Gnomon

Newsletter of the Association of Astronomy Education

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The 25th anniversary meeting is in Armagh: all welcome

The 2006 annual general meeting of the Association for Astronomy Education, which is held jointly with the British Association of Planetaria will be held in May at Armagh Planetarium. This meeting will also mark the 25th anniversary of the founding of the Association for Astronomy Education. The planetarium is situated in Armagh City, southwest of Belfast in Northern Ireland.

The conference will begin on the afternoon of Friday May 19th and the main business will be on Saturday 20th. Alternative programmes have been arranged for Sunday: a visit to the Armagh Observatory; or a tour around the ancient Newgrange site in the Boyne Valley.

Intending delegates should register early, especially if you would like to present a talk or demonstration. If you would like to make a presentation on Saturday please forward us details of the title, a brief outline and your equipment needs before May 5th. The presentations will be 10 minutes long, with 5 minutes for questions and changeover time. Details are needed by May 5th at the latest . To book your place, you should send full details to Eamon Rafferty at Armagh Planetarium (contact details below).

The delegate fee for the joint AGM is £10 before April 30th, from then until May 5th a late fee of £20 is available. The deadline for all payments is May 5th. Cheques, postal orders and credit card payments can all be processed by Eamon. Please note that to attend the conference, you must be a member of the BAP.

Armagh is a 50-minute drive from Belfast International airport (Easyjet) and from Belfast City Airport (BMI). It is about 75 minutes from Dublin Airport (Ryanair). If you are travelling by ferry to Belfast, the travel time to Armagh is also about 50 minutes. To get to Armagh follow the M1 south and stay on the Motorway to the M12 at junction 11, which is signposted to Craigavon, Portadown and Armagh. You could Google the AA route finder for the detailed instructions. The route is well signed.

Delegates are responsible for their own accommodation arrangements. Details of hotels and guesthouses in the Armagh area, as well as appropriate websites are available from the organisers.

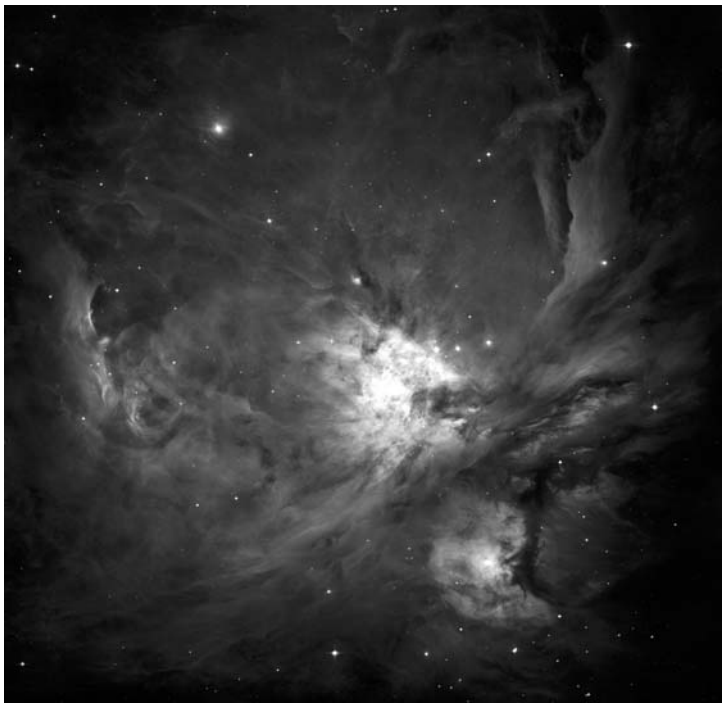
An afternoon session will be included to cater for portable dome demonstrations, and will allow delegates to meet each other. Murray Barber has indicated that he would like to show the latest LTI star field projector, and we have time for other portable operators to offer presentations or demonstrations on Friday afternoon. Armagh's portable dome (a French-made RSA model) will be available to use for demos.

On the first evening of the conference we have been lucky to obtain Dr Mike McKay as a guest speaker. The title of his talk is "Are we the Martians?" He has been to Armagh before and is a lucid and entertaining speaker. He is the Head of the Advanced Miss-☞

Orion Nebula reveals thousands of new stars

In January-2006 one of the most detailed astronomical images ever produced of the Great Orion Nebula was taken by the NASA/ESA Hubble Space Telescope. The image reveals a tapestry of star formation, from the dense pillars of gas and dust that may be the homes of fledgling stars to the hot, young, massive stars that have emerged from their gas-and-dust cocoons and are shaping the nebula with their powerful ultraviolet light.

In a mosaic containing a billion pixels, the Advanced Camera for Surveys (ACS) uncovered 3,000 stars of various sizes. Some of them have never been detected in visible light. Some are only 1% the brightness of stars seen previously in the nebula. Among the stars Hubble spotted are possible young brown dwarfs, the first time these objects have been seen in the Orion Nebula in visible light. Brown dwarfs are so-called "failed stars." These cool objects are too small to be ordinary stars because they cannot sustain nuclear fusion in their cores the way the Sun does. For the first time also, a small population of possible binary brown dwarfs has been seen.



