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EDITORIAL

The forthcoming observing season has seen a return to our natural enthusiasm for things astronomical and we have a packed 24-page issue of *The Mercury* as a result.

Mark Butterworth kicks off on page 2 with a look at the history of projection planetariums. These are very often the layman's first introduction to astronomy and the universe and, as such, have a major impact on the way astronomy is regarded in the community. Bert Mackenzie reports his observing experiences on a trip to Norway on page 5, while Sandi Cayless starts two articles on relating astronomy and spaceflight to music on page 6. Music has been linked to astronomy from the days of Ptolemy through Kepler and Holtz to the Brians of today (May and Cox) and there are countless other examples.

On page 11, Chris Davis gives his usual report on our Smith lectures, this time on the excellent talk given by Andy Longmore on adaptive optics. Janet Simpson presents a spectral analysis of the fluorescent lights of a fish farm local to her on page 12 and there are more examples of Janet's work on page 16. On page 17, our guest article for this issue is by John Rachlin and is about the particular scientific challenges of the SETI project. I contribute a series of questions on page 20 and these are meant to get members questioning what they do within the Society, whether the efficiency of these tasks can be improved, and what the future work of the Society should involve. The usual report on the night sky and announcement of forthcoming meetings can be found on pages 21 and 23 respectively.

Once again, I thank all contributors for their continued support.

Alex Houston

A HISTORY OF PROJECTION PLANETARIUMS

The idea for the modern projection planetarium came in 1913 from Oskar von Miller, the founder of the Deutsches Museum in Munich, while trying to develop an attraction for its astronomical section. He discussed possibilities with the astronomer Max Wolf[1] in Heidelberg who suggested a public show that demonstrated the motions in the sky. Originally, Wolf thought of a rotating sphere of stars with the visitor in the centre while the events occurred in time lapse. Miller approached the Carl Zeiss Company in Jena with the idea. Walther Bauersfeld, chief engineer at Zeiss, was working on shell constructions for large, free-standing observatory domes and developed a design, though the work was delayed by World War I.

Between 1919 and 1923 Bauersfeld invented and developed the first planetarium. The main design was an electrically driven star projector. The concept was a small sphere in the centre which would display the stars on the inner surface of a roof dome. A smaller sphere would be equipped with tiny projectors and rotate parallel to the axis of the World. This is the basis of original planetarium with the opto-mechanical projector which we might see today. The technical details of Bauersfeld's design amounted to more than 600 pages. A large staff of engine builders, opticians and electricians were commissioned to build the Zeiss Planetarium Mark 1 and it opened at the Deutches Museum in Munich on October 23rd, 1923.

A few weeks of public presentations followed and then, the projector was returned to Zeiss for final completion. Two instruments were manufactured, the second having some small improvements such as the ability to vary latitude and projecting circles for the meridian and ecliptic. It was intended as a trial device but was delivered to Dusseldorf as requests for planetarium projectors rapidly outpaced manufacturing capability. Munich's Model-I operated until 1951 and then it moved into another dome but in the same building. In 1960, it was replaced by a newer model and is now an exhibit in the museum.

While the engineers at Zeiss were still working on the first model, in 1926 a new generation design was developed. It was an all-purpose device for any place on Earth and could easily swing to project Southern skies. The objects below the local horizon were masked by a bezel. The idea envisaged two separate star spheres, one for each hemisphere. It used a dumbbell-design, the so-called "Mark-II". Each sphere was 75 centimetres in diameter and they were connected by a bridge that enclosed the planetary projectors. This bridge was also the main axis mounted on a pivot. The design of the Mark-II dominated the appearance of planetarium pro-

[1] Max Wolf discovered asteroid 4809 in 1928. In 2004 it was renamed Robert Ball after lobbying by Stirling Astronomical Society

A Zeiss Mark-II Dumbell Projector

jectors for several decades. Twenty five systems were produced before the Second World War, with five sold to the USA and two to Japan.

The first non-Zeiss projector was constructed by Frank and John Korkosz in Springfield, Massachusetts. It was a sphere of 1 meter and displayed 7150 stars down to 5th magnitude but no planets. The star fields were arranged on 41 individual plates. The projector went into service on October 10th, 1937. It was extremely well made and the original is one of the oldest machines still operating today. While John handled the technical details, Frank devoted himself to the public presentations. In the course of the following two decades he conducted more than 10,000 shows and his star demonstrations were seen by nearly 1 million people.

In the late 1950's Frank and John built a second and larger projector for the Hayden Planetarium in Boston, MA. It used separate lamps for each of the different magnitude stars and was brought into service in 1958. The lack of spare parts as well as no planet projectors meant it was eventually replaced in the 1970's with a new Zeiss projector.

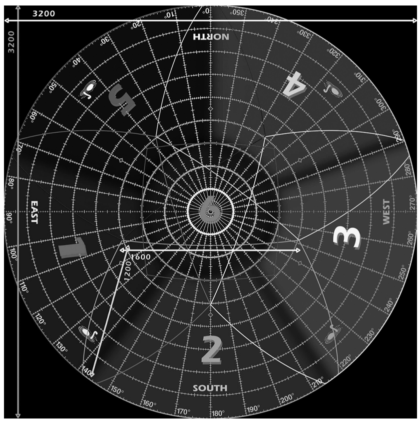
Armand Spitz gave his first public lecture using a projector of his own design at the Harvard Observatory in 1947. He constructed a projector that was to approximate the star globe by an icosahedron. The stacking and drilling of star holes into flat sheets would make the production process easier and cheaper than a star globe. Later, following a suggestion by Albert Einstein, Spitz used a dodecahedron as the projector body.

In 1949, he founded the Spitz Company and began marketing his "Model A" for $500. The Cold War encouraged the US government to provide enhanced funding for scientific education, so the cheap planetarium projectors were sold, many to American military academies, small museums, and schools. Within a few years Spitz introduced the model "A-1", which was the first mobile apparatus. It incorporated the Sun, Moon, and five naked eye planets, still using the dodecahedron shape. The models were continually improved, and the business peaked in the version "A3P". It became the most widely used projector of any type.

The Japanese industrialist Seizo Goto, established his company to produce telescopes in 1926, and expanded to include planetarium projectors. Later, the Minolta Company also began to produce projectors and presented their first "Model #1" at the Science Exhibition in Hanshin Park in Koshien (close to Kobe). Both companies continued to develop their designs and in 1984 Minolta launched its model "Infinium", the world's first single-sphere projector. The dumbbell-form was removed from its planetary cage, and the projectors for the solar system objects moved to a special platform outside. This allowed the ball to be moved much faster to its designated position. Zeiss copied this innovation and adopted it to its latest models after 1987. In 1996, Zeiss improved the imaging quality stars of the sky by using fibre optics for each star. Today, both the star ball and the fibres are the substantial elements of the modern opto-mechanical projector. Many large and middle-sized planetariums use these types of projector.

The audio-visual shows in the planetarium evolved as the technology advanced. Pre-recorded shows became available, graphical all-sky pictures filled the dome, and digital effects were added. Using a computer-controlled system, peripheral devices like tapes, slides, and video projectors were incorporated. The first moving scenes were possible when computers generated the image which was then projected onto the dome. A single projector installed near the centre could be employed with a fish-eye lens to spread the light over the whole dome surface, while in other configurations two or more projectors are arranged around the dome edge and interlinked to blend together seamlessly. This system is known as "full-dome".

