Sagittarius

The Newsletter of the Astronomy Section of La Société Guernesiaise

July – September 2013

Forthcoming Events

Perseids BBQ

Observatory: 13th August: 7.30 pm

Public Open Evenings

(now Thursdays)

25th July: 9.00 pm

1st August: 9.00 pm

8th August: 8.30 pm

15th August: 8.30 pm

22nd August: 8.30 pm

29th August: 8.30 pm

New format will be that Public Open Evenings will be on a Thursday evening and will comprise a talk or film show, with a clear night for observation being a bonus!

Section meets at the Observatory every Tuesday evening at 8.00 pm

Inside

Inserts

Star chart

Sunset, sunrise, moonset and moonrise times

L'Observatoire de Paris

During a recent trip to Paris I had the opportunity of visiting the Paris Observatory – an historic institution about which I had read much, but had never seen. It is in the 14th arrondissement, in the south of the city (left bank), not far from Montparnasse. It is normally open to visitors only through organised groups (tours in French or English) or individuals (in French only) once a month, and subject to prior booking, so I was delighted to be given the chance to see it privately. As I walked towards it from the nearest metro station (Denfert Rochereau) I became aware of its proximity from the names of streets: Boulevard Arago, Rue Cassini, and Avenue de l'Observatoire which runs all the way south from the Jardin du Luxembourg to the Observatory.

L'Observatoire de Paris

The Observatoire was founded in 1667, in the reign of the Sun King Louis XIV, and therefore pre-dates the Royal Greenwich Observatory (1675). It has a distinguished history, many famous astronomers being associated with it: Cassini, Römer (who established the speed of light from observations of Jupiter's moons), Arago, Le Verrier, Foucault, Fizeau. It is the oldest observatory in the world still in use, and today remains at the forefront of astronomical research. As an institution the observatory covers three sites: Paris, Meudon (in the Paris suburbs), and Nançay, and employs 1000 staff, including 250 at the Paris site alone and a third of all French astronomers. They carry out space research in collaboration with ESA and NASA, develop ground-based instrumentation and data systems, and

conduct studies in time and the Earth's rotation. The observatory also has teaching and public outreach roles.

I was met at the gate by Dr Daniel Egret, former President (Director) of the Observatory, who is planning to visit Guernsey later in the year. While waiting for him I watched the seconds ticking away, as shown on a digital display controlled by atomic clocks, for it is here that the French time standard is generated. ("*L'Observatoire de Paris realise et diffuse le temps legal français*.")

Daniel Egret at L'Observatoire de Paris.

My special interest was the main room at the centre of the Observatory, the Cassini (Meridian) Room, and we headed there first, pausing to admire the statue in the forecourt of Urbain Le Verrier (1811-77) whose calculations of the perturbations of Uranus led to the discovery of Neptune in 1846, and who was twice Observatory Director (1854-70 and 1873-77).

We also passed the first of the 135 '*Arago medallions*'. These small bronze plaques set in the pavement mark the meridian line across 9 km of Paris, and form the 1994 monument to scientist François Arago (1786-1853), who, over a period of years, surveyed the meridian in Paris and as far south as Spain, in order to determine accurately the length of the metre. It is possible to explore Paris by following the line of the medallions, although a number seem to be missing. The meridian crosses the Louvre, where there are no fewer than five Arago medallions.

Arago Medallion.

Arago later (1843-53) became the Observatory's Director, and being a man of clearly outstanding administrative as well as scientific abilities, achieved the rebuilding of much of the Observatory as well as furnishing it with world-class instruments.

Cassini Room. *Note the hole high up on the south wall, projecting the solar image. The meridian line can just be made out beneath the plastic sheeting.*

The Cassini Room is huge. The Paris Meridian is carved on the floor along its length, and high on the south wall is an 8.5cm lens allowing the projection of a sizeable and bright image of the Sun. (Originally it was

simply a hole without a lens, acting as a pin-hole camera.) The meridian is marked by figures recording the Sun's altitude at local solar noon throughout the year, with symbols indicating the relevant zodiac constellations. The markings are protected with plastic sheets, so that they are not eroded by people walking over them. They date from 1729-30. The line is not just a curiosity; it was constructed as a large-scale precise scientific instrument designed to determine variations in the obliquity of the ecliptic (the tilt of the Earth's axis with respect to the plane of its orbit around the Sun).

