Gnomon

Newsletter of the Association of Astronomy Education

Vol. 29 No.3 | **ISSN 0952 326X** | **SPRING 2010**

The Primary Curriculum Review

The primary national curriculum is under a major revision after a review chaired by Sir Jim Rose (the Rose Review). The new curriculum is planned to be in force by Sept 2011. What follows is from the QCDA website:

"A school's curriculum should help its children become the very best they can be. Following an independent review, a new curriculum has been developed to prepare our children for the opportunities and challenges of life in the 21st century.

The National Curriculum has three broad aims. It should enable all young people to become:

- successful learners who enjoy learning, make progress and achieve
- confident individuals who are able to live safe, healthy and fulfilling lives
- responsible citizens who make a positive contribution to society".

The new areas of learning capture the essential knowledge, key skills and understanding that children need to develop as they progress through their primary years.

For more detail of these areas of learning, see the article on page 7.

Dr Francisco Diego

AAE at Winchester 8th May 2010

The British Association of Planetaria would like to welcome members of the AAE to join us at INTECH for a joint meeting focussed on Astronomy Education in schools and for the public.

The venue for this joint event will be the INTECH Science Centre and Planetarium, Telegraph Way, Morn Hill, Winchester, Hampshire SO21 1HZ .

The BAP are having a two day meeting on Friday 7th and Saturday 8th May. Members of the AAE are welcome to join the BAP for both days for no extra cost as there will be relevant and interesting sessions on both days. However we have set aside Saturday 8th May as a date that is more specifically geared towards the interests of the AAE. The AAE's AGM will be on this day.

The theme of this event has been chosen as "Is there anybody out there...?".

Teachers are invited to join us for a free afternoon session crammed full of fascinating information and practical tips for astronomy education. This will include a stimulating workshop run by Dr. Francisco Diego using the great INTECH planetarium as a backdrop and based on the inspiring subject of extra-terrestrial life in the universe. For more details see page 7.

☞ *(cont. on p7)*

Taking a peek into a planetary nursery

A collection of 30 new images of embryonic planetary systems in the Orion Nebula representing the longest single Hubble Space Telescope project ever dedicated to the topic of star and planet formation were published recently. Also known as proplyds, or protoplanetary discs, these modest blobs surrounding baby stars are shedding light on the mechanism behind planet formation. Only the NASA/ESA Hubble Space Telescope, with its high resolution and sensitivity, can take such detailed pictures of circumstellar discs at optical wavelengths. As newborn stars emerge from the nebula's mixture of gas and dust, proplyds form around them: the centre of the spinning disc heats up and becomes a new star, but remnants around the outskirts of the disc attract other bits of dust and clump together. So far Hubble has found 42 protoplanetary discs in the nebula, from which these nine are selected. Researchers have identified two different types of discs around young and forming stars: those that lie close to the brightest star in the cluster (θ 1 Orionis C) and those farther away from it. This bright star heats up the gas in nearby discs, causing them to shine brightly. Discs that are farther away do not receive enough energetic radiation from the star to heat up the gas and so they can be detected only as dark silhouettes against the background of the bright nebula, as the dust that surrounds these discs absorbs background visible light. By studying these silhouetted discs, astronomers are better able to characterize the properties of the dust grains that are thought to bind together and possibly form planets like our own. The brighter discs are indicated by a glowing cusp in the excited material and facing the bright star, but which we see at a random orientation within the nebula. Some discs appear edge on, and others face on, for instance. Other interesting features enhance the look of these captivating objects, such as emerging jets of matter and shock waves. The dramatic shock waves are formed when the stellar wind from the nearby massive star collides with the gas in the nebula, sculpting many weird shapes, described variously as boomerangs, arrows or even jellyfish!

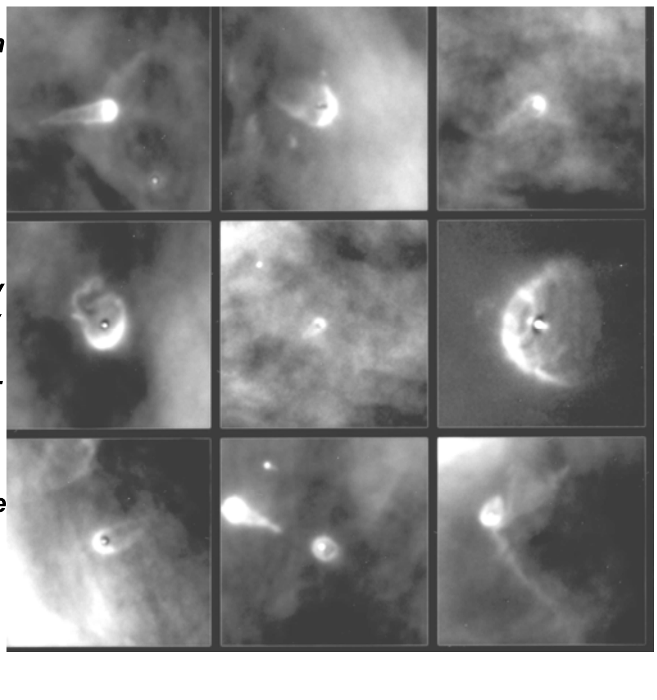

Photo: NASA, ESA and L. Ricci (ESO))

Report from the RAS Education Committee

The Royal Astronomical Society's Education Committee combines professional astronomers with those involved in primary and secondary science education. Its primary aim is to further and enhance astronomical and geophysical education within these phases.