NASA, ESA, M. Robberto (Space Telescope Science Institute/ ESA)

☞ Concepts and Technologies Office and former Flight Operations Director of the European Space Agency. He has had over twenty-five years experience with the European Space Agency, from probing the far-flung corners of our universe with the EXOSAT observatory, to monitoring the fragile environment of our own planet with Europe's ERS Earth Observation missions.

The Saturday proceedings will open at 08:30. The first sessions at 09:30 will be in parallel for the business meetings of the BAP and AAE. Time is allocated from 11:30 to see the new Digistar 3 installation at Armagh, and delegate presentations will take place in the afternoon, commencing 13:30.

Throughout the event there will be opportunity for delegates to browse and network. If you have any resources or information that you wish to display please send us details of your requirements (space needed, tables etc.) using the contact information provided at the end of this document.

On Sunday, it has been arranged for delegates either to travel by bus to see the ancient sites at Newgrange which mark the winter solstice, or have a guided tour of the Armagh Observatory Buildings, founded in 1790 by Archbishop Robinson. The planetarium was the brainchild of Observatory Director Dr Eric Lindsay and opened in 1968, many innovative developments in Planetarium shows and equipment design were pioneered at Armagh.

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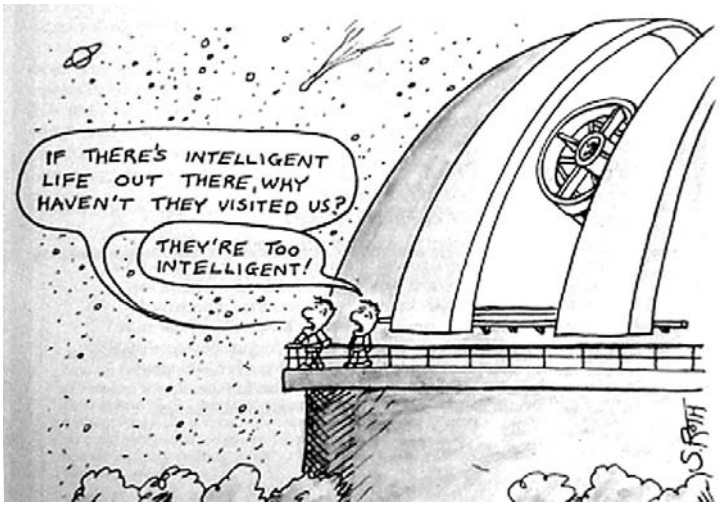
Alien life found!

Following the success of last year's Newspaper Competition, which invited students to explore a wide range of issues related to global warming, the Royal Astronomical Society has recently launched its 2006 version of the competition.

For this year's competition, students of primary or secondary school age are asked to imagine that an artificial radio signal has been detected from a planet orbiting a distant star! They can then combine their ability to explain the scientific ideas behind this discovery with their thoughts on the wider social and cultural implications of such a momentous discovery.

Younger students (7-14) are asked to produce a mini-newspaper containing short articles related to the discovery. Older students (14-19) can submit an extended feature article, in the style of *New Scientist* or other scientific magazine.

Winning students in each age group and their schools



will be rewarded with astronomical books, CD ROMS and other resources.

Full details of the competition can be downloaded from the Royal Astronomical Society's website at:
www.ras.org.uk by following the 'Information for Schools and Teachers' link on the Education page.

Entries should reach the RAS by Monday 17th July 2006. Schools who are keen to enter should register for the competition by e-mailing **newspaper#ras.org.uk**

Contact us on Yahoo!

A new Yahoo Group has been created as a forum for communication between members of the Association of Astronomy Education.

The new group encourages members to use it as a forum to express your views, share information and report on current news and forthcoming events with which you are involved.

The Group has been created to encourage members to communicate and share information and resources as well as keeping in touch and reporting on forthcoming news and events (*but not until all your news has been sent to* Gnomon *first! Ed. – who is a member of the new group, so watch it!)*.

The Yahoo Group will also act as a tool for teachers, students and other organisations with an interest in astronomy education to access resources and information. Please feel free to invite other members to join the group who you feel would benefit from this system.

The groups message forum will announce details of forthcoming council and general meetings, as well as sharing photos and general information about members' activities. Check out "astronomy-education" at the Yahoo UK site.

Subscription Rates:
Individual Members..... £12.00
Retired Members £10.00
Corporate Members
(e.g. schools, colleges etc.) £24.00
Members receive four issues of *Gnomon* a year. Corporate Members will receive three copies of each issue.

Extra Copies:
0 - 10..... £1.00 per copy
11 - 50..... £0.75 per copy
51 +..... £0.50 per copy
(Back numbers, not less than one year old, half these prices.)