The Paris Meridian was used by French cartographers as the Prime Meridian from the 17th to the 19th centuries, until the 1884 International Meridian Conference in Washington DC established the Greenwich Meridian as the Prime Meridian. (France abstained from the vote and continued to use its own meridian for some purposes, including time, into the 20th century.)

Museum of L'Observatoire de Paris.

I was there on the summer solstice, an ideal time to see the effect had cloud not interfered. My interest, however, was not just in the meridian line, but in the fact that it was in this room that Léon Foucault first set up his pendulum for public display in 1851 to demonstrate the rotation of the Earth (having previously experimented with it in the basement

of his house). It had an 11-metre wire – the height of the ceiling. (The Foucault pendulum which we set up in the Town Church in 2010 had a 9-metre wire.)

We then passed through the Observatory's museum of historic instruments, and a statue of Jean Dominique Cassini (1625-1712) another Observatory Director (1671-1712). A planetary observer, he is best remembered for discovering four moons of Saturn (Iapetus, Rhea, Tethys and Dione) and for recording the division in Saturn's rings which still bears his name. Perhaps less well known is the fact that he, with Jean Richer (1630-96), established the scale of the solar system by triangulation observations of Mars. Also bearing his name is the very successful spacecraft now orbiting Saturn. He conceived of the meridian line in what is now known as the Cassini Room, and which his son Jacques Cassini installed when he succeeded his father as Director (1712-56).

Our final stop was in the Library which serves, not only as a reference library but also holds historical archives, such as the correspondence of Helvelius (1611-87) and Cassini's observing notes.

Foucault's pendulum demonstration at the observatory created a huge amount of interest among scientists, and he subsequently set one up at the Panthéon with a 67-metre wire and a 28 kg bob. It is not very far, so on leaving the observatory I strolled northward, and paid my entrance fee. The pendulum is still there – except that it wasn't on my visit, because of major refurbishments being carried out to the dome – a disappointment but not an unexpected one as I had read that it was temporarily suspended (no pun intended). Nevertheless, I was interested to see this large and impressive building where so many famous Frenchmen are entombed, including our own Victor Hugo and scientists Pierre and Marie Curie.

That evening, being the summer solstice, Paris, in common with towns all over France, resounded with the Fête de la Musique. Outside Notre Dame a major pop concert was taking place, while a short distance away the Paris Police orchestra was performing. Music groups were everywhere – on street corners, outside cafés – creating a wonderful atmosphere, entirely free. A great way to mark the longest day of the year!

David Le Conte

Further information:

L'Observatoire's website (in English) is at www.obspm.fr/?lang=en.

The Meridian Line in the Cassini Room: www.imcce.fr/host/meridienne/meridienne.php.

For details of the Arago medallions see chrismolloy.com/page.php?u=p152.

For information about French astronomers start with Wikipedia: en.wikipedia.org.

The Panthéon: pantheon.monuments-nationaux.fr/en/.

Fête de la Musique: www.fetedelamusique.culture.fr/en/International/presentation/.

Panthéon - site of Foucault's pendulum.

Statue of Urbain Le Verrier.

Contemplating Light Speed

Light from the stars travels toward us at three hundred million metres per second, so when we look at the stars are we seeing back into history? The ancients wrote on the subject, Empedocles argued that light was in motion, whilst Aristotle argued that it was not. Euclid and Ptolemy argued that light must come from within the eye.

Heron argued that its speed would then be infinite because the stars are there when your eyes open. A thousand years later Alhazen surmised light to be substantial, its speed varying with the density of the bodies that it moves through.

