MERCURY

STIRLING ASTRONOMICAL SOCIETY

The Journal of Stirling Astronomical Society

www.stirlingastronomicalsociety.org.uk

Vol. 26 No. 4 October 2011

EDITORIAL

Well, this is finally it: my last issue as Editor of *The Mercury*. It has been an interesting and enjoyable experience for me but it is now time to do something else. During my time as Editor, we have seen a few changes within the Society and the acquisition of several new members who have contributed greatly to the continued success of Stirling Astronomical Society. The membership level of the Society is presently at a high level and with astronomy currently enjoying something of a renaissance, courtesy of the likes of Patrick Moore (as ever), Brian Cox and Chris Lintott, there is no reason why this upward trend should not continue.

In this edition, Mark Butterworth recalls “The First Attempt to Measure the Speed of Light” on page 2; I discuss my “Early Experiences with a Planetary Camera” on page 5; Chris Davis reports on the latest news from “Stirling City Observatory” on page 10; while our Chairman, Bert Mackenzie, explains a connection between wine and astronomy on page 11. Our guest article is “New Discoveries on Odd Stellar Explosions” by Kurtis Williams on page 14; Chris Davis and Sandi Cayless provide reviews of recent Smith lectures on pages 8 and 19 respectively; while Roberta and I combine to provide an article on “Stockholm’s Old Observatory” on page 22. The usual reports on “Forthcoming Meetings” and “The Night Sky”, the latter courtesy of Martin Palmer-Smith, appear on pages 7 and 18 respectively; while Douglas Cooper’s superb photographs fill centre pages 12 and 13.

I am left with the pleasant tasks of thanking all contributors, past and present, and of wishing my successor the very best of luck. I look forward to reading and contributing to *The Mercury* in the future.

Alex Houston

THE FIRST ATTEMPT TO MEASURE THE SPEED OF LIGHT

By the seventeenth century astronomers were beginning to ask if light had a finite speed. For centuries it had been assumed that light arrives the instant it has been emitted. In 1638 Galileo suggested an experiment to test the hypothesis. He proposed that one man on a hill uncovered a lantern to signal a companion on another hill. The instant the second saw the lantern he would uncover a lantern and signal back. By using hills further and further apart, Galileo suggested the men would see a progressively longer internal between the dual flashes. The test was eventually attempted by members of the Florence Academy but, of course, no delay was observed due to the crudeness of the experiment and the high speed of light.
In the mid-17th century, the Italian astronomer Giovanni Cassini had pioneered the use of the eclipses of the Galilean moons for longitude measurements, and published tables predicting when eclipses would be visible from a given location. He was invited to France by Louis XIV to set up the Royal Observatory, which opened in 1671 with Cassini as director, a post he would hold for the rest of his life.

One of Cassini's first projects in his new post in Paris was to send Frenchman Jean Picard to the site of Tycho Brahe's old observatory at Uraniborg in Denmark. Picard was to observe and time the eclipses of Jupiter's moons while Cassini recorded the times they were seen in Paris. If Picard recorded the end of an eclipse at 9 hours 43 minutes 54 seconds after midday, while Cassini recorded the end of the same eclipse at 9 hours 1 minute 44 seconds after midday in Paris – a difference of 42 minutes 10 seconds – the difference in longitude could be calculated to be 10° 32' 30". Picard was helped in his observations by a young Dane, Ole Rømer and he arranged for him to come to Paris to work at the Royal Observatory.

Io is the innermost of the four moons of Jupiter discovered by Galileo in January 1610. Rømer and Cassini refer to it as the "first satellite of Jupiter". It orbits Jupiter once every 42½ hours, and the plane of its orbit is very close to the plane of Jupiter's orbit around the sun. This means that it passes much of each orbit in the shadow of Jupiter i.e. in eclipse.

Most of Rømer's papers were destroyed in a Copenhagen Fire of 1728, but one manuscript that survived contains a listing of about sixty observations of eclipses of Io from 1668 to 1678. It details two series of observations on either side of the oppositions of 2 March 1672 and 2 April 1673. On 22 August 1676, Cassini advised the Royal Academy of Sciences in Paris that he would be changing the basis of calculation for his tables of eclipses of Io.

Cassini announced the prediction that the emergence of Io on 16 November 1676 would be observed about ten minutes later than would have been calculated by the previous method. There is no record of any observation of an emergence of Io on 16 November, but an emergence was observed on 9 November. With this experimental evidence in hand, Rømer explained a method of calculating the speed of light to the Royal Academy of Sciences on 22 November.

Rømer started with an order of magnitude demonstration that the speed of light must be so large that it takes much less than one second to travel a distance equal to Earth's diameter. Rømer said "assume that an observer could time an emergence of Io and also the emergence which occurs after one orbit of Io around Jupiter, which is 42½ hours later. During those 42½ hours, the Earth has moved further away from Jupiter by the distance equal to 210 times the Earth's diameter. If light travelled at a speed of one Earth-diameter per second, it would take 3½ minutes to travel this distance".

He then applied the same logic to observations when Earth is moving towards Jupiter. The time difference between immersions seen from one orbit of Io to the next should be 3½ minutes shorter than the true orbital period of Io. Hence, there should be a difference of about 7 minutes between the periods of Io measured six months apart. In practice, no difference is observed at all, from which Rømer concludes that the speed of light must be very much greater than one Earth-diameter per second.

However Rømer also realised that any effect of the finite speed of light would add up over a long series of observations, and it is this cumulative effect that he announced to the Royal Academy of Sciences in Paris. Jupiter was in opposition on 2 March 1672: the first observations of emergences were on 7 March and 14 March. Between the two observations, Io had completed four orbits of Jupiter, giving an orbital period of 42 hours 28 minutes 31¼ seconds.

The last emergence observed in the series was on 29 April. By this time, Io had completed thirty orbits around Jupiter since 7 March: the apparent orbital period is 42 hours 29 minutes 3 seconds. The difference seems minute – 32 seconds – but it meant that the emergence on 29 April was occurring a quarter-hour after it would have been predicted. The only alternative explanation was that the observations on 7 and 14 March were wrong by two minutes.

Rømer never published the formal description of his method, possibly because of the opposition of Cassini and Picard to his conclusions. Cassini announced that his new tables would contain the inequality of the days or the true motion of the Sun, the eccentric motion of Jupiter and this new, not previously detected, inequality. Hence Cassini and Rømer appear to have been calculating the times of each eclipse based on the approximation of circular orbits, and then applying three successive corrections to estimate the time that the eclipse would be observed in Paris.