One of its major projects in recent years has been the development of an on-line database of educational resources to support the teaching of astronomy and geophysics at the primary and secondary levels. The distinctive feature of the RAS Resources Database is that all items listed carry the RAS 'kite-mark', i.e. they have been checked by RAS Fellows, both for scientific accuracy and educational effectiveness.

The Fellows of the Education Committee help to check the scientific accuracy of any item in the database whilst their likely effectiveness in the classroom is checked by the RAS Education Focus Group, containing Fellows who work in primary or secondary education. In addition, we have recently begun to assemble a group of secondary school students who act as RAS Student Reviewers, allowing potential items to undergo some 'consumer testing' before inclusion.

The list of websites in the database has been growing steadily and it can thus lead teachers and students to resources to support teaching and learning across a wide range of astronomical and geophysical topics. The Education Committee is keen to develop further the impact of the database and would welcome any comments or suggestions regarding its use, or details of any high quality resources which are not currently included. AAE members are invited to explore the database at:

www.ras.org.uk/resources

Please pass on any comments or suggestions to me.

Having kept a close watch on recent changes to primary and secondary science curricula and examination specifications, the Education Committee has identified two topic areas which continue to be fully represented throughout the regularly changing incarnations of GCSE, AS and A2 Physics. The Committee is thus in the process of helping to produce two new titles in the popular series of RAS leaflets, which are now available as PDF files from the RAS website. A leaflet on Cosmology, written by former RAS President Michael Rowan-Robinson, and a second on stellar evolution by AAE Council member Francisco Diego, will be available soon. Although there is a large number of resources related to astronomical and geophysical topics available on the web, the Committee hopes that these two titles will provide teachers with an authoritative account, of particular use to science teachers who do not have a background in astronomy.

The prizes for last year's RAS Schools' Newspaper Competition have now been distributed to the winning and runner-up schools, once again generating very positive feedback.

Imagine...

...if this year, after thousands of years of wondering and fifty years of searching, the first message from intelligent life outside our Solar System was received…

Could you…

...create the words and pictures in that first message from an extra-terrestrial civilisation, showing what their world is like..?

This year's competition, designed to help celebrate fifty years of SETI, is now been publicised amongst primary and secondary schools in the UK. It asks students to imagine what the first message to be received from another civilisation might be like.

The Newspaper competition is open to groups of students in two age ranges: 7-11 and 11-14 years. The Feature Article Competition is open to individual students in two age ranges: 14-16 and 16-19 years

A copy of the information sheet for this competition can be downloaded by following the Education link on the RAS website.

Julien King

jk << at >> ras.org.uk

Julien King is Chair of the RAS Education Committee, Principal Moderator for GCSE Astronomy with Edexcel and teaches physics and astronomy at Ermysted's Grammar School, Skipton, North Yorkshire.

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Practising teachers may claim their subscriptions as an allowance against income tax, effectively reducing their contributions.

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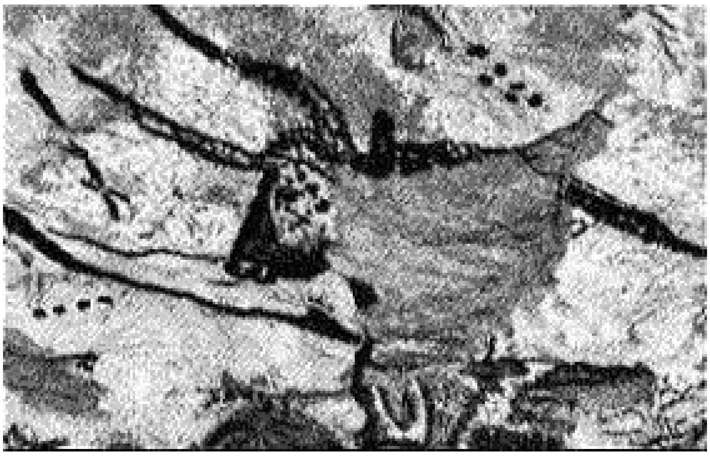
Pictures in the Dark

In September 1940, in south-west France, teenager Marcel Ravidat and three friends came across a hole in the ground hidden by a thicket, reportedly while searching for a lost dog. They found, on penetrating the two-hundred-metre long cavern below, not one, but many hundreds of animals – painted on the wall by Neolithic cave artists. Radiocarbon dating of charcoal and other artifacts found in the Lascaux cave complex points to a date of around 15 000 BC. Stags, horses, gazelles, felines, a rhinoceros and the occasional human figure cover the walls, but the pièce de résistance is the Salle des Taureaux (Chamber of Bulls), with its four



enormous paintings of long-horned aurochs bulls.

One might think that such a subterranean wonder would have little to do with our view of the stars above, but around one of the bulls, charging to the left, the artist has painted a tightly-knit set of black dots above its back, an array of dots in its muzzle and a line of dots in front of it. It was Dr Michael Rappenglueck, of the University of Munich, who first suggested that these might represent the Pleiades, Hyades and Orion's Belt, and the correspondence is remarkable. It seems likely that it was not the Egyptians or the Babylonians who first formed familiar constellations. Our ancestors have been stargazing and creating star-creatures for far longer: the paintings are more than three times older than the Great Pyramid.

I have recently incorporated the Lascaux Bull into my schools' planetarium talk on constellations, to show their antiquity and to introduce the idea of star-patterns to the very young. Recently, I took my dome to a Poole first school, and at 'question time' at the end, the teacher in charge was able to tell the children, and me, that she had not only visited the (replica) cave of Lascaux many years before, shortly after the original was closed to protect it from the impact of tourism, but had also been introduced to Monsieur Ravidat, the discoverer, who liked nothing better than to recount for the umpteenth time the story of how he had gazed in wonder at the bull of Lascaux in 1940.

