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Correction, and Apology to Paul Anderson

Due to a printing glitch, the end of Paul's contribution on Light Pollution in the last issue (April 2005) was omitted. It should have been:

If anyone would like to get involved in tackling this issue, please contact Paul Anderson on paul.anderson@scottish.parliament.uk

Paul Anderson

Sorry, Paul.

A SHORT BIOGRAPHY OF SIR CHRISTOPHER WREN

Sir Christopher Wren (1632-1723) had many technical and academic interests. These developed through association with members of the Royal Society of which he was a founder member and eventually the president. His two main interests were astronomy and architecture, but it is the latter by which he is remembered. In architecture his designs included many churches, including St Paul's Cathedral, to replace those destroyed by the great fire of London in 1666. He was also responsible for the design of libraries and theatres at the universities of Oxford and Cambridge. He was a close friend of Robert Hooke who was also an astronomer, scientist and architect, and arguably discoverer of the laws of gravitation before Newton.

At the age of 25 Wren became the professor of astronomy at Gresham College, London and four years later he moved to a similar at post at Wadham College, Oxford, where he collaborated in the construction of a 24 ft telescope at the university. He made observations of Saturn, and along with analyses of earlier observations determined the orbital period of the planet to be 30 years, (actual 29.4). He noted a satellite of Saturn but did not recognise it as such until a year later, when the Dutch astronomer Huygens published a paper on the moons of Saturn. He left the chair of astronomy in 1673 when Charles II appointed him to the post of Royal Surveyor for the reconstruction of London.

In 1674 a commission investigated a claim by a French astronomer that longitude could be determined by lunar distances from fixed stars. Included on the commission were Wren, Hooke and a young astronomer, John Flamsteed. The commission found the method was not valid due to inaccuracies in the positions of fixed stars. Resulting from the commission's findings, Charles II decreed an observatory should be built to determine star and planet positions accurately. Flamsteed was appointed to the new post of Astronomer Royal and charged with the task of making the determinations. Wren was appointed to design and build the observatory in collaboration with Flamsteed, and in turn he appointed Hooke to be his deputy and site manager. Wren and Hooke selected the site at Greenwich, contrary to the recommendations of the commission. It was a good decision as this site was elevated and distant from the smog of London. The observatory was built for occupation in less than five months, and was functioning for observations of an eclipse of the Sun some six months later. The success of the design and build can be attributed to the astronomers, Wren and Hooke, working on the design and construction team. Wren's astronomical interests continued throughout his life. In 1682 Wren gave Flamsteed a recreational problem. Flamsteed described it to a friend as follows: *"Yesterday I dined with Sir Christopher Wren who, as we were parting, proposed this problem to me. A person is left on an unknown island without any mathematical instrument, only he has a catalogue of fixed stars and line and plumet (plumb line). With a clock that goes true for an hour he observes two stars in the same azimuth and after 40 minutes of time another two stars in another azimuth. What is his latitude and the true azimuths of each pair of stars?"* Flamsteed concludes the note by wishing his friend could think about the problem at his leisure. It seems Flamsteed did not have an immediate solution. Maybe a reader can come up with an answer?

One final comment on a remarkable man. Sir Christopher Wren lived for 91 years, a notable lifespan in the 18th century.

John Shepherd

(This article is reprinted with permission from Ad Astra 6(2), Spring 2004, *the Newsletter of the Association of Falkirk Astronomers.)*

ASTRONOMY ACCORDING TO EVE

MANY YEARS AGO . . .

-15,000,000,000 : Creation of the Universe.

-10,000,000,000 : Formation of the Milky Way.

-5,000,000,000 : Formation of the Sun and planets.

-245,000,000 : Asteroid impact destroyed an estimated 96% of life on Earth.

-208,000,000 : Asteroid impact in what is now Quebec, Canada, created a crater 70 km in diameter and wiped out many species.

-65,000,000 : Impact at Yucatan Peninsula, Mexico, created crater almost 200 km across, caused global devastation and possible extinction of the dinosaurs, along with an estimated 85% of all life.

-48,000 : Iron meteor crashed in Arizona, creating a crater 4,000 feet wide and 570 feet deep.

AND THEN . . .

-2350 : En Hedu'anna, an Egyptian priestess, (maybe) the first female astronomer and scientist ever recorded. She traced the history and progressions of the Moon and stars.

-1878 : Aganice, a natural philosopher.

415 : Female astronomer, mathematician, inventor and philosopher Hypatia of Alexandria was killed by an angry mob. Rumours suggested her death was a political assassination.

16th Century : Sophia Brahe, the little (10 years younger) sister of Tycho, assisted him with his astronomical observations that became the basis for modern planetary orbit predictions. She was also a horticulturalist, healer and historian, and became a legend in her own lifetime. Her chronicles are still used as an example of exemplary methodology in research techniques.

1645 : Female astronomer Marie Cunitz provided simplified versions of Johannes Kepler's planetary theories and laws for many scientists.

1723-1788 : Mme Nichole-Reine Lepaute worked on predictions for the return of Halley's Comet in 1759, particularly on the computations to determine the gravitational effect of Jupiter and Saturn on Halley's orbit. She also carried out calculations to aid the French Astronomer Joseph Lalande on an annular eclipse of the Sun that would be visible in France, and she produced a chart showing the time and percentage of the eclipse for all of Europe. Mme Lepaute also assisted her husband, the royal clockmaker of France, by producing the table of the number of oscillations per unit time of pendulums of various lengths for the book that he published, *Traite d'horlogerie*, but she received no recognition for this.

1750-1848 : Caroline Herschel, brother of William, was an accomplished grinder and polisher of mirrors used in telescopes, as well as being an excellent astronomer. She was the first woman recognized for a scientific position when King George III gave her an annual pension of fifty pounds to enable her to carry out her work. She detected and catalogued nebulae, calculated the positions of her brother's and her own discoveries and collected them into a publication. She also discovered several comets and was proclaimed an honorary member of the Royal Astronomical Society and the Royal Irish Academy.

1780-1872 : Mary Fairfax Somerville, born 26 December 1780 in Jedburgh, Scotland, studied algebra, astronomy, and later mathematics, despite strong family opposition. In the summer of 1825 she carried out experiments on magnetism and in 1826 presented her paper *The Magnetic Properties of the Violet Rays of the Solar Spectrum* to the Royal Society to favourable notice. Apart from the astronomical observations of Caroline Herschel, Mary's was the first paper by a woman to be read to the Royal Society and published in its Philosophical Transactions (though it was later refuted). Mary was persuaded to write a popularized rendition of Laplace's

Mecanique Celeste and Newton's *Principia* and the outcome, *The Mechanism of the Heavens*, was a great success. In 1834 she wrote *The Connection of the Physical Sciences* and in 1835 she, along with Caroline Herschel, was elected to the Royal Astronomical Society, as the first women to be so honoured. Her book *Physical Geography* was published when she was 68 and was a standard text for 50 years. Mary's last book, *Molecular and Microscopic Science*, was published in 1869 when she was 89.

