Gnomon

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A happy Christmas
and a fulfilling and peaceful New Year

The Hubble Space Telescope captured this stunning image of one of the most dynamic and intricately detailed star-forming regions in space, located 210,000 light-years away in the Small Magellanic Cloud. At the centre of the region is a brilliant star cluster, NGC 346. A dramatic structure of arched, ragged filaments with a distinct ridge surrounds the cluster.

A torrent of radiation from the hot stars in the cluster eats into denser areas around it, creating a fantasy sculpture of dust and gas. The dark, intricately beaded edge of the ridge, seen in silhouette, is particularly dramatic. It contains several small dust globules that point back towards the central cluster.

The NGC 346 cluster is resolved into at least three sub-clusters and collectively contains dozens of hot, blue, high-mass stars, more than half of the known high-mass stars in the entire SMC galaxy. A myriad of smaller, compact clusters is also visible throughout the region.Some of these mini-clusters appear to be embedded in dust and nebulosity, and are sites of recent or ongoing star formation. Much of the starlight from these clusters is reddened by local dust concentrations that are the remnants of the original molecular cloud that collapsed to form N66.

An international team led by Dr. Antonella Nota of the European Space Agency and the Space Telescope Science Institute in USA, has been studying the Hubble data and reports the discovery of a rich population of infant stars scattered around the young cluster. These stars probably were formed 3 to 5 million years ago, together with the other stars in the cluster. These infant stars are particularly interesting as they have not yet contracted to the point where their interiors are hot enough to convert hydrogen to helium.

Image: NASA; ESA; A.Nota

Catch a Star! ... and discover all its secrets!

This famous educational programme returns for its fourth year, with new prizes including a trip to Chile, and more ways to enter the competition. ESO and the European Association for Astronomy Education (EAAE) again welcome school students to this exciting web-based competition. Introduction On a dark night, far from city lights, you can see about three thousand stars in the sky with the unaided eye. With binoculars you can see more than ten thousand, and with a small telescope even more celestial objects become visible. The Milky Way Galaxy in which we live contains hundreds of billions of stars, clouds of cosmic dust, stellar clusters, and a massive black hole in its centre. These objects are spread over more than a hundred thousand light years, making our own Solar System just a tiny speck in the Galaxy. And that is just our own Galaxy: beyond the Milky Way, there are also hundreds of billions more! These celestial objects are all very distant, and very large.

The stars are too far away for us to visit them even in the fastest spacecraft, but there's another way for you to "catch a star" by taking part in ESO's competition. Select an astronomical object - such as a star, a distant galaxy, a beautiful comet, planets, moons, or a nebula - and write an article about it to learn and share some of its secrets! Just like astronomers do, you can form teams to research your chosen object, and use scientific detective work to find out as much as possible about it. Younger contestants can take part in the competition by making a drawing of the object you have selected. You could also choose as your topic a celestial event or phenomenon, such as a solar or lunar eclipse, the Northern or Southern Lights, or a meteor shower like the Leonids. Or write about a visit to an observatory, describing the ways in which it studies the object you have chosen.

The "Catch a Star! 2005" contest will have three categories: Category 1 - Prizes include trips to observatories in Chile, Austria, Germany, and Spain. **(Cont. on page 4☞)**

Calendars, Crescents and Calculations: linking modern astronomy and Islam

The Royal Observatory Greenwich (ROG) has built a good relationship with the UK Islamic community through our online resources and our unique collections. Over the last year we have worked to capitalise on this connection through a series of innovative events that brought a new audience to the Observatory – a model that could be adopted elsewhere.

London is a unique setting for an observatory. It encompasses extremes of wealth and poverty within one of the world's most cosmopolitan populations. All the major religions are represented – according to the 2001 census 8.5% of its citizens are Muslim, 4% Hindu and 2% are Jewish. And yet with the honourable exception of our schools programmes, the Royal Observatory's astronomy education fails to reflect this diversity. Like most science institutions our audiences are almost exclusively white and middle-class.

Delegates viewing the Sun through a hydrogen alpha telescope.
Image: Dr Jamal Sherif, MCB.

The direct connection between astronomy and calendar systems gave us a chance to change this. In particular, the Islamic calendar depends upon astronomical observation – traditionally each month began with the sighting of the crescent Moon after sunset, a day or two after new Moon.