The company Evans & Sutherland launched this full-dome system naming it "Digistar". The technology developed from military flight simulators and it is extremely popular for space movies. The first planetarium converting to pure digital projection was London in 1995. Digistar-3 was released in 2003. However, the resolution of the computer generated stars has not yet reached that of the pinpoint stars of a top quality opto-mechanical projector, as they are limited by projector resolution.



Projection pattern for a six projector “full-dome” system

Modern digital planetarium employ up to six projectors to cover the whole dome. Located equally spaced around the floor of the dome, each is driven by its own computer and connected to a central processing centre. The images projected by each device are distorted by the software to create a realistic “full-dome” effect. Modern computer generated programs featuring star patterns, planetary motion, zoom effects, images, rapid sky movements and video are combined with surround sound effects with pre-recorded narratives, often presented by celebrities. The overall audience experience is a far cry from the first planetarium opened in Munich in 1923.

Mark Butterworth

OBSERVING AT 60 DEGREES NORTH

Perhaps I should add ‘in August’ to the title of this article. I spent nearly three weeks in Norway in the middle of August and was looking forward to seeing the Perseid Meteor Shower in dark rural areas with no light from the Moon to interfere. Perhaps, even some aurora? However, I had forgotten the problems of high altitude observing just three degrees south of the “Midnight Sun” - the sky barely darkened before one o’clock and as it happened, although we had excellent weather during the day, in the mountain areas, cloud or valley fog built up at night and I didn’t see any meteors.

On the 18th of August, we sailed on the Hurtigruten Ferry/Cruise from Trondheim to Bergen - an excellent one and a half day trip, part of the regular 10 day North and South service along the coast of Norway. At 0030, we lay on the abandoned deck chairs of the upper deck and tried to identify the prominent stars gradually appearing in the bright Northern sky. Arcturus and Capella were followed by the stars of the Plough but some thin cloud above the coastal mountains to the East made things difficult. The “expert” predicted that Jupiter would be seen above the mountains shortly and, low and behold, there it was ……..except it turned out to be a helicopter! As the boat drifted slowly southwards another bright object appeared in the southeast - yet another helicopter. Eventually Jupiter did appear and as the night slowly darkened I headed for bed about 1.30am, having just identified the Andromeda Galaxy through binoculars.

There were advantages to observing at this time of year - it was warm and particularly on the boat, there were no midgies, but dark skies? - forget it!

Bert Mackenzie

SONGS THAT FEATURE ASTRONOMY

There have been several different songs with *Astronomy* as or in the title – here are some examples:

Astronomy – first published on the 1974 album *Secret Treaties* by Blue Oyster Cult; it was also covered on the 1998 album *Garage Inc* by Metallica
Astronomy – a song on the 2006 album *Astronomy* by Dragonland; the album also includes the songs *Supernova*, *Cassiopeia*, *Contact* and *Antimatter*
Astronomy – a song on the 2003 fifth full-length album *Astronomy* by the Christian rock band Bleach
Astronomy – by Jethro Tull on *Under Wraps*, the 15th studio album produced by the band in 1984
Astronomy – by Good Luck Varsity on their September 2007 debut EP *Head High Heavy Hearted*
Astronomy – by Thin White Rope on their album *In The Spanish Cave* (1998) and also on their album *The One That Got Away* (1993 and 2002)
Astronomy (8th Light) – on *Black Star*, an album-length collaboration of Talib Kweli and Mos Def released August 1998
Astronomy Domine – by Pink Floyd: written and composed by Syd Barrett and the first track featured on their debut album *The Piper at the Gates of Dawn*, in 1967. It has been covered by several artists since then.
Astronomy Is My Life, But I Love You – on the 2006 EP *Astronomy Is My Life, But I Love You* by Breaking Laces
Divine Astronomy – by Human Fortress on their album *Lord Of Earth And Heavens Heir* in 2001

Sandi Cayless

SPACEFLIGHT AND WAKING UP TO MUSIC

The wake-up call is a long-standing NASA tradition that extends back to the mid-1960s and the Gemini programme. Each day during the mission, flight controllers in Mission Control aim to greet the crew with a suitable musical tribute. Wake-up calls are chosen by flight controllers or friends and family of the crew and most are musical, ranging from rock, country, classical and jazz to children's and international songs from crewmembers' countries. Musical themes recurring over the years include references to spaceflight and the view from up there, with classics such as Louis Armstrong's *What a Wonderful World*, the Beatles' *Here Comes the Sun* and various versions of *Fly Me to the Moon*. Movie themes have included *2001: A Space Odyssey* during the Apollo missions, and *Star Wars* and *Star Trek* for several Shuttle missions. Astronauts away from their families during holiday times have often been greeted with *I'll Be Home for Christmas* and similar appropriate jingles.

The 1965 Gemini VI mission awoke to *Hello, Dolly*! In 1972, the first wake-up call for Apollo 17 astronauts Gene Cernan and Jack Schmitt on the Moon was Wagner's *The Ride of the Valkyries*. On the morning of leaving lunar orbit for the journey home, they heard *Home for the Holidays* and subsequently The Carpenters' *We've Only Just Begun*, in the belief that the end of the Apollo programme was not the end of the lunar adventure. The morning of splashdown was a dual selection of the Navy's *Anchors Aweigh* and *The Star Spangled Banner*. Skylab 3 and 4 crews in 1973 were treated to favourites such as *Girl from Ipanema*, *Come Fly With Me*, *Moonlight Becomes You*, *The Lonely Bull*, and over the Christmas period, various seasonal tunes. The Apollo crew of the Apollo-Soyuz Test Project (ASTP) through July 15-24, 1975 heard among other appropriate wake-ups, *Good Morning Sunshine* and *Midnight in Moscow*.

With the advent of the Space Shuttle, wake-up songs or routines were required to be very recognisable to the crew, because the speaker units on board the shuttle are designed to communicate alarm tones rather than reproduce music. Wake-up calls are arranged before the mission. Non-musical wake-ups have included The Muppets' *Pigs in Space* routine for the crew of STS-2 in 1981, preceded by *Columbia, Gem of the Ocean*. The STS-3 crew heard *On the Road Again* by Willie Nelson, whilst *Up, Up and Away* greeted the crew of STS-4. The team aboard STS-8 in September 1983 heard *Tala Sawari* performed by Ravi Shankar on the sitar in honour of the release of the Indian INSAT satellite. Crewmembers on mission STS-51-A in November 1984 listened to, among other numbers, *Good Morning Starshine*. Songs for STS-51-D in April 1985 included the Carpenters' *Top of the World*, *Stargazer* and *Skybird* by Neil Diamond, Wagner's *Ride of the Valkyries* and *Rocket Man* by Elton John. *Waltzing Matilda* awakened the crew of STS-51-I in 1985 as they passed over Australia. Personal tributes to crew members have included Mendelssohn's *Wedding March* and *Get Me to the Church on Time* by Lerner and Loewe in honour of STS-51-G's pilot John Creighton's forthcoming wedding in 1985.