Bob Mizon

There is more on the 16,500 years old story at:

http://news.bbc.co.uk/1/hi/871930.stm

Astrophysics in a nutshell

The Universe has been upsetting me considerably. It was only a few years ago that it was stated that the galaxies had started to form about half way through the life of the Universe. We are now about 14 or so billion years since the Big Bang, so that implied galaxy formation began some seven or eight billion years ago.

Since then, Hubble started poking its nose in and nothing fits any more. When, a few years ago, someone who obviously had time on his hands, decided to aim Hubble at a totally blank bit of sky, it must have been very frustrating to find that in fact it was full of galaxies! Hundreds of them! They were all sorts of shapes and sizes and clearly had been around for quite a while. Since then, Hubble has looked deeper and deeper into space, and hence much further into the past. We still have not seen nothing yet. (If you see what I mean). As far back in time as we look, we have not found a time when there were not galaxies wall to wall. At this rate, it seems that the galaxies were there almost before the Big Bang had had time to say "pardon me!".

So it was decided to check up on just how far away some of those really distant objects were. After all, it really was quite a bit further than down to the corner store. So some no doubt well-meaning meddler found that some types of supernovae allowed an independent verification of how distant their home galaxies were when too far away to find Cepheid variables, etc. I wonder what they thought when they found that apparently gravity has just given up on holding the whole bang shoot together, and instead something else is forcing the galaxies to race apart even faster.

Of course, the answer was obvious. Most of the Universe must consist of a substance we have never found, could not explain, or even prove exists, and which repels everything in sight - in fact further than "in sight", because the speed of light wouldn't allow that!

Apart from rewriting the whole of physics, this acceleration of Universal expansion must be easy to explain. Mustn't it? As a friar called Bill Ockham in the year one thousand three hundred and something is reported to have said so wisely "*entia non sunt multiplicanda praeter necessitatem*", that is to say, "if it ain't bust, why fix it?" or *numquam ponenda est pluralitas sine necessitate,* which was later called "Occam's razor".

So I propose a simple explanation, which I shall call the "Knox Answer To All Strange Ticklish Riddles Of Physics Hubble Yields" (KATASTROPHY) and remember you read it in *Gnomon* first. And it's not 42, it goes like this:

Since time began, the speed of light, c, has been universal. But since light could cross the entire universe in less time that it takes to type "c", say 1 second after this Universe started up, the value of c must have been falling ever since! (This is probably because the Universe is still in the black hole it must have been in to start with. Or have I failed to understand dark matter?). One day, light will be travelling so slowly that *everything* will be pitch dark: we shan't be able to see it, and as for matter, well it won't!

Richard Knox

Solar Stormwatch

Galaxy Zoo have just launched a new project inspired by the success of your work on galaxies. You are invited to help scientists studying storms that eject millions of tonnes of matter from the Sun's surface. Volunteers can spot these storms and track their progress across space towards the Earth. Such storms can be harmful to astronauts in orbit and have the potential to knock out communication satellites, disrupt mobile phone networks and damage power lines. With the public's help, Solar Stormwatch will allow solar scientists to understand these potentially dangerous storms much better and help to forecast their arrival time at Earth.

The more people looking at the beautiful videos collected from NASA's STEREO spacecraft, the more discoveries we will make. If you want to take part, do log on to:

http://www.solarstormwatch.com

Letter from Down Under

Strange new “flowers” are sprouting in the Australian outback, but not as a result of the significant rainfall we’ve experienced recently. Work is proceeding apace on Australia’s next great radio telescope, the Australian Square Kilometre Array Pathfinder (ASKAP). As the name implies, this facility is intended to be a step along the path to the eventual construction of a telescope having a total collecting area of one square kilometre, albeit in the form of many thousands of smaller antennas linked together electronically. The shortlist of sites to host the SKA itself has already been narrowed down to two: South Africa, or Australia. While the site evaluation process continues, both potential host countries are proceeding with pathfinder facilities to demonstrate the key technologies involved, and although each will have a collecting area less than 1% of the final SKA, they are intended to be powerful radio telescopes in their own right.

The first ASKAP antenna erected in the West Australian outback undergoes testing, prior to the arrival of 35 similar antennas to which it will be electronically linked. Image credit: Dave DeBoer, CSIRO.

ASKAP will consist of 36 antennas, each 12 m in diameter, spread over an area of some 6 km of the Western Australian outback. The first antenna to arrive from its factory in China recently had “first light” when it observed the signal from a geostationary satellite, from which the accuracy of the antenna’s surface can be measured. This antenna will be joined by five more before the end of this year, and the entire ASKAP system is expected to become operational in 2013. What sets ASKAP apart most from earlier telescopes is its huge field of view – 30 square degrees, or more than 100 full Moons in area! Whereas earlier telescopes like the famous “dish” at Parkes, and the Australia Telescope Compact Array near Narrabri rely upon scanning a single pixel across the sky, coupled with the rotation of the Earth, to map an area this big over several hours or even days, ASKAP will use the equivalent of a digital camera for the radio to take in the whole area at once. Each ASKAP antenna will be mounted with a Focal Plane Array containing just 30 “pixels” in total, but this alone will enable ASKAP to survey huge areas of sky much faster than hitherto possible.