1818-1889 : Maria Mitchell began by helping her father with astronomical measurements. She discovered a comet in Autumn 1847. In 1848 she became the first woman to be appointed to the US Academy of Arts and Sciences. She later earned the first advanced degree awarded to a woman and became the first female professor of astronomy in the US. In 1865 she became professor of astronomy and director of the college observatory at Vassar College in Poughkeepsie, New York. In 1869 she was the first woman elected to the American Philosophical Society, and in 1873 she helped to found the American Association for the Advancement of Women, and served as its president from 1874 to 1876. In 1873 she attended the first meeting of the Women's Congress.

1846-1927 : Sarah Frances Whiting, astronomy instructor to several generations of astronomers at the turn of the century, including Annie Jump Cannon, was Wellesley College's (USA) first professor of physics and introduced the teaching of astronomy there in 1880. She was the first director of the Wellesley College Observatory after helping to establish it in 1900.

1848-1915 : Margaret Lindsey Murray Huggins of Ireland constructed home-made instruments from an early age. She, with husband William Huggins, a spectroscopist, produced some of the earliest spectra of astronomical objects, most notably the Orion nebula.

1857-1911 : Williamina Paton Stevens Fleming, born 15 May 1857 in Dundee, was the discoverer of white dwarf stars. She was employed at Harvard Observatory to do mathematical calculations. In 1881 she devised a system of classifying stars according to their spectra, and she successfully catalogued over 10,000 stars within the next nine years. She edited all publications issued by the observatory and was appointed curator of astronomical photographs in 1898. In 1906 she was the first American woman elected to the Royal Astronomical Society. In 1907 she published a study of 222 variable stars she had discovered.

1863-1941 : Annie Jump Cannon, who began her research classifying and cataloguing stars according to their stellar spectra using the procedure of Williamina Fleming, published nine volumes containing information about 225,000 stars between 1918 and 1924. In 1925 she became the first woman to receive an honorary doctorate from Oxford University. She discovered and documented five novae and about 300 long-period variable stars, and in 1938 was awarded the rank of professor at Harvard University.

1868-1921 : Henrietta Swan Leavitt, whose work made possible the first accurate determination of extragalactic distances. Working at Harvard College Observatory in 1912 on a survey of Cepheid variables, she discovered that the Cepheids which have the greatest average brightness also have the longest periods of variation.

1900-1980 : Cecilia Payne-Gaposchkin, whose PhD dissertation *Stellar Atmospheres, a Contribution to the Observational Study of High Temperature in the Reversing Layers of Stars* was said to the best one in 20th century astronomy, was the first person to receive a PhD in astronomy awarded either by Radcliffe or Harvard. She was the first person to receive a PhD for work done at the Harvard Observatory, and she was also the first woman to become a full professor at Harvard.

1905-1993 : Helen Sawyer Hogg began working on variable stars in globular clusters in the 1930s and developed a technique for measuring the distance of galaxies beyond the Milky Way. She taught at the University of Toronto and became a professor in 1957. In 1940-1941 she was visiting professor and acting chair of the department of astronomy at Mount Holyoke College, and in 1955-1956 she was program director in astronomy for the National Science Foundation. She became the first woman president of the physical sciences section of the Royal Society of Canada in 1960, the first female president of the Royal Canadian Institute (1964-1965) and founding president of the Canadian Astronomical Society (1971-1972).

1957 : The (female) dog Laika, a stray wandering the streets of Moscow, was captured, prepared for space and became the first living creature to orbit the Earth on board Sputnik 2. She died from overheating and panic just a few hours after the mission was launched. Her coffin circled the Earth 2,570 times and burned up in the atmosphere on 4 April 1958.

1929- : Carolyn Shoemaker, planetary astronomer and most successful comet hunter to date. As an astrogeologist, and together with husband Eugene, she made numerous contributions to the study of impact craters on Earth, lunar science, asteroids and comets. She has found more than 800 asteroids and 32 comets. In 1994, Carolyn, Eugene and David H. Levy discovered the short-period comet Shoemaker-Levy 9, which so spectacularly crashed into Jupiter. This is a hugely impressive set of achievements for a woman who only took up astronomy in 1980, at the age of 51.

1943- : Jocelyn Bell Burnell discovered the first four pulsars using a radio telescope that she helped build as part of her PhD.

1963 : Valentina Tereshkova became the first woman in space.

1970s-1980s : Eleanor F. (Glo) Helin in the early 1970s initiated the Palomar Planet-Crossing Asteroid Survey (PCAS) from Palomar Observatory. This was responsible for the discovery of several thousand asteroids, including about 30% of the Near-Earth Asteroids (NEAs) discovered world-wide, other rare and unique orbital types of asteroids and twenty comets. In 1989 she rediscovered the Halley-type Periodic Comet Borosen-Metcalf previously seen in 1919, and was instrumental in the discovery of asteroid (2062) Aten, the first found to have an orbit smaller than that of Earth. During the 1980s Dr Helin organized and coordinated the International Near-Earth Asteroid Survey (INAS).

1983 : US astronaut Sally Ride became the first American woman in space.

1984 : Russian Svetlana Savitskaya became the first woman to walk in space.

1991 : Helen Sharman became the first British astronaut when she was part of the Juno mission to dock with space station Mir.

1999 : Eileen Collins aboard Columbia became the first woman to command a US space shuttle mission.