When shuttle Discovery (STS-26) made the first post-Challenger flight in September 1988, the astronauts awoke to a parody of the Beach Boys *I Get Around* called *We Orbit 'Round* by radio disc jockey Mike Cahill; the astronauts themselves clowned for TV cameras in bright Hawaiian shirts. The STS-27 (Atlantis) crew late the same year awoke to a message in Darth Vader's voice against a background of the *Star Wars* theme music, followed by satirical lyrics to The Beatles tune *Do You Want to Know a Secret*? Such antics upset NASA, as the few minutes of play tended to get more airtime than the hours of hard work put in by the crews. Future crews were therefore ordered to tone things down when cameras or microphones were in use. Nonetheless, shuttle Discovery's (STS-29) crew in 1989 woke Mission Control with the Star Trek theme followed by congratulatory comments from William Shatner - Mission Control replied with a medley of school songs from crew members' alma maters and an *ad lib* from Capcom (spacecraft communicator) G. David Low: "Discovery, Houston – beam me up, Scotty."

The Star Trek theme is a common one. To the theme music of *Star Trek - the Next Generation*, the STS-44 Atlantis (Nov 24-Dec 1, 1991) crew heard "Space - the final frontier. This is the voyage of the Space Shuttle Atlantis - its ten-day mission: to explore new methods of remote sensing and observation of the planet Earth; to seek out new data on radiation in space, and a new understanding of the effects of microgravity on the human body; to boldly go where two hundred and fifty-five men and women have gone before. Hello - Fred, Tom, Story, Jim, Tom, and especially Mario. This is Patrick Stewart, choosing not to outrank you as Captain Jean-Luc Picard, saying that we are confident of a productive and successful mission. Make it so." This special wake-up call was especially for Mario Runco Jr, mission specialist and avid Star Trek fan.

The crew of STS-48 Discovery in September 1991 were treated to *Please Release Me* by Elvis Presley in anticipation of the deployment of UARS, the Upper Atmosphere Research Satellite., and then later to Presley's *Are You Lonesome Tonight*? - chosen for the line "Are you sorry we drifted apart?" with reference to Discovery's separation from the UARS payload. This was followed by Presley's *Return to Sender* in honour of the expected landing. Presley's *Please Release Me* also featured aboard STS-51 (Discovery) in September 1993 – it was sung by Elvis impersonator and astronaut Carl Walz, who was actually aboard, on his maiden spaceflight – he had the uncommon experience of hearing his own voice singing for his first wake-up in space.

Other appropriate pieces have included STS-52 (Columbia) waking to Hawaiian music in honour of the day's planned discussion between Columbia's crew, students at the University of Hawaii and the Polynesian sailing canoe "Hokulea" located somewhere in the South Pacific. During the same mission, *Monster Mash* by Bobby Pickett was played on Halloween and Control included a pattern for a cut-out mask in flight plans radioed to the shuttle. The first Russian cosmonaut to fly aboard a US spacecraft, Mission Specialist Sergei Krikalev, was honoured with Russian folk tunes as a wake-up aboard STS-60 in 1994. Only one wake-up call was included by Control to STS-68 in October 1994, as the crew worked two shifts around the clock: there was a problem with the galley water system putting bubbles into the crew's drinking water – so Capcom Bill McArthur sent the song *Tiny Bubbles* to Blue shift. The crew of STS-70 in July 1995 was awakened to the theme from Woody Woodpecker, the cartoon character adopted as the mission mascot: real woodpeckers had bored holes in protective insulation on Discovery's external fuel tank the previous month, delaying the mission.

Mission STS-84 from 15 to 24 May in 1997 set a record for the number of different countries in which crewmembers were born: Precourt, Collins and Lu (United States), Kondakova (Russia), Clervoy (France), Foale (UK) and Noreiga (Peru) and wake-ups included the British, French, Peruvian, Russian and US national anthems. The Superman TV theme song was played in 1998 (STS-91) in honour of Franklin Chang-Diaz's record-breaking time in orbit aboard a space shuttle, a total of more than 51 days spent in orbit during six shuttle flights. Aboard STS-96 on 4 June 1999, *Good Morning Starshine* was played in recognition of the deployment of the Starshine satellite, whilst astronaut Culbertson on STS-105 in August 2001 heard *Back in the Saddle Again* by Gene Autry to commemorate his third flight into space, eight years after he last flew. The crew of STS-111 in June 2002 were treated to *I Got You Babe* by Sonny and Cher from the Groundhog Day film soundtrack - a recurrent theme for wake-up calls on missions which are extended an additional two days, with the astronauts being required to repeat their de-orbit activities each day, to be told that because of bad weather they will have to go through the same tasks again the next day. This was Commander Ken Cockrell's third mission in a row where he had to remain in orbit for an extra two days because of poor landing weather in Florida. STS-111 eventually landed at the alternative site in California. This theme was also played for the crew of STS-113 in Nov-Dec 2003, who set a new record for the number of landing tries, as well as for the entire crew of STS-114 (Jul-Aug 2005) to commemorate its first day out of quarantine.

STS-114 was the first "Return to Flight" space shuttle mission following the space shuttle Columbia disaster. On 31 July 2005, astronauts Steve Robinson and Soichi Noguchi woke up to prepare for the second spacewalk of the mission to *Walk of Life* by Dire Straits, in honour of their upcoming repair work on the International Space Station. On 3 August, wake-up was *Amarillo By Morning*, not dedicated to the crew in space but to the Columbia STS-107 crew commanded by Amarillo Native Rick Husband. The day included a dedication to the Columbia crew and other space explorers who died during their missions. A few days later, on 7 August, Houston called up with Dexy's Midnight Runners' *Come On, Eileen*, in honour of Commander Eileen Collins.

Most wake-up calls are of necessity short, two to three minutes. The longest

Earth-to-space wake-up call, lasting almost 14 minutes, was a live wake-up mini-concert by Paul McCartney in 2005 to International Space Station astronauts Bill McArthur and Valery Tokarev. McCartney played *English Tea* and *Good Day Sunshine* in the first-ever concert link-up to the space station, the call observing the station crew's 44th day of a planned six month space mission. The performance was beamed from the West Coast to the space station 220 miles above Earth and broadcast on NASA television.