The three "inequalities" (or irregularities) listed by Cassini were not the only ones known, but they were the ones that could be corrected for by calculation. The orbit of Io is also slightly irregular because of orbital resonance with Europa and Ganymede, two of the other Galilean moons of Jupiter, but this would not be fully explained for another century. The only solution available to Cassini and to other astronomers of his time was to issue periodic corrections to the tables of eclipses of Io to take account of its irregular orbital motion: periodically resetting the clock, as it were. The obvious time to reset the clock was just after the opposition of Jupiter to the Sun, when Jupiter is at its closest to Earth and so most easily observable.

The opposition of Jupiter to the Sun occurred on or around 8 July 1676. Rømer's aide-mémoire lists two observation of emergences of Io after this opposition but before Cassini's announcement: on 7 August and on 14 August. With these data, and knowing the orbital period of Io, Cassini could calculate the times of each of the eclipses over the next four to five months. The next step in applying Rømer's correction would be to calculate the position of Earth and Jupiter in their orbits for each of the eclipses. This sort of coordinate transformation was commonplace in preparing tables of positions of the planets for both astronomy and astrology. Finally, the distance between Earth and Jupiter can be calculated. The distance from the Sun to Earth was not well known at the time, but taking it as a fixed value, the distance from the Sun to Jupiter can be calculated as some multiple from Kepler's third law.

This model left just one adjustable parameter – the time taken for light to travel a distance equal to the radius of Earth's orbit. Rømer had about thirty observations of eclipses of Io from 1671–73 that he used to find the value which fitted best: eleven minutes. With that value, he could calculate the extra time it would take light to reach Earth from Jupiter in November 1676 compared to August 1676: about ten minutes.

Cassini's objected, but Rømer's ideas received a much warmer reception in England. Although Robert Hooke dismissed the supposed speed of light as so large as to be virtually instantaneous, the Astronomer Royal John Flamsteed accepted the hypothesis in his ephemerides of eclipses of Io. Edmond Halley was also an early and enthusiastic supporter. Isaac Newton also appears to have accepted Rømer's ideas, and gives a value of "seven or eight minutes" for light to travel from the Sun to Earth in his 1704 book Opticks. Newton also noted that Rømer's observations had been confirmed by others; the value of 7–8 minutes is closer to the true value (8 minutes 19 seconds) than Rømer's initial estimate of 11 minutes (giving light a speed of 140,000 miles per second or 224,000 km/sec).

Rømer's view that the velocity of light was finite was not fully accepted until measurements of stellar aberration were made in 1727 by James Bradley. Bradley calculated a value of 8 minutes 13 seconds for light to travel from the Sun to Earth.

The first precision measurements of the speed of light using completely terrestrial apparatus were published in 1879 by A. A. Michelson in the United States. He published his more precise results (299,910±50 km/sec), and Simon Newcomb confirmed the agreement with astronomical measurements, almost exactly two centuries after Rømer's announcement.

Although Rømer's values were in error by over 25% of the currently accepted value for the speed of light, he was the first to make a reasonably accurate calculation. He was also the first to fully explain the timing discrepancies of the eclipses of Io.

Mark Butterworth

EARLY EXPERIENCES WITH A PLANETARY CAMERA

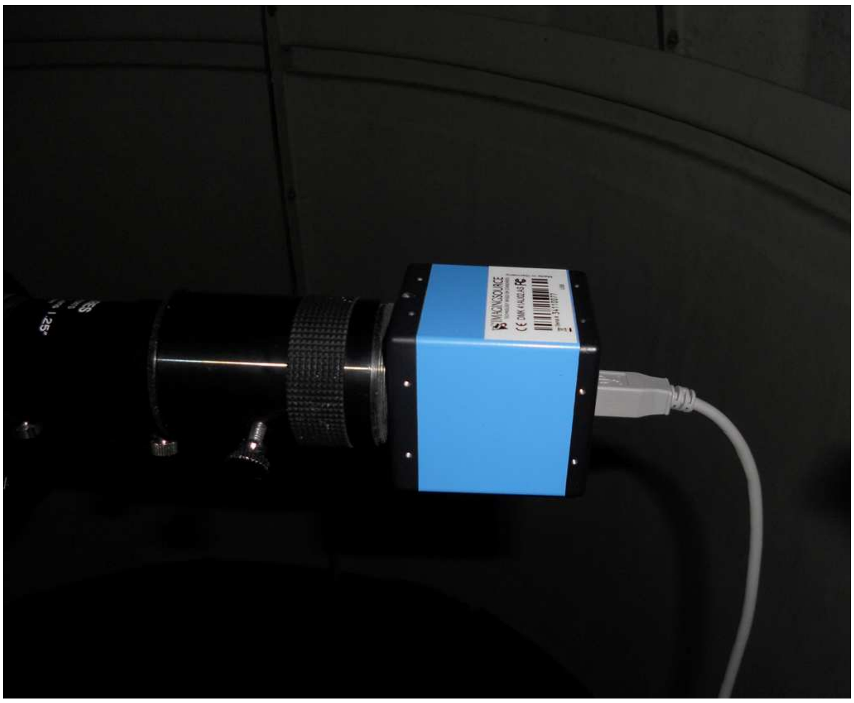
As I stated in the last issue, I decided to purchase an Imaging Source DMK 41AU02.AS monochrome planetary camera with LRGB (luminance, red, green, blue) filters. I contacted Bernard at Modern Astronomy and the device and filters duly arrived just over one week later leaving me with little change from £700. Since my filter wheel has five slots, and since the C (clear) filter comes as part of a package at only a little extra, I purchased that also. The monochrome version of the camera does not block off the infrared and, while the L filter does block it off, the C filter does not. The theory is that you should be able to use all five filters without the need for refocusing when changing between filters. The kit includes a USB cable and a CD containing the Imaging Source IC Capture.AS 2.2 acquisition software and an appropriate driver for the camera. The camera is capable of 15 frames per second capture in a 1280 x 960 array. It is possible to purchase Imaging Source cameras with increased temporal resolution but at the cost of decreased spatial resolution.
My first impression on opening the box was how small the camera is. I was used to working with a webcam, but expected the size of the camera to exceed that of the webcam rather than being comparable. Loading the software and fitting the camera and filters to the scope and filter wheel were straightforward.

As well as owning the acquisition software, it is necessary to use software for stacking and image processing. Registax is a freeware program for stacking the .avi movies which the camera takes and a comprehensive manual is available, as are several 'how to' videos which can be found on YouTube. I am fortunate to own a registered copy of Adobe Photoshop CS5 which I use for image processing, although I am reliably informed that the freeware program Gimp is sufficient for combining LRGB images.

