POLARIS

Newsletter of the London Centre, RASC
January, 2019

Getting Away From it All

We've long known that our life-giving atmosphere has deleterious effects on astronomy and have, since the beginnings of rocketry, attempted to move telescopes and high-tech sensors above our blanket of air. Early attempts, while furthering science didn't come to complete fruition until the launching and repair of the Hubble Space Telescope.

The HST's images have amazed those of us interested in astronomy; and even people with little interest in science have been awed by the grandeur of the heavens as shown by Hubble.

There have been many astronomy payloads put into orbit around the earth or into other positions in the solar system over the past several decades. Hipparcos and Tycho generated accurate catalogues of stars in our area of the Milky Way. Kepler has discovered hundreds of exo-planets. The STEREO satellites keep an eye on the sun for us and satellites like Uhuru, IRAS, and ROSAT have helped push the envelope in non-visual sensing.

In this article I'll look at a few of the satellites currently in place and working in different wavelengths on the electro-magnetic spectrum. I'll start with the highest energy (particles and gamma rays) and work my down to the lowest energy (radio). Of course, this is just a thin overview and if you're interested in any of these satellites, or others, please look at the websites for the satellite operators or Wikipedia.

So, let's leave this turbulent blanket of air behind and get away from it all...

Dark Matter Particle Explorer

The Dark Matter Partticle Explorer (DAMPE) or Wukong, is a satellite operated by the Chinese Academy of Sciences. It was launched in 2015 atop a Long March 2D rocket from the Jiuquan Satellite Launch Centre. It is China's first space observatory.

It was launched into a sun-synchronous low-earth, polar orbit at a height of 500km.

The telescope is used to detect gamma rays, electrons and cosmic rays in the TeV range in search for dark matter, especially Weakly Interracting Massive Particles (WIMPs).

Fermi Gamma Ray Space Telescope

The Fermi Gamma Ray Space Telescope is run by the US Department of Energy with partners from France, Germany, Ital, Sweden and other US institutions. It was originally called the Gamma-ray Large Area Space Telescope but was renamed to honour professor Enrico Fermi who was a pioneer in nuclear energy and high-energy physics.

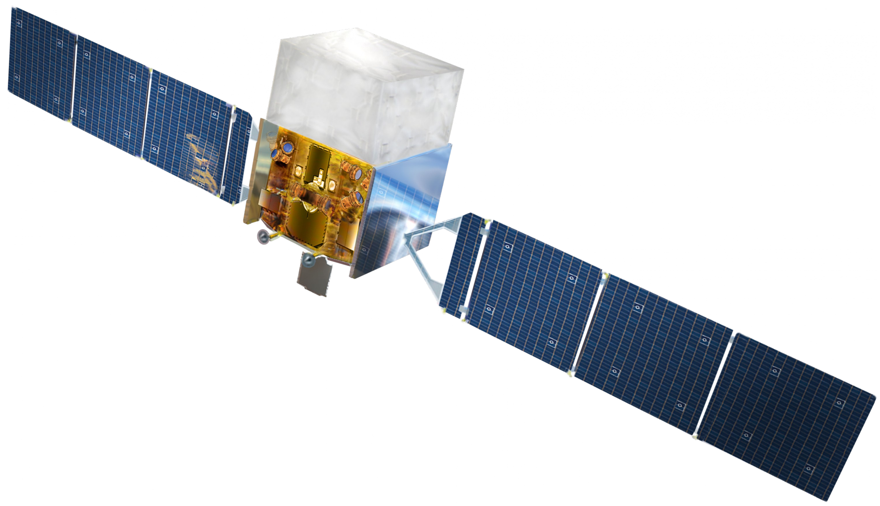
The satellite is in an almost circular low-earth orbit with a semi-major axis of 6913km and inclination of ~26 degrees.

The FGRST has two main instruments that can observe photons in the 8keV to 300GeV range (one electron-volt is about the energy level of visible light). The Large Area Telescope looks at areas about 1/5 of the sky at a time (2 steradians) and the Gamma-ray Burst Monitor.