Other than human ears have also been the recipients of wake-up calls – the robotic explorers on Planet Mars have been listening to their own since 1997, when mission controllers at NASA's Jet Propulsion Laboratory played *The Final Frontier* theme from American sitcom "Mad About You" for Mars Pathfinder and the Sojourner rover. Pathfinder and Sojourner have also heard tunes such as *Follow You, Follow Me* (Genesis), *Let the Good Times Roll* (Ray Charles) and *Love Me Like a Rock* (Paul Simon). The Spirit and Opportunity rovers have also had their share: *Dust in the Wind* by Kansas was played as Spirit tried to capture dust devils spinning across the Martian surface. Other hits for Spirit included: *(I Can't Get No) Satisfaction* by the Rolling Stones (Spirit's air bags not cooperating); *Get Up, Stand Up*, by Bob Marley (lift mechanism actuated); *Reach Out* by the Four Tops (first robotic arm activity); *We Will Rock You* by Queen (first arm activities and observations on a rock); *S.O.S.* by Abba (the objective was to regain contact with Spirit after a loss of communication – they did); *Baby, Talk to Me*, from the musical Bye Bye Birdie (the objective was to get Spirit to send data – she did); *We Can Work it Out* by The Beatles (beginning debugging activities to get Spirit back to normal); and, *I Still Haven't Found What I'm Looking For* by U2 to pay homage to Spirit's twin rover Opportunity's astounding findings of evidence of water at Meridiani Planum. Opportunity "heard" *Stand* (REM) and *I'm Still Standing* (Elton John) at stand-up, *Release Me* (Elvis Presley) at middle wheel release, *Born to Run* (Bruce Springsteen) at wake-up and *Going Mobile* (The Who) at egress. These were followed by, among others, *Pictures of You* (The Cure) for the first MI image, *Please, Please Tell Me Now* (Depeche Mode) at first MB data readout of soil, and The Flintstones Theme Song for the arrival at the "bedrock". On Mars day ("Sol") 29 of the mission, *Riders on the Storm* by the Doors was played in recognition of heavy weather at Deep Space Stations (DSS) DSS-63 (Madrid) and DSS-14 (Goldstone, California) and on Sol 39, *Bad Moon Rising* by Creedence Clearwater Revival was played in honour of the eclipse caused by the Martian moon Deimos. The transit of Martian moon Phobos on Sol 45 was recognised by Pink Floyd's *Eclipse*.

Such robotic explorers have also been given the capacity to return music to Earth: ESA's Mars Express spacecraft carried a recording called *Beagle 2* performed by pop band Blur (Blur helped raise funds for the Beagle 2 lander mission). It was supposed to be played back to Earth on Christmas Day 2003…

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Sandi Cayless

ADAPTIVE OPTICS

by Andy Longmore of the Science and Technology Facilities Council

Smith lecture 10 Sept 2010

Synopsis of principles

Andy gave a brilliantly clear explanation of how the seemingly impossible is achieved by adaptive optics to counteract the astronomers' bane of "bad seeing".

First he defined the "bad seeing" problem by explaining that light from a very distant object like a star arrives at the top of the atmosphere as essentially planar wave-fronts which then get buckled and corrugated on their way down to the telescope by the turbulent atmosphere.

The challenge for adaptive optics is to flatten out the wave fronts again before they are finally focused to an image. The first step is to detect the distortion in the wave-front, then deform an intervening mirror in such a way as to flatten out these wave-front distortions. Since atmospheric disturbances change significantly in just milliseconds the detection-correction cycle has to be very fast. The speed is achieved with CCD detectors (like those in sensitive cameras), powerful computers to convert the detector signals to actuator commands, and fast piezo-electric actuators acting on a very thin flexible correction mirror.

The distortion detector takes a sample from the entire cross section of the telescope's light path and passes it through an array of tiny lenses each with a focal point at the centre of its own square of four CCD pixels. The detector is aimed to detect any near-by star brighter than magnitude 10 to act as a guide star. In perfect non-turbulent conditions the image of that star would focus at the centre of each of the little four-pixel square windows giving an equal light signal from all four of the pixels. This would indicate that the actuator corresponding to that part of the mirror need not be moved up or down.

On the other hand in turbulence, a wave-front tilted by the atmosphere striking one of the detector lenses at an angle would be focused off-centre giving different light level signals from the four pixels. The adaptive optic system's computer is able to use the differences to calculate in which direction the wave-front is tilted and by how much, then goes on to calculate how much the corresponding actuator and its neighbours need to push or pull on the correction mirror to flatten the wave front in that area. Combining the detector information from all the lenses results in correction mirror actuator settings which help smooth out the whole of the wave-front heading towards the telescope's focal point.

The more detector lenses and correction actuators that are deployed across a telescope's optical path the flatter the final wave-front becomes, and the sharper the final image. This is particularly important for large aperture, ground-based telescopes, whose potential resolution is proportional to their diameter, but whose actual resolution was always limited by atmospheric distortions.

Andy showed us a computer generated image of a proposed 42m diameter European very large telescope observatory which dwarfed Stirling castle on its rock in a scale photograph. This optical telescope observatory will be comparable in size to the huge Jodrell Bank radio telescope. Such an optical giant will need some heavy duty adaptive optics, but the resulting high resolution view into the Universe should be stunning.

Chris Davis

FLUORESCENT LIGHT SPECTRUM

Across the burn from us is a Smolt fish farm which has recently expanded, and now has more, brighter lights than previously.

I had a look at them through the camera with a Star Analyser[1] (100 lines/mm blazed grating in 1.25¢¢ filter holder) mounted in front of the lens, and saw emission spectra. Since I had not, at that time, yet managed to get any spectra of Wolf-Rayet stars, I thought it would be fun to photograph an emission spectrum, even if not a star! Good practice, and I thought it would be interesting to find out from the spectrum what kind of lights they are.

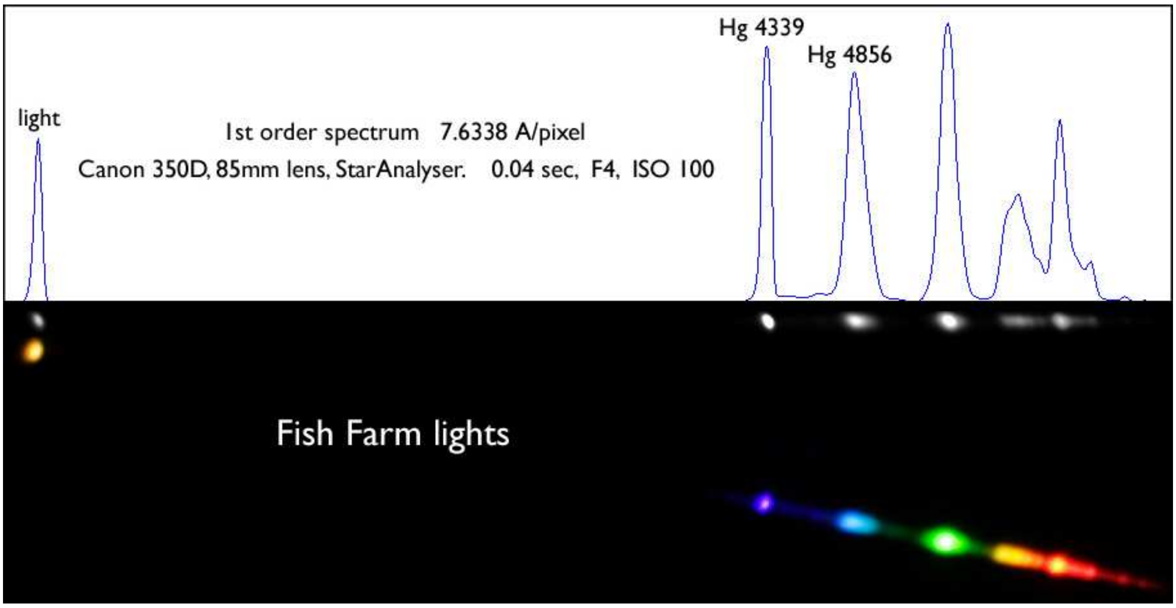


Figure 1: First attempt using 1st order spectrum.

