Gnomon

Newsletter of the Association of Astronomy Education

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BAP/AAE Meeting in Winchester

We had an action packed Saturday at the INTECH Planetarium at Winchester for the AAE's Annual General Meeting. This was a joint event with the BAP on 7th and 8th May. There were many sessions aimed at both professional planetarians and at educators. We also had a chance to experience the UK's largest capacity planetarium with its enormous tilted dome screen and state-of-the–art digital projection system. This was a fascinating insight into the new technologies and into its potential for science educators.

After the early morning BAP AGM in the Holiday Inn next door to the planetarium, Francisco Diego treated us to a special viewing of his show about extraterrestrial life in the Universe. A resume of this lecture appears overleaf at the end of this report. This was followed by a series of talks and workshops in the Science Centre meeting room, one of them encouraging us to use Twitter and Face- ☞ *(cont. on p2)*

The Intech Planetarium, Winchester

Congratulations to Bob Mizon MBE

We are delighted to hear that Bob has received an MBE in the Queen's Birthday Honours list on June 12. It was given for voluntary service to astronomy and the environment. Bob is National Co-ordinator of the Campaign for Dark Skies.

Happy 20th anniversary, HST!

The brand new Hubble image highlights a small portion of one of the largest observable regions of star birth in the galaxy, the Carina Nebula. Towers of cool hydrogen laced with dust rise from the wall of the nebula. The scene is reminiscent of Hubble's famous "Pillars of Creation" photo from 1995, but even more striking in appearance. The image captures the top of a pillar of gas and dust, three light-years "tall", which is being eaten away by the brilliant light from nearby stars. The pillar is also being pushed apart from within, as infant stars buried inside it fire off jets of gas that can be seen streaming from towering peaks like arrows sailing through the air. The new photograph was taken as part of the celebration of the 20-year milestone for the "The best recognised, longest-lived and most prolific space observatory". On 24 April 1990, the Space Shuttle and crew of STS-31 were launched to deploy the NASA/ESA Hubble Space Telescope into a low-Earth orbit. What followed was one of the most remarkable sagas of the space age" to quote the NASA/ESA press release. Hubble fans worldwide are being invited to share the ways in which the telescope has affected them. You can send an e-mail, post a Facebook message (to 💻 **www.facebook/hubblespacetelescope*****) or use the Twitter hashtag #hst20. Or you can visit the "Messages to Hubble" page on*** 💻 **://hubblesite.org** ***type in your entry and read selections from other messages that have been received. Messages will be stored in the Hubble data archive along with the telescope's many terabytes of science data. So far, Hubble has looked at over 30,000 celestial targets and amassed over half a million pictures in its archive. The last astronaut-servicing mission to Hubble in May 2009 made the telescope 100 times more powerful than when it was launched. In addition to its irreplaceable scientific importance, Hubble brings cosmic wonders into millions of homes and schools every day. You have all become co-explorers with this amazing observatory. (Does the photo look like a demon on a horse, riding straight at you?).***

Photo: NASA, ESA and , M. Livio and the Hubble 20th Anniversary Team

☞ ***(cont. from p1)***
book in our domes!

The AAE's Annual Business Meeting was brief and to the point. Inevitably, AAE attendance was tiny in comparison with that of BAP members. The latter is still growing as an association whereas AAE membership has stagnated in recent years. In view of this fact, Council has tried since last year's ABM to sound out members' views about future directions for the AAE. It should be said that we are, to some extent, a victim of our own success in fulfilling the Association's original aims. These were to lobby for the establishment of astronomy in the emerging National Curriculum and support teachers in its delivery e.g. by developing appropriate resources.

These objectives may have been realised but there are new challenges. In his report as AAE President, Dr Mike Dworetsky cited the likely effects of the Rose Review on the amount of astronomy taught in the primary school curriculum as a case in point. He feels strongly that the abilities and interests of UK children are being underestimated. By contrast, the Latvian curriculum covers most aspects of astronomy in some depth. This led to discussion of the appropriate AAE response. Those present agreed unanimously that space (like dinosaurs) remains one of the most powerful topic areas when it comes to engaging children's interest in science. Any erosion of its place in the curriculum should therefore be challenged.

Mike also noted that teachers are still required to teach that "The Moon orbits the Earth in 28 days". He plans to draft a letter of complaint to the QCA, though without much expectation that it will be corrected. On a more optimistic note, he cites the rising success of uptake for the new Edexcel GCSE in Astronomy, to the extent that some schools are formally teaching it as a third science. If nothing else this indicates that there is an irrepressible enthusiasm for astronomy out there in the school population.

Bringing astronomy to a wider public has occupied all the officers of AAE Council throughout the past year. This has included Mike's well-attended public evenings at the University of London Observatory and Vice-President Dr Francisco Diego's project which introduces primary school pupils to the working environment of post-graduate astronomy research students. These are both London-based initiatives. However Sotira Trifourki, another AAE Vice-President, is very active in the north of England e.g. involved with the National Science Centre in York and the development of a new resources website to be hosted by the European Space Education Resource Office (ESRO). Dr Robert Massey, our third Vice-President, works for the RAS and is responsible for its education and outreach activities throughout the UK. He envisages a closer relationship between our two organisations which will be good for AAE.