The LAT was assembled at the Stanford Linear Accelerator Center with input from the other partners. The Principle Investigator is Dr. P. Michelson of SLAC.

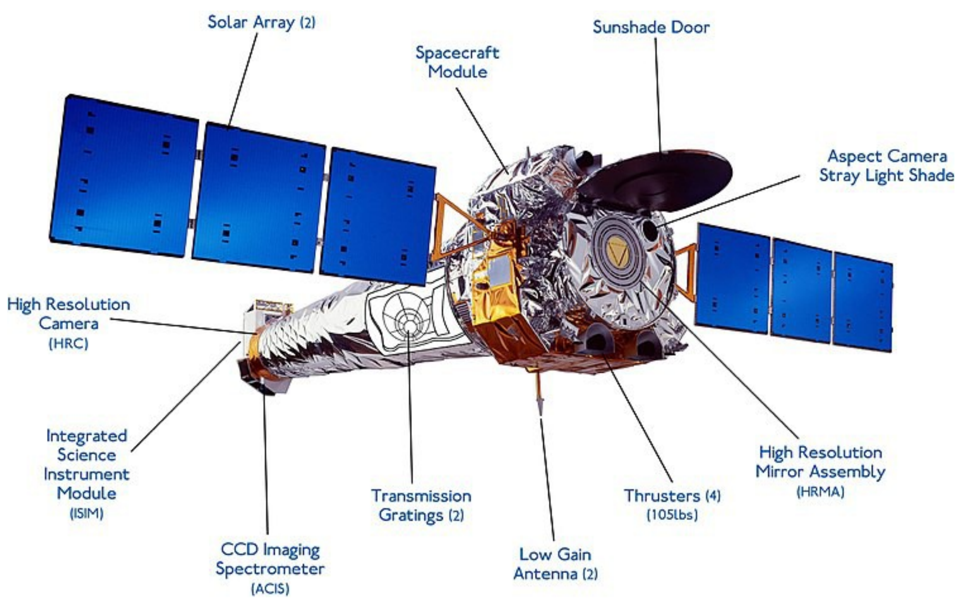
When an incoming gamma ray enters the LAT it interacts with one of 16 tungsten sheets which then turn the ray into an electron/positron pair. A tracker then uses silicon strips to measure the paths of both in order to determine what direction the original ray came from. The particles then pass through a calorimeter which measures their energies.

Unwanted cosmic ray particles, or particles from earth's atmosphere are filtered out by an Anticoincidence detector and software.