Sandie Cayless

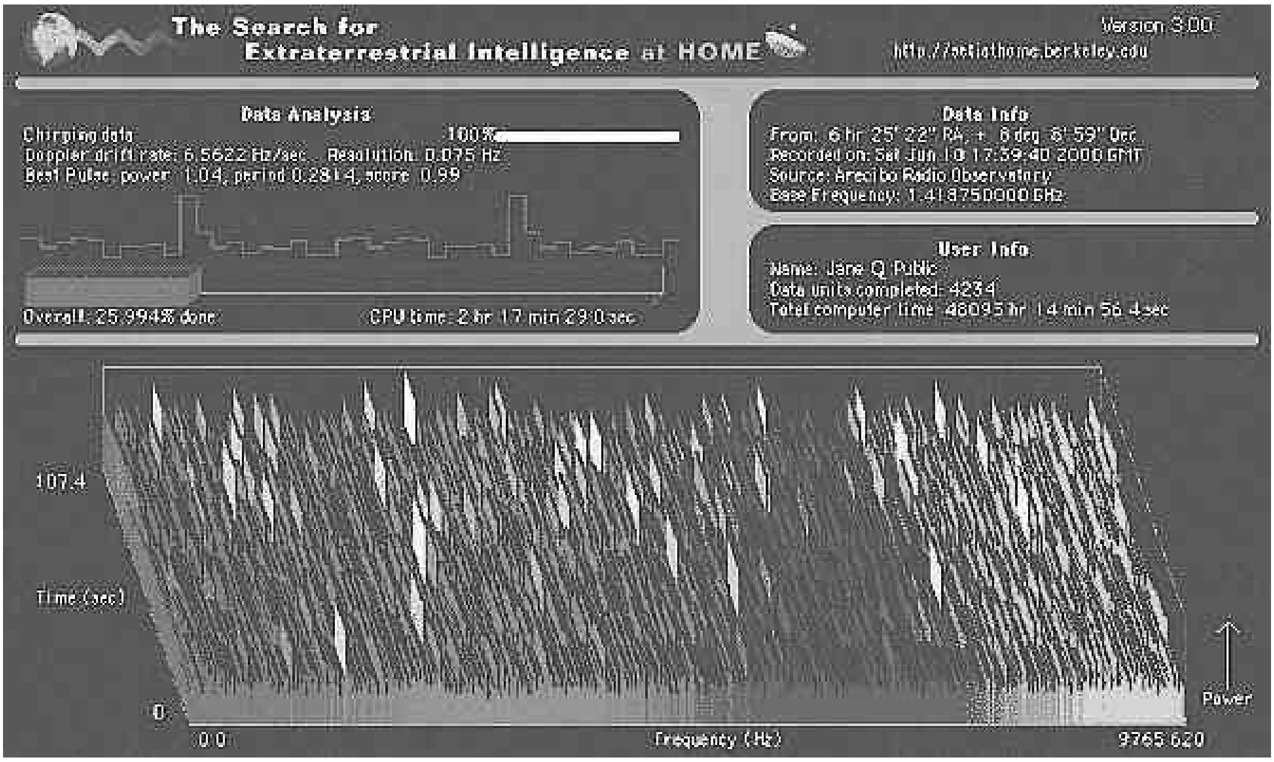
IS THERE ANYONE ELSE OUT THERE, AND HOW SHALL WE KNOW ?

Part 3 : AMATEUR INVOLVEMENT IN THE SEARCH FOR EXTRA-TERRESTRIAL INTELLIGENCE

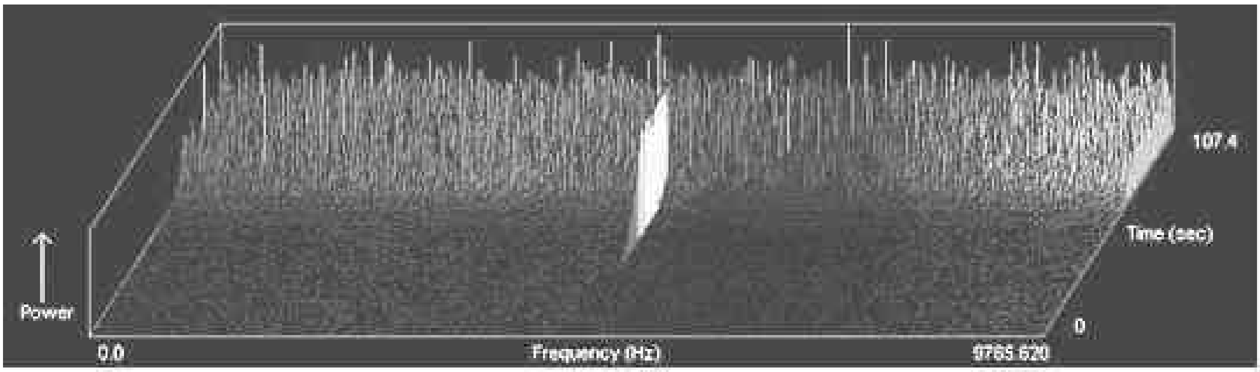
In Part 2 of this series, in the last issue of *Mercury*, Serendip projects were mentioned, in which receivers for SETI searches are piggy-backed onto telescopes as they undertake other astronomy work. Sifting through the resulting huge amounts of radio data for possible alien narrowband signals requires enormous computing power and, due to the limited funding available, this has proved to be a critical bottleneck in the searches. Even the special super-computer specially designed for SERENDIP IV can only identify simple signals having specific predetermined characteristics. Then ten years ago a computer scientist, David Gedye, realised that a deeper analysis of SETI radio data could be achieved by applying the technique of "distributed computing" to the use of tens of thousands of personal computers otherwise sitting idle in peoples' homes all over the World. Development of this idea suffered inevitable delays because of funding problems, but the new project of *SETI@home* eventually started up in May 1999 and has been running successfully ever since. Currently there are nearly half a million home PCs actively analysing SETI@home data in their spare time.

Anyone who wants to take part simply downloads a program from the SETI@home website. The program can manifest itself as the computer's default screensaver. Under the user's control, the program receives a chunk of data over the internet as a 340 kbyte work unit. This usually takes about five minutes. Then whenever the computer is switched on and idle, the program works on this data. Whenever the user needs the computer for anything else the program stops, and only continues its analysis when the computer becomes idle again. The analysis of a whole work unit can take anything from 3 to 50 hours of processing time, depending on the speed of the computer's CPU and its memory. When the analysis is finished the user sends the results to SETI@home and receives back another work unit of data for the program to analyse. Since the project started, three million PCs have returned at least one completed work unit, and one million have completed more than 80 work units.

SETI@home data originates from the Arecibo telescope in Puerto Rico which generates it at the rate of about 35 Gbytes per day. The data is sent to the SETI@home Centre at UC Berkeley where it is broken down into individual work units for analysis by PCs. What is the PC analysis looking for? It is logical to expect intelligent aliens to send signals in the most efficient manner for *them* that will allow *us* most easily to detect their signals. A narrowband, rather than a broadband signal is more efficient in a transmitter's use of power for sending strong signals, and this is also more effective for us in then being able to identify incoming signals against the background radio noise. What the SETI@home PC program does is like tuning a radio set to various channels and looking at the signal strength meter. If the signal strength shoots up for a particular channel, that could be an alien signal.



The SETI@home screensaver which shows pictorially some of the analysis being done.



How a strong "Wow" signal would show up on the screensaver.

