Gnomon

Newsletter of the Association of Astronomy Education

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Does astronomy inspire recruits to science?

The time when the science community could afford to be relaxed about its relationship with government has passed. Like other learned societies, the Royal Astronomical Society is lobbying senior civil servants, ministers and MPs to give astronomy the profile it deserves.

There are plenty of issues for professional scientists and teachers to grapple with over the next few years. A few of these are: addressing the shortage of graduates (pure physics enrolment is creeping up but numbers are still very low; ensuring that subscriptions to ESO and ESA do not compromise basic research elsewhere; and the ongoing debate on human space exploration. Harder to predict is the impact of a new prime minister and the change of emphasis that will follow. To make a serious contribution the RAS will need to commission and carry out research work.

For example, a large number of reports and space and astronomy education assume this science draws students to study Science, Technology, Engineering and Mathematics (the so-called STEM subjects). Although virtually all of us accept this viewpoint, it is mostly based on anecdotal and fragmented evidence. The Society now proposes to conduct a longitudinal study to see whether this is really the case. If so, we will have a powerful tool for influencing government in the future.

After a little over eight years working in the Royal Observatory Greenwich, I have moved to take up a new role in the Royal Astronomical Society. The RAS was founded in 1820 to encourage and promotes the study of astronomy, solar-system science and geophysics. It has more than 3000 members, including professional and amateur astronomers, teachers and science writers and represents UK astronomy nationally and internationally.

The AAE is affiliated to the RAS and has formal links via the RAS Education Committee (currently chaired by Julien King, who also sits on the AAE council and with our Vice President, Francisco Diego as a long-standing member). The Society now aims to raise its profile with policymakers, becoming a stronger advocate for our science in the corridors of power. As the new RAS Policy and Press Officer, I am there to see that this happens.

I believe that the AAE can only benefit from this work and from our other links with the RAS. As the Association is largely made up of teachers, it is well placed to be a serious partner and at the very least we should be making sure that our voice is heard.

Robert Massey

Still a globular baby boomer

Hubble observations of the massive globular cluster NGC 2808 show that it has three generations of stars that formed early in the cluster's life. This is a major upset for conventional theories. Astronomers have long thought that globular star clusters had a single "baby boom" of stars early in their lives and then settled down into a long, quiet middle age. Globular clusters are among the earliest settlers of the Milky Way Galaxy. A typical cluster consists of hundreds of thousands of stars held together by gravity in a compact swarm. It has been long held that its stars formed at the same time, in the same place, and from the same material, and that they have co-evolved for billions of years.

Photo: NASA, ESA, G. Piotto (University of Padua, Italy) and A. Sarajedini (University of Florida, USA) - May 2007

The stars in NGC 2808 were born within 200 million years, very early in the life of the 12.5-billion-year-old massive cluster, but finding multiple stellar populations in a globular cluster so close to home has deep cosmological implications. Hubble's Advanced Camera for Surveys measured the brightness and colour of the cluster stars. This showed three distinct populations, with each successive generation appearing slightly bluer. This colour difference suggests that successive generations contain a slightly different mix of chemical elements; it is assumed that the amount of helium increases with each generation of stars. The successively bluer colour of the stellar populations indicates that the amount of helium increases in each generation. Perhaps very massive clusters can retain enough light gases such as helium to affect future generations of stars, or NGC 2808 may have been a dwarf galaxy that was stripped of most of its material by gravitational capture by the Milky Way.

Change of Presidents at the 2007 AGM

The AAE Annual General Meeting 2007 at the National Space Centre, Leicester, was a joint meeting with the British Association of Planetarians again this year, generously hosted by the staff of the National Space Centre. We thank them very much for organising the whole weekend and making us so welcome.

The business meeting started with a farewell report from our President Robert Massey who has moved on to higher pastures at the RAS. "It has been a great pleasure working alongside everyone and watching new people join our small but perfectly formed organisation. We have at least stabilised our membership, cut our costs dramatically thanks to Alan who has taken over the printing of *Gnomon*, and greatly improved our links with other organisations like the RAS" he said. The assembled members gave a vote of thanks to Robert for all he has done for the AAE during his term of office and recognised his work in promoting astronomy to the general public, sometimes in high-profile TV slots.

The meeting duly elected a new Council for 2007/8 to be led by our new President, Sotira Trifourki, who is currently assistant secretary for the AAE and is ready to take on a greater role. The new line-up for Council is: President ,Sotira Trifourki; Vice-presidents, Robert Massey, Dave Buttery and Francisco Diego; Treasurer, Alan Pickwick; Secretary, Anne Urquhart-Potts; Assistant Secretary, James O'Neill; Council Members, Eva Hans, Nick Lister, and Sandra Voss. Representatives to Council of the RAS, Resource Centres and National Astronomy Week 2009 will be formally co-opted at the first Council meeting. The Editor is also formally co-opted at this time.

There was some concern about *Gnomon*. The Editor, Richard Knox, does not receive sufficient material from the membership in the way of news, articles, curriculum ideas, astronomical observations and illustrations. He sent an urgent plea to all of you to put your pens to paper and provide him with stuff for the next and future issues – there is a great deal happening out there that the readership would like to know about.

James O'Neill reported on the new-look AAE website that is now nearly ready to go on-line.