Figure 1 is done in the usual way using the first order spectrum (the one which gathers the most light, immediately to the right of the light) with more spectra spread out in a line stretching either side of the light source.
When compared to other spectra, one from Christian Buil's website [2], and one from Wikipedia[3], the spectrum proved to be from a fluorescent light. Through these comparison spectra I was able to make an attempt at identifying the elements.

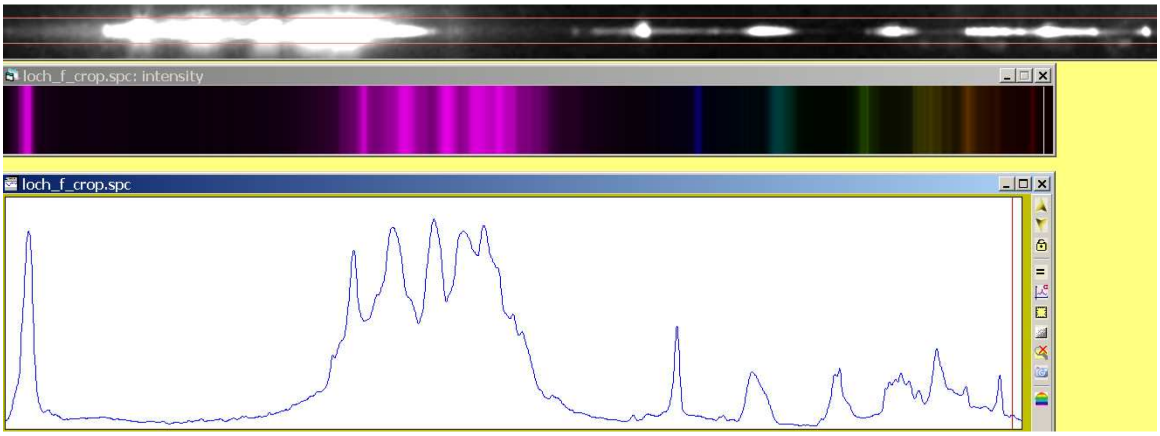


Figure 2: Over exposed light and 1st order spectrum (magenta), followed by more detailed second order.

Ken Harrison suggested I try the 2nd order from my over-exposed spectrum. In fact he produced Figure 2. He left the light source and 1st order in, so he could calibrate the spectrum with ‘0’ for the light source, and ‘Hg 4358’. The profile of the over-exposed 1st order spectrum is somewhat like my first attempt. The second order is more widely dispersed and has picked up more information.

Note that in the first order spectrum, 7.6338 Angstroms are crammed into one pixel, whereas in the second order spectrum (Figure 3) there are only 3.7798 Angstroms per pixel, and there is much more detail in the spectrum. This was quite a revelation to find it possible to get so much more with the Star Analyser, though I do not know if I shall be able to do it with stars. It made me try to think of other ways to get more from the Star Analyser. Over-exposing a very bright star (or planet) might work. I now have such a photo of Jupiter that I could try. When I tried my other idea of using spacers between the Star Analyser and the mount I found it made no difference at all to the spread of the spectrum.

Later, Robin Leadbeater[5] said: “When you put the Star Analyser in front of a lens the dispersion is only governed by the focal length of the lens. A longer focal length lens is the only way to increase dispersion with your setup and this can be worthwhile to give higher resolution as there are none of the aberrations you get when you place the Star Analyser after a telescope in the converging beam.

Using the second order is not very efficient as probably only about 5-10% of the light ends up there. A cheap way to increase the focal length might be to use a 2x converter. (At least that used to be the case - not sure with modern all singing and dancing electronic lenses). The downside is you might struggle to go as faint as WR140 then.” (This is a Wolf-Rayet star of which I obtained a spectrum recently).

“Increasing the dispersion by increasing the distance from the Star Analyser to the camera when using a telescope (instead of the camera lens) helps with resolution to some extent but then the aberrations take over. I find the optimum is generally around 10A/pixel though you might squeeze a bit more out by going further. It depends on the setup.”

Incidentally in Figure 3, you can see a blue emission directly over a red, at the end of the photograph spectrum. This must be the Hg 4358 line from the third order, overlapping what would have been a far smaller emission around 6538 Angstroms at the end of the second order spectrum. As spectra spread out they do tend to overlap each other. This explains why this red emission was much smaller in both comparison spectra.

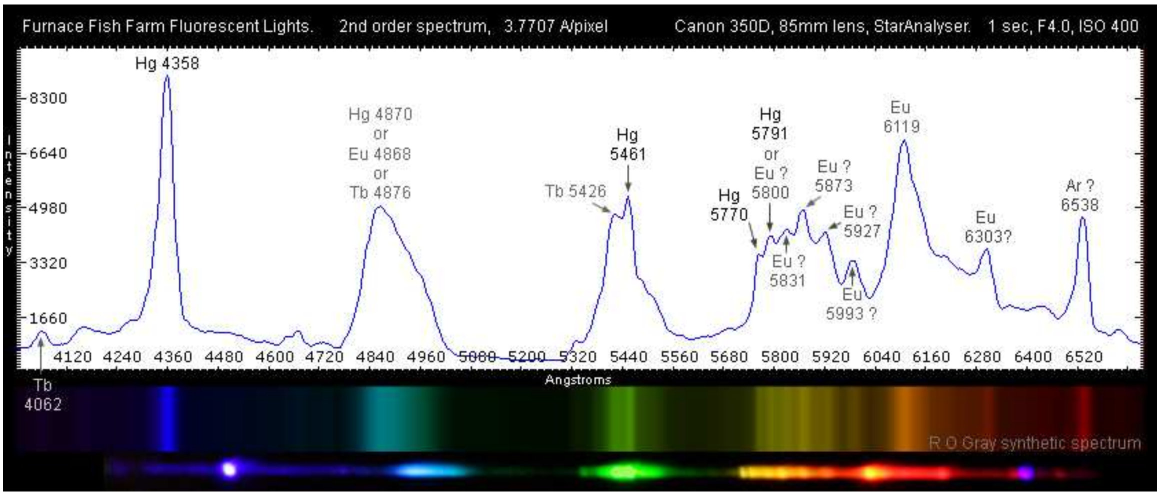


Figure 3: Cropped 2nd order with attempted identification of lines.
Hg - Mercury, Eu - Europium, Tb - Terbium, Ar – Argon

I used Christian Buil's spectrum[2] to aid identification of the lines marked with <u>dark</u> labels, and the spectrum from Wikipedia[3] to help identify the lines marked with <u>pale</u> labels. Very nearly, but not quite all lines are labelled exactly as in these two spectra. Any changes are due to better fits to my possibly shaky calibration, or the same fit of another element known to be in fluorescent light. Any mistakes are most likely mine.

To calibrate a spectrum you preferably have to be able to recognise one line so that you can then calibrate it with the first order (star/light source) at '0' and the wavelength of the recognised element, (the Balmer series is good if it is a hydrogen star). Once calibrated in the software I use, Visual Spec[4], you can open a list of elements and look for what fits. This is harder than it sounds as, especially with low resolution spectra, so many appear to fit the same position. The only way is to read up all you can about the star, or in this case fluorescent light, to try to find what you are looking for, or find a matching spectrum with elements identified.