This exciting new capability forces astronomers to adopt a different approach to doing radio astronomy. Rather than allocating hours or days to one or a few astronomers to observe a single target, or set of targets as has customarily been done, hundreds or even thousands of hours will be allocated to large collaborative teams of astronomers to carry out dedicated surveys of the entire southern sky. Although ASKAP will not be ready to commence these surveys for at least two more years, the process of selecting which teams will win the right to conduct their proposed survey has already begun. At first, Expressions of Interest only were sought from teams interested in proposing a large Survey Science Project (SSP) to be conducted with ASKAP. This alone generated 38 proposals from astronomers all around the world. Following the first official call for SSPs, the CSIRO announced in September 2009 the ten which had been selected to proceed to a Design Study phase. These 10 SSPs together involve 363 individual astronomers from 131 institutions, about 1/3 of whom are in Australia or New Zealand, 1/3 from North America, and the remaining 1/3 from Europe and elsewhere. The SSPs are:

- *Evolutionary Map of the Universe* (EMU) will search for typical star forming galaxies, powerful starbursting galaxies, and Active Galactic Nuclei (as well as undoubtedly discovering new classes of rare objects), by detecting the flux they emit across all parts of the radio spectrum.
- *Widefield ASKAP L-band Legacy All-sky Blind surveY* (WALLABY) will detect the signal from neutral hydrogen gas in up to half a million galaxies, some of which may have no known optical counterpart.
- *First Large Absorption Survey in HI* (FLASH) will detect low levels of hydrogen in nearby galaxies by looking for absorption against bright background sources.
- *Variables and Slow Transients* (VAST) will compare maps of the radio sky made minutes, days, months, and years apart to look for objects which change in random or regular ways, including flare stars, X-ray binaries, and radio supernovae.
- *Galactic ASKAP Spectral Line Survey* (GASKAP) will map emission from neutral hydrogen and from hydroxyl molecules across the disk of our Milky Way Galaxy, and in the Magellanic Clouds.
- *POlarization Sky Survey of the Universe’s Magnetism* (POSSUM) will use the polarization of objects across the sky to map out the magnetic fields in the Milky Way, other galaxies, and in clusters of galaxies.
- *Commensal Real-time ASKAP Fast Transients survey* (CRAFT) will find new pulsars and other objects which change brightness faster than 5 seconds.
- *Deep Investigation of Neutral Gas Origins* (DINGO) will focus on a small area of sky for as long as possible to find objects with the lowest hydrogen mass ever.
- *High Resolution Components of ASKAP* will use Very Long Baseline Interferometry to link ASKAP with antennas elsewhere in Australia to see the finest detail in radio sources ever achieved from Australia.
- *Compact Objects with ASKAP: Surveys and Timing* (COAST) will use pulsar timing measurements to look for evidence of gravitational waves.

Not one to miss out on such an exciting opportunity (and wanting to hedge my bets), I have signed on to both the VAST and WALLABY teams. Now the real work begins. Clearly, if the scientists involved put as much thought and care into preparing their programs and analyzing the results as they have in choosing their acronyms, then ASKAP will be an outstanding success indeed!

Stuart Ryder

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Proving Einstein Right

Ian's lecture tries to give a feel of Einstein's "Theory of General Relativity" and show how, over the last 90 years, it has stood up to all the observational tests that have been made.

Einstein's Special Theory of Relativity postulates that nothing can travel *through* space faster than the speed of light, 3 x 10^5 km s^{-1}. (The word "through" has been highlighted as the expansion of space *can* carry matter apart faster than the speed of light). Perhaps a rather far-fetched thought experiment will help to make it clear that, if this is the case, Newton's Law of Gravity cannot be totally correct. Suppose that the Sun could suddenly cease to exist. Under Newton's theory of gravity, the Earth would instantly fly off at a tangent. Einstein realised that this could not be the case. Not only would we not be aware of the demise of the Sun for 8.31 minutes, the time light takes to travel from the Sun to the Earth, the Earth must continue to feel the gravitational effects of the Sun for just the same time and would only fly off at a tangent the moment we ceased to see the Sun. Of course this assumes that whatever carries the information about the gravitational field of the Sun also propagates at the speed of light. So something has to propagate through space to carry the information about a change in gravity field. Einstein thus postulated the existence of gravitational waves that would carry such information. The existence of such gravitational waves has already been shown indirectly.

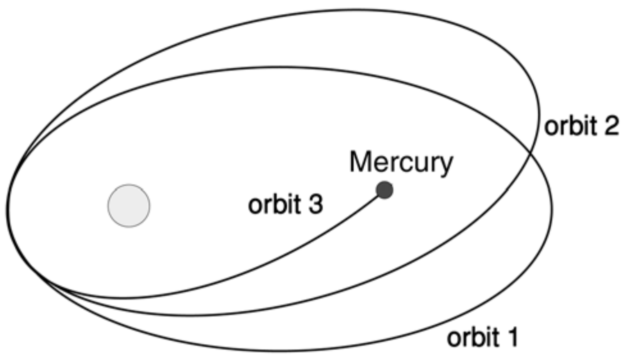
In 1915, Einstein published his "General Theory of Relativity", often called General Relativity, which is essentially a theory of gravity. Objects in our Universe exist in a four dimensional space-time continuum which combines the three co-ordinates of space with a fourth co-ordinate, time. For simplicity, in what follows, the term "space" will be used. In the absence of mass, Einstein's theory predicts that space is "flat". This is a rather unfortunate term as it seems to imply a 2 dimensional plane surface. In fact, it simply means that light will travel in straight lines, so two initially parallel beams of light remain parallel. In "flat" space a triangle in any orientation will have inscribed angles that add up to 180 degrees. Euclidian Geometry holds true! (Personally, I would like to start a movement to stop calling space "flat" and use the terms "Euclidian" or "zero curvature" space instead!)