An important item on the agenda each year is the subscription rates. The treasurer proposed that we increase them by £2 this year to £14 for individual members and £12 for retired members. A £4 increase for corporate members would increase their subscription to £28. However he also proposed that those paying by standing order would receive a £2 discount and thus effectively avoid a rate increase. All members present thought this a good idea, encouraging members to pay by standing order. The increases were therefore unanimously accepted.

Anne Urquhart-Potts (secretary)

Observations

Sotira Trifourki has been a member of the AAE for three years, writes Anne Urquhart-Potts, and has been assistant secretary for the last two years. She is a member of the Manchester Astronomical Society and was their secretary two years ago. She has a lot to offer the AAE and we warmly welcome her in this important new role.

I look forward to representing you as the President for the forthcoming year, but before doing so would like to thank Robert Massey for representing us in the past two years.

My interest in astronomy began in the September of my first year of secondary school. I remember it well. My main reason for getting into astronomy was to get over my fear of ET (yes, *that* film!) Putting unreasonable fears of the unknown aside I went on to study astrophysics at the University of Manchester and the Open University, with both of which I have ties to this day. I currently run an organisation, Cosmos Media, which acts as an educational trust. We work as a team bringing people from all areas of industry to present science education based activities encompassing cross-curriculum subjects such as astronomy, to creative media like animation, dance workshops, movie making and citizenship. We produce the *Cosmos Journal* that allows youngsters from as young as primary school age to publish papers, observations and articles alongside their peers.

I also represent Greater Manchester SETPOINT as a Science and Engineering Ambassador, which takes me into local schools and the wider community to support the Science, Engineering, Maths and Technology programme. Through SETPOINT I have recently developed a set of career professional development and teacher training courses on an individual basis which, due to the curriculum changes in Key Stage 4 GCSE, has left many teachers finding teaching astronomy a daunting task, especially those without a physics background. My current role also involves developing courses for teachers in primary schools who also face the task of getting up to speed with the science on the Earth, Sun and Moon units.

Over the past year I have developed a major initiative, the launch of a new international network of teachers and science communicators. This brings together people involved in all aspects of science education, enabling them to

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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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share common resources and teaching materials and to develop new tools for engaging the next generation of scientists. In October 2006, I was invited to attend the Universe Awareness Workshop. More than 50 attendees from 20 different nations discussed the next step forward in developing an initiative which seeks to engage young children from the ages of 4 to 10 in disadvantaged communities to the inspirational aspects of astronomy education.

In my role as President for the forthcoming year, I see building stronger links with fellow science education organisations as a top priority in asserting the primary aim of the AAE, which is to represent our members in putting astronomy education on the map and sharing resources with similar groups (to refrain from "reinventing the wheel").

With recent changes to PPARC to form the Science and Technology Research Facility and the new option of GCSE Astronomy as a science subject to be chosen for study in its own right, it is a vital time for the AAE to let teachers know that we exist. The AAE can help ensure that astronomy is just as important as a science as biology, chemistry, nanotechnology and engineering. As in recent years, our links with the Association of Science Education will see a new edition of the AAE textbook (*Earth and Space*) being submitted to publication through the ASE's bookshop. Workshops, with sessions provided by our members, will be taking place at the January 2008 ASE Conference.

I am also pleased to endorse the Yahoo Group Forum that was introduced last year to encourage members to communicate with each other, and to share files, photo albums, ideas and suggestions. And to bring our outreach efforts full circle, a revamped AAE website is on the way with downloadable resources and multimedia materials.

The AAE is your association, and we can continue to move forward. But only with your input. If you have any ideas and suggestions on how we can participate in new initiatives or support you as a member, please get in touch!

Sotira Trifourki

That was the silver year that was

Last September, the AAE celebrated its 25th Anniversary and with new changes to Key Stage 4 Science being brought into the national curriculum and the opening of two new Space Education Offices in Bradford and Northern Ireland, the AAE has the opportunity to play an important role in providing its members and teachers across the UK with the necessary tools and support to ensure Astronomy is at the forefront of science education. The Council this past year has worked hard on behalf of the members, with representations held at the January '07 ASE conference in Birmingham, the recent RAS meeting in Preston and numerous international conferences broaching education and science communication as a whole.

Last year saw the launch of the AAE Yahoo Group Forum which has been a great success. It's still a little quiet on there at the moment and is not being used to its full potential. The group can be used to communicate events, activities and has a file area where documents can be loaded up and shared with the rest of the group. Reports, white papers and news on important issues involving Astronomy Education are currently being loaded for access into the members area, so if you haven't registered already you really are missing out on the chance to use an important resource! To join the Yahoo group visit:

//uk.groups.yahoo.com/group/astronomy-education

A new version of the website is on the way with areas for members to also showcase their resources, events and activities and advertise to the rest of the global astronomy community what the UK do best, which is providing innovative education initiatives using the outreach efforts of our research institutions and science visitors centres. Attending this year's AAE/BAP AGM in May it was easy to see why our members take pride in the work that they do and the tremendous effect our activities in their multidisciplinary nature and their variety have on schools and members of the wider community.

What d'ya mean: "dark sky"?

Regarding your "Observations" in the last issue regarding "Dark Sky Scotland" may, if read in a certain way, seem to suggest that all is well with the starry sky in Scotland. In fact, it is just as easy there to take the stars away from neighbours with inappropriately aimed and over-powered lighting, in both rural and urban areas, as it is in any other country in western Europe.