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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The Royal Astronomical Society
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Telephone: 01736 362947
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

Advertising Charges:
Whole page..... £120
Half page £60
Quarter page..... £30
Inserts £75
(Inserts may be of any size which may conveniently be inserted in the newsletter. Heavy items may incur an additional charge for postage.)
A 25% reduction is made for advertising in all four issues.
Publication Dates:
These are at the equinoxes and the solstices, that is four times a year. Copy deadlines are six weeks before these dates.

Harmonica serenades from space

In 'The Gift', a 1959 science fiction story by Ray Bradbury published in 1959, a little boy on a space trip receives both tree lights and an unforgettable gift on Christmas Eve as the captain shows him the stars through the viewport on the spacecraft bridge.

A futuristic scenario perhaps, but Christmas has already been celebrated in space. On 16th December 1965, *Gemini VI* astronauts Walter Schirra and Thomas Stafford reported a mysterious object flying at great speed across their path. Sound effects followed, with Schirra playing "Jingle Bells" on a tiny harmonica and Stafford on sleigh bells. Legend has it that the items were smuggled aboard, but pictures show both instruments well prepared with lanyards and Velcro!

A minuscule Hohner "Little Lady" harmonica as played by Gemini VI astronaut Walter Schirra (and Mr. Men?).

This was the groundbreaking mission in which two Gemini modules docked successfully in orbit. Both harmonica and bells were donated by the *Gemini VI* crew to the Smithsonian National Air and Space Museum and may be seen on the Museum's website.

Despite the seasonal music, the *Gemini VI* astronauts did not actually spend Christmas aboard their capsule. This honour fell to the crew of *Apollo 8*, the first men to orbit the Moon, between 21st and 27th December 1968. Frank Borman, James Lovell and William Anders took turns reading from the Book of Genesis to the people of Earth before signing out with a 'Merry Christmas' wish. *Apollo 8* also produced the famous 'Rising Earth' photograph.

It is of course quite possible that any future Mars mission may entail another Christmas spent in space.

There are many excellent websites, including NASA's, containing information about these missions, and the Smithsonian National Air and Space Museum website: **www.nasm.si.edu**

More mission information is given on:
www.geocities.com/fdoccanders

Peter Ford

Have Pipehenge, will travel

Last year I attended the astronomers and astronomy public outreach conference at Tucson, Arizona from September 14 to 16. This was organised by the Astronomy Society of the Pacific (ASP) as their annual meeting and attended by 350 people involved at all levels of astronomy education and public outreach.

Eric Jackson demonstrating the portable version of his Pipehenge to a volunteer from the Tucson group of attendees at the annual ASP meeting in Arizona

I co-presented the Portable Pipehenge project with Larry Rand, a past president of the Science Teachers Association of New York State and an astronomy presenter for a teachers centre in that state. The "Tucson group" was one of the presentations.

To demonstrate Portable Pipehenge the person on the seat is looks out towards the sun through the plane of the ecliptic. The lower of the two pipe arcs is the Tropic of Capricorn and the Tropic of Cancer is the upper (and larger) arc.

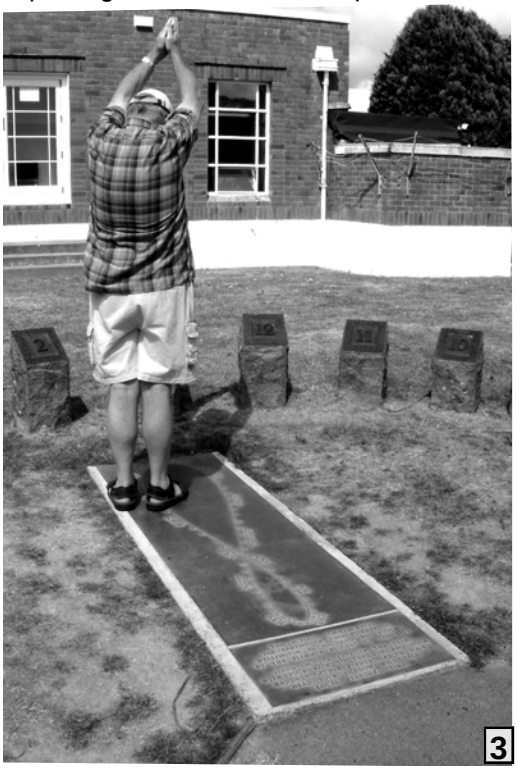
When the structure is aligned true north/south and adjusted for the particular latitude, the roll of paper in the circle behind her head is the gnomon of an equatorial sundial.

At night Polaris in seen where the paper is and the pipe circle is the path of the Little Dipper.

Eric Jackson

Gnomon editor gnomon

Eric's item above reminded me of this time last year when my wife and I visited the Wellington Botanic Gardens in New Zealand, where the Carter National Observatory has a Pipehenge, and this intriguing analemmatic sundial. This, like the portable Pipehenge to the left, also requires human participation. In the photo, your editor stands on the date, that is marked around the analemma, and acts as the gnomon, casting his shadow on the surrounding dial (stone blocks) to give the precise local mean time (just after noon - remember it is in the southern hemisphere!). It also fills an awkward hole in this issue of *Gnomon*.