SETI@home looks at 2.5 MHz of bandwidth centred at 1420 MHz (hydrogen emission) line) and splits it into 10 kHz slices, 256 of them. SETI@home data collection operates when the Arecibo telescope is stationary, not tracking stars across the sky. The sky thus moves slowly past the focus of the stationary SETI@home receiver dish. It takes about 12 seconds for an incoming signal to pass across the focus. An alien signal would appear, get louder, fade and disappear over a 12 second period. To cover this and allow for overlaps to avoid missing anything, about 100 seconds of data are included in a work unit. Each work unit sent to a PC is thus a 100 second look at a 10 kHz slice of bandwidth.

The full analysis has to check for signals at several bandwidths the aliens might be using. To contain information, a signal is likely to be transmitted as pulses rather than as a continuous signal, and this also has to be looked for. Because planets rotate, the extra-terrestrial transmitter's and our receiver's relative motion will change, resulting in a changing doppler or frequency shift of any signal received. This is another factor which has to be taken into account in the analysis. The end result of all this is a vast amount of calculation. To complete a work unit a PC carries out about three *trillion* mathematical operations! And an individual work unit is only a very small part of the total ongoing analysis needed for the search.

All PC users taking part of course hope that they will be the first to identify a genuine alien signal. Any signal that a PC's analysis finds which is stronger than the background radio noise and that rises and falls over a 12 second interval gets sent back in the results to UC Berkeley for further analysis. The SETI@home Centre there maintains a large up-to-date database of known radio frequency interference (RFI) sources with which candidate signals detected by PCs are compared. At this point 99.9999 % of candidate signals are rejected as RFI. Those remaining are checked again by new observations, first by SETI@home and then by other independent astronomers using different telescopes and equipment. A comprehensive international protocol has been established for the exhaustive tests, checks and procedures required to confirm a signal as being truly from an alien source. When (and if!) this happens, the user of the PC which first identified the signal will be famously named as a co-discoverer of the extra-terrestrial intelligence.

While large numbers of amateurs are involved in analysing SETI@home data, some enthusiasts are also out there with the professionals, with properly equipped home satellite dishes and narrow band signal analysers. These small dishes have a much wider beam that can cover more sky for a longer time than large radio telescopes. Amateurs can thus increase the breadth of coverage, although at much lower levels of sensitivity and noise rejection.

An example is Project BAMBI (**B**ob **A**nd **M**ike's **B**ig **I**nvestment!). This is a pair of small, 3.1-million channel radio telescopes 1000 miles apart in California and Colorado working together to screen out local interference. The dishes are pointed straight down the spiral arm of the Milky Way to give the maximum number of stars in the sky being looked at. There is now a SETI League to help, advise, provide technical guidelines and coordinate amateur work of this nature around the World.

Derek Allen

The final article in this series will look at future developments in the search for extra-terrestrial intelligence.

For more detailed information on SETI@home, and how to get involved in it, a useful place to start is the website http://setiathome.berkeley.edu/index.html

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REPORT ON SMITH MEETING, 11 FEBRUARY 2005

The scheduled popular speaker David Gavine unavoidably had to cancel his appearance. The Society once again drew on its own resources which were able to fill in at the last moment.

Our Chairman Alan Cayless presented an extended "tour of the night sky". In addition he tackled the amateur's oft experienced bewilderment with the Moon's choreography in the sky. He showed how the tilting of the Earth's axis relative to the orbital planes of the Moon and the Earth results in the Moon appearing at a wide variety of points on the horizon, and reaching many angles in the sky. From all this, it was possible to show when is the optimum time of year to observe each Moon phase. The fact that the orbits of the Earth and Moon are elliptical and not perfectly synchronized means the Moon only appears at exactly the same time and place once every eighteen years.

The Moon theme was continued in the next contribution by our President Ken Mackay who demonstrated a new piece of software, "Lunar Phase Pro", acquired by the Society. It is to aid Lunar observations, particularly from the Stirling Telescope. Ken showed off the program's impressive set of features, including a brilliant animated demonstration of how the Moon oscillates and nods a little as seen from Earth. The Moon's axial rotation, synchronized to once every orbit, locks one face towards us, but the Moon slows at the extremity of its orbital ellipse while the rotation carries on and reveals a bit of the Moon we could not see before. Also, because the Moon's axis is slightly tilted, we are periodically able effectively to see over the top a little.

Next the Society's most intrepid and prolific astrophotographer, Douglas Cooper, shared some of his recent spectacular pictures with us. He started mysteriously by delving into the top pocket of a camera bag: out came a little 60 mm Takahashi fluorite lens telescope. He then proceeded to show what he had photographed through this small but very fine instrument. All sorts of exciting surprises showed up in tracked time exposures, including the Crab Nebula in Taurus, and the Flame Nebula in Orion. There was also a memorable shot of a huge Orion's belt over tree tops with the bright sword and nebula gleaming in a gap between branches. He also showed pictures taken through other instruments, including time exposures of the comet Machholz with bright nucleus and long thin tail, and the main Orion Nebula revealing beautiful colours and structure.

To round off the presentations, the author showed a three minute video of recent colourful ice crystal effects seen in the sunny winter skies: a sun halo, a sun dog, and a nacreous cloud. (See last Mercury for colour frames printed from this video.)

The rest of the Meeting was spent in the usual convivial way over coffee, tea and cakes kindly prepared for us by Chris Duffy and Sandie Cayless.

Chris Davis.

A VISIT TO THE EDINBURGH INTERNATIONAL SCIENCE FESTIVAL

On Sunday 3 April five of us set off from Bridge of Allan at around 11.30 am to attend events at the Edinburgh International Science Festival. The intrepid travellers were Jennifer Cameron and her husband Stewart, Jessica Moncrieff, and my wife Roberta and I. The plan was to attend the open day at the Royal Observatory Edinburgh, followed by a visit to The Hub to hear a lecture entitled "The Artful Universe Expanded" by astronomer and mathematician John D Barrow.

The drive took less than an hour and soon we were purchasing our tickets at ROE. The beauty of the visit to ROE was that it meant different things to all five of us; for me it was pure nostalgia and an interest in what had become of the place since I left in January 1971 to pursue a new career in medical image processing. I had been back, but my last visit was towards the end of the seventies and I anticipated many changes. I was not disappointed.

The first stop was the 36" telescope where I obtained the spectra of metallic-line stars for my PhD project. It was awesome to see the telescope again and disappointing to learn that it had not been used in earnest since 1975. Since we were told that there would be a talk on the telescope at 1.30 pm, we moved on the Schmidt telescope where my old friend and colleague, Bill Samson, obtained his images of star clusters, a project which he presented at an SAS meeting recently. The walls were covered in photographs of "The Bruck Years" from the time that Herman Bruck was Astronomer Royal for Scotland and when Bill and I did our PhDs. Many old friends were either in the photographs or were mentioned in the texts; however, a glaring omission was any mention of Bill or me!