If a mass is now introduced into flat space it makes the space positively curved so that two initially parallel beams of light will converge and the inscribed angles of triangles will add up to more than 180 degrees. A simple, two dimensional, analogy is a flat stretched sheet of rubber. Ball bearings rolled across it will travel in straight lines. If a heavy ball is now placed on the rubber sheet, it will cause a depression and should a ball bearing come close, it will follow a curved path. In just the same way, the space around our Sun is positively curved and the Earth is simply following its natural path through this curved space - there is no force acting on it.

Imagine a spherical world where the inhabitants believe totally (but incorrectly) that the surface is flat. In the region near their north pole the icy surface is virtually frictionless. The inhabitants use a hovercraft like transport so that, once moving, the craft experience no frictional forces. Two craft, 10 km apart, and at identical distance from the pole, set off at the same time and at the same speed heading due north on parallel paths across the ice. As they believe that the surface is flat, they will expect to remain this distance apart as they travel across the ice. They will thus be somewhat surprised (and possibly hurt) when they collide at the North Pole! In order to maintain their belief that the surface of their world is flat they could postulate a force, that they might call "gravity", to explain why their craft were drawn together. In the same way, *we* postulate the force of gravity to explain what *we* observe in the (incorrect) belief that three dimensional space is flat in the vicinity of mass, not curved.

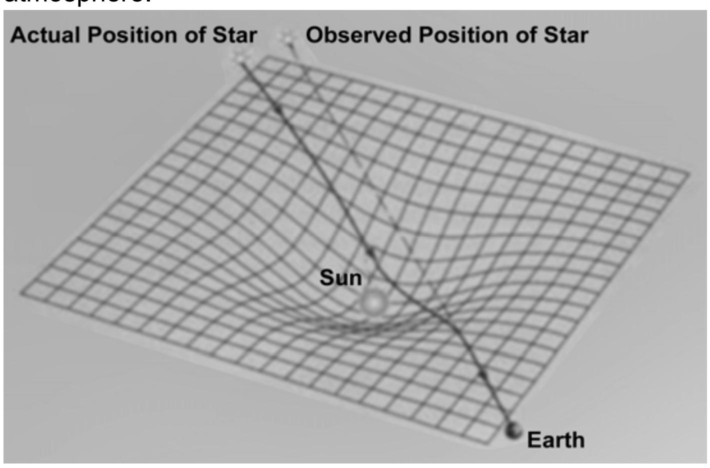
Gravity is a force that we "invent" to explain what we observe happening (such as the planets going around the Sun) in the belief that space is flat when it is, in fact, positively curved.

The first "test" of Einstein's theory was its application to the orbit of Mercury. As Kepler's first law of planetary motion tells us, the orbit of Mercury should be an ellipse with the Sun at one focus. The point of closest approach, called its perihelion, would remain fixed in space if the Sun was a sphere and there were no other planets. However the oblateness of the Sun and perturbations caused by the other planets cause the orbit to "precess". Think of the patterns produce by a "spirograph". Accurate observations showed that the observed value of this precession, 5599.7 arcsec per century, disagreed with that calculated from



Newton's theory by 43.0 arcsec per century. However Einstein's theory provided a correction term of 42.98+/- 0.04arcsec, exactly the amount needed to remove the anomaly.

It was realised that Einstein's theory could be tested by observing the positions of stars when observed close to the Sun. Einstein's theory predicted that the positions of the nearest stars would be shifted by just 1.75 arc seconds - close to the limitations in measurement accuracy due the atmosphere.

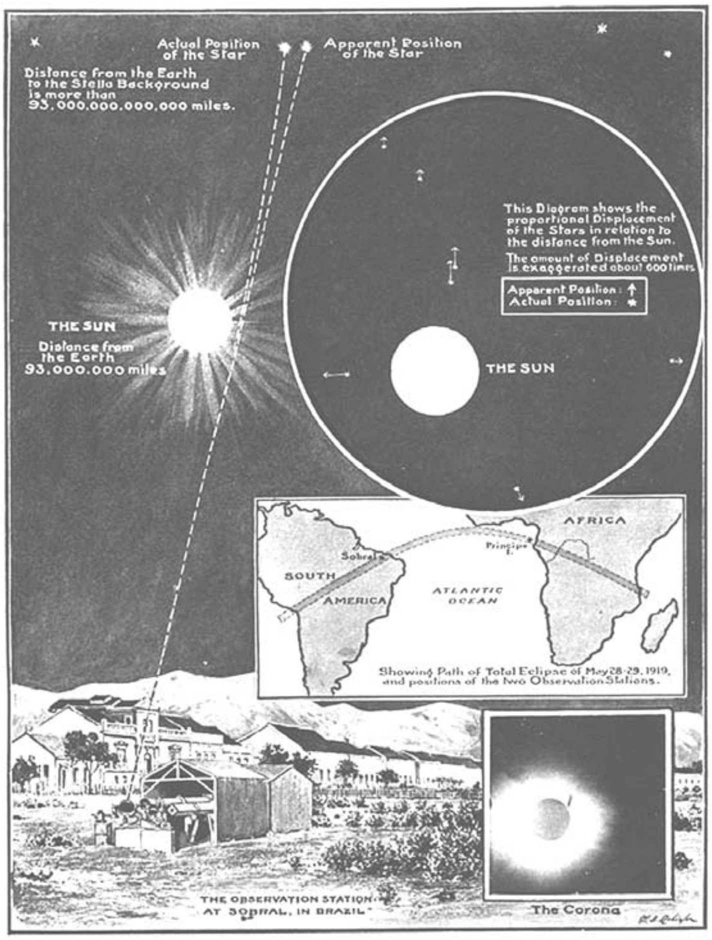


We cannot usually measure the positions of stars close to the Sun except during a total eclipse of the Sun and thus the eclipses of 1919 and 1922 which followed the publication of Einstein's theory played a significant role in the history of science. In essence the plan was simple. Prior to a solar eclipse, take images of the sky where the Sun would be during totality. Take the same images during to- ☞

☞ *(cont. from p5)* tality (the only time when stars can be seen close to the Sun's position) and compare positions of stars.