Galileo proposed that light speed could be measured by the opening of distant lamps but it proved difficult to do. When he found the moons of Jupiter with his new telescope he measured the period of their orbits. Ole Roemer looked at this cycle for the moon Io, and found it delayed by a number of minutes which increased with the distance between Jupiter and the Earth.

The only possible explanation was that light travelled at a finite velocity. Time was considered no more than fractions of a day or a sum of years but the questions were fundamental, can we measure this, can we explain it. Christiaan Huygens compared the delay to the size of earth's orbit and made a good estimate for the speed of light, just over two thirds of the current value.

After exhaustive investigation Newton introduced the idea that light travels in the form of particles. The alternative he considered was that space is filled with a substance called aether, not tangible but able to vibrate and transfer light in the same way that air transports sound.

A century later, Maxwell published his Treatise which gave a technical explanation revealing light to be an electromagnetic wave. From this theory the speed of light could be calculated, but it was not a satisfying explanation. The notion of an aether persisted, not just because Newton was the great oracle of physics, but because it seemed more substantial than waves of force in a vacuum with nothing to support them.

In the late nineteenth century Foucault used a rotating mirror to find its speed to one part in a hundred. Maxwell's theory was proved correct. Soon after, Michelson and Morley built an interferometer which could measure the speed of light in two directions at once. This was done by splitting a beam of light, reflecting it between mirrors set at right angles to each-other across a floating table, then merging the beams again so that the point could be found where they cancel.

The experiment showed that the speed of light was identical in all directions. The explanation was maddeningly elusive, how could anything have a finite velocity which remained the same in all directions, when the planet

it was measured from was hurtling through space at twenty miles per second. The idea of an aether collapsed and the conversations which led to relativity began.

Einstein's great raspberry to the notion of time as an inflexible sequence across the entire universe, is general relativity. No longer can our progress through time be independent of our motion or our location. After a decade searching for the right mathematics he replaced the universal clockwork with a subtle concord of continuity between mass, motion and energy.

Now the fall due to gravity can be understood as our response to a gradient of space-time, not a magical action of forces over empty distance. What could be more alluring, a foundation of comprehension fit for the space age. A century of experimentation has confirmed his thesis.

The displacement of stars close to a solar eclipse was predicted and found. The fracture of the atomic nucleus was predicted then found, and then fearfully demonstrated. The penetration of short lived particles into our atmosphere was observed where Newtonian mechanics would not allow them to go.

The dilation of time itself was measured aboard aircraft and then by satellite. Ever larger particle accelerators were designed with the aid of relativity, and their findings confirmed it. This culminated recently in the frame dragging experiments of the Gravity Probe B satellite which used gyroscopes to test general relativity to the most exacting standards. It hardly seems appropriate to ask if we are sure that the good Dr Einstein was correct.

Relativity shows the speed of light to be the same from all directions, for any observer, irrespective of their velocity. It sprang from the electromagnetic relations derived from direct measurement. To suggest that a mistake was made in this process is to misunderstand how revealing the last century of physics has been.

Relativity may be difficult to put into context and may have little to say about the reality we live in but if we are to understand the uniformity of the speed of light or its relevance to interstellar travel, we must look to it.

Many things remain uncertain but space travel will reveal its own secrets as it becomes possible, and it will become possible as destinations are discovered. Do we look into history as we gaze at the stars, certainly, are we looking into our own future, oh yes, of that there is little doubt.

John Newell

[John is a former Astronomy Section member, now living in South Australia. This article was originally published in the monthly newsletter of the Astronomical Society of South Australia, "The Bulletin" in 2012]

The Importance of Knowing Where You Are

Recently I had the pleasure of a holiday in the foothills near Granada in Spain, where the skies were clear, the days hot and the evenings balmy. At a latitude 12º further south than Guernsey the southern stars were that much higher in the sky. The celestial Scorpio stood proud of the snow-covered Sierra Nevada, looking just like the terrestrial arachnid with its lobster-like pincers, its tail curved over its back, its deadly stinger in striking poise. Way above it Saturn shone gloriously, seeming to make a pair with Spica, α Virginis.