After that, we attended a demonstration on "how to make a comet" which was very informative as well as being lots of fun for the children present. Then it was back to the dome of the 36" telescope for the presentation. For an awful moment, it seemed that the speaker might not turn up, and one of the guides even suggested that I might be asked to present. At last, my old colleague Russell Eberst appeared and spared my blushes.

After a snack lunch at the observatory refectory, we attended a short presentation on "Hunting for Planets in Stardust". Most planets that are known to exist in other stellar systems have been predicted by measuring the "??wobble" of the star due to the gravitational pull of the orbiting planet. This requires that the planet is large. Scientists at ROE have developed a method for detecting smaller planets of nearby stars by looking at the sub-millimetre part of the electromagnetic spectrum. The detectors they use are sensitive to low levels of heat emitted by dust and rocky debris surrounding the star.

It was time to leave and head for The Hub where we enjoyed a coffee prior to the lecture. In his lecture, Professor Barrow demonstrated the links between art and science by showing several examples, many of which were quite fascinating. If I were to offer any criticism (done with cap in hand, of course) there was very little flow to the talk (and not too much astronomy in spite of the title!); however, having bought and read his book, I can now see that it is impossible to encapsulate the content into a one-hour lecture and hold the flow together. That criticism apart, it was a rewarding experience.

After the lecture we headed for home, tired but fulfilled. It was a great day out.

Alex Houston

The approach to the Royal Observatory Edinburgh with the dome of the 36" telescope in the foreground.

WHAT WILL THE NEW SPACE TELESCOPE SEE ?

The Hubble telescope has already peered far into the Universe with its ultra deep field exposures. The James Webb space telescope, with its much larger aperture and more sophisticated infrared detectors able to overcome red-shifting and space dust, will see even further. The images will come from ever earlier epochs of the Universe; perhaps the first galaxies will be seen forming shortly after the Big Bang.

However, for an expanding Universe what is seen at very great distances may not be exactly as it appears. We are told light travelling through expanding space becomes red-shifted. This is in addition to the "Doppler" red-shift of a receding object, but there may be other effects as well.

Imagine a narrow pencil-beam pulse of parallel visible light, (actually about the length and width of an ordinary pencil) entering a volume of expanding space. As the beam passes through this volume it expands with the space so that it emerges as a longer pencil than when it went in. This effectively stretches the visible wavelengths to longer, redder wavelengths; hence the "space expansion red-shift". It could be argued that since the light beam enters a volume of space expanding in all three dimensions, x, y and z, then the light beam will also be expanded in all three dimensions. The expansion red-shift could be said to be the observed result of the light being expanded in the z dimension. In which case what might be the observed result of the light being expanded in the x and y dimensions? On the face of it, we would expect the pencil beam to emerge not only longer but also fatter. The same amount of light spread over a greater area will make images of distant galaxies appear dimmer than expected. There may be further, less predictable, optical effects caused by space diverged beams which would be relevant to deep space observations, and these might be explored in another article.

However, it is likely that the space-expansion that causes red-shift also causes time dilation. As our example pencil beam gets longer, so would its duration. It would be expected to emerge from the volume of expanding space as a pulse of light lasting longer than the one that entered. Therefore processes such as a supernova observed in a very distant galaxy would appear slowed down, that is, more slowed down than would be expected from the galaxy's recession velocity (the real Doppler effect).

I believe that recent observations of distant supernovae might have found them exploding too slowly, even allowing for recession velocities and the steady expansion of the Universe, and this has lead to the conclusion that the Universe is not expanding steadily, but at an accelerating rate. It has to be said; "Perhaps the James Webb telescope will throw more light on this convoluted subject"!

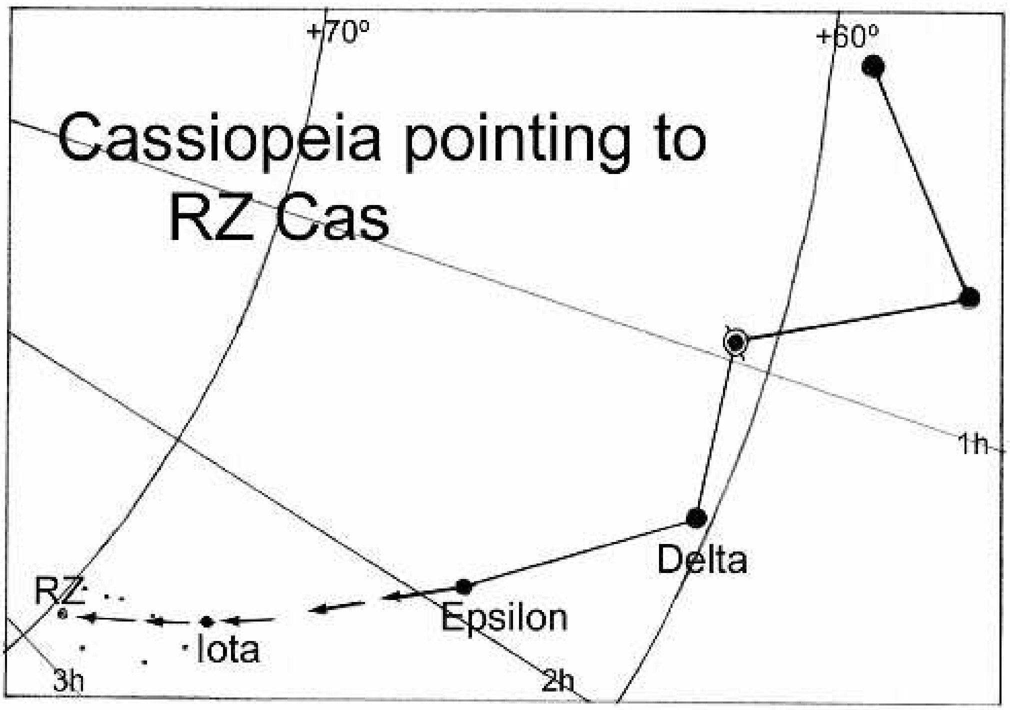
Chris Davis

RZ CASSIOPEIAE - THE ECLIPSE OF A BINARY STAR

24 April was cloudless, but with an even milky haze covering the sky and a full Moon. These were definitely class 3 conditions and not ideal for observing my first binary eclipse. However, the timing was convenient with the minimum predicted in "Astronomy Now" for 23.00 UT.