Sir Arthur Eddington led the British eclipse expedition to the Atlantic Island of Principe, whilst a second set of observations were made from Sobral in Brazil. Fortuitously, at the time of the eclipse, the Sun lay in front of the Hyades star cluster, so giving a rich field of stars to measure - comparing individual star positions made during the eclipse with earlier observations of the cluster. The telescopes used thus had to be portable and this limited their accuracy. The control images had to be taken at night when it would have been colder than during the day. Even disregarding these problems, the experiment was not easy. The anticipated deflection of 1.6 arcsec compares with the typical size of a stellar image as observed from the ground (due to atmospheric turbulence) of 1 to 2 arcsec.

The data were not quite as conclusive as was implied at the time. The telescope at Principe was used to take 16 plates, but partial cloud reduced their quality. Two usable plates from the telescope on Principe, though of a poor quality, suggested a mean deflection of 1.62″. Two telescopes were used at Sobral where conditions were superb; sadly however the focus of the main instrument shifted, probably due to temperature changes, and the stellar images were not clear.



They were thus difficult to measure and produced a result of ~ 0.93 arcsec. A smaller instrument did, however, produce 8 clear plates and these showed a mean deviation of 1.98 +/- 0.12 arcsec. If all the data had been included, the results would have been inconclusive but Eddington, with little justification, discounted the results obtained from the larger Sobral telescope and gave extra weight to the results from Principe (which he had personally recorded). The Astronomer Royal and the President of the Royal Society declared the evidence was in favour of Einstein's theory. However there were many scientists who, at the time, felt there were good reasons to doubt whether the observations had been able to test the theory accurately.

☞ *(cont. on p7)*

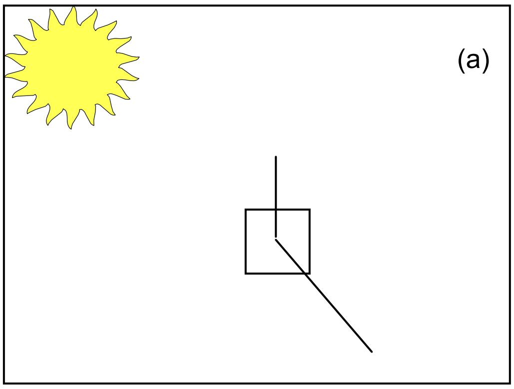
Curriculum Corner

WORKING OUT SOLAR NOON (2)

(by measuring shadows)

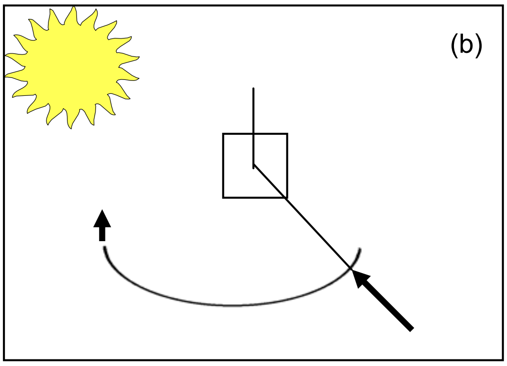
Between 10 and 11 a.m. on a sunny morning place a stick on a paved area. Make sure that it is vertical by using a plumb line, level, or sighting to the corner of a building.

(a) Tie about a two-metre length of string to the base of the stick and stretch it out to the end of the stick's shadow. Draw along the shadow with chalk.



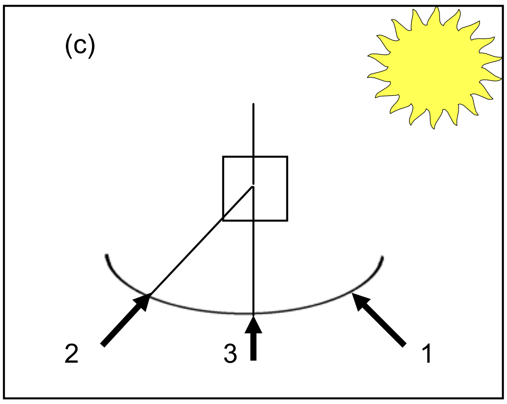
(b) Attach a piece of chalk to the string at the end of the shadow and draw an arc clockwise on the ground (about half a circle).

Mark the arc ↖ where the shadow touches it.



(c) Mark the arc again ↗ where the afternoon shadow touches it.

Measure the distance accurately between the ends of each shadow 1 and 2, divide in half. Mark this point on the ground (3). Draw a line from this point to the stick.



This line 3 marks the time and direction of solar noon for this place when the sun is on true south. This means that the shadow lies along a line from the north to south poles through your place.

Eric Jackson

☞ *(cont. from p6)* A more positive test of the theory came from observations made by William Campbell's team from the Lick Observatory who observed the 1922 eclipse from Australia. They determined a stellar displacement of 1.72 +/- 0.11 arc seconds. Campbell had believed that Einstein's theories were wrong, but when his experiment proved the opposite, he immediately admitted his error and thereafter supported relativity. (One tends to believe an experiment when the results do not agree with the expectations of the observer!)