Council Elections

Unsurprisingly, many of the current Council were re-elected unopposed to serve another year. Your new elected Council is:

President: Mike Dworetsky
Vice Presidents: Francisco Diego,
Sotira Trifourki,
Robert Massey
Treasurer: Alan Pickwick
Secretary: Teresa Grafton
Council Members: Dave Buttery, James O'Neill
Resource Centre Reps:
Sandra Voss (Observatory Science Centre at Herstmonceux)
Chris Hudson (Centre for Life)
Shaaron Leverment (BAP representative)
(NB The Editor is co-opted at a Council meeting).

No decision was made about the date and venue for next year's ABM. Ideally we would like members to have a say in this, so expect to be asked for your opinions in the near future.

In conclusion, AAE has a number of concerns in 2010. These include the need to recruit members, to revitalise the website and also make use of electronic means of communication with our membership.

AAE are very grateful to BAP and INTECH for their generosity in allowing us to participate in this excellent weekend.

Teresa Grafton

Aliens! Could Darwin work on the worlds of Galileo?

What follows is a brief description of the planetarium presentation given by Francisco as part of the BAP/AAE meeting. These mere words cannot convey the sense of awe that it inspired, nor can they hint at the spectacular images.

This show follows the work of two intellectual giants of science that bravely challenged traditional myths and religious beliefs by exploring the world as nobody had done before. Following Galileo's discovery of other worlds out there with landscapes like the Earth, modern technology shows in delicate detail their barren and sterile images. None are like the Earth, because for billions of years, an amazing series of chance events have transformed what was hell into a living paradise, explored and so beautifully described by Charles Darwin. The recent discovery of planets around more than 400 nearby stars, indicates that there may be billions of planets in the Milky Way galaxy. Will we ever know how many of them might also be living paradises suitable to Darwinian processes?

This is a public lecture also suitable for secondary school groups. The different topics usually provoke animated discussions about the origin of life, divine intervention, possibility of alien intelligence, etc. It is part of The Mind of the Universe series, developed under a fellowship from the STFC. Please find more details on:

💻 www.ucl.ac.uk/themindoftheuniverse

Francisco Diego

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There will generally be a 10% discount to AAE members on all publications and advertising rates.
Practising teachers may claim their subscriptions as an allowance against income tax, effectively reducing their contributions.

All communications (except those to the Editor) should be addressed to:
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Any photographs sent to the Editor by email (preferred) should be sent in a common format (TIF or JPEG) with resolution not less than 300 dpi

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And Now - Moon Zoo

Did you enjoy "Galaxy Zoo"? Following the success of that programme, we now have a new initiative on the Moon Zoo website. Members of the public can examine high resolution images from NASA's Lunar Reconnaissance Orbiter Camera. These show the moon's surface in unprecedented detail. One task would be to count the number of craters in a particular area. This is a key indicator of the age of the regolith. Other tasks focus on domes and boulders. There will be outreach information and support for participants, FAQ's and a blog. Go to the website at:

http://www.moonzoo.org

Anne Urquhart-Potts

The Sun Dog and the Sea

The Sun Dog, or Mock Sun, or *parhelion*, like noctilucent clouds, is strictly speaking hardly astronomy, but rather an interesting, and attractive, *meteorological* phenomenon. However, it often falls to us astronomers to spot them, and to explain them to the bystanders.

Sun Dogs are a 22º halo round the Sun, formed by refraction through ice crystals suspended in thin clouds. If you imagine a circle with two diametrical lines crossing at right angles, you have the general shape of the most spectacular and complete halo. At each of the four intersecting points round the halo there is a "Mock Sun", a bright coalescence in the ring. The halo displays the familiar colours of the rainbow - but apparently in reverse order! Red is on the side of the halo nearest the Sun but since the halo is in the same general direction as the Sun (unlike the rainbow) the red band is on the *inside* of the curve. It is rare indeed to see a full-blown halo with four Sun Dogs, but quite common to find one or two, with the rest of the halo, and maybe the Sun itself, invisible behind thicker cloud nearby.

My wife Annette, who is the principal photographer in our family, took this photo of a veritably brilliant Sun Dog with part of the halo. It was bright enough to reflect brilliantly with all spectral colours, which alas merge into one in grey-scale on this page. The Sun Dog was clearly visible, at the same altitude as the Sun, and to the east of it (the Sun was totally obscured by thick cloud and was just on the right-hand edge of this exposure).

The halo itself was faint, part of it appearing below the Mock Sun in this photo. The reflection in the sea and the wet sand of Mount's Bay being of the parhelion itself.