The main problem I have had since the purchase has been the weather. I managed to obtain some images of the summit of Dumyat, but have only had a couple of attempts at the Moon and Jupiter, when they were low in the sky, before clouds took over. I have practised my software skills with these images and, despite the fact that I have yet to get to grips with the operation of the camera and the various software options for stacking and image processing, I have decided to include opposite two of my early attempts - the Mare Crisium on the Moon and Jupiter - if only to demonstrate potential. Having seen the wonderful photograph of Jupiter taken by Damian Peach, which won him the title of Astronomy Photographer of the Year 2011, I know how high I need to aim.

I am hoping for some clear skies and perhaps I will be able to bring my efforts along to the Mayfield and/or will be able share them with the other members of the Society's astrophotography SIG.

Alex Houston



Imaging Source DMK 41AU02.AS monochrome planetary camera

Mare Crisium

Jupiter

Photographs by Alex Houston

FORTHCOMING MEETINGS (October—December)

Meetings at the Smith (7.30pm—9.30pm) - open to all

14th October 2011
Speaker - Dr. Alexander MacKinnon, University of Glasgow
Title - "Flares on the Sun and Other Stars"

11th November 2011
AGM & 2 short talks by members.

9th December 2011
Speaker - Mark Butterworth, Stirling Astronomical Society
Title - "The Hubble Space Telescope"

Meetings at the Mayfield (7.30pm—9.30pm) - members only

28th October 2011
25th November 2011

Autumn Moonwatch: 7th October 2011 at David Marshall Lodge, Aberfoyle. (6.30pm - 8pm) with possible observation of the Draconids meteor shower.

NEAR EARTH ASTEROID IMPACT

Smith lecture, 11th February 2011

Dr. Massimiliano (Max) Vasile, Space Advanced Research Team, Glasgow University.

There are three main groups of near Earth asteroids: those which orbit the Sun inside Earth's orbit, those that orbit just outside Earth's orbit, and thirdly those that cross Earth's orbit.
Major impacts are mercifully very rare but, because the number of asteroids increases geometrically as you progress down the size groups, minor impacts are not rare, and near misses are quite common. Max actually showed us a film of one rock grazing through the upper atmosphere in a blaze of glory almost from horizon to horizon in broad daylight.

The most immediate problem is posed by the smaller objects which are difficult to detect until they are almost upon us, and where they hit can release the energy of several Hiroshima bombs. A map of the world showed a few dozen such recorded hits distributed fairly evenly over the Earth's land masses. The Chinese were unlucky in the 15th century to lose about ten thousand people in one of these impacts because the size of the impact's lethal footprint was small compared with the size of mostly-agricultural China at the time.

Max and his engineering group have studied in great detail the feasibility of intercepting and deflecting Earthbound asteroids. This study was prompted by the asteroid Apophis which after its discovery in 2004 turned out to have a concerning nearly three percent chance of hitting the Earth in the 2030's. Longer observation refined the prediction accuracy, and it could be seen it was going to miss. Unfortunately it was now seen to be heading for an area in space called a gravitational keyhole. If it passed through this 600 metre sized keyhole the asteroid's trajectory would be exactly adjusted to cause a second Earth encounter a year or two later. It would be due to cross Earth orbit at exactly the same time as the Earth was at that point in its orbit. Further observation and orbit refinement was subsequently able to confirm that Apohis would not pass though this keyhole and therefore the Earth will be safe in both first and second encounters.

Anyway, after the wake-up call Max and his group were able to carry on with their work. Among their detailed research was of the course the subject of asteroid deflection hardware. He admitted to scoffing at the Bruce-Willis nuclear-brute-force approach. The danger of nuclear weapons in space peppering the Earth with radioactive rock from a nuclear bomb shattered asteroid seemed to militate against nuclear weapons. However, after long and detailed assessment of the alternatives it was realised that the readiness and power of a nuclear weapon could prove to be the only effective defence against a surprise threat from a big asteroid. The weapon would not be aimed to hit the asteroid head on, but would be exploded some distance to one side. The intense radiation would suddenly vaporise a large area of asteroid surface into space. The recoil from this explosive vaporisation would push the asteroid off course without shattering it, and without converting the threat from a celestial cannon to a threat from a giant shotgun. Nevertheless, this would probably only be a last-ditch desperate measure against something about to land on a critical populated area or city.

Happily, we would likely get fifty years or so warning of a potential successor to the Yucatan monster liable to cause a global extinction event. This would give the human race time to deploy gentler more certain deflection technologies. Any force, however small, if applied persistently over long enough periods of time will deflect the biggest asteroids. Such forces could come from solar-powered lasers doing steadily what a nuclear bomb would do suddenly, and that is vaporise a large area of the asteroid's surface. Since lasers only deliver about a quarter of the power they collect from the Sun it was thought: why not use concave mirrors to concentrate all the collected Sun's energy onto the asteroid's surface, bypassing lasers altogether. Experimental multiple solar mirror arrays on Earth have generated temperatures of three or four thousand degrees, enough to vaporise any asteroid surface rock material.

This multiple solar mirror approach has the advantage of being relatively simple and could be designed to tolerate the failure of one or two of the small steerable space mirrors. The unavoidable problem is the contamination of the mirror surfaces with the condensing rock vapour they throw out from the asteroid. It is possible to orbit the mirrors out of the worst of the rock vapour plumes, but eventually the mirror efficiencies will drop off too far to be effective any more. However, it has been calculated, even allowing for mirror contamination, big rocks could be deflected up to ten thousand kilometres from their course in the time available before the mirrors were too contaminated.

It has been proposed that just heating one side of a space rock will cause it to move away due to the heat radiation pressure leaving the surface. A few solar mirrors could do this without throwing out mirror contaminating rock vapour, and deflections up to five thousand kilometres are feasible.

Another simple deflection technique considered is to use the solar radiation forces already acting on space bodies. For smaller asteroids, painting one half white makes the usual forces asymmetrical and would change the asteroid's trajectory. The effect, however, is very small and would need a lot of time to change a rock's path.

The process of landing deflection equipment on an asteroid is a complication that critical asteroidal defence projects could do without. There is the risk of crashing in too fast or bouncing off again in the low gravity, or simply falling over at the wrong angle to operate. Nevertheless, it has been proposed that a swarm of asteroid-rock-mining rock-guns be landed on an offending asteroid, at least some of which would succeed in shooting rock off into space and causing a "gun recoil" effect to deflect the asteroid.

One of the favourite asteroid deflection methods is to fire a heavy impactor at an asteroid to knock it off course. The bad word here for project-cost-conscious engineers is "heavy". Another problem with impactors is that some asteroids are just rubble piles only held together by their own weak gravity. An impactor could go right through the rubble. The rubble stones would be agitated like a swarm of bees that would settle back under their own group gravity converting the impact energy mostly to heat and little deflection.

