought his David Levy Explore Scientific 152mm Maksutov-Newtonian Comet Hunter, Mohammed brought his Sky-Watcher 20.3cm Dobsonian and Mark brought a 1961 Criterion RV-6 (15cm) Newtonian reflector and 10 X 50mm Nikon binoculars on a pantograph mount. Four members of the community brought small telescopes, which RASC members helped them set up and learn to use. Objects observed included the 3-day-past-first quarter Moon, Jupiter and Saturn.

There was an International Space Station (ISS) pass predicted for 7:58—8:03 p.m. (19:58:03—20:03:56) and travelling west northwest to southeast, reaching a maximum altitude of 51 degrees above the southwestern horizon at 8:01 p.m. (20:01:18). The ISS pass was observed by everybody. (See: *ISS – Visible Passes* for London, Ontario, on *Heavens Above*: <http://www.heavens-above.com/>)

## Cronyn Observatory Special Events, September 14<sup>th</sup>—October 5<sup>th</sup>, 2019

*By Robert Duff*

### Doors Open London at the Cronyn Observatory, Saturday, September 14<sup>th</sup>, 2019

Skies were partly cloudy and there was an estimated 400 visitors for Doors Open London at the Cronyn Observatory, Saturday, September 14<sup>th</sup>, 2019, 2:00—10:00 p.m. Doors Open London is an annual celebration (in its 18<sup>th</sup> year) of the London's history, heritage and culture, with events across the city, running September 14<sup>th</sup>—15<sup>th</sup>, 2019. Professor Jan Cami coordinated the event at the Cronyn Observatory and began by talking to visitors in the "*1940s Period Room*" until the arrival of RASC member Mark Tovey. Jan then did 3 "*Spectroscopy Demonstrations*" in the "*Black Room*," with the visitors putting on *diffraction grating* glasses to view the spectra of 4 gas discharge lamps, including hydrogen, helium, neon and mercury. Jan talked to about 30 people in the 2 hours he was at the Cronyn Observatory. Mark gave tours of the "*1940s Period Room*," a recreation of Dr. H. R. Kingston's 1940 office, with his brass refractor and the *Sotellunium*—a mechanical eclipse demonstration model built by W. G. Colgrove—on display; and the "*1967 Period Room*," recreating the early control room of the Elginfield Observatory to celebrate the 150<sup>th</sup> anniversary of Confederation—Canada 150. The "*W. G. Colgrove Workshop Period Room*" was open for visitors' inspection. The 3 "*Period Rooms*" were designed by Mark Tovey.

RASC London Centre was represented by Everett Clark, Henry Leparskas, Bob Duff, Mark Tovey and Paul Kerans. RASC London member Heather MacIsaac was also there as a graduate student and Exploring the Stars program TA. Henry gave 2 slide presentation twice in the afternoon, including “*Brief History of the Observatory*” followed by “*Indiana Jones Discoveries*,” between 2:00—4:00 p.m. He gave the 2 slide presentation 3 times in the evening, between 7:00—9:30 p.m. There were an estimated 85—90 visitors in the afternoon if we include the 71 people who attended Henry’s slide presentations and some 300 visitors in the evening for a rounded total of about 400 visitors for the entire event, 2:00—10:00 p.m. This included an estimated 60 children and youth (15% of total visitors).

Everett gave afternoon tours of the big 25.4cm refractor in the dome. In the evening, graduate student Hadi Papei showed visitors Jupiter through the 25.4cm refractor (17mm Nagler eyepiece, 258X). On the observation deck in the afternoon Heather showed visitors the Sun through the observatory’s Coronado 90mm H-Alpha Solar Telescope (CEMAX 18mm eyepiece, 44X) and Meade 8-inch (20.3cm) Schmidt-Cassegrain (K 40mm eyepiece, 50X), fitted with the Kendrick Astro Baader film Solar Filter. Bob later took over the Coronado 90mm H-Alpha Solar Telescope around 4:48 p.m. and swapped in the CEMAX 12mm eyepiece (67X) for a better view of the Sun. Paul Kerans arrived around 7:00 p.m. and set up his Celestron 9.25-inch (23.5cm) Schmidt-Cassegrain on a Vixen equatorial mount and showed people Jupiter and Saturn, using a 15mm LE eyepiece (156.6X); the full Moon and the Owl Cluster (NGC457), using a 25mm LE eyepiece (94X), and the Ring Nebula (M57), using a 15mm LE eyepiece (156.6X).