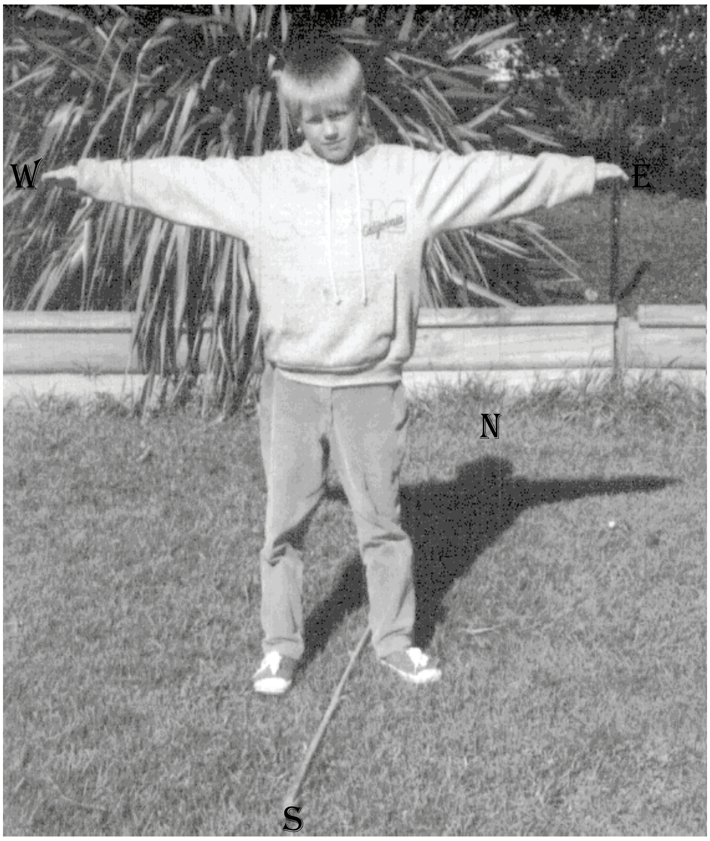
Richard Knox

A brilliant Sun Dog, and part of the halo, seen in the sky and reflected in the sea and wet sand of Mount's Bay in January this year. **Photo: Annette Knox**

Curriculum Corner

I'm a Compass

At solar noon have the students stand facing the Sun. (They will be facing true south; true north is behind them). By raising their left hand out sideways they will point to east and the eastern horizon. Their raised right hand will point to west and the western horizon.



In the northern hemisphere the Sun appears to travel from the eastern horizon to the western horizon via south. Standing in this position the student has used their body as a compass to show the four cardinal points. Also their right hand points to starboard and their left hand to port. This activity can be used to introduce map reading, orienteering and navigation.

Now place a magnetic compass in the middle of the solar noon shadow and note in which directions the head and shoes of the shadow lie. The magnetic compass points to magnetic north which is different from true north. This may be the first time that the students have learnt that there is a difference between the two "norths".

Find the time at which the shadow was at its shortest. The shortest shadows of each day always occur at solar noon when the sun is at its highest point half way between sunrise and set at the place where you live. This time varies throughout the year depending on the season and time changes, such as daylight saving, and is usually after "clock" noon.

Find out the magnetic variation for your locality.

Vocabulary: horizon, orienteering, navigation, starboard, port, solar noon, meridian, magnetic variation, daylight saving, summer time.

Eric Jackson

Letter from Down Under

I was recently invited to be a key speaker at the 2010 Royal Astronomical Society of New Zealand (RASNZ) annual conference. What made this meeting particularly special for me was that it was held in my home town of Dunedin (sister city of Edinburgh), to mark the centenary of the founding of the Dunedin Astronomical Society (DAS). As a schoolboy I was fortunate to get to use the facilities of the society's Beverly-Begg Observatory, including a 30cm Newtonian reflector (pictured), and a 36cm Dobsonian. For a city of just over 100,000 people, the skies of Dunedin were relatively dark (though not often all that clear!), and these telescopes afforded wonderful views of the southern sky. The DAS would hold usually two meetings per month, as well as opening to the public every Sunday night for stargazing. It never ceased to amaze me how many people would turn up even on cloudy nights, which usually meant a hastily arranged slide-show to keep them informed and entertained. The DAS was formed in 1910, which not surprisingly coincided with a rather favourable apparition of Comet Halley (compared with its subsequent apparition in 1986), so it seemed appropriate to mark the centenary by hosting the RASNZ conference.

Where it all started: this is the 30cm reflector at the Beverly-Begg Observatory in Dunedin that Stuart Ryder (at left) used for stargazing and astrophotography while a member of the Dunedin Astronomical Society in the early 1980s.

Unlike the Astronomical Society of Australia, the majority of RASNZ members are amateur rather than professional astronomers. Nevertheless amateur astronomers in New Zealand have made impressive contributions to a number of fields of research:

- The Variable Star Section of RASNZ was established by the late Dr Frank Bateson in 1927 and has accumulated millions of visual observations of variable stars that provide a treasure trove for professional astronomers worldwide who seek to understand the various causes of stellar variability, orbital parameters for binary stars, etc. Under the leadership of Dr Tom Richards it has been renamed Variable Stars South (http://www.varstars.org/) and encourages members to participate in a number of active observational (visual and CCD) and data analysis projects.
- New Zealand's mid- to far-southern latitude coverage and dark skies make it one of the best places to observe the Aurora Australis. The Aurora and Solar Section of RASNZ led by Bob Evans (no relation to the Australian supernova hunter of the same name) collects and distributes reports.
- The Occultation Section of RASNZ led by Graham Blow carries out observing campaigns of lunar occultations, when the Moon's motion causes stars (and occasionally planets) to disappear behind the Moon's eastern limb and reappear from behind its western limb about an hour later. Such observations help constrain the Moon's orbit, as well as give hints to the possible binary nature of the star. Coordinated observations of the occultation of a background star by a minor planet by multiple observers spaced a few kilometers apart can help determine the diameter of the asteroid, as well as turn up any satellites in orbit around them.
- New Zealand's longitude also gives it a key role in discovering and confirming new comets, minor planets and supernovae.