A more certain way to deal with a rubble-pile asteroid is to hold a heavy space craft on station with solar powered ion thrusters a little to one side of the rubble pile, using its gravitational attraction to the heavy craft to pull it off course.

This was a fascinating lecture and gave us assurance that some able people were considering the threat seriously.

Chris Davis

STIRLING CITY OBSERVATORY.

By good fortune most amateur astronomers have craftsmen, engineering and scientific talents. Those with strengths in these talents are keeping the historic Stirling telescope and Observatory in working order, and presentable for public visitors. (We are also grateful for the co-operation of the Highland Hotel who give us access.)

Recently, Terry Aitchison has restored the telescope-tube main-mirror-hatch, providing it with securing clips and ingenious detachable hinges. He has also set about repairing damaged woodwork inside the dome, including fitting matching locks to the two equipment wall-cupboards.

David Harrison, who of course made the manual equatorial slow-motion drive, has tackled the awkward problem of the storm damaged dome-hatch chain securing-hook.

Hamish freed up a very unexpected recent seizure of the dome rotation mechanism. It took four of us to home in on what was binding in the mechanism, which we did without taking it apart.

Meantime all the maintenance volunteers have recently started to clean up the telescope and dome interior, which should help make it all more presentable for the splendid SAS volunteers who show visitors around the Observatory.

Chris Davis

”FINDING THE WHOLE UNIVERSE IN A GLASS OF WINE”

This is the only quote I could find connecting wine and Astronomy although I am sure Galileo had said something similar.

This wine bottle label proves you can study the star patterns of the night sky without getting cold!

Mercury does not encourage product placement nor advertising but this is the exception. Perhaps we can encourage members to submit other examples of finding Astronomy in unusual places.

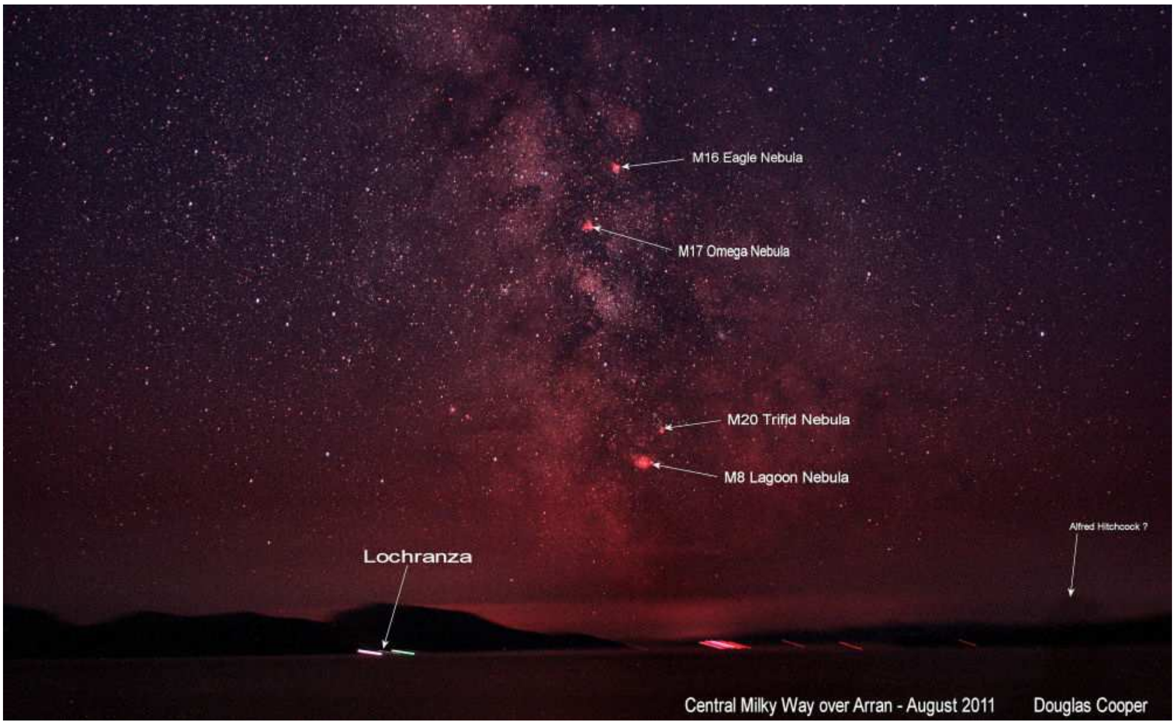
Bert Mackenzie

Bert also contributed the following URL for the newsletter of Best Astronomy Books which members might find useful.