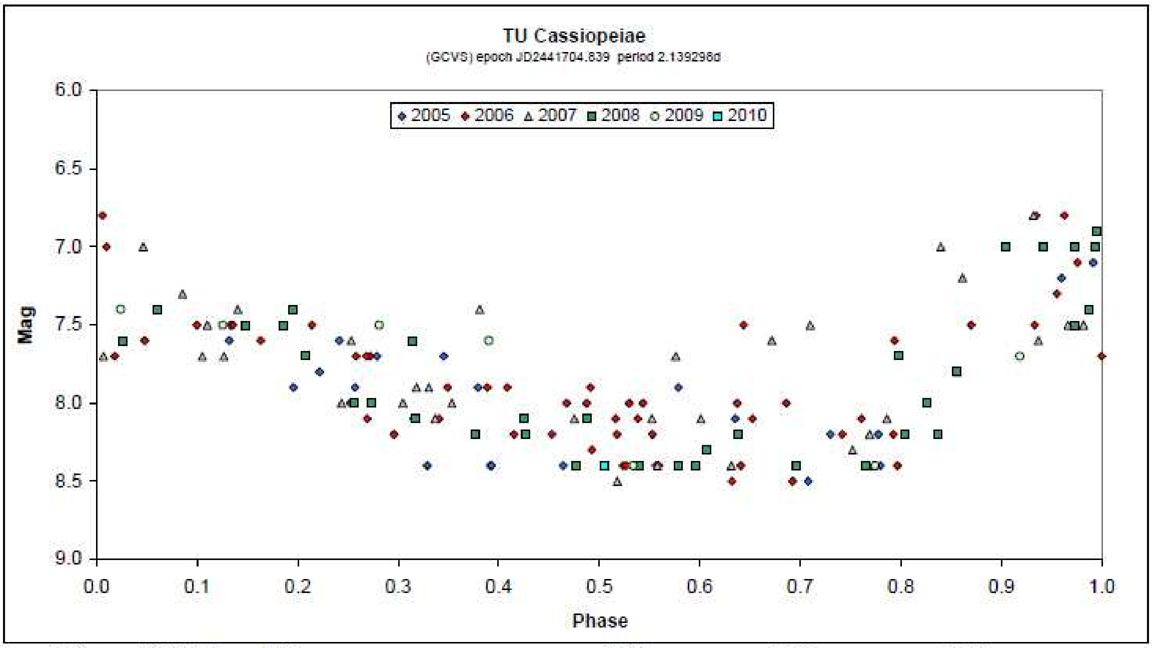
References

1. www.patonhawksley.co.uk/staranalyser.html
2. http://astrosurf.com/buil/us/spe2/calib2/osram_1.gif
3. http://en.wikipedia.org/wiki/File:Fluorescent_lighting_spectrum_peaks_labelled.png
4. http://www.astrosurf.com/vdesnoux/
5. http://www.threehillsobservatory.co.uk

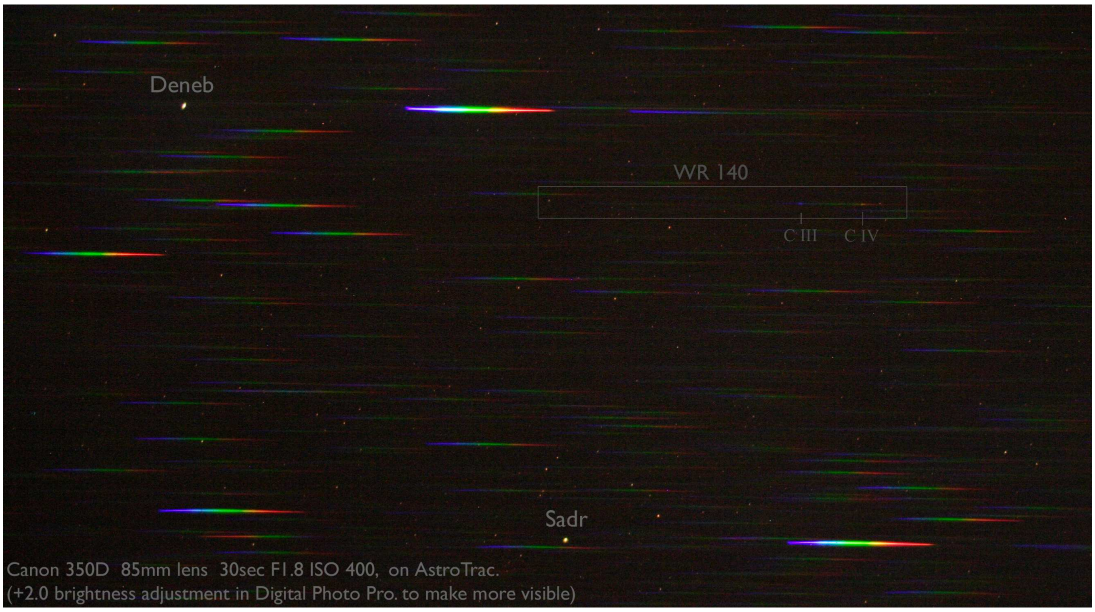
Janet Simpson

MORE FROM JANET SIMPSON

When it comes to the practice of amateur astronomy, there is no more enthusiastic member of our society than Janet Simpson. As well as contributing the previous article on *Fluorescent Light Spectrum*, Janet is deeply involved in variable star observing, stellar spectroscopy and astrophotography. Below you will find two examples of her excellent work which should act as an inspiration to all of us.



Date	Time (UT)	Mag			JD 24....	orbits	phase	
26/10/2005	23:35	7.9	53670	0.482638889	53670.48264	5593.257059	0.257058572	7.9
27/10/2005	19:00	8.1	53671	0.291666667	53671.29167	5593.635233	0.635232991	8.1
28/10/2005	20:30	7.6	53672	0.354166667	53672.35417	5594.131891	0.13189124	7.6
29/10/2005	01:07	7.8	53673	-0.453472222	53672.54653	5594.221809	0.221809106	7.8
31/10/2005	05:28	7.6	53675	-0.272222222	53674.72778	5595.241419	0.241419278	7.6



GUEST ARTICLE: LEARNING FROM SETI: OVERCOMING THE ROADBLOCKS TO DISCOVERY

Imagine you're a scientist looking to make a discovery – not merely an insight, a profound earth shattering once-in-a-lifetime kind of discovery; a discovery so significant, it will change the course of history, and man's perceived place in the universe. You believe it's out there waiting to be revealed. Logic alone tells you it must be so. You start collecting data. And you collect and analyze, collect and analyze. And you do this for fifty years, and still you find nothing! Unbelievable!