The conference got underway with an afternoon excursion on the Taieri Gorge Railway. However heavy rain in the preceding days resulted in a small landslide which blocked the railway for nearly two hours before the participants finally made it back to Dunedin! My friend Bill Allen opened the conference with a history of his first 50 years as an amateur astronomer, culminating in his current setup which has both his own automated 36cm telescope with CCD photometer, as well as a Spanish-supplied 60cm telescope for responding to Gamma Ray Bursts on his vineyard property in the Marlborough region.

The DAS recently made an award to the Dunedin City Council in recognition of their decision to install fully-shielded lighting on a newly-opened cycle path. It is hoped that such an award (giving positive feedback rather than criticism) will encourage the council to employ this style of lighting more widely in future. My colleague Dr Karen Pollard gave an overview of the astronomy research and outreach program at the University of Canterbury, including their share in the 11 metre Southern African Large Telescope. Professor Sergei Gulyaev from the Auckland University of Technology showed the first results from very long baseline interferometry linking their newly-installed 12 metre radio antenna to the first of the Australian Square Kilometre Array Pathfinder antennas installed in Western Australia (see my previous Letter from Down Under). The conference dinner at the Otago Museum featured a talk by Peter Hayden about NHNZ, a major supplier of nature documentaries worldwide which has managed to maintain its base in Dunedin.

I gave two talks at the conference, one of them on my own supernova research using the Gemini telescopes in Hawaii and Chile. My second talk "CSI: Supernova" was for a public audience, and described the stellar forensic techniques which astronomers use to learn more about stars which go supernova. Even my former high school physics teacher came along to hear what had become of the young lad who set out all those years ago to become an astronomer! It was a great pleasure to revisit the place where it all began, and seek to inspire the next generation of kiwi astronomers.

Stuart Ryder
sdr#aao.gov.au

A Little Plea from the Editor

Since it seems that I'll be Editor for another year (!), I am taking this very little opportunity to ask all members to send in their news and views, letters and reports of events. It takes such a short time to e-mail me a few paragraphs, but it is so interesting to hear how everyone is getting on. This is ***your*** news forum—USE IT! ***Ed***

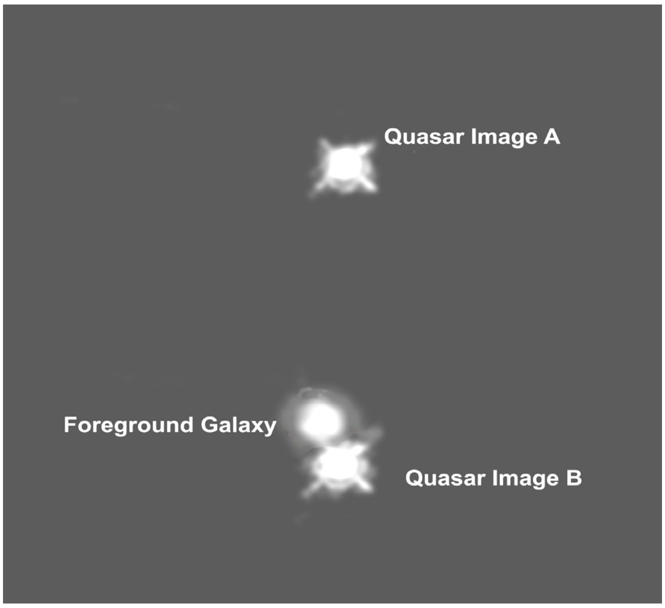
Proving Einstein Right (Part 2)

(*Continuing Ian Morison's lecture on General relativity)*

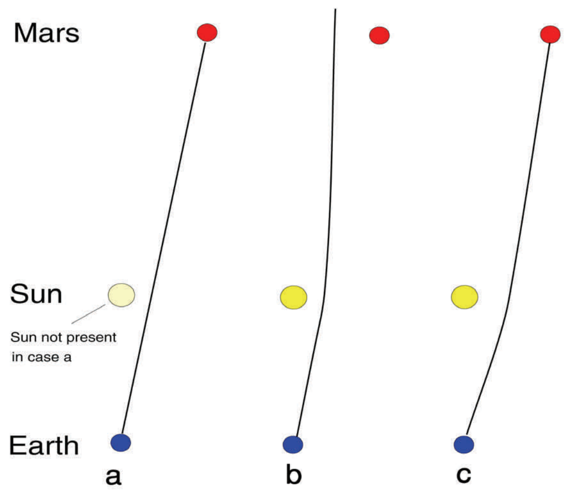
If the Sun's mass can produce a small shift in the position of a distant object, so also should the mass of a galaxy. Occasionally, a galaxy will be close to the line of sight of a more distant object. The mass of the galaxy distorts the space around it forming a "gravitational lens". Depending on the relative positions, this lens can form multiple images of the distant object or even spread its light or radio emission into an arc or ring - called an Einstein ring.