http://www.best-astronomy-books.com/index.php/bi-monthly-newsletter

MORE PHOTOGRAPHS FROM DOUGLAS COOPER

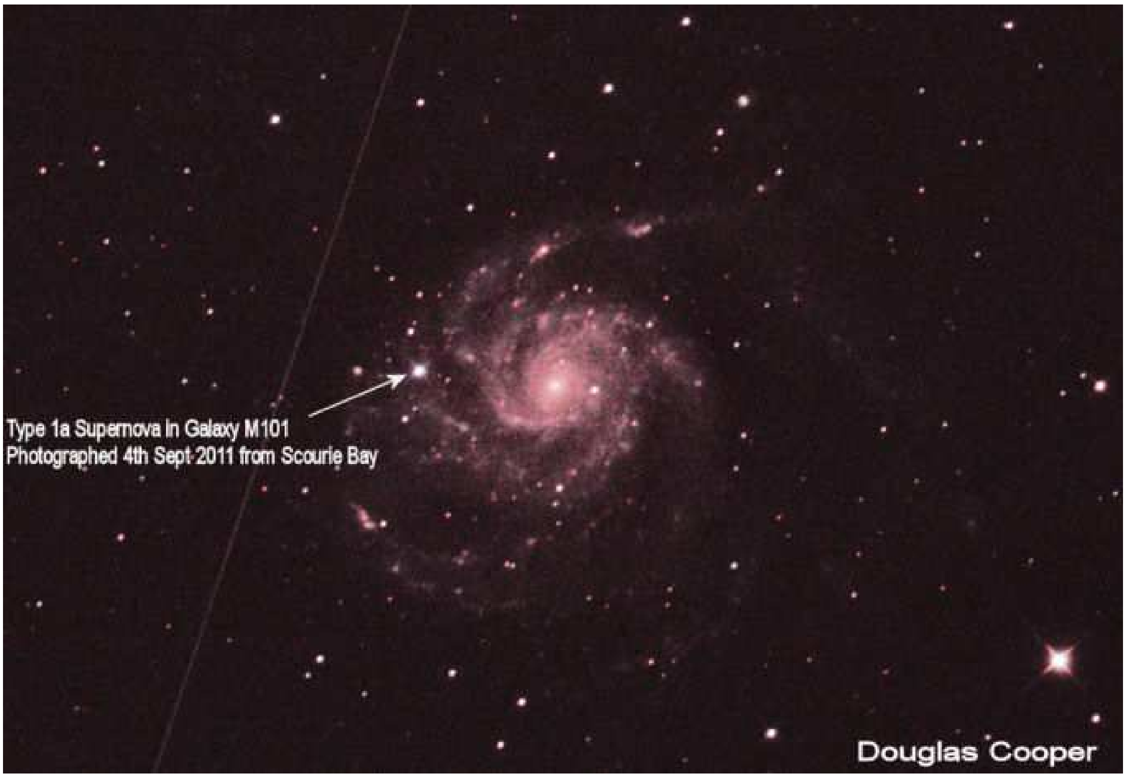
IC 1396 Elephant Trunk



Milky Way over Arran 2011

M101 SUPERNOVA

Photographs taken by Douglas Cooper showing M101 before the supernova (above) and with supernova (below)



GUEST ARTICLE: NEW DISCOVERIES ON ODD STELLAR EXPLOSIONS

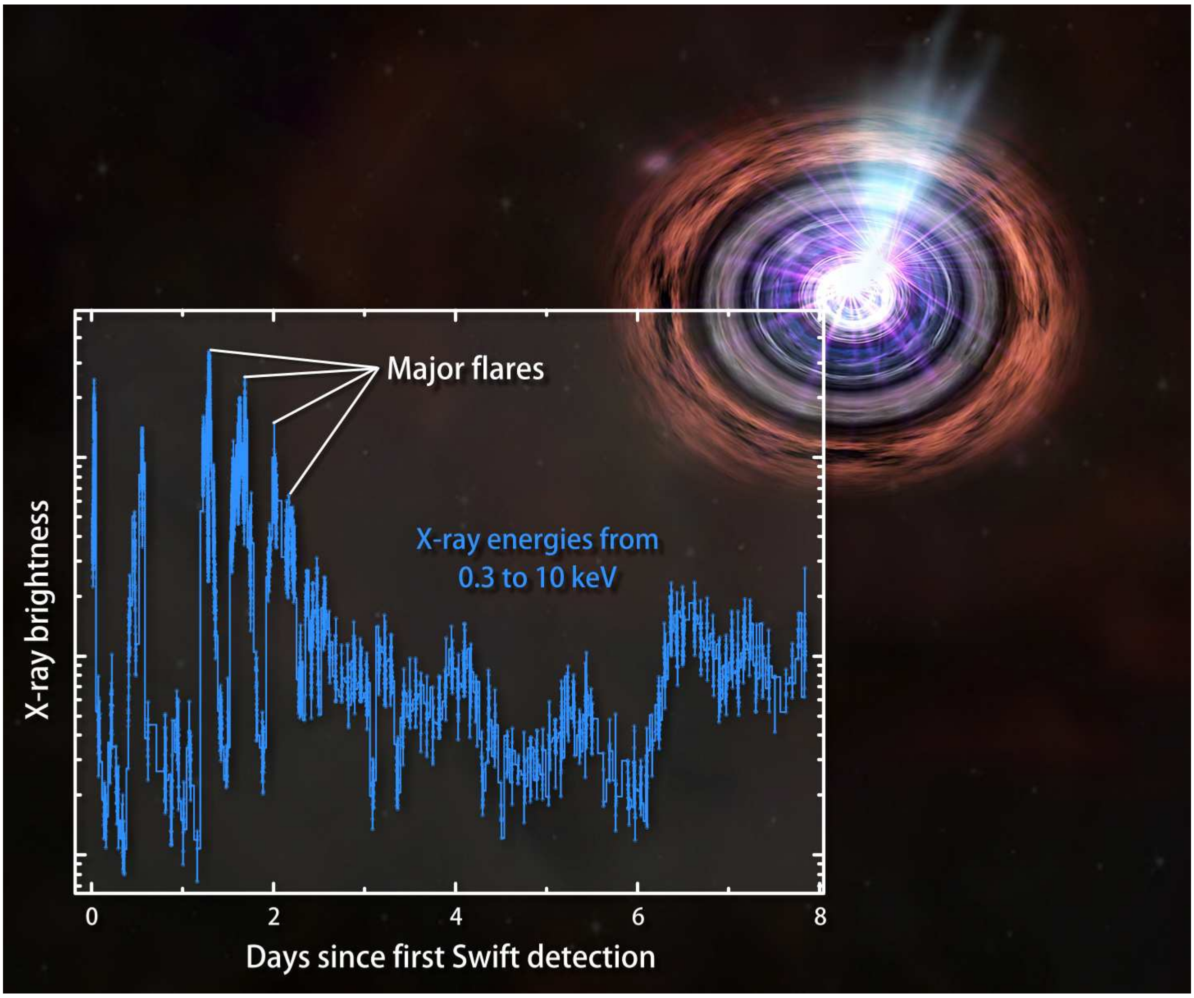


Image Credit: NASA/Swift/Penn State/J. Kennea

Over the last week and a half, there have been a couple of news releases about stellar explosions. In the first story, astronomers have spotted a puzzling blast of gamma ray and X-ray emission that could be a star being ripped apart by a massive black hole. In the other story, astronomers have made substantial progress in understanding the brightest supernovae ever observed.

First, the puzzling gamma rays. For decades, astronomers have seen sudden, short bursts of gamma rays coming from all over the sky. About ten years ago, after a lot of hard work (and a little luck) by many different researchers, most astronomers came to believe that many of these "gamma-ray bursts" are the birthing cry of new black holes formed at the centres of massive, exploding stars.

Several space missions have been studying these gamma-ray bursts, including the currently-operating Swift satellite. These satellites automatically detect the few-second long burst of gamma rays, locate where in the sky they are coming from, and send emails and instant messages to astronomers around the globe alerting them to the event. Especially interesting events can get rapid observations from large telescopes and major satellites such as the Chandra X-ray Observatory and the Hubble Space Telescope.

On March 28, the Swift satellite detected a burst of gamma rays in the direction of the constellation Draco. Since gamma-ray bursts are seen every few days, this burst started the normal response. Automated messages went out, a team analyzed the data and put out some standard preliminary analysis. But just 43 minutes later, Swift detected another burst at exactly the same place. This is very rare, though not unheard of - but it is rare enough that additional resources started swinging into action. Over the next few days, many additional bursts of both gamma rays and X-rays were seen coming from the same object.

Finally, data from the Chandra X-ray Observatory and the Hubble Space Telescope came in. The source of the gamma rays and X-rays lies very close to the centre of an otherwise normal-looking galaxy. In fact, as far as astronomers can tell, the source lies directly in the centre of that galaxy.