Correspondence received by the Campaign for Dark Skies confirms this, and I well remember a conversation with a long-time resident of the village of Drumnadrochit, near Loch Ness, who has watched the stars over the loch gradually veiled over the last few decades by wasted light from development, tourism and the growth of Inverness, 20 miles away.

All credit to the organisers of Dark Sky Scotland, however - if England had had such events before the rot of light pollution really set in in the 1960s, perhaps it might not now be a sad fact that there is almost nowhere in mainland England where a truly dark night sky can be seen on a clear night. In the eleven years during which I have operated a Starlab inflatable planetarium in South Central England, about 90,000 schoolchildren have sat in it (90,000 is about the capacity of the new Wembley Stadium). Every single one of those audience members has been told about light pollution, and it is gratifying that even very young children often already know that clouds are not the only reason why they cannot see the stars in all their glory!

It is important that their teachers, too, are made aware of the irony inherent in teaching a curriculum which requires children to "appreciate the wider Universe", while our imperfect lighting technology takes it away from them by allowing emissions above the horizontal. I recently told the staff at a primary school in the New Forest what Southampton City Council is planning to do to their local stars: 15-mile laser beams across our latest National Park - and, to a woman (male staff seem increasingly to be absent in primary schools - a worrying trend!), they either gasped or laughed out loud in disbelief.

All astronomy educators should take the time to assess local sky conditions with particular reference to the sources of light pollution, and tell their audience (of whatever age) what those sources are and what they can do to alleviate the situation. **www.dark-skies.org** has plenty of advice. To paraphrase Sir Winston, the loss of the night sky is something up with which we should not put!

Bob Mizon

Copy for *Gnomon*

Welcome to our new President, who, together with many others, has overwhelmed me with copy for this issue marking the end of our quarter century anniversary year. Thank you all very much, and please keep it up for at least the next quarter century. I have not been able to use all the material you sent, and the items that were "features" rather than "news" had to go first - but have no fear, those whose work has not yet appeared, it is in my in-tray still! Many thanks again to you all.

The Editor

The things people ask!

Sharon, an amateur astronomer from Hemel Hempstead commented: I have a new Meade LX200GPS telescope and was expecting to be able to see spectacular spiral galaxies with it. Last night in my garden, I used a 9.7mm eyepiece to try and find M81 and M82 but all I could see was a very faint, blurry smudge. What am I missing?

You are missing nothing. I had the same frustration years ago! Photographs of galaxies taken with large telescopes from very good locations are amazing but misleading, once we try to see them from our backyards. We need to adjust our perception a bit. However, we can make the most of our telescopes. I also have a Meade 8-inch and I would not use a 9.7mm eyepiece, but a 20 to 30mm instead, as these provide more light and better contrast, despite the lower magnification. Even so, the brightest galaxy, M31 in Andromeda still looks like a blurry smudge. Try M81 and M82 again. They will fit in the same field of view. Also try the Virgo Cluster. You need a very clear, dark night, with no Moon.

Ken Macneal of Rhode Island wrote: I'm actually doing a term paper on the career of astronomy for English, can you answer these questions and email the answers back, thank you. Interview questions for professor / astronomer:
1. What is required to be an astronomer? 2. What is everyday work like for an astronomer? 3. Are earning different with each degree for an astronomer? 4. What is the required training to become an astronomer? 5. What are the earnings for an astronomer? 6. How many vacation days do astronomers get each year? 7. What are the benefits to being an astronomer? 8. What classes do people take or are necessary to become an astronomer? 9. How competitive is it to become an astronomer. 10. Are some places that astronomers work in dangerous?

Dear Ken, 1: Curiosity about our environment. Maths and physics mainly. 2: Nice! You become a detective finding out the mysteries of nature (in the broadest sense), using computers a lot to analyse the data that you take at the telescope or to produce simulations and models of what you think happens so far away. 3: You earn as you produce, mainly publications of your work. It also depends on your age and expertise. 4: See 1 and 2 above. 5: Between £20,000 and £50,000 a year. 6: In theory about 25 days. 7: You earn a decent living with the satisfaction of contributing little grains of knowledge to the colossal total human cultural heritage. Also, you do not have to exploit other people, damage the environment or kill anything or anybody. 8: Physics, maths, quantum mechanics, statistics, optics, cosmology, astrophysics, spectroscopy, and practical work in the lab and at the telescope. 9.- It is very competitive, you need to be very dedicated and hard worker, - as in almost all other professions. 10.Not especially. Sometimes when you walk in the night near the telescope you may hit something or fall in the dark. I've never had that happen so far!

Jen wrote from Illinois: I am an 8th grader and I need to find the distance from the constellation Hercules to my school. How do I start doing this? Thank you, a response would be greatly appreciated.

Dear Jen, I can not imagine why you need to do this, or if this is part of your homework. The project does not make sense. A constellation is an arbitrary area in the sky. Within a constellation, we find the stars, possibly planets, etc. As any other constellation, Hercules has a quite few stars and all are at enormous and different distances from the Solar System. Distances to stars are measured in light years - a practical way to do it since the distances are so great. A light year is the distance that light travels in one year at a speed of 300,000km/s. So a light year is about 10 million million kilometres. With this measure, the Moon, for example, is only about 1 light second away and the Sun 8 light minutes away. The planet Saturn is around 90 light minutes. The distances to the brightest stars in Hercules, or, in fact, to the majority of the 3000 stars that you can see in a very clear night, range from 20 to 700 light years. With this perspective, you may understand that the position of your school, which is carried round the Earth by its rotation every 24 hours, and around the Sun in one year, becomes meaningless. I hope this helps, but feel free to send me additional comments if you need to.