The things people ask

John Thompson took over the job of answering questions to the AAE's Query *service from Mike Dworetsky in 2004. Very sadly, he died soon after he had started in that particularly hot seat (*Gnomon *Vol.23 no.4). Several of his replies to questioners have not been published before in* Gnomon *and, because their usefulness has in no way diminished since he sent them to his questioners, they are presented on this page.*

A letter with an obviously heartfelt question from Query *himself, was sent to several of the AAE committee members shortly before his death:*

Following a talk to a class of Year 5 children, I have been asked, in a thank-you letter:

"Why do we have space?"

The best reply I can think of is:

There has to be space to put things like galaxies and stars in, otherwise everything would be in the same place.

Can anyone come up with a better answer, and why can't they ask easy questions like "how long is Pluto's year"?

John Thompson.

Constellations

Q: *I live on the coast line of North Wales and I was wondering if you could tell me about some of the constellations I may be able to see.*

A: There are so many constellations visible throughout the year that it is not much use me listing them. The best way to find out about them is to go to a good bookshop and buy a Phillips Planisphere, which costs a few pounds. This shows which constellations and stars are visible for any time on any day of the year. You may also want to buy a copy of an astronomical magazine which will give a sky chart for the month. *Astronomy Now* is the best British magazine.

There are also plenty of books available in the science or astronomy sections of good bookshops and libraries which are written for beginners, so you just have to have a good look around to find what suits you.

Black holes

Q: *What are black holes? How do they form? Can we see them? Why do we know so little about them? Are they really wormholes that can alter time? If so by how much? Can we use them to get to different dimensions? I heard that X-rays can escape black holes is that true?*

A: A black hole is a region in space where the gravity is so great that even light cannot escape from it. If a star is large enough, when it has used up all its fuel and stops giving out light, it might collapse under its own gravity to become a black hole. Its material is concentrated at a point, where it is crushed to infinite density. This is a black hole. Its gravity remains, so planets and companion stars may continue to orbit around it, and gas may spiral down into it.

The gravitational field at the surface of the black hole is so great that even light cannot escape from it and is pulled back in, just as a stone thrown up in the air is pulled back to Earth by gravity.

Nobody knows where a black hole leads to, some scientists think it might lead via a worm-hole through space into another part of the Universe, but that really is only guessing. A black hole is not exactly like a hole in the ground, but a hole in space, where matter is squeezed by gravity to a point. Therefore you cannot talk about how deep it is.

You cannot actually see a black hole because light and other radiation, including X-rays, cannot escape from it. It can be detected if you see another star orbiting around an invisible objects of a sufficiently large mass. Also the gas which may be swirling down towards it gets very hot and can radiate X-rays before it reaches the surface of the black hole, (the event horizon), so that can be detected. Another type of radiation called Hawking Radiation can be emitted from just above the event horizon, and causes the black hole to slowly evaporate, as it loses energy.

Astronomers think that there may be great numbers of mini black holes which were formed at the Big Bang. We know there are stellar mass black holes from collapsed stars, and at the centres of galaxies there are black holes weighing several million or several billion star masses. These have resulted from smaller black holes merging, and gas and stars being swallowed up by the black hole.

I hope that this goes some way to satisfying you curiosity about black holes. Your public library should have books which tell you more about them.

Progress in our knowledge of Universe

Q: *How are we able to learn more about the universe today compared with 50 years ago?*

A: Fifty years ago astronomers could study the Universe only in the optical waveband, which is a very small part of the electromagnetic spectrum, although radio astronomy was beginning to be developed. Together with some parts of the infrared and ultraviolet, these are the only parts of the spectrum that can penetrate the atmosphere.

Since the late 1950's the introduction of artificial satellites has enabled instruments to be orbited above the atmosphere, and, together with great improvements in land based optical, infra red, microwave and radio telescopes, observe the Universe in all parts of the spectrum, from high energy gamma rays, X-rays, ultraviolet, optical (without the distortions caused by the atmosphere), infrared, microwave, and radio waves.

Significant discoveries have been made at all these wavebands, showing that there are objects out there at all sorts of temperatures radiating at different energy levels, many of which are not visible or prominent at optical wavelengths.

The development of new types of light detectors fitted to optical telescopes, which can register up to 90% of the photons focussed by the telescope, compared with perhaps only 5% registered by photographic plates in the past, has increased the sensitivity of telescopes enormously.

Other types of radiation are being explored, such as cosmic rays, neutrinos, and gravity waves, all of which add to our understanding, as well as posing new questions. In parallel with these developments in observational instruments, theoretical astronomy has come along in leaps and bounds, to explain these discoveries and find out where they fit into the evolutionary pattern of the Universe, galaxies, stars, and planetary systems. Sophisticated computer models are the tools of the theorists.

So you can see how development in the technology of telescope construction, artificial satellites, computers, detecting equipment, computer modelling, etc. have led to such a rapid advance in astronomical knowledge. In particular, the opening up of the whole electromagnetic spectrum has been of vital importance

Curriculum Corner

GCSE Astronomy: graphical and computational work

This article continues the series looking in detail at the various practical projects which students can complete as part of their GCSE Astronomy Coursework Portfolio.