This discovery, that the weird source lies at the centre of a galaxy, casts suspicion squarely on the type of object that lives in the centre of most galaxies: a supermassive black hole. Now unlike what many people think, a black hole is not some sort of cosmic vacuum cleaner, sucking in everything around it. A black hole can only eat anything that wanders too close.

How close is too close? The diameter of a black hole can be found by multiplying its mass (in terms of the sun's mass) by 3.7 miles. So, if the sun were to collapse into a black hole, the black hole would be 3.7 miles across. Typical black holes that form from dying stars are about 10 times the mass of the sun, and so are a few dozen miles in diameter. The black hole at the centre of our Milky Way galaxy is about 4 million times the mass of the sun, and so it is about 15 million miles in diameter.

The really weird stuff that happens around black holes due to Einstein's general relativity (time slowing way down, space highly distorted, light being highly bent, and unfortunate space explorers being turned into spaghetti) only happens when you get closer than a few times this distance. So, if the sun were to be magically transformed into a black hole, really weird things would only happen if you happened to get within a dozen miles or so of the black hole. The

Earth, 93 million miles away, would be unharmed.

The black holes at the centres of galaxies are much larger, but compared to the distances between stars, they are still tiny. The black hole at the centre of the Milky Way has many stars orbiting it, including one star that gets within 10 billion miles (about three times the average Sun-Pluto distance) every 16 years. That star passed by the black hole in 2002 with no ill effects.

Still, if a star were to somehow wander within a hundred million miles or so of a supermassive black hole in the centre of a galaxy, it would get ripped to shreds. This shredding would release a lot of energy in the form of gamma rays and X-rays. A press release from NASA suggests that this is precisely what caused the multiple gamma ray bursts from the otherwise normal galaxy in Draco last week.

This explanation makes sense, but it's important to emphasize that it is just a hypothesis right now. More data continues to come in, and as news of the discovery spreads, more astronomers will begin to compare these data to simulations of what happens when a star is shredded by a black hole. Perhaps they will agree, and perhaps they won't. Time will tell.

This leads us to the second story, which was announced this week by McDonald Observatory. This story is based on a journal article that has been published in the Astrophysical Journal, one of the main astronomy journals, so the science has already passed significant vetting by peer reviewers. It doesn't mean the science is absolutely, positively right, but it does mean the science has met some substantial level of quality control.

About four years ago, astronomers announced the discovery of what was then the most energetic supernova ever detected. The initial discovery was made by Robert Quimby, then a graduate student at the University of Texas in Austin, and now a postdoctoral researcher at Caltech.

Many people initially speculated that this supernova, and a few others like it, was a new kind of exploding star. Some models of really massive stars suggest that, as the star ages, it becomes unstable, manages to create large amounts of antimatter, and rips itself apart in the ensuing explosion, called a pair instability supernova.

However, new studies by Emmanouil "Manos" Chatzopoulos, a graduate student at the University of Texas at Austin, and his advisor, Dr. Craig Wheeler, seem to show that these very luminous explosions are not a pair instability supernova. The stars are, alas, not being torn asunder by the explosive mixture of matter and antimatter. Instead, the evidence suggests that these are normal supernova explosions, but as the blast wave from the star travels outwards at high speeds, it rams into shells of matter thrown off by the star decades or centuries before the supernova. This violent collision releases tremendous amounts of energy in the form of visible light, and makes the supernova appear much more luminous than it otherwise would.

These shells of matter are known to exist around a type of star called a Luminous Blue Variable (LBV). These stars sometimes shed huge amounts of material into space via dramatic eruptions from the surface of the star. In our own Milky Way, the LBV Eta Carinae had just such an eruption back in the 1840s. The Hubble Space Telescope has taken amazing images of the material blown off the star during that eruption.

If Eta Carina were to explode as a supernova now (and it almost certainly will explode within the next million years), the blast wave from the supernova would smash into those large lobes of material, brightening in a very similar way to the very luminous supernovae Manos has been studying.

So, it looks as if Manos's work may have changed the explanation of these ultra-bright supernovae from some exciting and exotic antimatter-driven explosion mechanism to a slightly more mundane "giant outer space train wreck" explanation. But this is so often how science works, and how it should work: explanations for observed phenomena must be tested, re-tested, and then scrutinized some more. Only then can we be reasonably sure we understand what is happening in the depths of space.

Kurtis Williams

Kurtis Williams' blog *Professor Astronomy* is at
http://blog.professorastronomy.com/

This content distributed by the AAVSO Writer's Bureau.

N.B. The AAVSO website is at *http://www.aavso.org/*

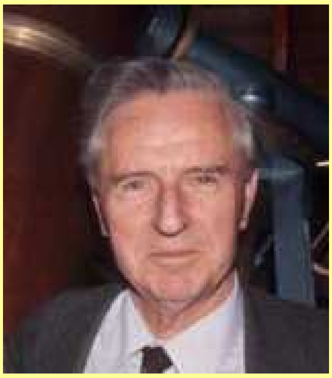
Editor's note: I would like to thank the AAVSO Writer's Bureau for use of their articles during my term as Editor of *The Mercury*. The AAVSO has been one of the friends *The Mercury* has made during my Editorship, others being Martin Palmer-Smith who has given permission for me to use his excellent "Astronomical Calendar" website (see page 19) and *New Leaf News* and its Editor, Michelle McCallum, who has published some of our articles and given us good publicity; and, I expect, will continue to do so in the future. To all of these, I say "thank you".