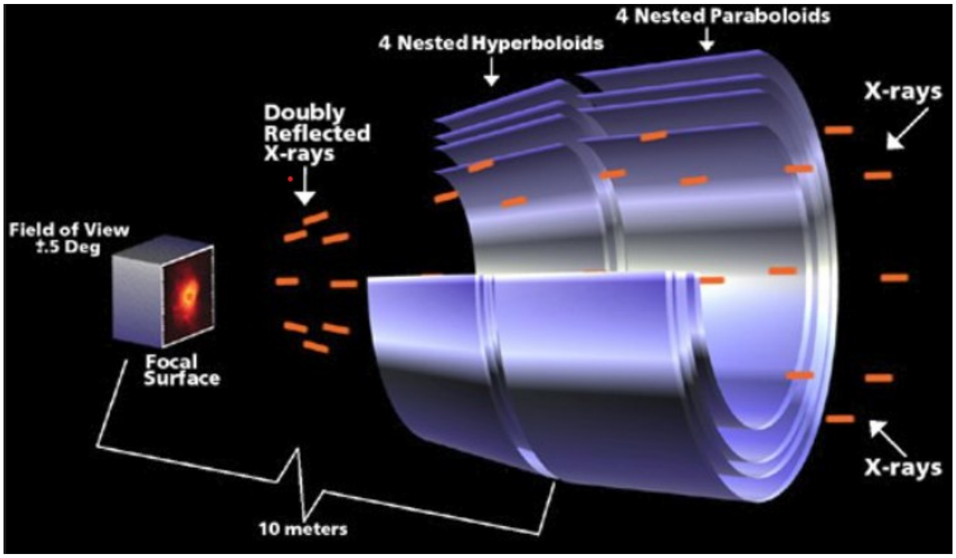


Chandra X-ray Observatory

The Chanbdra X-Ray Observatory (previously known as the Advanced X-ray Astrophysics Facility) was launched by the Space Shuttle on STS-93 in 1999. The telescope is sensitive to X-ray sources 100 times fainter than any previous facility. It is in a highly elliptical, almost polar, orbit with a semi-major axis of 80,795km. Perigee is 14,308km and apogee is 134,528km.

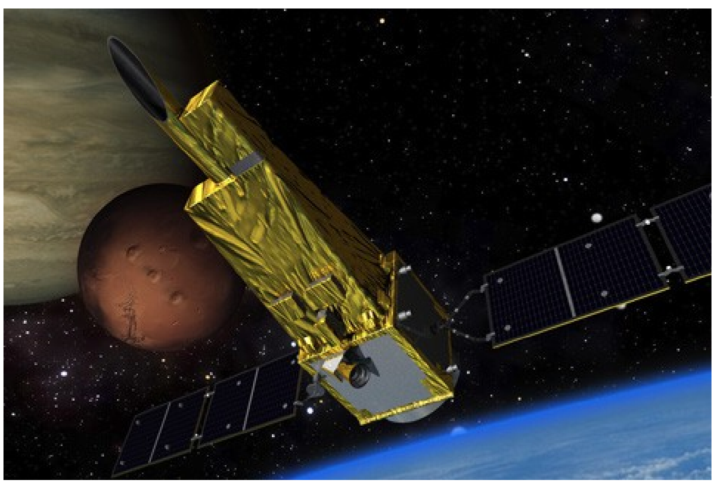


As X-rays can't be focused by a normal mirror, the Chandra satellite uses a series of 'grazing incidence reflectors' which look like slightly curved cylinders. The X-rays hit these at a slight angle and are reflected into the next, and the next etc. Until they come to focus at the sensor



The spacecraft isquite as the focal length of the reflectors is 10m and its mass is 5.9t. The telescope has a collecting area of .04 square meters and operates from .1 to 10keV and has a resolution of .5 arcsec. Its planned 5 year mission has been extended and it is currently approaching 20 years in operation.

Hisaki



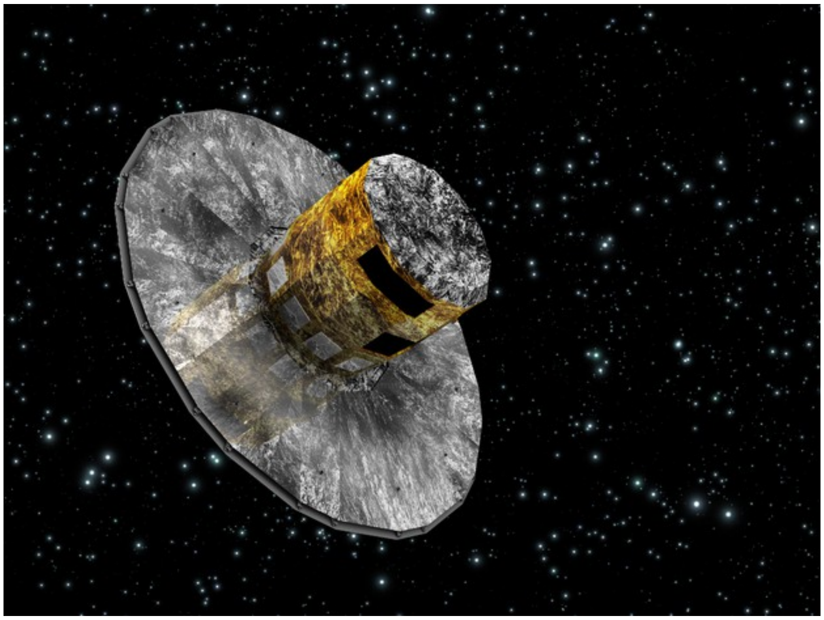
Hisaki is also known as the Spectroscopic Planet Observaotry for Regognition of Interaction of Atmosphere (SPRINT-A) and is operated by the Japan Aerospace Exploration Agency. It was launched in 2013 on the first flight of the Epsilon rocket. Still in operation, it has surpassed it's one year planned life and, in conjunction with the Juno spacecraft is still returning data.