The previous article covered the observational project which all students need to complete. This article looks at the project titles which are available for the second coursework list – Graphical and Computational work.

The underlying principle behind the project titles in this list is that of using graphical skills to illustrate an aspect of astronomy. The work which students produce for these titles can often be used as display materials in classrooms or corridors. Students can also use their work as the basis for a presentation to other students and staff.

The most popular project titles include:

Star Chart – this involves students in constructing a large right ascension and declination grid on which are plotted the major constellations and a section from the path of a planet. Once again, careful preparation and accuracy are rewarded as are those candidates who use colour or other systems to differentiate between the various types and magnitudes of stars. Although most students submit a Cartesian grid, a few polar plots are seen by the Examiners every year.

Moon Chart – rather like the Star Chart project, this also results in a large display item, in this case showing the principal features of the near side of the Moon. Accurate and realistic drawing helps to produce high quality projects, along with a clear system for indicating the major landing sites. In recent years, increasing use has been made of photographs from the Internet which can be used to illustrate important features of the lunar surface.

Computer Plot of Stars and Planets – this project allows students to use a spreadsheet or other computer program to construct a Star Chart with part of the path of a planet shown. Some candidates are able to use the facilities of spreadsheet programs, often combined with an art package, to produce some visually impressive charts.

An interesting variant on the theme of using a spreadsheet to illustrate an aspect of astronomy involves students in plotting stellar magnitudes and temperatures to form a Hertzsprung-Russell diagram with a clear Main Sequence.

Simulation of orbital motion – this project allows students who have the necessary ICT skills to produce animations to illustrate the orbital motion of planets or satellites. Particularly effective examples of this project allow the user to change their viewpoint from one planet to another and then to a point above the ecliptic plane.

Full details of and further guidance on all the coursework project titles available for GCSE Astronomy can be found in the Specification. In addition, a comprehensive Coursework Guide is now also available, giving more suggestions for producing high quality coursework, as well as some marked examples of coursework from each of the three lists of project titles. Both these documents can be downloaded from the GCSE Astronomy pages on the Edexcel website at

www.edexcel.org.uk.

Julien King
Principal Moderator for GCSE Astronomy
Edexcel Examinations

GCSE astronomy study resources: new website

A Bristol teacher and keen amateur stargazer has turned a small hobby into a new exam resource, one of the first of its kind! The Edexcel GCSE Astronomy course has been available for a while but largely with only text based support. So, Frank Ward, Head of IT at John Cabot City Technology College in Kingswood, Bristol, has designed and built a one stop Astronomy website which is a full study resource and guide that covers the GCSE specification.

With a previous career in animation and web design, Frank has built this world of astronomy which boasts more than 500 hundred pages. With over 100 animations, videos and quizzes this is one of the most comprehensive interactive websites on astronomy.

With pilot schools around the country already signed up and using this resource it is proving to be a great success with students and teachers alike, and with the growth of personalised learning this site will go a little way in achieving this for some students. The site is free to try out until the end of March and can be viewed at:

www.gcseastronomy.co.uk

Frank Ward said about the launch of this site "Producing this website has been a real labour of love, what makes this more gratifying though is that students who enjoy finding out about space, the cosmos and universe will now have a major resource if they wish to achieve a GCSE in this subject."

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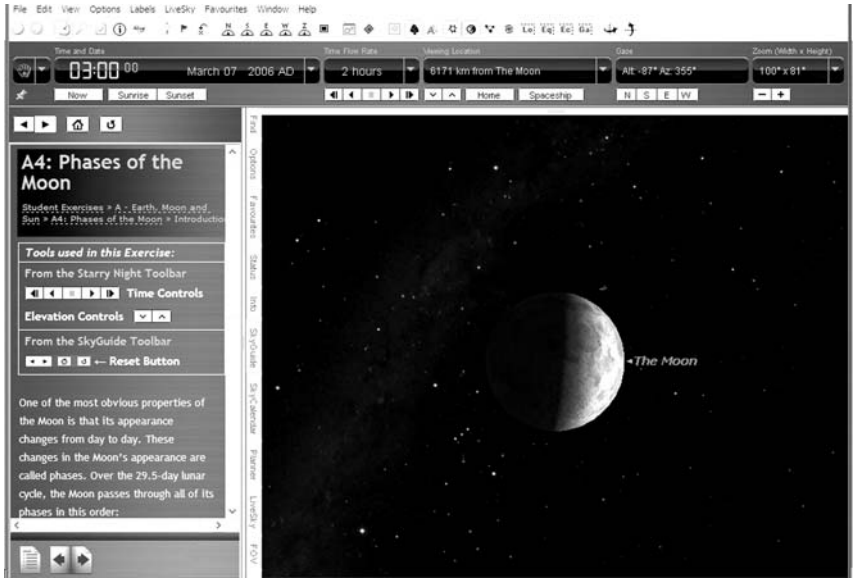
For your library

Starry Night Education (Starry Night High School): Avanquest UK Ltd. Windows and Macintosh compatible, four-disc Imaginova software set and book. Single boxed copy £99.95 inc VAT. Multi-user pricing available (contact 01752 895100)

Starry Night hardly needs any introduction, having taken over the role once enjoyed by the now defunct *Dance of the Planets* as the most realistic and comprehensive home and semi-pro software for astronomy. Now Avanquest UK have announced the latest version of Imaginova's special edition aimed specifically at education applications, which, in the UK comprehensively (and most enjoyably) covers Key Stage 3 through to A-Level.