I had been meaning for some time to try this star, having checked out its position and the comparison stars, but so far something had always prevented me, so this time I was determined to give it a go. The sky was so bright I realised I would not be able to follow it to minimum with 8.5x44 binoculars alone, so I brought out my ETX90 telescope with 40 mm eyepiece which magnifies x31. Ideally, to observe binary eclipses you need Universal time accurate to within seconds. A GPS will give this, but I also found a useful website, *www.lagado.com/tools/time,* remembering to deduct an hour for BST. However, since some time inevitably passes between observation and checking one's watch, it is difficult to keep time that accurately.

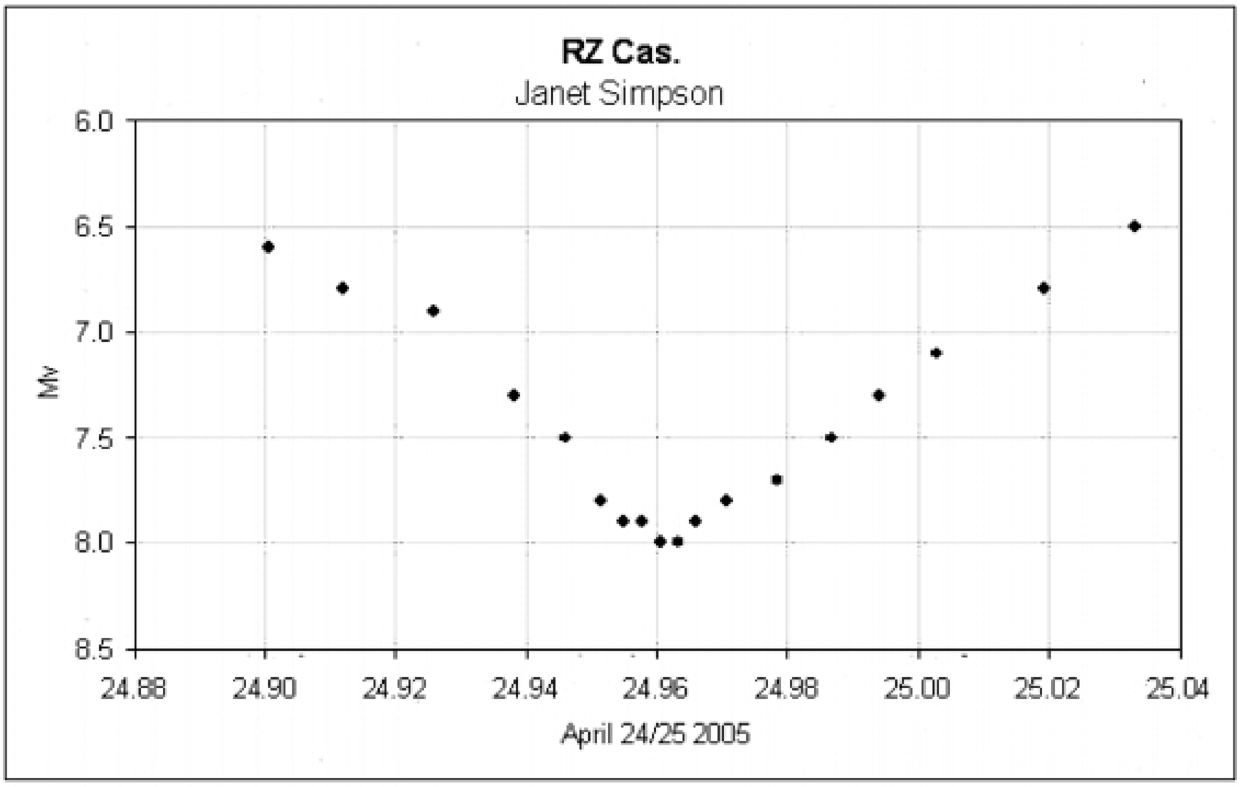
I started observing with binoculars, a bit later than intended, so I was not going to be able to cover the whole eclipse (4 hours 50 minutes). As I did not carry on to the end due to deteriorating visibility, my observations only covered 3 hours 11 minutes. My intention was to make an observation every 15 minutes, but I found it difficult to keep it this regular. In between the first three binocular observations I spent the time finding and recognising RZ Cas and the comparison stars with the ETX90 telescope, which reverses the sky horizontally. With this star I found it easier than expected, as RZ Cas lay more or less on an extended line from Delta and Epsilon Cas through Iota, a bright star of magnitude 4.5, with the comparisons on either side of this line.



The aim of following eclipsing binaries is to produce a light curve from which the time of the minimum can be deduced, to determine the system's period. If a change or correction to the orbital period is found, this is significant information which needs to be reported. The General Catalogue of Variable Stars elements gives the time of a minimum, from which other minima are predicted by adding multiples of the period.

The mid minimum can be deduced using computer software. Another approach is to use Pogson's method of bisecting cords. Points on the falling and rising sides of the curve are noted at regular intervals and the times of the two points for each magnitude are averaged. Points are then drawn on the graph corresponding to each magnitude and averaged time, and a curve is drawn through them to meet the light curve. This point of intersection defines the time and magnitude of the mid minimum. With this method my mid minimum worked out as 24.9617, approximately 2305 UT.

Thus my minimum was five minutes late. Tony Markham, the Eclipsing Binary Secretary of the Variable Star section of the BAA, said the elements for RZ Cas are over 10 years old, and over the years the orbital period has been slowly increasing. So consequently a mid eclipse a few minutes later than predicted is not unreasonable. My 8.0 magnitude minimum was slightly fainter than the normally quoted minimum, but that is not a problem as the time of mid eclipse is more important than the exact magnitude.