Conor Davies from Harrogate wrote: I often wonder (and am frequently asked) how we know how far away the objects are that we see in the Universe. Do we really know how far away Cepheid variables are, or is it just an estimate? I hope you understand what I'm getting at.

Dear Connor: You are right, measuring distances in astronomy is the greatest challenge and it has been so for centuries. Please do a Google search on Cepheid variables and use the name of Henrietta Leavitt (who discovered the period-luminosity relationship for these stars). The principle is simple; if you know how bright something *really* is and you can measure the apparent brightness of that object, a simple application of the inverse square law of light will allow you to determine the distance.

This is the case with Cepheid variables. We can measure how fast they change their brightness and from that we know how bright they really are. Of course this needs to be calibrated by measuring by other methods the distances to typical Cepheids. One of those methods is to use stellar parallax and the other is to identify them in objects that have many of them, like globular clusters and the Magellanic clouds, where distances can be found using other techniques. I hope this helps.

Michael, from London, said: I am planning to view the Perseid shower with friends and have got my information from NASA's Science@NASA website. I was wondering where the best place might be to see them, and which is the best night. Because of time/work restrictions we will probably be limited to the south coast, between Portsmouth and Devon. I hope this finds you well and that you may be able to help us clueless idiots in our attempt to see this event this year.

Dear Michael, meteor showers do not happen instantly. The amount of meteors increases towards the peak and then decreases. In the case of the Leonids, seen in November, this takes a few hours, but in the case of the Perseids, it takes two or three days. One needs clear weather and no moonlight. The south coast is good in general. Go away from city lights to a location good enough to see the Milky Way. Take a deckchair, a thick blanket and a thermos flask with your favourite hot drink.

Be patient, you will see one meteor every minute or two. Unfortunately clouds and fog usually prevent observing. We have three more main showers coming: Orionids at the end of October, Leonids in mid-November and Geminids in mid-December. You can visit **www.spaceweather.com** and get in their e-mailing list to receive automatic updates on meteor showers and northern lights. I hope this helps.

Best regards

Francisco Diego
AAE Query line

(*The Perseids appear in the* Sky Diary *of this issue on page 8.* Ed.)

Letter from Down Under

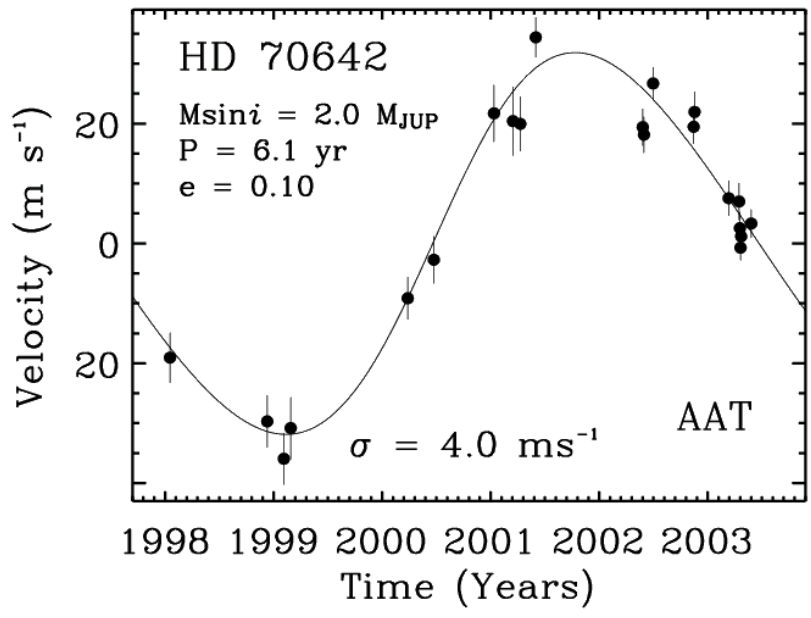
Earlier this year, the Anglo-Australian Telescope devoted 48 consecutive nights to a single observing program, the largest single allocation ever. What sort of science would be so important that fully one third of the available nights in the current semester schedule would be committed to it? The answer can perhaps best be described as a "Battle of the Planets".

Ever since the discovery of the first extrasolar planet around a normal star by Michel Mayor and Didier Queloz in 1995, the hunt has been on to find out just how common are planets around other stars, and indeed how common are multiple planets around any given star? As of 4 May 2007, the "Extrasolar Planets Encyclopaedia" **(💻 ww.exoplanet.eu)** lists some 232 extrasolar planets, with at least 20 stars found to host more than one planet. By far the vast majority of these have been found using the radial velocity technique, in which high-precision spectroscopy is used to detect the tell-tale "push me, pull you" signature of a massive planet on its parent star's line-of-sight velocity. Other methods, including measurement of the light loss when a planet transits in front of its parent star, or conversely the amplification by gravitational lensing of light from a background star by chance alignment of the planet, have also contributed to the census. The Anglo-Australian Planet Search (AAPS), initiated by Paul Butler (now at the Carnegie Institution of Washington) when he was at the AAO, and now led by Chris Tinney (University of New South Wales) and Hugh Jones (University of Hertfordshire), has been measuring velocities of nearly 200 stars since 1998, and has discovered 28 new planets.