Since the rising full Moon could not be viewed from the observation deck, and the stairwell was crowded with visitors, Heather MacIsaac helped Bob Duff set up the RASC London Centre’s 25.4cm Dobsonian on the sidewalk on the southeast side of the observatory. Visitors were redirected outside where they lined up on the sidewalk for Bob to show them the full Moon through the 25.4cm Dobsonian (18mm Radian eyepiece, 62X), as it rose above the eastern horizon. On the observation deck Heather showed visitors Saturn through the observatory’s 20.3cm Schmidt-Cassegrain (20mm Plossl eyepiece, 100X).

RASC London member Heather MacIsaac distributed some 25—30 “*Star Finder*” planispheres to visitors and was there from 2:00—10:00 p.m. as a graduate student TA.

RASC London member volunteer *Person Hours* were recorded as follows: Henry Leparskas was there from 2:00—6:00 p.m. and 7:00—10:00 p.m.; Everett Clark, 2:00—4:30 p.m.; Mark Tovey, 3:00—10:00 p.m.; Paul Kerans, 7:00—10:00 p.m. and Bob Duff, 3:25—5:27 p.m. and 8:15—10:00 p.m.

The observatory was closed down around 10:15 p.m. with the visitors gone after an enjoyable evening of stargazing, “*Spectroscopy Demos*” and tours of the historic “*Period Rooms*.”

## Space Out! Science Literacy Week Event at the Cronyn Observatory, Saturday, September 21<sup>st</sup>, 2019

Partly cloudy skies greeted an estimated 70 visitors (including 25 children) for Space Out!—the Science Literacy Week celebration at Western University’s Cronyn Observatory, Saturday, September 21<sup>st</sup>, 2019, 5:00—10:00 p.m. Science Literacy Week, September 16<sup>th</sup>—22<sup>nd</sup>, 2019, is an effort to showcase the excellence and diversity of science outreach institutions across Canada. This event was hosted by Western Space in partnership with the London Centre of the Royal Astronomical Society of Canada.

The event organizers included Dana Beaton, Outreach Assistant Coordinator, and Dr. Parshati Patel, Outreach Program Coordinator, Western Institute for Earth & Space Exploration. Activities included stargazing through the big 25.4cm refractor in the dome and amateur telescopes set up on the observation deck (7:30—10:00 p.m.); *Asteroid Mining*, *Comet Mystery Boxes* and the *Space Themed Virtual Reality Station* (5:00—9:00 p.m.) and *Space Trivia* (7:00—8:00 p.m.) in the main floor lecture room; and the *Historical displays and artifacts* in the basement “*Period Rooms*” (5:00—9:00 p.m.). Earth Science graduate students in the lecture room included Gavin Tolometti on the welcome desk and Leah Sacks on the *Comet Mystery Boxes*, and Jahnavi Shah on *Asteroid Mining*. The *Space Trivia* activity was done on the large TV screen newly installed in the lecture room.

Graduate student Hadi Papei was telescope operator in the dome and showed visitors Saturn through the big 25.4cm refractor (17mm Nagler eyepiece, 258X). RASC London Centre was represented by Henry Leparskas, Bob Duff, Steve Imrie, Mark Tovey and Mohammed Mubeen. Henry operated the observatory’s Meade 8-inch (20.3cm) Schmidt-Cassegrain (20mm Plossl eyepiece, 100X) and alternated between showing visitors Jupiter and Saturn before directing the telescope to the yellow and blue double star Albireo. Steve Imrie showed visitors Jupiter and Saturn through the RASC London Centre’s home-built 30.5cm Dobsonian (18mm Radian eyepiece, 83X).

Mark Tovey gave tours of the “*1940s Period Room*,” a recreation of Dr. H. R. Kingston’s 1940 office, with his brass refractor and the *Sotellunium*—a mechanical eclipse demonstration model built by W. G. Colgrove—on display; and the “*1967 Period Room*,” recreating the early control room of the Elginfield Observatory to celebrate the 150<sup>th</sup> anniversary of Confederation—Canada 150. The “*W. G. Colgrove Workshop Period Room*” was open for visitors’ inspection. The 3 “*Period Rooms*” were designed by RASC London member Mark Tovey.

RASC London member volunteer *Person Hours* were recorded as follows: Henry Leparskas (5:00—10:00 p.m.), Bob Duff (7:15—10:00 p.m.), Steve Imrie (7:25—10:00 p.m.), Mohammed Mubeen (5:30—8:30 p.m.) and Mark Tovey (7:00—9:30 p.m.)

The visitors were mostly gone and the observatory was closed down around 10:00 p.m. after an enjoyable and interesting evening of space themed activities and observing through telescopes.