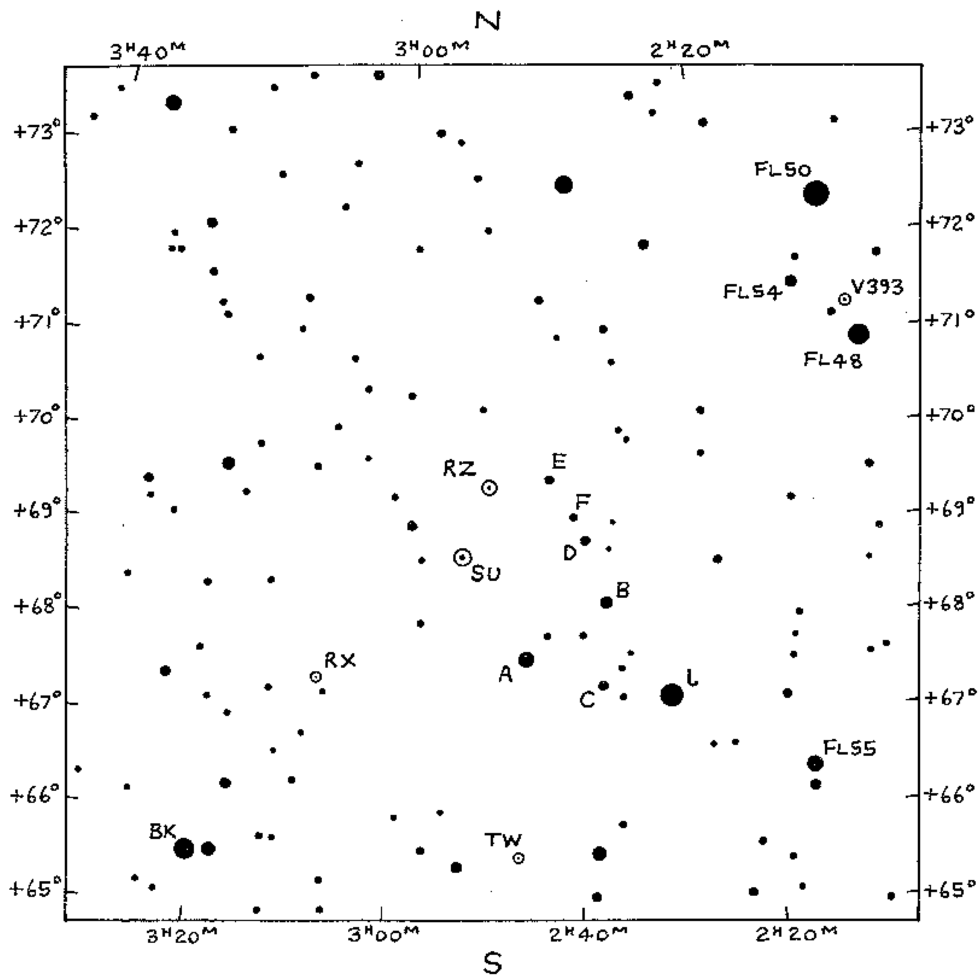
Light Curve of RZ Cassiopeiae

Eclipsing Binaries are binary systems of stars with an orbital plane lying near the line-of-sight of the observer. The components thus periodically eclipse one another, causing an apparent decrease in brightness which is greatest when the fainter star passes in front of the brighter. The period of the eclipse, which coincides with the orbital period of the system, can range from minutes to years.

RZ Cas is a classic Algol-type eclipsing binary. In Algol-type stars, the beginning and end of the eclipse can be identified from the light curves. Between eclipses the light remains almost constant, or it varies only slightly. This can be due to reflection effects (increased brightness on the side of the star facing a companion caused by heating from the radiant energy of the companion star), the slightly ellipsoidal shape of components, or physical variations. A secondary minimum may be absent. Light amplitudes also range widely and may reach several magnitudes.

236·01 9° FIELD DIRECT

RZ CASSIOPEIAE 02H 48.9M +69° 26′ (2000)



SEQUENCE: SKY & TEL - SEPT 1968.
CHART: FROM BOREALIS

A	6·0	D	7·4
B	6·8	E	7·7
C	7·3	F	8·0

BAA VSS
EPOCH: 2000
DRAWN: JT 26-12-97
APPROVED: [illegible]

RZ Cas consists of a hot primary star and a cooler, evolved secondary component. The system is highly active and has a complicated history of period changes due to mass exchange between components and the ejection of material from the system. The period is known to have increased substantially around 1993. Even although RZ Cas is well observed, the AAVSO still need more data to define and confirm details in the period.

Most light curves of RZ Cas at minimum have the rounded form of a partial eclipse, but occasionally the light curve seems to show a brief interval of constant light at minimum, which could indicate a total eclipse. However, these light curves should be interpreted with caution. All minima are "flat" at the moment when the direction of the light change is reversed. The displacement of just one or two data points by observational scatter can strengthen the impression of a brief interval of constant light. In addition, the shape of the minima of highly active binaries like RZ Cas could be affected by circumstellar gas streams, accretion discs, and starspots.

RZ Cas is one of the most popular eclipsing binaries. It has a magnitude range of 6.2-7.8 so is normally bright enough for binocular observers. It is circumpolar and so is visible all year for observers in mid-northern latitudes. It has a short eclipse, and an unusually fast period of 1.195 days which means there are several observable minima per month. Its period also changes in time.

Janet Simpson

MESSENGER IS COMING BACK AGAIN!

The *Messenger* spacecraft mission to the planet Mercury, currently on its way, was discussed in earlier articles in this *Mercury* last year. In the April 2004 issue (Vol 19 No 2) it was explained how the sling shot effect will be used to help guide the spacecraft towards Mercury and get it into orbit around that planet. *Messenger's* original launch date from Earth was meant to be in March last year and its trajectory would include two slingshot flybys of Venus. Problems occurred and the launch date had to be put off to a date in May. The consequence of this was that then three flybys of Venus would be needed to get the spacecraft to Mercury. As it turned out, *Messenger* was not actually launched until August, and the whole complex trajectory manoeuvres had to be worked out all over again (the relative positions of the planets are of course changing all the time). This time the actual trajectory the spacecraft is now following includes a flyby of Earth to set it on a course towards Venus.

At present *Messenger* is in orbit around the Sun moving at over 69,000 miles/hr. Its Earth flyby will be quite close. On 2 August this year it will be less than 1500 miles above Mongolia as it shoots by. It is then due to make two flybys of Venus and a flyby of Mercury before going into orbit around Mercury in March 2011, 20 months later than was originally planned.

Derek Allen

THE SKY AT NIGHT : July, August and September 2005

SUN

		July			August		September	
		2	16	30	13	27	10	24
(approx)	Rises	04.37	04.54	05.18	05.44	06.12	06.39	07.06
(approx)	Sets	22.04	21.51	21.28	20.58	20.24	19.48	19.11

MOON

	July				August				September			
Phase	NM	FQ	FM	LQ	NM	FQ	FM	LQ	NM	FQ	FM	LQ
Date	6	14	21	28	5	13	19	26	3	11	18	25
Rises	03.20	13.38	22.20	23.22	04.54	15.44	20.53	21.57	05.20	16.26	19.22	21.53
Sets	22.42	23.58	03.38	14.53	21.59	22.36	04.26	15.31	20.03	21.36	06.50	16.46