A dramatic close up at only 6171 km from our satellite, together with one of the many programmed topics included in the new education version of Starry Night. Orion and the Milky Way stand out in the background

Boasting the world's most realistic astronomy presentation software, with which it would be hard to argue as the sample below gives some idea (even though only in greyscale reproduction!), Starry Night Education contains over 400 pages of astronomy related classroom activities in the form of worksheets; questions and answers; and computer based exercises. The new package includes a special version of the Starry Night Pro 5 software and a built-in Sky Guide which integrates with other resources provided in the pack, presented in a four-ring binder.

It has been developed especially for students and teachers. Over 100 interactive, multimedia tours cover both science and history, with an "easy-to-use" interface so that students can quickly tap into the new suite of features. This includes computerised telescope control for most popular brands of instrument. There are on-line links to 500 million stars. Practical features include data on over 16 million stars and 1 million galaxies and objects; observational planner and observational logs for storing comments and images on individual targets. The user can "see the sky from any location in the universe. Up to 700 million light years away! The star charts allow printing of the full sky or of any area in the sky. Automatic internet updates keep track of new discoveries and orbital data for satellites, comets and asteroids.

The package is designed to link closely with the Curriculum at Key Stages 3 and 4, and with post-16 A-Level and GCSE astronomy.

The binder includes many features, ranging from the enhanced teacher manual and embedded User Manual to "illustrated Space Fun Facts"! Many "click-on" pre-set images and animations are provided of the Earth, Moon, planets, stars, galaxies, asteroids and comets, explaining such things as the phases of the Moon and why the seasons change on Earth. Images can be simply imported into homework assignments and projects.

This package is vast, and will take a great deal of time for this reviewer to find anything to be critical about. The only problems found so far were at the very start—there are no instructions on how much computer space you will need (1.5 GB), nor on how to get started (with disc 1, *mirabile dictu*!), and perhaps most important of all, how the devil to get the discs out of there oh so secure pockets in the two-sided multi-pocketed A4 plastic wallet without getting them covered in fingerprints. But these are quibbles: another teacher I tried it out on thought it was "marvellous, cheap at the price!" A "must", I would add.

Richard Knox

David Levy's Guide to variable stars. David H. Levy. Cambridge University Press. ISBN 0251608600 (paperback) £18.99.

Not many technical authors get their names in the titles of their books. *Norton's Star Atlas* comes to mind (and even though Arthur Norton died over 50 years ago) so David Levy may justly be thought of as one of the definitive variable star authorities for the "amateur" observer.

The term "amateur" in this area of astronomy may be somewhat misleading: it is an area in which the non-professional observer is still valued, even in an era of automated sky surveys, simply because there are not enough professional standard telescopes available to devote much time to watching for or measuring variability in so many stars.

So this is still an area that many new or upcoming "amateurs" feel that they can do something useful. And they need Mr. Levy to get lift off! His introduction along transmits the enthusiasm and satisfaction a true lover ("amateur") of observational astronomy feels, and from this point one is hooked. One can't wait to get outside and see Chi Cygni again and how it is getting on.

The book starts from square one: you need to get to know the sky first, so we start with the Big Dipper (Mr. Levy is an Arizona resident) and then start to get to know the stars themselves: what they are, and why they look different from each other. Then we are introduced to the various reasons stars appear to, or actually do vary in brightness.

The book is essentially practical, and goes on then to explain carefully how observers with or without optical aids of varying degrees of complexity can make useful (which means meaningful) estimates of star brightness.

Many famous, infamous, and obscure variable stars are described, with charts to find and identify them with, and what to do with your observations for them to be useful.

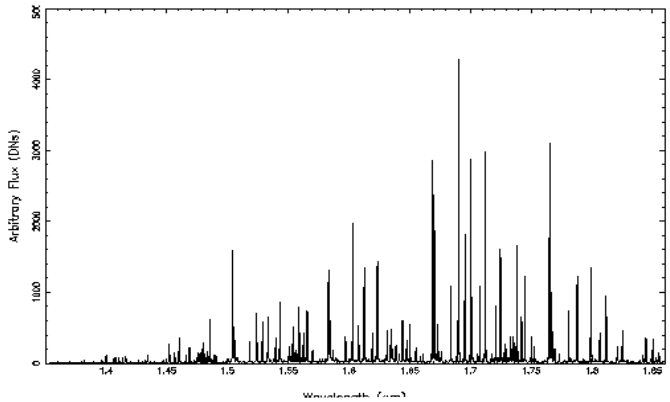
The text is very anecdotal and easy to read, with many lessons for us all in the process. It is not essentially an educational establishment's library book, but it will give young people in such establishments a very good idea of why their interest in astronomy as a hobby is not merely an introverted pursuit (even if it can be lonely!). The reader is helped to appreciate the importance, even today, of amateur science.