In 1977, observations by the Lovell Telescope at Jodrell Bank discovered two quasars whose positions were close (~ 6 arc seconds) to that of a foreground galaxy. Quasars are very distant bright radio sources that appear like stars on photographic plates - hence their full name "quasi-stellar-object" which means "looking like a star". Now called the "Double Quasar", it was soon realised that we were observing two images of the same object. But there is a subtle difference. The path length through space between us and the quasar is longer for one of the images by a distance of 417 light days. We thus, simultaneously, see it at two times in its existence - separated by 417 days! Time and space *do* interact showing why space-time is implicit in Einstein's theory.

[One might wonder how the time difference has been measured. Quasars are giant galaxies which, at their heart have a "supermassive black hole". Stellar material falling in towards the black hole provide the energy source of the quasar, and as the rate at which material is consumed varies so does the energy output of the quasar. The effect is that the brightness varies with time. Suppose the image whose light has travelled furthest is seen to increase rapidly by 10%. Then we would see the image whose light travels less far would increase by the same amount some time later determined by the difference in path length. By comparing the brightness curves of the two images, a "match" was found when the time difference was 417 days.]



In the 1960's Irwin A. Shapiro realised that there was another, and potentially far more accurate, way of testing Einstein's theory. Shapiro was a pioneer of radar astronomy and realised that the time that a radar pulse would take to travel to and from a planet would be affected if the pulse passed close to the Sun. In the accompanying diagram, **a** shows the direct path that a radar pulse would take to and from Mars if we could imagine that the Sun was not present and that, as a consequence, space was flat. Path **b** on the diagram shows that, due the curvature of space a radar pulse sent along this precise path would curve away to the left and not reach Mars. The pulse that *would* reach Mars, shown as path **c**, has to take a path slightly to the right of its true position so the curvature of space near the Sun would deflect it towards Mars. The echo would follow exactly the same path in reverse. As the pulse has had to follow a longer route to Mars and back it will obviously take longer than if the Sun was not present. The radar pulse will thus be delayed. The "Shapiro Delay", as it is called, can reach up to 200 microseconds and provided an excellent test of Einstein's theory.



Further tests, of even higher accuracy, using the Shapiro delay have been made by monitoring the signals from spacecraft as the path of the signals passed close to the Sun. In 1979, the Shapiro delay was measured to an accuracy of one part in a thousand using observations of signals transmitted by the Viking spacecraft on Mars. More recently, observations made by Italian scientists using data from NASA's Cassini spacecraft, whilst en route to Saturn in 2002, confirmed Einstein's theory of general relativity with a precision 50 times greater than previous measurements. At that time the spacecraft and Earth were on opposite sides of the Sun separated by a distance of more than 1 billion kilometres (approximately 621 million miles). They precisely measured the change in the round-trip travel time of the radio signal as it travelled close to the Sun. A signal was transmitted from the Deep Space Network station in Goldstone California which travelled to the spacecraft on the far side of the Sun and there triggered a transmission which returned back to Goldstone. New techniques enabled the effects of the solar atmosphere on the signal to be eliminated so giving a very precise round trip travel time. The Cassini experiment confirmed Einstein's theory to an accuracy of 20 parts per million.

Though not specifically a "test" of Einstein's theories, the Global Positioning Satellite network (GPS) is a beautiful illustration to show that, if Einstein's two theories are not taken into account, then the GPS system could not function. GPS essentially works by the transmission of highly accurate timing signals from a constellation of satellites orbiting the Earth. By "knowing" where the satellites are when they transmit their time signals, a receiver on the ground can calculate the distances from each observed satellite and hence where on the surface of the Earth it must be. The timing signals are derived from hydrogen maser atomic clocks carried in each satellite. They orbit the Earth at a height of ~20,200 km while moving at a speed of ~14,000 km per second. Both these statements are significant.

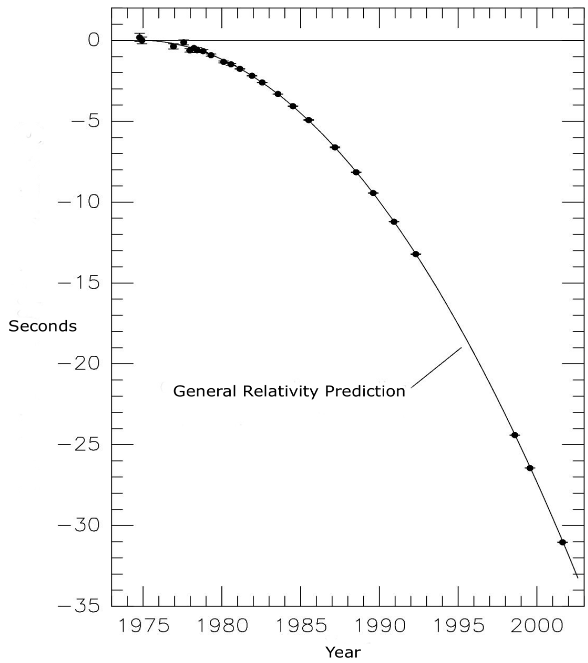
Einstein's special theory of relativity shows that a moving clock, when observed from a body at rest, will appear to run slow. The result is that, if the hydrogen maser is set to give precise timing signals on the ground, it will appear to run slow when in orbit by 7 microseconds per day. One might thus set the clock to run fast on the ground so that, when in orbit, it runs at the correct rate.