Its mission is to study the composition of atmospheres of solar system bodies using an extreme ultraviolet spectrometer. One of the main goals is to investigate the solar wind's influence on the inner magenetosphere of Jupiter. When launched it was the first space telescope solely to be used observing planets.

Hisaki/SPRINT-A was the first satellite based on the SPRINT bus system for small scientific satellites. The telescope's launch mass was 348kg and it is in a low-eccentricity earth orbit with a semi-major axis of 7432km and inclination of ~28 degrees.

Gaia

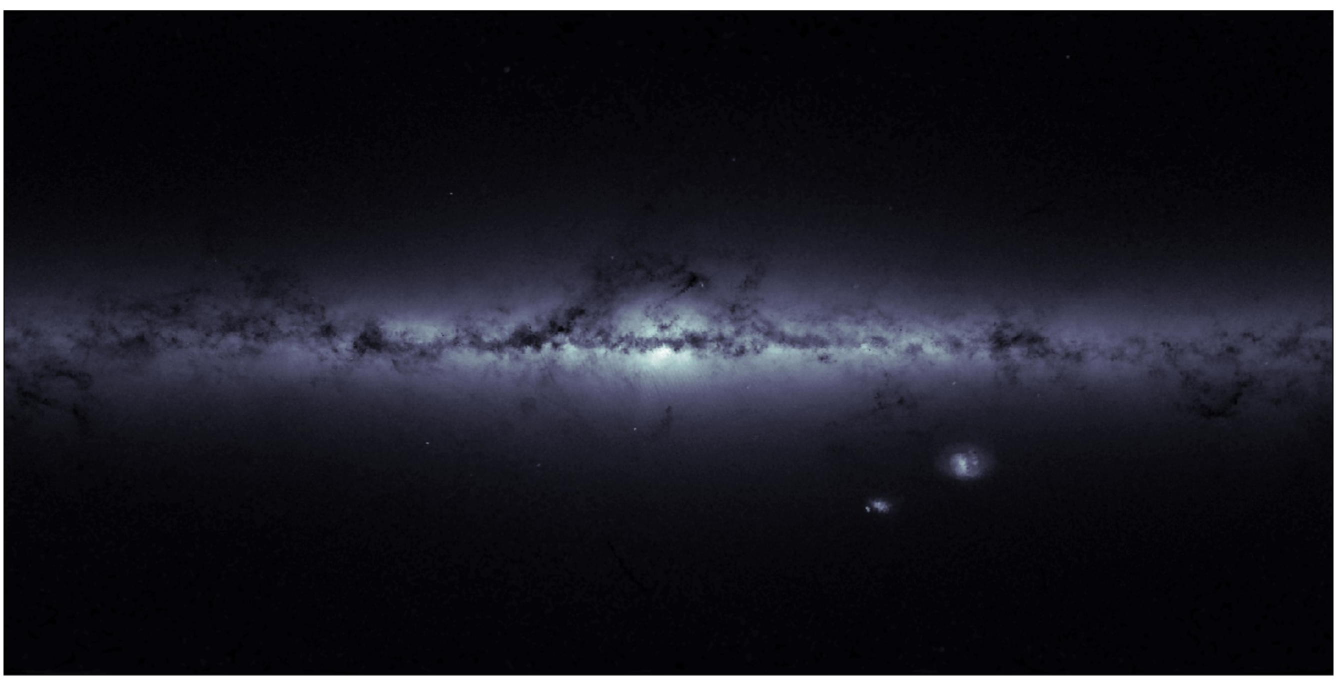
Gaia is an astrometric observatory launched by the ESA in 2013 with an expected life of about 9 years. Its purpose is to measure the position, distance and motions of stars with a very high precision. This should generate the largest and most precise star catalog ever conceived, but also give positions of comets, minor planets etc.