Ian Morison
Gresham Professor of Astronomy

This article is the first instalment of a lecture given at the RAS Burlington House as one of its lunchtime lecture series for the public. The remaining sections will appear in the next two editions of Gnomon.

The New Primary Curriculum (contd)

There are now six areas of learning:

- Understanding the arts - Developing creativity and imagination
- Understanding English, communication and languages - Developing communication and language skills-
- Historical, geographical and social understanding - Understanding how the past shapes the present and the future and how people, places and environments are interconnected
- Mathematical understanding - Understanding mathematics and its use in everyday life
- Understanding physical development, health and wellbeing - Understanding what makes a healthy, active and fulfilling life
- Scientific and technological understanding - Understanding the natural and made worlds and the relationship between science and technology.

(Religious education is a statutory subject with a non-statutory programme of learning. The Education Act 1996 requires schools to offer religious education to all children, unless their parents withdraw them).

At the very end of the scientific programme of study there is the section called "the environment, earth and solar system"

L14. to investigate and explain how plants and animals are interdependent and are diverse and adapted to their environment as a result of evolution

L15. to investigate and explain how scientific and technological developments affect the physical and living worlds

L16. to explore and explain practical ways in which science can contribute to a more sustainable future

L17. to explore and explain how time measurement relates to day and night and the Earth's place in the solar system.

The "Level Descriptions" for this section are also illuminating. There is no room to print them all here but they may be read on the QCDA website.

The ASE's response to this review is given on

http://www.ase.org.uk/htm/journals/psr/ps110/04-07.pdf

Also there is a response from the ASE president Prof Wynne Harlen at:

http://www.ase.org.uk/htm/homepage/notes_news/feb2009/Sir%20Jim%20Rose%20Letter%20Jan09.pdf

The ASE expresses concerns over the omission of science enquiry skills and the demotion of science as a core subject along literacy and numeracy and over the teaching of ICT as a discrete subject rather than a tool to develop skills.

Full details of the new curriculum and links to level descriptions are given on the website of the QCDA (Qualifications and Curriculum Development Agency) at:

http://curriculum.qcda.gov.uk/index.aspx

Francisco Diego
Vice-President of the AAE

(What do you think? Write to us and let us know. Ed)

☞ *(cont. from p1)*

Programme For AAE/BAP Meeting

9 a.m. BAP AGM at the Holiday Inn (next door to INTECH). All AAE members are welcome to join us there for our meeting.

10 a.m. Alternatively, feel free to arrive at the doors of INTECH Science Centre to browse the centre before the main timetable of events begins on site. There will be talks and meetings, followed by the free teachers' event from 1.30 to 5.00 pm.

Cost: The meeting for the BAP is sponsored this year and we would like to extend the benefits of this sponsorship to members of the AAE. £30 for the full day (including AAE AGM, tea/coffee and lunch). To get the sponsored rate of £30 for the day (or 2 day conference) you need to register as soon as possible. To register please fill in the online form at www.planetaria.org.uk/bap_agm.asp Registration is a 2-stage process. Fill in the online form, press SEND and then read/print the following screen. This contains details of how to pay the registration fee directly to BAP. The registration will be open from 22nd March to 23rd April. The conference fee will rise to £45 for late registration. You must register before 30th April. We are cracking down on late arrivals due to the limitations of our sponsorship so those who haven't registered will not be able to attend.

If you would like to join us for our conference meal on Saturday evening please contact Shaaron Leverment directly at: **admin << at >> planetaria.org.uk** (as places are limited).

The brand new Winchester Holiday Inn is situated a stone's throw from the venue. Conference rates are £70 for a double or £65 for a single room.

A promotional code to book these cheaper rates will be released over the next week. Please ensure you speak to in-house reservation and quote 'BAP Conference' to ensure the special rate is offered. Tel: 01962 670700 (or email).

There are cheaper B&Bs in Winchester itself so it might be worth doing your own search. Bear in mind public transport from Winchester to INTECH is poor so you may need to hire taxis or bring your own car (easy access from the M3).

Elections: The AAE Annual Business Meeting will hold elections for the new Council. Please send nominations to the AAE secretary, Teresa Grafton, before the meeting.

Shaaron Leverment

Sky Diary Spring 2010

The quarter starts with a chance to catch Venus and Mercury together in the early evening twilight almost exactly due west. At the end of Civil Twilight (when the Sun's depression is 6º at, say, 19:20 GMT) the two planets are separated by some 3½º at an altitude of 10º. This is a good photo opportunity or just a useful way of spotting Mercury, not very easy, despite its magnitude of nearly –1. The best date is April 4, four days before Mercury reaches its maximum elongation east of the Sun (an angle of 19º). After the first week in April the two planets drift apart. This first April week is about the best this year for spotting the closest planet to the Sun in the northern hemisphere sky. Just find Venus, and Mercury is to the right by about the distance between two knuckles of your fist held at arm's length. ☞

☞ ***(cont. from p.7)*** Venus remains visible throughout the Spring and into the Summer in the evening sky, as do Saturn and Mars, the latter fading from the bright red object that has been such a pleasure through the Winter. At the end of June the three planets line up along the western area of sky, setting between 22:46 and 00:11 (GMT) in order Venus, Mars, Saturn.

The ecliptic lies almost parallel to the western horizon at this time of day and date. Well to the east of the three planets on June 26, the Full Moon is low in the southern sky, in the "Teapot" of Sagittarius, which also helps us to imagine the line of the ecliptic, low across the south to west quadrant of the sky. The Moon at culmination that night is at an altitude of only about 12º (depending on your latitude, of course).