In the west, after most beautiful sunsets, the Moon progressed higher in the sky evening by evening, as it grew from a thin crescent towards first quarter. Leo, heading downwards, appeared to be stalking clearly visible Mercury, which itself was pursuing the brilliant Venus towards the horizon.

My fellow villa occupants were as enraptured as I by the scene, and I thought to enrich their experience by pointing out an Iridium flare – the brilliant, but fleeting apparition caused by communications satellites with large, flat antennas which directionally reflect sunlight as they orbit the Earth. I had already entered 'Granada' into the database of the Heavens-Above website in order to determine whether there would be any suitable appearances of the International Space Station (there were not). It took, therefore, a moment to determine that a bright (magnitude minus 6.5) flare would take place at two minutes before midnight.

A small gathering of those who had not already retired watched carefully from the patio for the flare, which I assured them would be stunning. I identified that it would appear just below the forepaws of the Lion, about halfway between them and the western horizon. So we all gazed at the spot as the seconds ticked by, while I announced the time from my radio-controlled watch. To my chagrin none of us saw anything, and I had the job of inventing possible reasons – perhaps the website had not taken daylight savings into account (but I knew that it had), perhaps a little cloud had obscured it (but there did not appear to be any).

It was not until I went upstairs to bed that I discovered the real reason. My wife, who had viewed from the bedroom window, exclaimed: "Wasn't it spectacular!". Upon further enquiry it transpired that, knowing only the general direction of the event, she had cast her gaze far wider than we more confident observers had, and had seen it higher in the sky than my prediction. I then realised that we, being some seven kilometres north-east of Granada, were closer to the path of the satellite at the critical moment – a crucial piece of data for which I not accounted.

There was no excuse, and I could only explain this errant factor to my companions. I had ensured that our own website (at www.astronomy.org.gg/iss.htm) had emphasised the point that for Iridium flares it was necessary to enter one's location more precisely than for general satellite observations. I had, indeed, arranged with Heavens-Above to include the locations of each of Guernsey's parishes, as well those of Alderney, Sark and Herm, and had provided relevant links from our website.

So learn from my embarrassing experience and ensure that you know your location with appropriate precision when making precise celestial observations, and perhaps more importantly, ensure that the website you are using knows just where you are.

David Le Conte

Geoff Falla's regular roundup of articles from popular Astronomy and Space Journals

The History of Charles Messier's Catalogue. How the astronomer Charles Messier began a search for Halley's Comet in 1757 and began finding other comets. During this search he also recorded other less distinct and nebulous objects, many of these now known to be galaxies like our own, and dense groups of stars. These now form a well known and useful catalogue of objects to be seen. (Astronomy Now, March 2013)

The Life and Times of Sir Patrick Moore. The extraordinary life of this famous astronomer, from his introduction to astronomy, his wartime experiences, the rise to television stardom from more than fifty years of monthly TV programmes, and his place in history. (Astronomy Now, March 2013)

The Herschel Infrared Telescope. The European Space Agency's major space telescope is the largest of its kind placed into Earth orbit. The telescope has gathered infrared images to gain a better understanding of what causes star formation, but is now completing its mission and is due to shut down. A summary of what has been achieved, with analysis work on the results continuing. (Astronomy Now, March 2013)

Cosmic Extremes. Much of the character and behaviour of stars is known, but there are extremes observed or measured in all of this. Examples include the fastest spinning star, the fastest movement through space, the largest structure of galaxies, the coldest place and measurement of the strongest electrical current. (Sky and Telescope, March 2013)

The Russian Meteor Airburst. A set of articles describing the event and implications of the meteor explosion over Chelyabinsk on February 15th this year. Can Earth be protected from

dangerous asteroids, and could near-Earth asteroids be of some benefit? (Astronomy Now, April 2013)