The spacecraft has a mass of just over 2t and its dimensions are 4.6m x 2.3m. It is solar powered with a circular array that generates over 1.9kW. It was boosted by a Soyuz ST-B/Fregat-MT rocket from Arianespace's facility at Kourou.

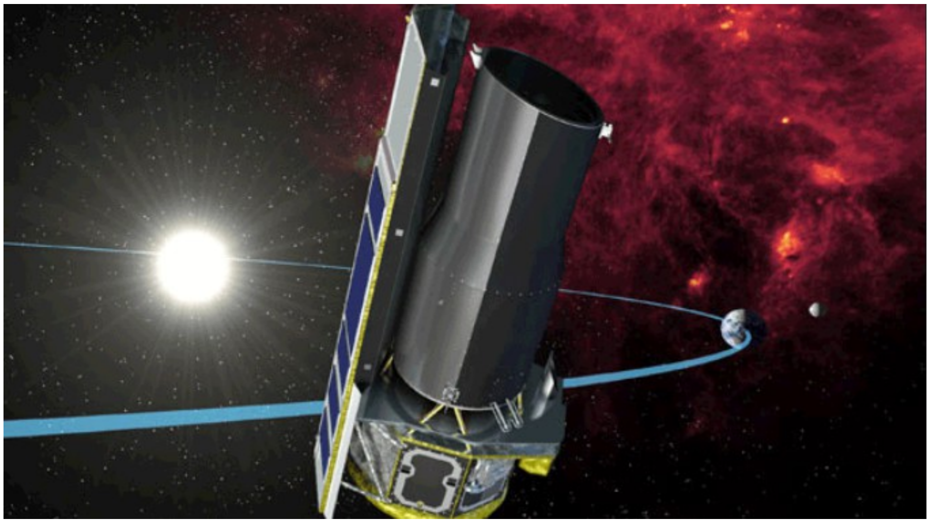
Unlike the spacecraft previously discussed, Gaia isn't in earth orbit but orbits the Sun-Earth L2 Lagrange point about 1.5 million km from earth. Interestingly, Pan-STARRS 'discovered' 2015 HP116, an asteroid 'orbitting earth' but which turns out to have been Gaia.

The spacecraft went through a 6 month calibration phase and began collecting data in July 2014 and discovered its first supernova on 12 Sept, 2014. By July 2015 a Milky Way density map was released and by Aug 2016 “more than 50 billion focal plane transits, 110 billion photometric observations and 9.4 billion spectroscopic observations have been successfully processed."



Spitzer Space Telescope

The Spitzer Space Telescope was originally called the Space Infrared Telescope Facility and was launched in 2003. It is the fourth and last of the NASA Great Observatories program.



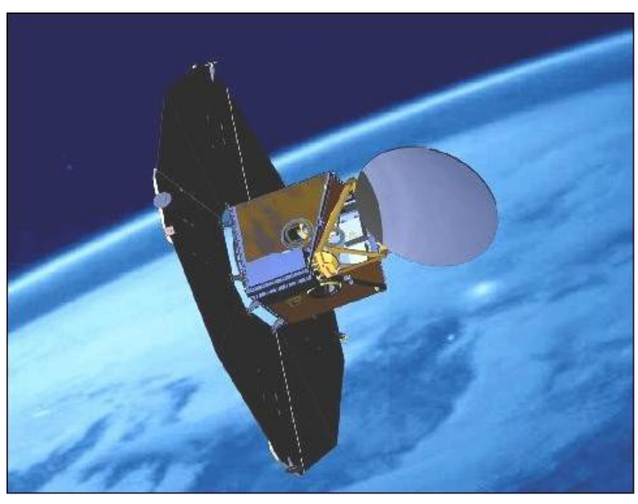
Like the Gaia spacecraft, the Spitzer telescope is not in earth orbit. It is in an earth-trailing orbit around the sun with an eccentricity of .011, a perihelion of 1.003AU and an aphelion of 1.026AU. It is inclined to the ecliptic by 1.13 degrees and has a period of 373.2 days.