PLANETS			***Magnitude***
MERCURY	*July*	Unsuitable for observation.	
	August	Unsuitable for observation until last few days of month. It then becomes a morning object.	+0.5 to -0.9
	September	Visible only first five days of month, low ENE sky.	-1.1
VENUS	*July*	Visible W horizon half hour after sunset.	-3.9
	August	Visible W horizon half hour after sunset.	-4.0
	September	Visible W horizon half hour after sunset.	-4.1
MARS	*July*	Morning object visible after midnight in Pisces.	-0.1 to -0.5
	August	Now visible before midnight In Aries.	-0.5 to -1.0
	September	Visible all night. Moving from Aries into Taurus.	-1.0 to -1.7
JUPITER	*July*	Evening object in Virgo in SW sky.	-1.9
	August	Visible short time SW sky. Becoming more difficult due to twilight.	-1.8
	September	Unsuitable for observation - will reappear in November.	
SATURN	*July*	Unsuitable for observation.	
	August	Becoming visible in morning second half of month, low E horizon.	+0.3
	September	Morning object SE quadrant in Gemini.	+0.3
NEPTUNE	*August*	In Capricornus, not visible to naked eye.	+7.8
URANUS	*September*	Barely visible to the naked eye in Aquarius.	+5.7

CONSTELLATIONS (near meridian at 22.00)

16 July	Ursa Major, Draco, Coruna, Hercules, Lyra, Serpens, Ophiuchus, Libra, Scorpius.
16 August	Draco, Hercules, Lyra, Cygnus, Sagitta, Aquila, Orphiuchus, Serpens.
15 September	Draco, Cepheus, Lyra, Cygnus, Vulpecula, Delphinus, Sagitta, Capricornus.

CONJUNCTIONS (with the Moon unless otherwise stated, and based on observing at 51°N)

July

Day	*Time*	
5	06.00	Earth at aphelion (152 million km)
7	18.00	Saturn 5^{O} S
8	22.00	Venus 3^{O} S
8	23.00	Mercury 5^{O} S
9	11.00	Venus 2^{O} N of Mercury
13	19.00	Jupiter 0.7^{O} N
23	04.00	Mercury at stationary point
23	18.00	Saturn in conjunction
27	18.00	Mars 4^{O} S

August

Day	*Time*	
4	07.00	Saturn 5^{O} S
5	07.00	Mercury 9^{O} S
6	01.00	Mercury in inferior conjunction
8	06.00	Venus 1^{O} S
8	17.00	Neptune in opposition
10	08.00	Jupiter 1^{O} N
16	05.00	Mercury at stationary point
25	05.00	Mars 6^{O} S
31	20.00	Saturn 4^{O} S

September

Day	*Time*	
2	01.00	Jupiter 1^{O} N
2	13.00	Mercury 3^{O} S
6	23.00	Jupiter 2^{O} N
7	10.00	Venus 0.6^{O} N
18	04.00	Mercury in superior conjunction
22	05.00	Mars 6^{O} S
28	09.00	Saturn 4^{O} S

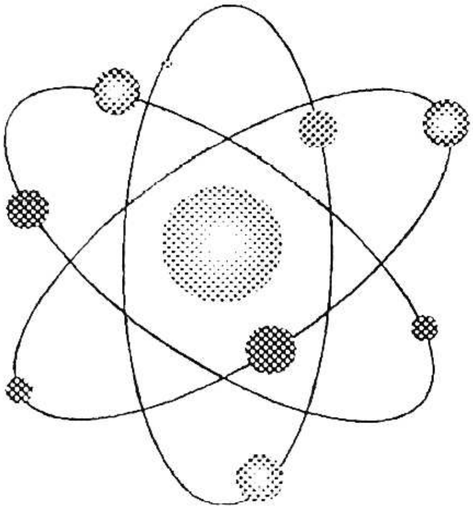
METEORS

12 August Perseid shower occuring from late evening onwards.

ZODIACAL LIGHT

September Morning cone can be seen reaching up from eastern horizon along the ecliptic before the beginning of the morning twilight from 3 to 16 September.

Compiled by Hamish Macphee



Stirling Astronomical Society

OFFICERS AND COMMITTEE FOR 2005

President	Dr Ken Mackay
Chairman	Dr Alan Cayless
Secretary	Keith Waller
Treasurer	Dr Iain Smith
Membership Secretary	Albert MacKenzie
Committee Member	Terry Aitchison

For information about Stirling Astronomical Society, membership and activities, please contact the Secretary, Keith Waller :

Tel : *01786 474242*
E-mail : *k.waller@contactbox.co.uk*

Or visit the SAS website :
www.stirlingastronomicalsociety.org.uk

STIRLING ASTRONOMICAL SOCIETY MEETINGS

Regular Society Meetings are held from September through to May. Lecture Meetings usually take place on the second Friday of the month in the Smith Museum Lecture Room, Dumbarton Road, Stirling from 7.30 pm to 9.30 pm. Details of the lecture programme are available from the Secretary (tel 01786 474242). They will also be published here in *Mercury*, on the Society's website, and in the *Stirling Observer*. These Meetings are free and anyone with an interest in astronomy is welcome to attend, whether a member of the Society or not.

Members' Evenings are informal discussion meetings which are usually held on the last Friday of the month at the Mayfield Community Centre, St. Ninians, Stirling, from 7.30 pm to 9.30 pm.

At suitable times and with suitable weather conditions, arrangements are also made for groups of members to meet for observation sessions.

Meeting dates for the 2005 - 2006 session are as shown below.

2005

9 September	Smith Lecture
30 September	Mayfield Members' Evening
14 October	Smith Lecture
28 October	Mayfield Members' Evening
11 November	Smith AGM (business with two short lectures)
25 November	Mayfield Members' Evening
9 December	Smith Lecture
16 December	Mayfield Christmas Festivity *(Note - not 30 December)*

2006

13 January	Smith Lecture
27 January	Mayfield Members' Evening
10 February	Smith Lecture
24 February	Mayfield Members' Evening
10 March	Smith Lecture
31 March	Mayfield Members' Evening
21 April	Smith Lecture *(Note - not 14 April)*
28 April	Mayfield Members' Evening
12 May	Last Smith Lecture
26 May	Last Mayfield Members' Evening

Noctilucent clouds and jet trail, 19 June 2005 - Douglas Cooper

EDITORIAL

Thanks to all contributors. Please think about pieces, articles and images for the next issue. Items describing events or the activities of the Society, or of individual members or groups of members, are especially welcome; also advanced notification of future events and activities.

Please give your contributions to (or first discuss them with) the Editor :

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Copy can be in clear handwriting, typescript, images for scanning, e-mail attachments, or on floppy disk or CD. Contributions should normally not be more than about 750 words in length, or 1000 at the most. Please try to have material ready by the beginning of September for the October issue of *Mercury*.