But this would ignore Einstein's general theory of relativity. At a height of 20,200 km, the value of the acceleration due to gravity, g, is reduced by a quarter as compared to that measured on the Earth's surface. Clocks run faster in weaker gravitational fields and this effect would make the clocks run fast by 33 microseconds per day. In order to run at the correct rate in orbit the clocks have to be made to run slow by ~ 28 microseconds per day when calibrated on the ground!

The next major advance in testing Einstein's theory came with the discovery, by Russell Taylor and Joseph Hulse in 1974, of the first "binary pulsar". As observations of pulsars are key to what follows a brief resume of their origin and properties is in order. In the latter phases of their life, nuclear fusion in the cores of massive stars builds up the elements to iron, the element with the most stable nucleus. When the core has converted all its mass into iron, nuclear fusion stops and gravity makes the core collapse. The vast majority of the protons fuse with electrons to give neutrons and finally, when the core is about 20km in diameter, "neutron degeneracy pressure" halts further collapse. Not surprisingly, the resulting object is called a neutron star. The density is incredibly high – one cubic centimetre would weigh about 10 time greater that Mount Everest – and it has a very powerful magnetic field, perhaps 600 trillion times stronger that that of the Earth. The progenitor star will have been rotating relatively slowly, as will its core. As the core collapses down, conservation of angular momentum causes the rotation speed of the core to greatly increase, rotating initially perhaps 60 times per second.

The magnetic field axis of the neutron star will usually be inclined to its rotation axis. This rotating field accelerates particles which give rise to beams of radio emission, in some cases with light and x-ray emission as well. The two beams, from above the north and south magnetic poles, sweep around the sky rather like that from a lighthouse. Should one or, rarely, both of these beams sweep across the Earth's position in space radio telescopes will pick up a short pulse of energy. These radiating neutron stars thus rapidly gained the name "pulsar". The first was discovered by Jocelyn Bell in 1967. The radiation of energy away from the pulsar takes energy out of the system and thus their rotation will gradually slow down. But, as you can imagine, the rotational energy in a 1.4 solar mass object spinning at a typical rate of 10 rotations per second is enormous so the slow down rates is very slow and thus pulsars make exceedingly good clocks – comparable to atomic clocks on Earth. In fact, when the first pulsar was discovered, it was not initially thought that a natural phenomenon could give rise to such accurately timed pulses and it was suspected that perhaps it was a signal from an alien race. Its first, unofficial, name was LGM1 – Little Green Men one!

It is the fact that pulsars are such accurate clocks that have made them such valuable tools with which to test Einstein's theory. In the "binary pulsar" system discovered by Taylor and Hulse, a 1.4 solar mass pulsar is orbiting a companion star of equal mass. It thus comprises two co-rotating stellar mass objects. General Relativity predicts that such a system will radiate gravitational waves – ripples in space-time that propagate out through the Universe at the speed of light. Though gravitational wave detectors are now in operation across the globe, this gravitational radiation is far too weak to be directly detected. But there is a consequent effect that *can* be detected. As the binary system is losing energy as the result of its gravitational radiation, the two stars should gradually spiral in towards each other. The fact that one of these objects is a pulsar allows us to determine very precisely the orbital parameters of the system. Observations over the 40 years since it was first discovered, shown in the diagram, show how the two bodies are slowly spiralling in towards each other, exactly agreeing with Einstein's predictions! Taylor and Hulse received the Nobel Prize for Physics in 1993 for this outstanding work.



(Ian Morison's Lecture will be concluded in the September issue where he describes the testing of five predictions of General Relativity using the "Double Pulsar").

For your Library

An Introduction to Radio Astronomy . Bernard F. Burke and Francis Graham-Smith. Cambridge University Press, Third Edition (2009). ISBN-13: 978-0521878081.
RRP: £40.00 (US $75.00) Amazon Price: £31.23. Hardcover: 456 pages.

In this university-level text book the authors give a comprehensive review of Radio Astronomy. The first six chapters deal in detail with the detection of radio signals. Chapter 7 then reviews the propagation of radio waves. The next four chapters cover the emissions and absorptions of stars, nebulae and galaxies. Chapters 12 and 13 cover pulsars and active galaxies. The next three chapters deal with cosmology including the cosmic microwave background and gravitational lensing. The last chapter covers future plans for radio astronomy and importantly, the need to protect parts of the radio spectrum from radio transmissions which would overwhelm the precious and faint radio signals. This book would be suitable for someone with a degree-level background in the subject. Perhaps some parts of the text would be of interest to others without a mathematical background.

Alan Pickwick

"For Your Library" is continued overleaf ☞ ***(cont. on p7)***

☞ **(cont. from p6)** *GCSE Astronomy: A Guide for Pupils and Teachers. Fourth Edition. Nigel Marshall. Mickledore Publishing 2009. ISBN 978 0 9536345 7 6. RRP £8.95.*

This excellent little volume has appeared in a new edition especially rewritten to accompany the new Astronomy GCSE specification (first examination 2011). It is a compact study aid which will be of great use to both students and their teachers. It appears with stunning colour photos and diagrams.

There are four sections: "Earth, Moon and Sun", "Planetary Systems", "Stars" and "Galaxies and Cosmology". Each contains everything a student needs to know for the exam, with key words shown in bold type. There are also "Just For Fun" extras, "Wacky" facts and trivia. Many opportunities are taken to invite the student to investigate further from books, magazines and the Web. Helpful tips from examiners are provided, pointing out the "DO's" and "DON'T's" when answering questions.