The spacecraft had a launch mass of 950kg and was launched on a Delta II rocket from Cape Canaveral.

Mission life was supposed to be 2.5 years but it has been delivering data for over 15 years now while NASA prepares for the James Web Space Telescope. It uses three main instruments, the Infrared Array Camera (IRAC), the Infrared Spectrograph (IRS) and the Multiband Imaging Photometer for Spitzer (MIPS). The IRAC works on four bands between 3.6 and 8 um with a 256x256 pixel detector. The IRS operates at 5.3-14um in low-res, 10-19.5um in high-res and 14-40um low-res and 19-37um high-res; each with 128x128 pixel detectors. The MIPS uses three detectors; 128x128 at 24um, 32x32 pixels at 70um and 2x20 pixels at 160um.

Spitzer images have become as famous as those from the Hubble Space Telescope with images of stellar nurseries, galaxies, planetary nebulae and even some directly imaged exo-planets in its catalogue. To gather its images it uses a .85m Ritchey-Chretien telescope with a focal length of 10.2m.

Odin



The Odin satellite was launched by the Swedish Space Corporation with Canadian, French and Finnish partners in 2001 using a Russian Start-1 booster. It was placed in a circular low-earth polar orbit 622km high. Its orbit is sun-synchronous and follows the terminator.

The satellite's intended functions are aeronomy, the study of the earth's upper atmosphere, and astronomy. In the aeronomy mode it uses a spactrograph called OSIRIS (Optical Spectrograph and Infrared Imaging System) where it can observe at 280-800nm and an IR channel at 1.27 microns. In astronomy mode it uses a radiometer working at 486-580 Ghz and 119 Ghz. Both modes use the satellites 1.1m telescope in a 3-axis stabilized mode. The satellite can switch back and forth between modes on the fly.

In aeronomy mode the satellite looks at the 10-120km region of the earth's atmosphere along the limb 40 times per orbit. In astronomy mode it has already discovered neutral oxygen in interstellar space.

Spektr-R

Spektr-R is a radio astronomy satellite launched by Russia in 2011 using a Zenit-3F launcher from the Baikonur Cosmodrome. It was placed in a very highly elliptical orbit with a perigee of 10,000km and an apogee of 390,000km. In 2018 the orbit had been changed to have a perigee of 57,000km and an apogee of 320,000km so as to no longer intersect with the orbit of the moon.

It carries a 10m radio telescope and was used to study radio objects with a resolution of a few millionths of an arcsec. Studies in star formation, black holes and dark matter were undertaken using wavelengths of 1.3, 6, 18 and 92cm. It took part, with 15 telescopes on the ground, with generating the highest resolution radio image taken to date, an image of an active galaxy's supermassive black hole swallowing surrounding matter, creating an accretion disk and forming jets of high-energy particles.

On Jan 11 last week the spacecraft stopped responding to control signals but it's science payload was functioning. Its replacement will be launched later this year.