THE NIGHT SKY

Oct	4	First quarter Moon (03:15)
Oct	6	Algol at minimum (03:00)
Oct	8	Algol at minimum (23:49)
Oct	11	Algol at minimum (20:38)
Oct	12	Full Moon (02:06)
Oct	13	Saturn at conjunction
Oct	20	Last quarter Moon (03:30)
Oct	21 + 22	Orionid meteor shower maximum (20/hr). Moon 31%
Oct	26	Algol at minimum (04:42)
Oct	26	New Moon (19:56)
Oct	28	Occultation of Mercury by the Moon, visible in Australia and South Pacific (02:00)
Oct	29	Algol at minimum (01:30)
Oct	29	Jupiter at opposition
Oct	31	Algol at minimum (22:19)
Nov	2	First quarter Moon (16:38)
Nov	3	Algol at minimum (19:08)
Nov	9	Neptune stationary (evening object)
Nov	10	Full Moon (20:16)
Nov	14	Mercury (evening object) at greatest elongation, 23° E
Nov	17 + 18	Leonid meteor shower maximum (40/hr). Moon 57%
Nov	18	Last quarter Moon (15:09)
Nov	18	Algol at minimum (03:13)
Nov	21	Algol at minimum (00:02)
Nov	23	Algol at minimum (20:51)
Nov	25	New Moon (06:10)
Nov	25	Partial eclipse of the Sun visible from S Africa, Antarctica, Tasmania and New Zealand: Global map | Animation | NASA solar eclipse page
Dec	2	First quarter Moon (09:52)
Dec	4	Mercury at inferior conjunction
Dec	8	Algol at minimum (04:56)
Dec	10	Full Moon (14:36)
Dec	10	Total eclipse of the Moon visible in North America, Asia, Australasia, central and eastern Africa and Europe: Diagram | NASA lunar eclipse page
Dec	10	Uranus stationary (evening object)
Dec	11	Algol at minimum (01:46)
Dec	13	Algol at minimum (22:35)
Dec	13 + 14	Geminid meteor shower maximum (60/hr). Moon 89%
Dec	16	Algol at minimum (19:24)
Dec	18	Last quarter Moon (00:48)
Dec	22	Northern winter solstice (05:30) and shortest day
Dec	23	Mercury (morning object) at greatest elongation, 22° W
Dec	24	New Moon (18:06)
Dec	26	Jupiter stationary (evening object)
Dec	29	Pluto at conjunction
Dec	31	Algol at minimum (03:30)

Courtesy of Martin Palmer-Smith and his website "Astronomical Calendar" at: *http://astronomical-calendar.org.uk* . Times are UT. Reproduced with permission.

THE SEARCH FOR INTELLIGENT LIFE
Smith lecture, 9th September 2011
Professor Sir Arnold Wolfendale, Durham University


Professor Sir Arnold Wolfendale

The Stirling Astronomical Society had the pleasure of welcoming Professor Sir Arnold Wolfendale, FRS FRAS Emeritus Professor of Physics at Durham University and former Astronomer Royal, as the first monthly speaker of the 2011-2012 lecture season. The venue as usual was the Lecture Theatre of the Smith Museum and Art Gallery in Dumbarton Road, Stirling and the title of Professor Wolfendale's lecture was *The Search for Intelligent Life*.

Professor Wolfendale attempted to answer the question "Are we alone in the Universe?" He began by asking the members of an audience of well over 50 if they believed that we were alone in the Universe or if there were likely to be other civilisations similar to ourselves out there. The majority of the audience were firmly in favour of the latter.

Professor Wolfendale set out an assessment of historical standpoints on the question, beginning with quotations by the 13th Century philosopher Teng Mu and the 16th Century Italian monk Giordano Bruno that not only were there likely to be other worlds in the Universe, but that they were likely to be inhabited. The science leading up to the current searches for extrasolar planets was then examined, beginning with the initial pictures of an earth-centred cosmos and continuing with the meticulous and exemplary work of Nicholas Copernicus (1473-1543), the first scientist to comprehensively construct a heliocentric picture of the Universe that displaced the Earth as its heart in his famous diagram published in 1543. The telescopic observations of Galileo Galilei (1564 – 1642) that contributed to astronomy were then presented, particularly his discovery of the four largest Jovian satellites of Jupiter.

The modern era, with the wonderful pictures sent back by the Hubble Space Telescope since its Space Shuttle launch into orbit in 1990, was followed by an examination of the Drake Equation, an interesting formula devised by radio astronomer and Emeritus Professor of Astronomy and Astrophysics Frank Drake of the University of California in 1961. It is an equation whose purpose is to estimate the number of detectable extraterrestrial civilizations in the Milky Way and is used, *inter alia*, by SETI (Search for ExtraTerrestrial Intelligence). The equation proposes that a large number of extraterrestrial civilizations are likely to develop but, given the lack of evidence of these civilizations, the implication is that civilizations with advanced technology are liable to disappear rather speedily.

The work of SETI (Search for ExtraTerrestrial Intelligence) since Frank Drake made the first radio search in 1960 in seeking out intelligent life on planets other than Earth was discussed, in particular the monitoring for signs of transmissions from civilizations elsewhere, the great challenge being that characterizing something received as intelligent is difficult, given that the direction, range and means of communication are all unknowns. The input of American astronomer Carl Sagan was also acknowledged. As in so many scientific endeavours, the original government contributions to the early SETI projects dried up and recent work is principally funded privately. With the advent of powerful computers and wider access to a vast amount of data, dredging a signal out of the noise remains problematical.

The Drake equation can be represented as: $N = R f1\ n f2 f3 f4\ L$, where N = no. of detectable civilizations in space, R = rate of star formation, f1 = fraction of stars with planets, n = number of planets hospitable to life per star, f2 = fraction where life emerges, f3 = fraction where intelligent life appears, f4 = fraction capable of communication and L = length of time for which signs of such civilizations remains detectable. The factor *f*2 (fraction where life emerges) was exemplified by Professor Wolfendale by examining Mars, its impact craters and the white and pristine surface of Antarctica, where meteorites are relatively easy to see and collect and some of which hail from the red planet. The first Martian meteorite of the shergottite type, the Shergotty, was found at Shergotty in India in 1865 and was found to be of volcanic origin and had experienced alteration over centuries by water before reaching Earth, certain internal features indicating possible microbial life. The more famous Allan Hills 84001 (ALH 84001) meteorite found in Allan Hills, Antarctica by a team of American meteorite hunters in 1984 and believed to be a piece of Mars that struck the Earth about 12,000 years ago was originally purported to contain microscopic fossil evidence of extraterrestrial life. It was conjectured to be one of the oldest pieces of the solar system, is related to other Martian meteorites and is suggested to have formed from molten rock about 3.56 billion years before the present.

Such findings gave rise to a plethora of cartoons on possible Martian life that amused the audience and led on to an examination of the work of Jocelyn Bell (Burnell), the astrophysicist who discovered the first four radio pulsars as a postgraduate student at Cambridge[1]. A pulsar is a rotating neutron star that is highly magnetized and emits a beam of electromagnetic radiation. The radiation can only be picked up when the beam is directed towards Earth, resulting in the pulsed phenomenon that gives pulsars their name. Neutron stars are very dense, hence their rotation period and interval between pulses is highly regular. Bell was at first puzzled as to the apparently artificial regularity of the emissions and the first pulsar was accordingly christened LGM-1 for Little Green Men One. The hypothesis that pulsars were signals sent out from alien civilizations was not taken particularly seriously (hence the cartoons) but some discussions as to the consequences if such turned out to be the case ensued. A pulsar is formed when a supernova causes collapse and compression of the core of a massive star into a vastly smaller neutron star. The latter keeps most of its angular momentum but as its moment of inertia is much reduced, it has a very high rotation speed. A beam of radiation is emitted along its magnetic axis, which spins along with its rotation. The pulsar's magnetic axis establishes beam direction, but the magnetic axis is not necessarily the same as the rotational axis, hence the beam is seen once per rotation, resulting in the pulsed effect. The radiation beam comes from the neutron star's rotational energy – it generates an electrical field by the movement of the very strong magnetic field, protons and electrons are accelerated on the star surface and the resultant electromagnetic beam emanates at the poles of the magnetic field. It is now known that a few pulsars have planets orbiting them and Professor Wolfendale described the data provided by the Spitzer telescope on planets Tr-ES1 and HD209458b.