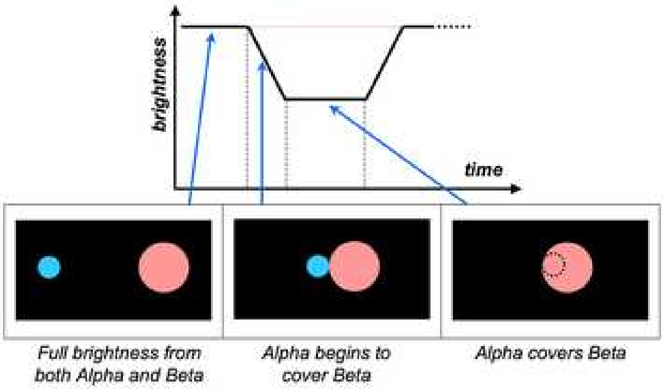
What do you do? Well, you have several options. First, you can try to increase the amount of data you are collecting. Perhaps your signal is very weak and merely hiding amidst the cosmic noise. Secondly, you can change your data. Maybe you've been collecting the wrong type of data. Maybe you've been looking in the wrong places, or at the wrong time. Perhaps you simply need to be a bit more clever about where and when and how you gather your raw observations. Your third and final option is to try to look at your data with a fresh perspective – to change your analysis. Maybe the signal is there all along, but you just aren't sifting through it in the right way. You're looking for the wrong patterns. Maybe the pattern your looking for is really quite alien.

By now, you've probably guessed that what I'm talking about, of course, is that most profound and potentially history-making career-risking data-mining effort of all time: The Search for Extraterrestrial Intelligence (SETI). And which of the above strategies is the SETI Institute currently pursuing to address the fact that after all these years, it has yet to detect a signal from an alien intelligence? Answer: All of the above!

Increasing SETI's data receiving capacity. SETI is pursuing a major technological upgrade to its receivers via the development of the Allen Telescope Array. Amir Alexander offers a brief history of the SETI project in which he describes the Allen Array as "one of the best funded and most promising projects for the future of SETI." He goes on to write:

"The Allen Array represents a true breakthrough for radio SETI. As a dedicated observatory, SETI researchers will be using it year-round to search for alien signals, as compared to the several weeks every year, which are allotted to Project Phoenix at Arecibo. In addition, since it is composed of hundreds of separate dishes, the array can be pointed at several points in the sky at the same time, and therefore listen to signals from several stars simultaneously. The latest technology will enable the Array to cover a frequency band 9 gigahertz wide, more than three times wider than project Phoenix, which scans the widest band of any of today's searches. All of this represents a qualitative leap in the capacity of SETI searches, and increases the chances of detecting a 'real' signal several-fold."

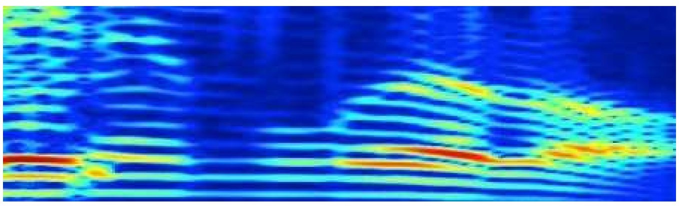
New sources of data. Dr. Seth Shostak gave a talk earlier this year at Foothill College as part of the Silicon Valley Lecture Series entitled: "The Search for Intelligent Life Among the Stars: New Strategies." In his talk, he presents a wonderful range of novel and clever ideas aimed at trying to use the detection resources available in new and smarter ways. One of my favourite ideas, theoretical modelling, suggests that planets can in fact form in binary systems, and some such planets have already been discovered. An intelligent alien race in such a system would likely try to colonize planets in the companion star system. If the orbital plane of the binary system is in the line of sight of our own solar system, we will observe the star system as an eclipsing variable star. Many such stars are known. Now imagine this alien civilization communicating back and forth with its colony. At times when we would observe the eclipse, the communications beam will be focused right in our direction! So why not point our receivers at eclipsing variables specifically when they are undergoing the eclipse! As with all good strategies, this approach tells you 'when to look and where'.



credit: Cosmos – The SAO Encyclopaedia of Astronomy

New analytical methods. Here, the SETI Institute has done something truly interesting. Jill Tarter, director of the Centre for SETI Research recently announced a new initiative by the SETI institute to enlist the help of researchers and programmers to see if the signal process and pattern detection algorithms can be improved.

We'd like to take the next step and invite all of the smart people in the world who don't work for Berkeley or for the SETI Institute to use the new Allen Telescope. To look for signals that nobody's been able to look for before because we haven't had our own telescope; because we haven't had the computing power…For people who don't have black belts in digital signal processing, we want to take regions of the spectrum that are overloaded with signals and get those out and have them visualized in different ways against different basis vectors. We'd like to see if people can use their pattern recognition capabilities to look or maybe listen; to tease out patterns in the noise that we don't know about (Source: O'Reilly Radar).



So remember: the next time you're stuck in your own efforts at scientific enlightenment and discovery, think about the challenge of SETI and its strategy: more data, more data sources, and better analysis.

John Rachlin

John Rachlin's blog *Data-Mining for Astronomy* is at http://astrodatamining.net
This content distributed by the AAVSO Writer's Bureau

FOOD FOR THOUGHT

Here are some questions for you to ponder.

Can we adapt outreach events to make them attractive to more members or is outreach simply the special interest of a select few? Also, we know how to attract the public to outreach events; how can we persuade them to develop their interest in astronomy through membership of a society such as ours? Does the way we practise outreach create an “us” and “them” situation where non-members are actually discouraged from joining by our enthusiasm and knowledge? Do we have a tendency to show off our knowledge a little too much?

Is the aim of educational outreach to plug a gap in the education system on an on-going basis or to change the education system thus making our role redundant? Is the former as much as we are ever likely to achieve? If so, does our participation have a positive, negative or neutral role in effecting change? Does it make the education authorities realise that this type of scientific education is absolutely necessary or is it equivalent to plugging a hole in the dyke with your finger, whereby it never gets repaired properly and the act becomes self-perpetuating? Or maybe it is precisely what it is meant to be and does not effect change at all.

Should the practice of amateur astronomy be left to individuals in a society or should an effort be made to encourage collaboration? If the latter, by what means can such collaboration be achieved? How can the issue of different levels of skill and experience be addressed?

Should the aims of a society remain static or should they be allowed to evolve with a changing membership? In particular, what proportion of an astronomical society’s work should be spent on teaching and how much on practising astronomy? Does this depend on the interests of the current membership? Also, if current interests demand it, should a society broaden its scope to include other scientific disciplines related to astronomy? If an evolving society is the answer, should this be reflected in an ever-changing constitution or should a society’s aims as defined in the constitution be sufficiently general to accommodate change?

These are questions which will influence the future of our Society and, as such, will affect you as a member. Surely, some of them have evoked a strong response in you as they pertain to and question what you do within the Society. I have tried not to give my opinion on these issues; I have left that to you. Please let *The Mercury* know your views. I will publish them in future issues.