The planet search programme uses the University College London Echelle Spectrograph to provide the high spectral resolution, and intrinsic stability required to have any hope of finding extrasolar planets. The UCL spectrograph alone however can measure velocities to an accuracy of only about 1km/s, whereas extrasolar planets induce velocity changes a hundred times smaller. The key to the instrument's success in finding planets is a simple glass cylinder filled with iodine gas through which starlight passes as it enters the spectrograph, resulting in a forest of iodine absorption features superimposed on the star's own spectrum. It is primarily distortions in the starlight path as it reaches the spectrograph that smear out the spectrum, and normally impose the limiting precision of the spectrograph. However, as both the star's and the iodine spectra are affected in the same way, it is possible to account for these effects and improve accuracy by a factor of a thousand!

Although other search programs are now underway on telescopes even larger than the AAT, sheer aperture is no substitute for time baseline, since finding a planet in a Jupiter-like orbit requires at least half an orbit, and preferably a full orbital period (i.e. a decade or more) of data to be proven (e.g. see the accompanying graph). The main competition for the Anglo-Australian Planet Search in the southern hemisphere comes from the HARPS instrument on the European Southern Observatory's 3.6-metre telescope. Although Anglo-Australian programme has been running longer it gets typically 32 nights per year on the AAT, whereas HARPS has at least three times as many nights and can monitor many more stars as a result, allowing them to catch up. The question is how then to maintain the lead in this intense rivalry?

Until recently, it was thought that the absolute limit of measurement precision was around 3m/s. Below this level, one has to contend with the effects of granulation in convective cells at the star's surface, as well as asteroseismological oscillations (useful to probe the star's internal structure), which produce velocity changes of a few metres per second on timescales of minutes to hours. The Anglo-Australian team however has now shown that by co-adding repeat observations of the same star over one or more nights allows this noise to be "beaten down" to only 1m/s (i.e. walking speed!). At this level of precision, it becomes possible to begin finding planets with as little as five to ten times the Earth's mass (so-called "super Earths"), in addition to the "hot Jupiters" which have so far dominated the discoveries.



Radial velocity variation of the solar-like star HD 70642, from over five years of monitoring by the Anglo-Australian Planet Search team. Only with such long-term monitoring can the presence of a planet at least twice the mass of Jupiter, and in a surprisingly almost circular orbit of 6 years, be conclusively demonstrated.
Figure courtesy of the AAPS : **(💻 www.phys.unsw.edu.au/~cgt/planet/)**

Faced with increasing competition elsewhere, the Anglo-Australian team made an audacious bid for 48 nights, to monitor just 20 stars for "super Earths". Because these low-mass planets may have orbital periods as short as a few days, it was essential that these 48 nights be all in one block, so there would be no gaps (other than the unavoidable losses due to bad weather) in the coverage. Even by the standards of earlier major surveys at the AAT, principally galaxy and quasar redshift surveys with the 2dF instrument, this was asking a lot of the AAT time assignment committee! How to compare the potential science return from this "super Earth" program, to the five to ten equally-worthy science programs which would be displaced a result? Naturally a vigorous debate ensued, and in the end it was felt that the proven track record of the planet search team in finding new and interesting planets, coupled with the high level of public interest in planets around other stars (with obvious implications for the question of life elsewhere in the Universe), made this too good an opportunity to pass up. Nevertheless, the onus is now on the team to come up with a bounty of new planets, so stay tuned for more announcements shortly about new terrestrial-like planets discovered right here in Australia.

Stuart Ryder
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Curriculum Corner

LIFE the universe and everything

Readers of *Gnomon* will be distressed to hear of the closure of the planetarium at what many in Newcastle still think of as the South Shields School of Navigation. As a teacher, both my classes and I benefited from Eva Hans' knowledge and enthusiasm. Its closure and Eva's departure are both losses to the region.

But, as in the heavens, there is a continual cycle of birth, death and rebirth, and there is now a new digital planetarium at the Centre for LIFE, conveniently situated in the middle of Newcastle. Its mission is to inspire curiosity in science through imaginative exhibitions and events, raise standards in science education and support world-class research.

The 10m dome seats 68 people and we have two projection systems. One is de Pinxie unit which projects a custom-built show which explores life in extreme environments on Earth then takes of to other parts of the solar system to search for places where life could be possible. However, teachers will probably be more interested in the D3 system which projects a conventional starfield and allows exciting animation of plants, nebulae and other astral images.

We currently have a seasonal astronomy show that can be enhanced for school, audiences with information about the factors giving rise to days, years, months and seasons. We are actively writing an interactive show aimed at key stage 1 that will make more use of showmanship that is possible with the D3 system. We also intend to write a show to support higher level astronomy based on the theme of star birth and death. We have a novel idea for its delivery – so watch this space for news of its world premiere!

In addition to the conventional astronomy shows we have curriculum-linked workshops which we deliver in our education suite. Here are some examples.

KS1: Alive in Space. The children are told that they are going on a space journey and they are asked to pick things from a basket that they will need to stay alive. The objects include cuddly toys and sunglasses as well as replica food, canisters labelled air and bottles of water. The children then sit on mats in a "spaceship" and are briefed on the procedures they must follow in an emergency. They then follow an animated PowerPoint to fly through the Solar System. Beyond Eris, they encounter a strange planet populated by strange life forms. The children have been divided into groups before the flight and given a secret thing which they have to mime as a group. The rest of the children have to guess what the object is and say whether or not it is alive. At the end of the last mime, the emergency alarm sounds and the children have to jump on board for a speedy return to Earth.