RAK

Letter from Down Under

While optical fibres have revolutionised telecommunications and brought broadband Internet to our own doorsteps, they have also quietly revolutionised astronomy. I have written many times in this column about the achievements and breakthroughs of the many fibre-linked optical spectrographs at the AAT and UK Schmidt Telescopes, going by such acronyms as 6dF, 2dF, FOCAP, Autofib, AAOmega, CIRPASS, FLAIR, and PANACHE! Historically, developments in optical fibre technology have been driven (and research funded by) the needs of telecommunications carriers. However, their needs (thin fibres, optimised for the infrared, with lasers delivering more than enough signal strength to compensate for light loss in the fibre) have often been at odds with the needs of astronomy. Now at last, astronomers are starting to form strategic alliances with fibre optic researchers and manufacturers, and to achieve things that many said could not be done.

Here at the AAO, a research team led by Dr Joss Bland-Hawthorn has been investigating ways of suppressing the dominant and time-variable emission lines from OH molecules in our atmosphere that have plagued infrared astronomy for decades. A veritable "forest" of lines occupies much of the spectrum between 1.0 and 1.8 micrometers (see figure), leaving only a few gaps for the light of a distant quasar (say) to peek through. Just as bad, the brightness of these lines adds to the "noise" when trying to see faint objects in infrared images, while the lines brighten and fade on a timescale of a few minutes. It is akin to the strong interference from radio stations and satellites that radio astronomers have had to contend with, except that the OH glow comes from natural causes. So short of putting all our telescopes into space, we just have to live with it – or do we?



Spectrum of the night sky over Mauna Kea, Hawaii, in the 1.4–1.85 micrometres range. The strong narrow lines are due to OH (hydroxyl) radicals, and make it hard to spot the much weaker emission lines from (say) a quasar at a redshift around 2, unless they just happen to fall in a gap between these lines. Using special optical fibres, we can stop these lines from getting inside the spectrograph, making the infrared sky even darker than in the optical.
(Figure courtesy Joint Astronomy Centre, Hawaii)

Previous attempts to suppress these OH lines by spreading the infrared light into a broad spectrum, bouncing it off a mirror specially blackened in certain regions to absorb these lines then fed back in to the spectrograph, achieved some success, but only at the expense of a low overall throughput due to all the extra optics involved. Here at the AAO, we have been working on technologies for a different problem: namely how to bring infrared light from many objects of interest spread over the huge focal planes which the next generation of 20–30 metre telescopes will possess, into one central spectrograph? One solution is to use optical fibres, so we began to wonder "What if it was possible to block out the OH lines in the fibres themselves?"

The developing field of photonics has demonstrated that optical fibres can be much more than just "light pipes". Using techniques similar to holograms, cyclic changes to the refractive index inside a fibre turn it into a diffraction grating, which can be "tuned" to almost perfectly reflect light of a specific wavelength back where it came from. By mixing several such gratings within a fibre, we could eliminate the worst of these OH lines, with virtually no losses at other wavelengths.

In collaboration with a local photonics company here in Sydney, we have already demonstrated the feasibility of such a system in the laboratory. Proving that it works on a telescope is much more of a challenge, since the fibre must be much thicker to accept the input beam, and thick fibres behave in much more complicated ways than thin fibres. But here again we think we have a solution, and hope to be the first to demonstrate this technology later in the year using our own IRIS2 infrared spectrograph on the AAT. Then we shall truly have entered the era of "astrophotonics".

The AAO's innovation in this area has also been rewarded with a recent substantial research grant from the UK's Particle Physics and Astronomy Research. Such is the level of interest from competing astronomical and commercial interests that we have had to confront the issues of intellectual property, and even patenting some of this technology with our industrial partners. To astronomers who are used to openly sharing ideas and breakthroughs at conferences and in peer-reviewed journals, this is a whole new world! But the scientific spin-off is the one we treasure most – by being able to "turn out the lights" above us, and artificially create one of the darkest infrared skies anywhere on the planet, we hope to peer deeper and further back in time than has ever been possible before.

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Sky Diary Spring 2006

The summer twilight encroaches on the evening sky increasingly during the quarter, making observations of fainter objects difficult. The northern summer solstice is on June 21st, at 12h 26m UT (add an hour for BST) and astronomical twilight lasts all night (see last Spring's Sky Diary).

When the sky gets reasonably dark in the April evenings Mars, which has been such a fascinating northern sky object for so long, continues to fade to its minimum brightness as we see it, as the planet continues slowly towards its next meeting with the Sun in October. The planet is disappointing in a telescope in most respects at this time, but in April, it is close to quadrature. This is a not particularly interesting point when the angle at the Sun between Earth and Mars is 90°. The planet, although then just over only 5.5 arcsec in angular diameter, shows a distinct gibbous phase. This is just about the only example of a superior planet showing a phase to observers on Earth. It may be tricky to find Mars low in the northwest above Betelgeuse in Orion, roughly half way between Procyon and Capella.