Meeting Speakers for 2019

Jan. 18th.	Jim Goetz, KW-RASC member. Talk on The RASC’s SRO Sierra remote observatory
Feb. 15th.	Bjarni Tryggvason. Talk on ISS projects
Mar. 15th.	Dr. Christopher Essex, Prof. Dept. Mathematics, UWO (Talks to be confirmed)
Apr. 19th.	Prof. Martin Houde, Dept. of Physics & Astronomy Talk to be announced.
May 17th.	Nicole Mortillaro , Senior Reporter Science at CBC
June 21st.	Brian McCullough. Ottawa Centre Talk on Astro Sketching a short talk Friday Night followed by a work shop on the Saturday for those who want to learn to sketch.
July 19th	Speaker to be announced.
Sept. 20th.	Member’s Night

RASC London Centre Library

Books of the Month

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

Accessory to War: the Unspoken Alliance Between Astrophysics and the Military, by Neil deGrasse Tyson and Avis Lang. – New York; London: W. W. Norton & Company, c2018.

Clyde Tombaugh: Discoverer of Planet Pluto, by David H. Levy. – Cambridge, Mass.: Sky Publishing Corp., c2006.

Out of the Darkness, the Planet Pluto, Clyde W. Tombaugh and Patrick Moore. – Harrisburg, Pa.: Stackpole Books, c1980, 1981 printing.

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**

RASC London Centre Library New Acquisitions

We wish to thank Henry Leparskas for donating the following book to the RASC London Centre Library, received at the RASC London Centre Friday, November 16th, 2018:

Out of the Darkness, the Planet Pluto, by Clyde W. Tombaugh and Patrick Moore. – Harrisburg, Pa.: Stackpole Books, c1980, 1981 printing.

We also wish to thank David McCarter for the following donation to the RASC London Centre Library, received at the RASC London Centre Friday, December 21st, 2018:

Accessory to War: the Unspoken Alliance Between Astrophysics and the Military, by Neil deGrasse Tyson and Avis Lang. – New York; London: W. W. Norton & Company, c2018.

We wish to express our deepest thanks, once again, to Henry Leparskas and David McCarter for their valuable contributions to our RASC London Centre Library!

Outreach

Exploring the Stars at the Cronyn Observatory, January 2019

1st Ilderton Beavers, January 10th, 2019

Cloudy skies with light snow flurries greeted 15 visitors (8 children and 7 adults) from the 1st Ilderton Beavers for Exploring the Stars at Western University's Cronyn Observatory, Thursday, January 10th, 2019, 6:30 p.m. Graduate student Ben George presented the digital slide presentation *"The Earth—Moon System"* and fielded questions. Ben then introduced the *"Telescope Kits"* activity with the children assembling and testing simple refractor telescopes from kits. He showed several slides including one showing a refractor and reflector telescope and other slides showing how to assemble the telescopes.

Since it was cloudy and snowing RASC member Bob Duff set up the RASC London Centre's 25.4cm Dobsonian inside the dome, installing the 17mm Nagler eyepiece (66X). When everybody arrived upstairs in the dome, Ben introduced Bob and he gave a talk on some of the history of the observatory and technical aspects of the big 25.4cm refractor, using the 32mm Erfle eyepiece (137X) for demonstration. Bob explained and demonstrated how the 2 small finder telescopes were used to direct the big telescope. He also explained the Schmidt-camera piggy-backed on the 25.4cm refractor. He opened and closed the shutter on the Schmidt camera to demonstrate how it worked. Ben invited the Beavers to look through the 32mm Erfle eyepiece in the 25.4cm refractor, which was pointed at the ceiling of the dome.

Bob called their attention to the Cassegrain reflector, also piggy-backed on the 25.4cm refractor, and showed them the London Centre's 25.4cm Dobsonian, explaining the difference between a refractor and reflector telescope. He then invited the Beavers to view the wind turbine on the Engineering building through the 25.4cm Dobsonian (17mm Nagler eyepiece, 66X), from just inside the door to the observation deck. The visitors were gone from the dome by around 7:55 p.m., after expressing their thanks and appreciation for a very enjoyable evening learning about astronomy and telescopes, despite the cloudy, snowy weather.

Polaris On-Line

Please see the **on-line edition** of Polaris to view current and past issues and view any articles not found in the print editions. To access this issue of Polaris on-line, click on the pull-down menu **Polaris** on our **RASC London Centre** Web site: **http://rasclondon.ca/**