The worked examples of calculations have disappeared, but will have reappeared in the new companion book called "New Practice Calculations for GCSE Astronomy" from the same publisher. Two CD-ROM's are available - one a teacher's toolkit of resources, questions and solutions, the other a Pupil kit of study and revision aids.

The text is straight-forward, factual and readable for anyone aiming at Grade D or above. It is right up-to-date, mentioning accelerating expansion and dark energy.

For all those teaching or studying for the GCSE this is an essential text. I cannot recommend it highly enough.

Anne Urquhart-Potts

An Evening with the Planets

There seems to have been a real surge of interest in the night sky just recently. Well, this is from the point of view of The Observatory Science Centre! As the former home of The Royal Greenwich Observatory we are very proud to house some of the country's largest telescopes and even more proud to be able to use them. As a result, to complement our daytime programme, we open our doors at least once per month in the evening during autumn, winter and spring. This helps to bring astronomy to the general public in the setting of what was once a world renowned observatory.

Although the weather of course has a lot to do with attendance in the evenings, there is plenty to occupy children and adults at The Centre with about 100 fully interactive science exhibits. However despite special offers and some very clear weather, visitor numbers on open evenings have not been great this year. That is until 24th April! This evening was advertised as "An Evening with the Planets" and promised views of Venus, Saturn and Mars as well as being able to look at the Moon, one of the most beautiful objects to observe through our telescopes. The weather was very clear and when the doors opened at 6.30pm an unprecedented 387 visitors filed in. There was a wide range of people from families with children to seniors and young adults.

The Moon was visible straight away and when it eventually became dark the sky was stunning. Our local astronomy society (Wealden AS), who volunteer at The Centre, were kept extremely busy guiding people through the constellations and showing them the different planets through their own amateur telescopes. Queues did form at the three historic telescopes that were in use, especially the 26-inch refractor that had to fill up before it could raise the floor, but visitors were very patient and the buzz of excited chatter was very infectious. No-one complained about the wait. Even in "headless-chicken" mode, scurrying about The Centre making sure everything was running smoothly, I was able to stop occasionally and aim a laser pen to the sky and point out a few constellations to appreciative queuing people. Because the Moon had been visible before and during twilight many people had managed to see it before spending time on the exhibits in anticipation of darkness, which helped enormously.

What a night! Everyone seemed to leave happy and many vowed to be back, especially for the Astronomy Festival in September when our evening programme of events resumes after the summer months. The volunteers from Wealden AS were exhausted but could not stop talking about what a great night it was and how busy they were. I was amazed by the enthusiasm as people left The Centre and was left happily wondering "why so many people?" I remembered the close approach of Mars in 2003 when we thought 250 people through the door was manic. We attributed this to the national coverage of the event on television and in the newspapers.

I suppose I am still wondering. Could it be that the planets hold such a fascination that targeting them on an evening when so many were visible was the key? Possibly, but The Centre has done evenings with the planets before without receiving so many visitors. Could it be that programmes such as the excellent BBC series "Wonders of the Solar System" by Prof. Brian Cox has helped? Maybe it is a combination of factors but it is so refreshing to see so many people who are interested in the night sky and long may it last. Sowing the seed early with astronomy education can be crucial but maintaining interest is the key and breathtaking journeys through the solar system via the medium of television cannot do any harm. It remains to be seen if the public's interest continues into the autumn and winter.

The Observatory Science Centre is open 7 days a week for 10 months of the year and is a registered charity. Please see our website for further details:

www.the-observatory.org

Sky Diary Summer 2010

A table of dates for the phases of the Moon appears overleaf. The full Moon on August 24th will be the most distant and therefore the smallest of the year.

The Autumnal Equinox occurs in the northern hemisphere at 03:09 UT on September 23rd (when the next issue of Gnomon is due out!). There will be equal amounts of "daylight" and "darkness". This is also considered to be the first day of Autumn.

The Summer Triangle dominates the sky this quarter. It is huge—an *asterism* not a constellation. The blue-white star Vega is at its top right hand corner, Deneb to its lower left and Altair below. Each of these is the brightest star in its own constellation. If you have a dark sky and no moonlight you will be able to see a great swathe of the Milky Way running between Vega and Altair. To the left of the Summer Triangle is the delightful little constellation of Delphinus the dolphin. By the time the Summer Triangle is high in the South at dusk, Autumn will be on the way.

Special events this quarter include a Total Solar Eclipse on July 11th. The path of totality will only be visible in ☞

☞ *(cont. from p.7)* the southern Pacific Ocean, making landfall in the Cook Islands and Easter Island and a very small strip of southern Chile and Argentina. It will be winter down there, so we wish eclipse chasers good luck with visibility! Totality begins 07.40 UT and ends 08.53 UT. A partial eclipse will be visible in many parts of southern South America and the South Pacific. Search on the Internet for more information and for live camera feeds of the event. The NASA website has detailed maps and timings.