KS2/3: How do we *know* that the Earth is Rotating? We start off by asking the students this challenging question. They come up with a variety of ideas but soon realise that they don't really *know* that it is true. We then set up a giant pendulum and return to the tables to work with little pendulums on turntables. We quickly establish that pendulums keep going the same way regardless of whether the base is turned. We then repeat the experiment with a little model man on the turntable and we get the students to recognise that the apparent direction of motion changes, not because of the motion of the pendulum changes but because the surface on which the model is standing has been moved.

We then go back to the big pendulum which has, of course, precessed. We make a big fuss about "Did any one touch the pendulum?" We get them to recognise that the apparent direction of motion has shifted and this is the point where one can see the light bulbs beginning to come on. We persist with the chain of logic. Did the building move? Was there an earthquake? Foucault's pendulum is nothing new but without the small scale work with pendula, turntables and models, it is too big a leap for young minds to make. At the end of this session the students will *know* that the Earth is rotating. We contrast the position between the start and end of the workshop and point to the difference between scientific proof and mere belief.

KS3/4: What do satellites do for us? Students use satellite images to plot the decline of the Aral Sea and use online resources to find aerial images of their own house and track polar bears. They use handheld GPS to monitor the satellites visible from the centre for LIFE and compare this with the satellite orbits we have shown in the planetarium.

KS4/5: How old is the Universe? It took me a little while to realise that astronomers don't spend a lot of time looking at stars. They do their real work on photographs of astronomical objects. In a programme devised in conjunction with Durham University, students measure the red shift and apparent size of selected galaxies. From size they can estimate distance, make a Hubble plot, derive a value for the Hubble constant and hence a value for the age of the visible universe.

Most students get the right order of magnitude and generally estimates are within 10% of the currently accepted value. The transition from astronomical pornography (nice pictures but all you do is look at them) to research tool is a valuable illustration of how science works.

KS5: What evidence is there for dark matter? In another programme devised by astrophysicists from Durham University, students measure the rotational speed and apparent magnitude of distant galaxies in Hubble Deep Field images. They then compare real mass and visible mass and find that the former is much greater than the latter.

Next they look at the arcs caused by gravitational lensing of very high red shift objects. From the size of the arcs and the distance calculated from red shift they can calculate the mass of the object which is focusing the light. This is always very massive and located in deep space between galaxies. So students have evidence which can be explained by large amounts of unseen material both within galaxies and between galaxies – evidence for dark matter.

If you are interested in visiting the Centre for LIFE or finding out more about its astronomy programme, please contact Noel Jackson, Head of Education at **noel#life.org.uk** or ☎0191 2438211. For more information visit **www.life.org.uk**

Noel Jackson
Head of Education, Centre for Life

For your library

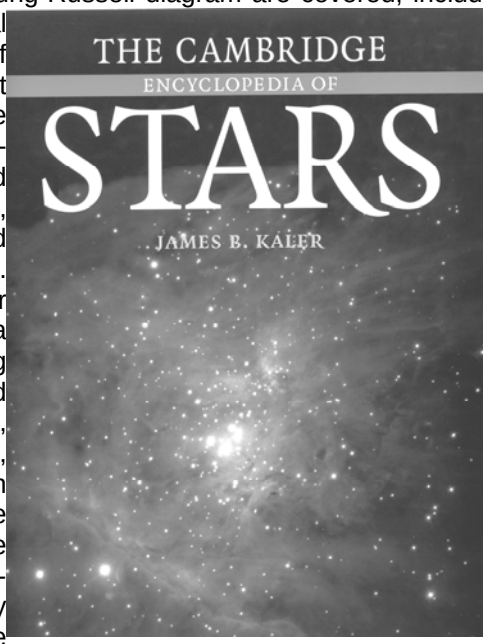
The Cambridge Encyclopedia of Stars. James B. Kaler. Cambridge University Press. Full colour illustrations. ISBN 0 521818036 hardback. £35.00 ($60.00)

The Cambridge Encyclopedia series are by now so well known that a reviewer need explain only what the subject matter is. If there are any readers left who are unfamiliar with this splendid range of books, suffice it to say that they are well written, authoritative, up to date as any major work in astronomy can be, magnificently illustrated and good value for money (these days!). This volume (although it is fairly large!) would grace any library or bookshelf and it would rate well as a coffee table book in the appropriate establishments.

The objective of the book is to describe stars in an accessible way that allows the reader to dip into the book anywhere

to find out about a particular aspect of the subject. This might be double stars, stellar distances, the make-up of stars and so on as stand-alone topics. The only references the reader ought to need are other chapters in the book. The first two chapters cover fundamentals such as star nomenclature, constellations, positional measurements, basic appearance and other main ephemeris data, such as distances, variability and so on. The next two chapters examine the grouping of stars and the formation of galaxies describing the motion of the Sun, proper motion of stars and related topics.

Then spectroscopy, the classes of stars, spectral sequence, and the Hertzsprung-Russell diagram are covered, including the physical composition of stars of different types. Three chapters discussing binary and multiple stars, star clusters, and variable stars. The last four chapters form a group dealing with the detailed structure of stars, their evolution, and the formation of stars, in the context of the interstellar medium, and finally main sequence stars such as the Sun and the evolution of lower masses and more massive bodies than the Sun. This covers unusual stars such as white dwarfs, neutron stars and black holes.