☞ Venus, almost at its brightest in the morning sky at the beginning of the quarter, is visible throughout the period but very low in the east. The slim morning crescent Moon will be close and to the south of Venus on April 24, and close again to the north of Venus on May 24. By June, the conjunction has widened, and occurs on the 23rd.

Mercury makes a fairly favourable eastern elongation in mid June, again twilight will be the problem. Mercury will be setting about two hours after the Sun at eastern elongation on the 20th. By the time civil twilight ends, the planet will still be about 10° above the north-western horizon. Mercury will be to the south of Pollux, with Saturn and Mars close by to the east, and Jupiter also in the sky, low in the south. The evening crescent Moon is to the north of Mercury by just over 5° on June 27. This will form a line east to west along the ecliptic of Mars, Saturn, the Moon, Mercury, covering about 15° (the Moon, being in a northerly ecliptic latitude will spoil the line-up a bit!).

Moon phases for the second quarter of 2006

	New Moon	First Quarter	Full Moon	Last Quarter
April	27	5	13	21
May	27	5	13	20
June	25	3	11	18

Saturn, in Cancer, remains around for the whole quarter, although getting lost in the twilight by the end of June. The Moon (just past first quarter) appears 4° to the north of the planet during the evenings of April 7 and May 4, and 3° north on May 31 and June 28.

Jupiter is in Libra, and is highest above the horizon around midnight during this quarter. On the evening of May 15 the Moon, two days past Full, rises closely to the east of Antares with Jupiter close by to the west, and beyond the planet, the star Spica (see illustration). The Moon is not far to the south of Jupiter on April 15, and conjunctions also occur on May 12 and June 8 (all with the Moon south).

The illustration (from *Starry Night Education*, see page 6) gives a good impression of the main zodiacal constellation that the astrologers ignored, Ophiuchus (The Serpent Bearer). The ecliptic passes through more of this constellation than it does of Scorpius to the south. Actually, too many astronomers are heard to say, smugly, something like "the astrologers have got it wrong, there are thirteen zodiacal constellations". Well when they say that, they are wrong themselves, on two counts! Firstly, there are 12 astrological "houses" *by definition.* They divided the band of sky where the planets appear into 12 equal monthly sections, and named them after the associated constellation, or the most significant. That's all there is to it, so there is nothing to suggest as being "wrong". Secondly, if the zodiac is defined by the band of sky in which the five naked eye planets plus the Sun and Moon may appear, then there are at least 14 zodiacal constellations, because Cetus also has the occasional visitor from that list. No more astrology rubbish.

Ophiuchus is probably the largest least-known area of sky with the most unrecognised name. Bearing in mind that the diagram extends more than 90° east to west, the largely empty space, roughly oval in shape, to the north of the Scorpion's claws extends from about declination –30° to about +15°, and is some 30° east to west. In fact, one part of the constellation pokes down south and to the east of Antares! To recognise Ophiuchus, the best way is probably to start with the "claws" of the Scorpion and look north to a line of stars more or less parallel with and due north of the line of three bright stars on the north side of Scorpius with Antares at the centre. The line-up in Ophiuchus starts in the south east (η Oph.) and leads north west through ζ Oph. and on to a pair of stars, ε and δ Oph. The line continues, but now it is fainter and straggles on generally north-westwards. This is the head of the two-part serpent that poor Ophiuchus grapples with. In the diagram, you may be able to make out the star α Serpentis on this line which continues towards a bright star at the top of the frame just west of south, which is Arcturus. The rest of Ophiuchus is roughly outlined by the fainter stars trailing down to the south-east.

Richard Knox

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

	April 15		May 15		June 15	
	Rise	Set	Rise	Set	Rise	Set
Sun	05h 18m	19h 07m	04h 20m	19h 57m	03h 51m	20h 33m
Mercury	04h 50m	16h 23m	04h 12m	19h 35m	05h 31m	22h 20m
Venus	04h 04m	14h 45m	03h 12m	15h 54m	02h 21m	17h 16m
Mars	08h 10m	01h 16m	07h 40m	00h 24m	07h 23m	23h 12m
Jupiter	20h 56m	06h 21m	18h 37m	04h 15m	16h 19m	02h 05m
Saturn	11h 15m	03h 05m	09h 24m	01h 11m	07h 37m	23h 12m
Uranus	04h 16m	15h 06m	02h 20m	13h 14m	00h 15m	11h 11m
Neptune	03h 28m	12h 52m	01h 30m	10h 56m	23h 20m	08h 49m

Scorpius rising with the just-past-full Moon, and Jupiter low in Libra provide a nice photo opportunity on May 15. This illustration is from the new version of Starry Night for educators (see page 6) (complete with a typical mid-Worcestershire scene?)