At dusk on August 12th we have a triple conjunction with the Moon. The planets Venus, Mars and Saturn will all be a few degrees from the thin crescent moon on this evening. Look to the west just after sunset - a great photo opportunity. To generate a star-map for your location visit:

💻www.heavens-above.com

and register your details. **NB** You **must** put in the hyphen in this address! Mercury, which is also close-by, will be too close to the horizon to pick out in the glare of the sunset.

Let us focus on the inner planets. Mercury during this quarter is not very favourable. Certainly during July and August it is not in a position for easy observation. You will have to wait until September to catch a glimpse. Half way through this month Mercury appears above the eastern horizon at civil twilight around 40 minutes before sunrise.

After the brilliance of Venus in our evening skies over the past couple of months, from July onwards it is not a very dramatic object. If you do wish to view it then you need to be looking very low down in the south-west, just after sunset, before it vanishes below the horizon. Once we get to September it is too near solar conjunction to be a creditable astronomical target.

Mars is in Leo for the first part of the month, eventually reaching Virgo. It heads slowly towards the Sun and is close to Venus during the first three weeks of August. You will be able to observe the ever-decreasing distance between these planets but bear in mind Mars' brightness has also reduced a great deal since the start of this year and is

Moon phases for the third quarter of 2010

	New Moon	First Quarter	Full Moon	Last Quarter
July	11	18	26	4
August	10	16	24	3
September	8	15	23	1

now at magnitude 1.5 so a map will be useful to locate it.

Jupiter is heading for opposition in September so is just getting better and better as this quarter passes. On the 21st September the Solar System's largest planet will be at its closest approach to Earth. This is the best time to view and photograph Jupiter and its moons. The giant planet will be as big and bright as it gets in the night sky, at an unmissable magnitude –2.9! A medium-sized telescope should be able to show you some of the details in Jupiter's cloud bands. Even a decent pair of binoculars will show you the four Galilean moons. In fact Jupiter is the astronomer's target of choice at the moment as Jupiter has lost one of its prominent stripes. Scientists are not sure what triggered the disappearance of the band. Jupiter's appearance is usually dominated by two dark bands in its atmosphere. Recent images taken by amateur astronomers show that the south equatorial belt has vanished. Jupiter remains near to Uranus throughout the quarter, making a very close approach (about 1°) while on a retrograde path on

Rising and setting times (UT): lat.52°N; long.3°W

	July 15		August 15		September 15	
	Rise	Set	Rise	Set	Rise	Set
Sun	04:09 ♊	20:25	04:55 ♌	19:36	05:46 ♌	18:27
Mercury	05:42 ♋	21:23	07:33 ♌	19:59	04:14 ♌	17:55
Venus	08:10 ♌	22:08	09:24 ♍	20:45	10:10 ♍	19:04
Mars	09:43 ♌	22:31	09:30 ♍	20:57	09:25 ♍	19:29
Jupiter	22:47 ♓	10:57	20:45 ♓	08:50	18:38 ♓	06:29
Saturn	10:25 ♍	22.54	08:39 ♍	20:58	06:58 ♍	19:00
Uranus	22:39 ♓	10:43	20:36 ♓	08:38	18:32 ♓	06:30
Neptune	21:41 ♒	07:39	19:38 ♑	05:33	17:35 ♑	03:26
Moon	09:14 ♌	21:49	12:29 ♍	21:17	14:44 ♐	22:15

Data for other venues and dates can be estimated from this (and Moon phase) table. Symbols after rise times show constellations where body is, at rising. ⛎ is a symbol "borrowed" for Ophiuchus, the "13th" zodiacal constellation.

September 18th.

Saturn can be seen during July and August and positions itself around other planets and the Moon on occasion to make some nice patterns in the sky. By September Saturn ends up poorly placed in the constellation of Virgo and it will be a little while before it is available for viewing again. The two distant planets, Uranus and Neptune, are visible but are as hard to find as usual. A good pair of binoculars or a telescope is needed. Uranus will be about magnitude 5.8 and will appear faintly blue/green. It is at opposition on Sept 21st when it will be just to the lower left of the "Circlet" in Pisces. Jupiter is very close at this point (see above). If you don't own binoculars visit the AAE website for information on how to find a local astronomy society that will be able to advise you.

Now let us talk meteor showers. In July the only meteor shower of note is that of the Capricornid stream with two peaks on the 8th and 15th. Capricornids are characterised by their often yellow colouration and their frequent brightness. They are also slow interplanetary interlopers, hitting our atmosphere at around 15 miles per second. Although you can expect only 15 meteors per hour at best under dark sky conditions, the Capricornids are noted for producing brilliant fireballs. August brings us a yearly favourite, the Perseids. This shower produces about 60 meteors per hour, and its performance is fairly consistent from year to year. The parent comet that seeds this shower is 109P/Swift-Tuttle. This year's shower should peak on the night of August 12th and the morning of the 13th, but you may be able to see some meteors any time from July 23rd - August 22nd. The radiant point for this shower will be in the constellation Perseus. The thin crescent moon will be out of the way early, setting the stage for a potentially spectacular show. For best viewing, look to the northeast after midnight.

Finally, we will see the final Space Shuttle flight on September 16th, if all goes according to plan. The orbiter Discovery will depart on mission STS-133 and bring to a close the thirty-year era of space shuttles as the work horses of the United States space program. After this flight the remaining shuttle orbiters will find their final resting places in museums across the country.

James O'Neill