Finally there are five Appendices covering such things as the Messier objects, the 51 brightest stars (so that Polaris can be included!) the nearest stars (all but two within 4pc), and there is a list of further reading and a good index.

Mathematics is kept to a minimum throughout the book, being used only where essential to make a particular point. The author stresses his objective of keeping background and peripheral material separate from the main text (he uses sidebars and footnotes to achieve this) and makes sure the reader understands what is known and, equally important he says, not known.

This book is a must-have!

Richard Knox

Cosmic Catastrophes: Exploding Stars, Black Holes, and Mapping the Universe. J. Craig Wheeler. Cambridge University Press. Illustrated. £25.00 (US$40.00). ISBN 0-521857147.

This is the second edition of a book that, at first glance seems an odd mixture: the most dramatic events in astronomy coupled with "mapping" the Universe. In fact, the mapping means the extension of our picture of the Cosmos through the discovery and growing numbers of theories concerned with the birth and death of stars.

Professor Wheeler's main area of research has been in supernovae, and those bodies have been at the heart of an upset that has already fundamentally shaken the theoretical basis of modern cosmology, namely that the expansion of the universe is accelerating. It may be that further research in this area will be similarly instrumental in undermining this new baffling state of affairs. It would certainly be doing us all a favour! The author states in his preface to the second edition that, at the time he was preoccupied with the first edition, and working with supernova 1987A, Kip Thorne and Igor Novikov brought about revolutionary new ideas about wormholes and time machines that opened up a new dimension, but too late to include in the book. This is now included, coupled with the work of Lisa Randall and Raman Sundrum that suggested there might exist large extra dimensions that leave gravity acting essentially as an agent of three-dimensional space. Wheeler writes: While little else can compete with this dramatic breakthrough astronomy, astrophysics and cosmology rush on, and these all add up to the new material in the second edition. (Personally I'm hoping that someone can show that the speed of light has been slowing with time since the Big Bang; it seems to me that this would explain a lot of things quite simply, and I'm a total fan of Occam's Razor. So when the decline of c is discovered, please call it the "Knox Paradox").

Much more has been found about the aspherical core collapse in supernovae, and Type 1a supernovae show other significant irregularities. Many of these developments required additions and revisions to the appropriate chapters as did new work in the behaviour of neutron stars. But the major revisions were required to add the news of the "Randall/Sundrum revolution." The first edition did not contain enough discussion about dark matter and dark energy which, the author feels, although not related to the theme of stars very directly, is so important in modern cosmology and required coverage. He concludes his preface to this edition expressing "modest contentment" with the current content, knowing full well that in a year's time he will decry the lack of some new, amazing development. "Astrophysics is like that" .

Richard Knox

Sky Diary Summer 2007

Last *Gnomon*'s Sky Diary was headed "Summer 2007" and the complaints have been pouring in. Well, one or two people must have noticed? The months of July, August and September qualify better, so at least I have saved myself a bit of work in typing the above headline.

The let-down of the quarter is the Moon's passage through its ascending node on the ecliptic on August 28, the same day as Full Moon. That means an eclipse of the Moon is certain. Also, there is always at least one eclipse of the Sun two weeks earlier and/or later when there is an eclipse of the Moon, so this should be an exiting period. Well, the eclipse of the Moon will be total, but will be seen by about the fewest possible number of people on Earth,, being centred in the middle of the Pacific Ocean. But that pales into insignificance when compared with the eclipse of the Sun on September 11! To see that at its best you will have to go to an ice-flow somewhere just above the Antarctic Circle in the Bellingshausen Sea when, if you are very lucky indeed, you may just be able to make out the Sun 75% covered by the Moon, and on the horizon! Not worth the effort, I think.

Solar eclipse chasers are viewed by the uninitiated as a bit fanatical and eccentric: that may be true, ☞

Moon phases for the third quarter of 2007

	New Moon	First Quarter	Full Moon	Last Quarter
July	**14**	**22**	**30**	**7**
August	**12**	**20**	**28**	**5**
September	**11**	**19**	**26**	**4**

☞ but it is entirely understandable. From your first immersion in moonshadow you are hooked, without fail! There have been a spate of articles in various publications recently about the 10, 20, 50 or 100 sights on this planet you should see before you leave it, but until you have seen a total eclipse of the Sun you cannot appreciate the complete failure of every single photograph and film ever made to

March 29 total eclipse of the Sun: composite photograph taken in central Libya by Shigemi Numazawa. The photograph shows much of the bright features of the outer corona, and, impossible with a single exposure, some of the amazingly delicate features of the faint outer corona. It also clearly shows the dark maria features of the Moon's face, made visible by the light of the Full Earth in the lunar heavens.

capture the appearance, the emotion, the stunning originality of this spectacle that knocks all these other "100 things to do before you die" into a cocked hat! Another reason for being an eclipse junkie is that it takes you to places the people who compile the 100 best sights etc. lists have never heard of. I can think of at least five of the top 20 places/thingies that my wife and I have seen while chasing the eclipsed Sun. Next year, D.V., we will add another when we ride the World's highest railway after seeing (if all goes well with the forecasted conditions) the eclipse of the Sun in August. And at least two other of the top 20 sights are also possible on that trip. Go for it! It is even during the school holidays!

As a taster, I came across the magnificent photograph shown above on a blog by some of our intrepid fellow explorers in the Sahara Desert in March last year. *Gnomnon*'s printing cannot do the photo justice, and the photo fails to do that eclipse justice, but it was almost unanimously voted one of the best eclipses in living memory. This photo gives the answer to a challenge issued during the trek through Libya at the time: can the features of the Moon's face be seen during a total eclipse of the Sun?