To close, the factor L (length of time for which life remains detectable) was examined and Professor Wolfendale began with the evolution of life on our planet and the dinosaur story, which ended spectacularly for the great reptiles when a cometary (or similar) impact in the Late Cretaceous period wiped them out, leaving tiny mammals, well hidden away, to evolve along various evolutionary tracks into the forms we see today. As noted previously, although the Drake equation implied the development of a large number of extraterrestrial civilizations, the lack of evidence for such suggests a rapid demise, and this was explored with Mankind as the example. Another comet, solar flares of exceptional magnitude and the eventual demise of the sun were put forward as the means by which human civilisation would finally have to bid goodbye to the home planet. However, given that planets are common, life can exist for a long span of time and elementary life is also common, the professor posited that waves of colonisation from elsewhere should have already occurred – but

[1] Bell controversially did not even get a mention when her supervisor, Hewish, picked up the Nobel prize for the discovery despite the facts that she built the massive radio telescope used, first recorded and then noticed the anomaly leading to the result, and had to be relentless in recording and reporting her findings over the ridicule of said supervisor; she has campaigned tirelessly ever since to improve the status and number of women in physics and astronomy.

have not been recorded here. The lack (as far as we are aware) of extraterrestrial visitors might lead to the conclusion that perhaps we are alone in the cosmos. This final point was debated with much audience participation, the eventual result being inconclusive. In other words, in answer to the question "Are we alone in the Universe?" the answer is, as yet, "We don't know."

Professor Wolfendale was thanked in the customary fashion for a stimulating and amusing lecture and for providing us with an excellent start to the new season.

Sandi Cayless

STOCKHOLM'S OLD OBSERVATORY

Recently, Roberta and I were fortunate enough to take a Baltic Cruise which included a stop in Stockholm starting very early on a Sunday morning. Equipped with a map, we visited some of the city's sights before stopping for a well-earned coffee. It was then that we noticed from the map that we were close to the site of Stockholm's old observatory. A short walk took us to Observatory Hill, where Roberta took the photographs shown on the page opposite. The observatory itself was closed although notices stated that it was open for tours in the afternoon. Unfortunately, our schedule meant that we had to return to the ship by 1 pm local time for onward sailing and this precluded such a tour. With insufficient time available to us for research into the observatory's history, I will quote from the observatory's website.

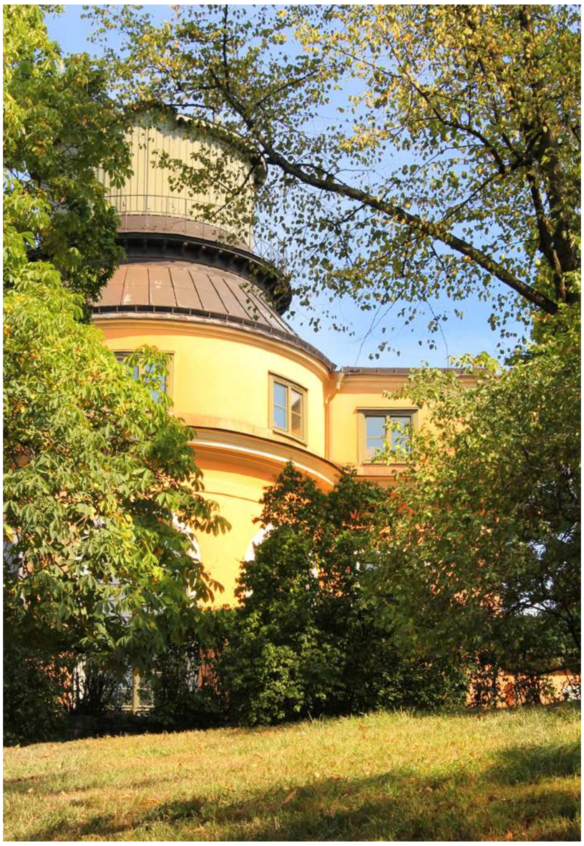
"On the highest point of Observatoriekullen (the Observatory Hill), boasting a panoramic view over the city, lies the old Stockholm Observatory. From here research within the fields of astronomy, meteorology and geography was conducted during the 18th and 19th centuries.

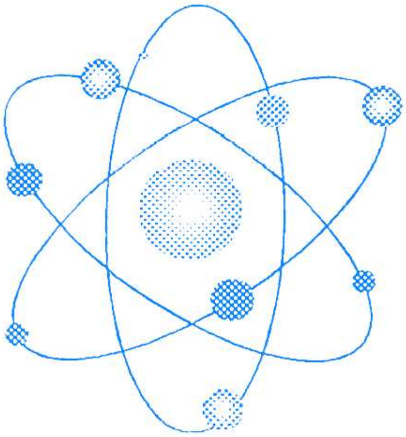
Today this building holds a museum, dedicated to the history of science, and run by the Royal Swedish Academy of Sciences. The museum tells us of the history of the building, and of some of the activities which have taken place here.

The foundations of the Observatory were laid down in 1748 by the Royal Swedish Academy of Sciences. This was to become their very first own building."

It is always a pleasure finding unexpected treasures like this and it is a pity that time was not available for us to do justice to the old observatory.

Alex Houston *Photographs opposite by Roberta Houston*



For information about Stirling Astronomical Society, membership and activities, please contact the Secretary:
E-mail: *johnmoffat@inaberfoyle.demon.co.uk*
or visit the SAS website :
www.stirlingastronomicalsociety.org.uk

A FINAL THANK YOU

It is time for me to say goodbye as Editor of *The Mercury* after four years. I have enjoyed being Editor very much but there comes a time when you need to move on to something else and that time has come for me. I would like to take this opportunity to thank all contributors to this issue and to previous issues over the past four years.

As yet it is unclear who will be the next Editor of *The Mercury*. As such, it is best that you retain articles, which you may wish to submit, until after the AGM on 11th November 2011, when the way forward should become clearer. I sincerely hope that a new Editor can be found and that *The Mercury* continues, either in its present form or in some alternative form such as a blog.

I wish the new Editor, assuming that one can be found, every success in what is a challenging but very worthwhile task.

Alex Houston