Further east around the ecliptic, Jupiter is just peeping over the eastern horizon. By the time the giant planet reaches culmination, at about 06:27GMT, it is well after sunrise, and Jupiter is at an altitude of just under 40º. This shows how the ecliptic climbs rapidly northwards through this part of the sky, the constellations of Aquarius and Pisces, leading towards the position the Sun occupies at the Spring Equinox.

Jupiter, being a superior planet, (at a greater distance from the Sun compared with Earth) takes longer to orbit the Sun. A Jovian year is about 12 Earth years, and so as we watch it moving round the ecliptic, it takes (*very* roughly) a year to pass through each Zodiacal "House". So for long-term observers who began to watch the stars in their Primary School years, it makes about six tours around the celestial sphere in a lifetime. For planetary observers, this means a long wait while Jupiter meanders through the southern constellations of the Zodiac over six years or so. So now it is back in our half of the sky where it will stay until late 2016. Welcome back Jupiter!

On June 7, at 06:20 Jupiter passes south of Uranus at a distance of about 26arcmin. Jupiter and Uranus rise at about 01:14, and sunrise is at 03:54. The Moon, close to Last Quarter, will rise just before the two planets, even though it is to the east of the two planets by some 12º. Civil twilight begins with the Sun 6º below the north-east horizon at this time, and Jupiter is 15º high in the east south east. So this is about the optimum time for seeing the two planets together in a low power field of a telescope. They will be situated fairly close together for some weeks in the small hours of the morning, but well worth setting the alarm for (or having a very late night!).

Moon phases for the second quarter of 2010

	New Moon	First Quarter	Full Moon	Last Quarter
April	**14**	**21**	**28**	**6**
May	**14**	**20**	**27**	**6**
June	**12**	**19**	**26**	**4**

Meanwhile Saturn is now roughly where Jupiter will be again in midsummer 2017, south of the equator, and going down! Saturn takes almost 30 years to journey round the Sun once, so makes only about two tours of the sky during most people's observing lifetime. So some of us (quite a few, I suspect) will not be seeing Saturn's bottom again now we have passed through the plane of the planet's equator.

The two-day old slim crescent Moon will pass close to the north of Venus on May 16 at 10:00GMT. Of course the Sun is high in the sky at that time, separated from the pair by an angle of 30º. It may be tempting to try and find the pair with binoculars, and that will be fine if you are extremely careful in avoiding "sweeping" anywhere near the Sun. The Sun will be preceding the pair across the sky, so the sensible plan is to find a corner of a building to provide an instant "sunset" for you. Make sure you are in the shadow of the side of the building, and the clear sky is to the east of the Sun (i.e. the Sun is moving deeper into the shadow). Then you have a better chance of spotting the pair without optical aid of any kind, or you can safely scan the area with your binoculars.

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

	April15		May 15		June 15	
	Rise	Set	Rise	Set	Rise	Set
Sun	05:15 ♓	19:09	04:18 ♉	19:59	03:51 ♉	20:33
Mercury	05:28 ♈	20:57	03:53 ♓	17:41	03:07 ♉	19:12
Venus	06:02 ♈	21:20	05:45 ♉	22:45	06:44 ♋	23:00
Mars	11:15 ♋	03:20	10:31 ♌	01:43	10:02 ♌	00:06
Jupiter	04:26 ♒	15:43	02:38 ♓	14:19	00:44 ♓	12:43
Saturn	16:22 ♍	04:57	14:16 ♍	02:57	12:15 ♍	00:54
Uranus	04:36 ♓	16:28	02:41 ♓	14:38	00:40 ♓	12:41
Neptune	09:30 ♒	19:13	01:46 ♒	11:42	23:40♒	09:40
Moon	05:04 ♈	20:55	04:44 ♉	22:!3	07:16 ♋	22:46

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.

During a good deal of this period, fainter stars become swamped by twilight. The Sun's azimuth is evident all night from the middle of May by the nimbus of light that follows it round the horizon as the night progresses.

"Twilight" was originally an imprecise term devised for very different purposes. *Civil twilight* was invented so we knew when to switch on street lighting and vehicle lights. *Nautical twilight* defined the time when you could still see the horizon and hence measure the angle between the horizon and a celestial body to determine it altitude for navigational purposes. *Astronomical twilight* was needed to indicate when an observer could be confident that the Sun's light was not still causing visibility problems.

Now these three definitions have been refined and properly quantified, using the depression, or negative altitude of the Sun. From the time of sunset, or till the time of sunrise, the Sun is below the horizon and the darkness depends upon how deep the Sun's position is. Twilight lasts from between the times when the Sun is on the horizon, and at a specified angle *below* the horizon. So Civil twilight exists while the Sun is below the horizon as far as up to 6º. This angle is defined as 12º and 18º respectively for Nautical and Astronomical Twilight. These phenomena provide an interesting practical exercise for students.

The depression of the celestial equator as it crosses the observer's meridian to the *north* as seen from UK latitudes (take 52º north, for example) is equal to (90 - lat)º, or 38º in this example. If the Sun's ecliptic position has a northerly declination exceding (38 - 18)º, that is +20º , then at midnight, it is *just* low enough for twilight to end, and instantly begin again, as seen from latitude 38ºN. So with the Sun at any declination above 20º, astronomical twilight cannot end. The Sun will be at a more northerly position than declination 20º from about May 20 until July 24, and so between these dates Astronomical twilight lasts all night!

Richard Knox