Alex Houston

THE NIGHT SKY - October, November, December 2010

	SUN			MOON		
Date	*Rises*	*Sets*	*Phase*	*Rises*	*Sets*	*Constellation*
07 Oct	07.31	18.36	NM	07.13	17.51	Virgo
14 Oct	07.45	18.18	FQ	15.23	23.00	Sagittarius
23 Oct	08.04	17.56	FM	17.27	08.50	Aries
30 Oct	08.19	17.39	LQ	22.45*	14.55	Cancer
06 Nov	07.34	16.24	NM	08.16	15.57	Libra
13 Nov	07.48	16.11	FQ	13.19	23.27	Aquarius
21 Nov	08.05	15.58	FM	15.22	08.06	Taurus
28 Nov	08.18	15.49	LQ	23.55	12.34	Sextans
05 Dec	08.29	15.43	NM	08.30	15.12	Scorpius
13 Dec	08.40	15.40	FQ	11.59	00.46**	Pisces
21 Dec	08.46	15.41	FM	15.53	08.58	Gemini
28 Dec	08.48	15.46	LQ	00.37	11.23	Virgo

* on 29 Oct; ** on 14 Dec (Moon does not rise on 30 Oct or set on 13 Dec)

	MERCURY				VENUS			
	Rises	*Sets*	*Mag.*	*Constellation*	*Rises*	*Sets*	*Mag.*	*Constellation*
07 Oct	06.41	18.36	-1.27	Virgo	11.13	18.17	-4.52	Libra
23 Oct	08.30	18.02	-1.04	Virgo	09.39	17.11	-4.15	Virgo
06 Nov	08.58	16.36	-0.50	Libra	06.37	15.28	-4.24	Virgo
21 Nov	10.14	16.29	-0.39	Ophiuchus	05.02	14.53	-4.60	Virgo
05 Dec	10.29	16.45	-0.22	Sagittarius	04.24	14.23	-4.65	Virgo
21 Dec	08.15	15.44	4.20	Ophiuchus	04.22	13.50	-4.57	Libra

	MARS				JUPITER			
	Rises	*Sets*	*Mag.*	*Constellation*	*Rises*	*Sets*	*Mag.*	*Constellation*
07 Oct	10.45	19.20	1.48	Libra	18.13	05.49	-2.89	Pisces
23 Oct	10.50	18.39	1.44	Libra	17.08	04.36	-2.82	Aquarius
06 Nov	09.55	17.09	1.40	Scorpius	15.11	02.35	-2.73	Aquarius
21 Nov	09.57	16.43	1.35	Ophiuchus	14.11	01.35	-2.62	Aquarius
05 Dec	09.54	16.28	1.30	Sagittarius	13.17	00.43	-2.52	Aquarius
21 Dec	09.41	16.21	1.24	Sagittarius	12.15	23.45	-2.40	Pisces

	SATURN				URANUS			
	Rises	*Sets*	*Mag.*	*Constellation*	*Rises*	*Sets*	*Mag.*	*Constellation*
07 Oct	06.52	18.41	0.87	Virgo	18.10	06.02	5.73	Pisces
23 Oct	06.00	17.41	0.89	Virgo	17.06	04.55	5.75	Pisces
06 Nov	04.15	15.48	0.89	Virgo	15.10	02.58	5.76	Pisces
21 Nov	03.25	14.52	0.88	Virgo	14.11	01.57	5.79	Pisces
05 Dec	02.37	13.59	0.86	Virgo	13.16	01.02	5.82	Pisces
21 Dec	01.41	12.58	0.82	Virgo	12.13	23.56	5.85	Pisces

CELESTIAL EVENTS VISIBLE FROM THE STIRLING AREA

TOTAL LUNAR ECLIPSE

Date	
21 Dec	Total phase (07.40 - 08.53), partial phase (06.32 - 10.02) in dawn sky.

CONJUNCTIONS, OPPOSITIONS AND ELONGATIONS

Date	Planet	
01 Oct	Saturn	Conjunction
17 Oct	Mercury	Superior conjunction
29 Oct	Venus	Inferior conjunction
01 Dec	Mercury	Greatest elongation E
20 Dec	Mercury	Inferior conjunction

COMETS (visible* on 11 October, 10 November, 10 December)

	Date	RA	Dec	Transit	Magnitude
10P/Tempel					
	11 Oct	01h22m	-20°	01.04	11.5
29P/Schwassmann-Wachmann					
	11 Oct	10h49m	4°	10.32	13.2
	10 Nov	11h05m	2°	07.50	13.1
	10 Dec	11h15m	0°	06.01	12.9
103P/Hartley					
	11 Oct	03h02m	56°	02.45	5.3
	10 Nov	07h22m	-1°	04.06	5.7
	10 Dec	07h36m	-18°	02.22	8.3

* Magnitude brighter than +14; declination > -30°; transit time not ±2 hours from 13.00 BST (until 30 Oct) or 12.00 GMT (after 31 Oct).

METEOR SHOWERS

		Radiant		
	Maximum	RA	Decl.	
Piscids	13 Oct	01h44m	14°	Low rates.
Orionids	22 Oct	06h24m	15°	Fast meteors. Unfavourable.
Taurids	05 Nov	03h44m	14°	Slow meteors; very favourable.
		03h44m	22°	
Leonids	18 Nov	10h08m	22°	Fast meteors. Unfavourable.
Geminids	14 Dec	07h32m	33°	Rich with slow meteors.
Ursids	22-23 Dec	14h28m	78°	Unfavourable.

Times are BST until 30 Oct, GMT thereafter; as viewed from Stirling. Compiled by Alex Houston

Note: This will be the last episode of "The Night Sky" in its current format. A simplified format will be introduced next year.

FORTHCOMING MEETINGS

Meetings at the Smith (7.30pm—9.30pm)

8th October 2010
Speaker - John Davies, Royal Observatory Edinburgh.
Title - Runaway rockets and other space exploration disasters.

12th November 2010
AGM and two short talks by Society members

10th December 2010
Speaker—Mark Butterworth, Stirling Astronomical Society
Title—Animals in space

Full programme is on the website at www.stirlingastronomicalsociety.org.uk/lectures.html

Meetings at the Mayfield (7.30pm—9.30pm)

29th October 2010

26th November 2010

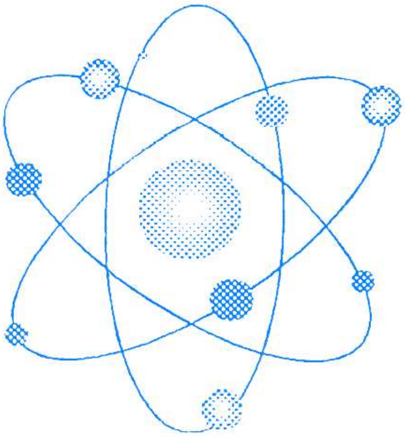
A Christmas event will be arranged for December

Meetings at the Smith are open to all. Meetings at the Mayfield are for members only.

Other meetings

Autumn Moonwatch

Friday 15th October
At David Marshall Lodge, Aberfoyle from 6.30pm until 8pm.



Stirling Astronomical Society

OFFICERS AND COMMITTEE FOR 2010

President	Ken Mackay
Chairman	Bert Mackenzie
Secretary	John Moffat
Treasurer	Derek Banks
Membership Secretary	Jennifer Cameron
Members without portfolio	George Love
	Alex 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

Thanks to all contributors. Please think about pieces, articles and images for the next January issue. Items describing events or the activities of the Society, or of individual members or groups of members, are especially welcome. Advanced notification of future events and activities can be included, particularly as *The Mercury* can now be accessed on the web.

Please give or send your contributions to:

Alex Houston
41 Keirfold Avenue — Tel: 01259-220958
Tullibody, FK10 3BE — E-mail: *editor@themercury.org.uk*
(Please note that this has changed)

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 to 1000 words in length. Please try to have material ready by the beginning of December for the January 2011 issue of *The Mercury*.