The Hunt for Moons of Exoplanets. With almost a thousand exoplanets already discovered, it seems inevitable that larger ones will also have moons. This may greatly increase the possibility of habitable worlds in other star systems, but it will be a major challenge to find these moons. (Astronomy Now, April 2013)

Impending Birth of our Supergalaxy. The closest galaxy to our own Milky Way is heading towards us. The Andromeda galaxy is just visible to the naked eye, and is due to merge with the Milky Way - but not for about another four billion years. It is expected that the Earth will be uninhabitable long before then, because of the Sun's increasing luminosity. (Astronomy, April 2013)

Saturn at its Best. A set of articles describing the ringed planet, the huge storm observed recently in its northern hemisphere, the large and varied family of Saturn's moons, and a summary of the Cassini spacecraft mission to Saturn's largest moon, Titan. (Astronomy Now, May 2013)

How Life Survived an Early Faint Sun. Water is considered essential for the development of life, but the Sun's luminosity was much less during the early history of the solar system. It is thought that Earth would have had below freezing conditions for more than half of its history, so other conditions must have allowed the earlier development of life. (Astronomy, May 2013)

The Science behind UFOs. Explanations for the many reports of strange sightings and appearances in the sky, those which can be explained in more conventional ways, but not including many of the more puzzling sightings and associated effects which cannot at present be explained. (Astronomy, May 2013)

The Historic Russian Meteorite Fall and Near Earth Asteroid of 15.2.13. A detailed account of the Russian meteor explosion, the largest event of its kind since the Tunguska explosion over a forest area of Siberia in June 1908. On the same day in February a much larger near-Earth asteroid made the closest ever observed pass near our planet. (Astronomy, June 2013)

The Future of Mankind in Space. Buzz Aldrin, who accompanied Neil Armstrong on the first Moon landing in 1969, recalls that historic mission, and envisages future lunar exploration with more international co-operation. This would include further use of robotic vehicles, and there could be control from a manned outpost at one of the Earth-Moon neutral gravity Lagrangian points. (Astronomy, June 2013)

Space Robotics. A set of articles focusing on the increasing role of robotics in space missions, with Mars rover Opportunity now joined by the larger remote controlled rover

Curiosity; space probes are now conducting more activities robotically, and there is discussion on whether human spaceflight should be abandoned completely in favour of robotic missions. (Astronomy Now, June 2013)

Radio Astronomy for the Amateur. The British Astronomical Association's Radio Astronomy Group encourages interest in a very different type of astronomy. Amateurs can monitor the effect of solar flares by recording signal strengths of distant radio stations operating at very low frequencies. Meteor activity can also be detected from the reflection of radio waves by the ionised gas of meteor trails, and Jupiter can also be monitored as a strong natural source of radio waves - some of the variations also being correlated with the orbital position of its innermost Galilean moon Io. (Astronomy Now, June 2013)

The Chelyabinsk Super-Meteor. The asteroid explosion over the Russian city of Chelyabinsk on the morning of February 15th was briefly brighter than the Sun. Photographs of the airburst and trail left by this largest event of its kind for more than a hundred years. (Sky and Telescope, June 2013).

Astronomy Section Officers

Secretary	Frank Dowding	255215
Hon Treasurer	Peter Langford	239575
Editor	Colin Spicer	721997
Facilities	Geoff Falla	724101
	George De Carteret	
Public Relations	David Le Conte	264847
Library	Geoff Falla	724101
Research	Colin Gaudion	
Light Pollution	Vacant	

Observatory

Rue du Lorier, St Peters,
Guernsey
Tel: 264252

Web page

www.astronomy.org.gg

Material for, and enquiries about Sagittarius should be sent to the Editor

Colin Spicer
60 Mount Durand, St Peter Port
Guernsey GY1 1DX
Tel: 01481 721997
colin.spicer@cwgsy.net

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La Société Guernesiaise, Candie Gardens, St Peter Port, Guernsey GY1 1UG.
Tel: 725093