## International Observe the Moon Night at the Cronyn Observatory, October 5<sup>th</sup>, 2019

Partly cloudy skies greeted an estimated 90 visitors (including 25 children) to the Cronyn Observatory for the 10<sup>th</sup> International Observe the Moon Night, Saturday, October 5<sup>th</sup>, 2019, 5:00—10:00 p.m. The event was hosted by Western University's Institute for Earth & Space Exploration (Western Space) in partnership with the Department of Physics and Astronomy, the Canadian Lunar Research Network and the Royal Astronomical Society of Canada (RASC) London Centre. The event organizer was Western Space Outreach Assistant Coordinator Dana Beaton.

Activities included (1) *Public Talks* (7:00 p.m.), (2) *Moon Trivia* (7:30 p.m.) and (3) *Various Moon Themed Hands-On Activities* (5:00—9:00 p.m.). Western Space graduate student Gavin Tolometti gave his digital slide presentation on "*Returning to the Moon, How and Why.*" Both the slide presentation and the *Moon Trivia* activity that followed were done on the large TV screen newly installed in the observatory's lecture room. Western Space also did a small collaboration with the El Paso Community College in Texas, using the Zoom video conferencing application to broadcast Gavin's slide talk and the *Moon Trivia* activity to them and their attendees. Afterwards, El Paso Community College broadcast their view of the Moon to be displayed on the large TV screen in the lecture room.

Downstairs in the "*Black Room*" graduate student Viraja Khatu gave demonstrations of the "*Transit Demonstration*" model, showing how the transit detection method worked for finding extra-solar planets, and the "*Spectroscopy Demonstration,*" with the visitors putting on *diffraction grating* glasses to view the spectra of 4 gas discharge lamps, including hydrogen, helium, neon and mercury.

Mark Tovey gave tours of the "*1940s Period Room,*" a recreation of Dr. H. R. Kingston's 1940 office, with his brass refractor and the *Sotellunium*—a mechanical eclipse demonstration model built by W. G. Colgrove—on display; and the "*1967 Period Room,*" recreating the early control room of the Elginfield Observatory to celebrate the 150<sup>th</sup> anniversary of Confederation—Canada 150. The "*W. G. Colgrove Workshop Period Room*" remained closed. The 3 "*Period Rooms*" were designed by RASC London member Mark Tovey.

Graduate student Chris Fox was telescope operator in the dome and directed the big 25.4cm refractor (17mm Nagler eyepiece, 258X) to show visitors the first quarter Moon, Saturn and then the Moon again. RASC London Centre was represented by Henry Leparskas, Bob Duff, Mohammed Mubeen and Mark Tovey. RASC London member Heather MacIsaac was also there as a graduate student TA. On the observation deck outside the dome, Henry operated the RASC London Centre's home-built 30.5cm Dobsonian, showing visitors the Moon, using the Meade 28mm Super Wide Angle eyepiece (54X), and then swapping in the 18mm Radian eyepiece (83X) to show them Jupiter and the Andromeda Galaxy (M31). Heather set up her Celestron NexStar 90SLT 90mm Maksutov-Cassegrain and showed visitors the Moon, using a 32mm Plossl eyepiece (39X), and then swapped in a Vixen 17mm Lanthanum LVW eyepiece (73.5X) to show them Saturn, the Moon again, and then the Andromeda Galaxy (M31).



Bob and Henry called everybody's attention to an International Space Station (ISS) pass predicted for 8:46—8:50 p.m. (20:46:58—20:50:02) and travelling west northwest to west, reaching a maximum altitude of 73 degrees above the western horizon at 8:50 p.m. (20:50:02). The ISS pass was enjoyed by people on the observation deck. (See: *ISS – Visible Passes* for London, Ontario, on *Heavens Above*: <http://www.heavens-above.com/>)

RASC London member Heather MacIsaac gave out 5 “*Star Finder*” planispheres and 3 “*Moon Gazers’ Guide*” cards to visitors and was there from 5:00—10:00 p.m. as a graduate student TA. A visitor also took 2 “*Moon Gazers’ Guide*” cards. RASC London member volunteer *Person Hours* were recorded as follows: Henry Leparskas (5:00—10:00 p.m.), Bob Duff (7:10—10:00 p.m.), Mohammed Mubeen (5:00—9:30 p.m.) and Mark Tovey (7:00—9:30 p.m.)

The visitors were mostly gone and the observatory was closed down around 10:00 p.m. after an interesting and enjoyable evening with the slide presentation about “*Returning to the Moon, How and Why*,” Moon themed activities, the “*Transit*” and “*Spectroscopy*” demonstrations, tours of the historic “*Period Room*” and observing the Moon, Jupiter, Saturn and M31 through telescopes.