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

	July 15		August 15		September 15	
	Rise	Set	Rise	Set	Rise	Set
Sun	04h 09m	20h 25m	04h 55m	19h 36m	05h 45m	18h 27m
Mercury	03h 02m	18h 50m	04h 45m	19h 46m	07h 59m	18h 56m
Venus	07h 51m	21h 41m	05h 52m	18h 52m	02h 53m	16h 43m
Mars	00h 07m	14h 54m	22h 54m	14h 48m	21h 50m	14h 21m
Jupiter	17h 12m	01h 22m	15h 07m	23h 13m	13h 17m	21h 18m
Saturn	07h 04m	21h 47m	05h 24m	19h 53m	03h 45m	17h 59m
Uranus	22h 20m	09h 36m	20h 17m	07h 29m	18h 13m	05h 20m
Neptune	21h 28m	07h 02m	19h 24m	04h 55m	17h 21m	02h 49m

If the reproduction here does not show the familiar dark lunar features, which will depend on the printing of the newsletter, look at the original on the web site: 💻 **//jpll.jp/libya/**

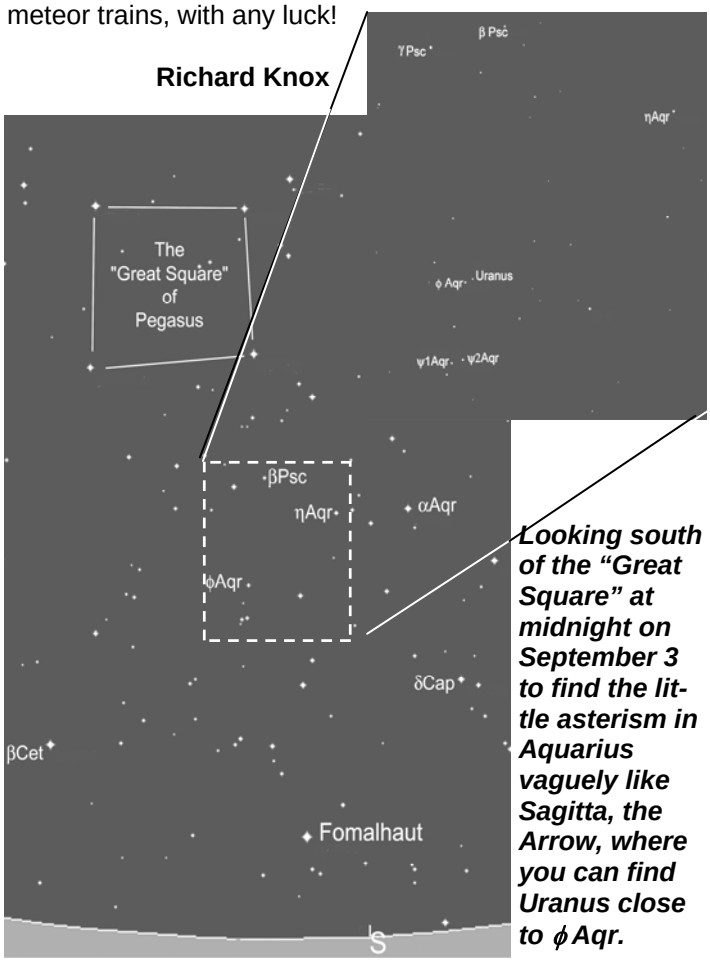
The quarter starts on July 1 with an interesting photo opportunity of the close conjunction of Saturn and Venus close together in the evening sky low in the west to west - nor-west. The planets will be separated by about 0.75°. At the same time you can see Jupiter low in Scorpius, making a pleasant contrast with Antares 5° to its south west, and they will be much the same on the preceding evening, with the Moon to be found inside the curved handle of Sagittarius' "Teapot" into the bargain. Great evenings for sky photos. On July 16 and 17, the slim crescent Moon will join the two planets to make a pleasing close trio in the low evening sky.

Mercury may just be visible low in the morning sky in the middle of July. But don't expect it to be easy to spot.

Uranus will be in the sparse area of Aquarius for some while yet, which gives the best opportunity to pick it out in binoculars, or even to spot it with the unaided eye, if conditions are very good. The maps below show the area south of the "Great Square of Pegasus" with Fomalhaut of the Southern Fish above the southern horizon. The western side the Square points down to Fomalhaut, and roughly half way down this line stands a faint straggly arrow on its tail. The point of this arrow is ϕ Aquarii, a fourth magnitude star from which Uranus will be only 20 arcmin to the west, and a little north. In a telescope, the planet's disc is easily seen, and is a delicate blue shade.

Mid-August promises well for one of the best of the year's meteor showers, the Perseids. These may be seen from late July to a month later, with the best of the shower predicted early on August 13 (soon after midnight). The Moon was new the day before, so cannot be a problem! At maximum some 80 per hour can be expected, so a camera, preferably tracking the sky, and pointing somewhere around the radiant, that is roughly in the north of Perseus, an exposure of 5 minutes or so could pick up as many meteor trains, with any luck!

Richard Knox



Looking south of the "Great Square" at midnight on September 3 to find the little asterism in Aquarius vaguely like Sagitta, the Arrow, where you can find Uranus close to ϕ Aqr.