The weather prevents UK observers from seeing the Moon on the right date for much of the time, so mosques pragmatically work out when it would have been seen using predictions from HM Nautical Almanac Office (HMNAO) and elsewhere. Perhaps surprisingly, there is still real uncertainty in knowing exactly where and when the Moon will first be seen each month. This fuels a vigorous debate across the Islamic world, particularly at the beginning and end of Ramadan.

British Muslims are familiar with the ROG's role as a key supplier of these data. The Observatory also has one of the world's largest collections of Islamic instruments with some dating from as early as the 13th century, when Arab astronomy was at its height. In 2004 we decided to take advantage of these physical and electronic resources, applying for a COPUS grant to fund a range of activities designed to bring in these and other traditionally 'hard to reach' groups.

Working closely with the Muslim Council of Britain, we ran our first workshop for "specialists" in late October 2004. Speakers including Alan Longstaff (best known for his column in *Astronomy Now* and now teaching part-time in Greenwich) and Steve Bell from HMNAO set out exactly how various calendars work, how they relate to the Sun, Moon and stars and how difficult calculating the position of the Moon can be. The seminar took place on the last but one day of operation for our old Spitz planetarium (now enjoying a new lease of life in Sidmouth) and attracted 48 participants, with as many again on a waiting list. Delegates also enjoyed a view through our 28-inch refractor, looked at sunspots and toured our site.

In the spring of this year we put on a grander event, this time also working with the Jewish, Chinese and Hindu communities. Fewer visitors came from these groups, perhaps indicating that without a direct stake in the subject they had less compelling reasons to attend –most other calendars lack the ambiguity of the Islamic system.

Steve Bell and I then took our "roadshow" to the National Space Centre in Leicester and the Glasgow Science Centre. In both we enjoyed large groups and a chance in my case to play with some brand new planetarium equipment. Visitors in Leicester were predominantly Muslim – in line with our project aims – whereas the Glasgow guests reflected the city's largely white population. Irrespective of the audience composition, the feedback was extremely positive, partly a result of the novelty of the material.

Supporting all this work is a brand new online resource on calendars, illustrated with our own bespoke animations and due to go live at the end of December. This will be part of the ROG website and we would welcome your feedback. In the meantime we also plan two further events in the autumn of this year, one in the Manchester Museum of Science and Industry and one back here in Greenwich.

It's easy to be cynical about the impact of one-off projects. But I suspect that this will have a lasting legacy, bringing new visitors to our 'modern astronomy' events like our observing evenings, lectures and planetarium shows. After all broadening the base of science enthusiasts is a core aim for all of us – I hope that this initiative will help make this happen.

Robert Massey

www.rog.nmm.ac.uk

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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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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

Publication Dates:

These are at the equinoxes and the solstices, that is four times a year. Copy deadlines are six weeks before these dates.

For your Christmas stocking

Stargazers' Almanac 2006. A monthly guide to the stars and planets. Hawthorn Press. £12.99. ISBN 1 903458 57 9. Available from Booksouce, 32 Finlas Street, Glasgow, G22 5DU, ☎ (08702) 402182, fax (0141) 557 0189, **orders#booksource.net.** *Or on-line from the publisher* www.hawthornpress.com.

The new edition of this annual treat has several innovations for the new year. These include subtle colouring of the brighter stars to indicate that they do not all have the same appearance, a representation of the Moon's phase on the charts themselves, and representation of the greater extent of twilight during the months close to the summer solstice. The charts are prepared to show the sky at 22:00UT throughout the year, so that the sky can be assumed to be reasonably dark on any date. The artwork is elegant and, apart from a bit of artist's licence extending a glow all around the horizon (but there is also an article by Bob Mizon on the Campaign for Dark Skies!), the charts manage to represent the actual sky, even though the width covers over 180° of the horizon! The overall result would grace any wall.

The monthly charts, centered on the views north and south, are arranged on the same spreads so that the complete sky up to an altitude of about 60° is displayed when the almanac is hung on the wall (the reinforced eyelet is a worthy attention to practical detail also). The ecliptic is indicated by the silhouettes of the zodiacal figures drawn against the stars themselves. These are subtly shaded so as to be unobtrusive, and have a pleasingly ghostly effect.

Each month has a chart showing the Moon's phases for each day, and its meridian altitude as seen from the middle of the UK (in the same way as *Gnomon*'s normal Sky Diary charts are prepared). This issue's Sky Diary shows a sample section of the mid-February chart from the new almanac on the back page.

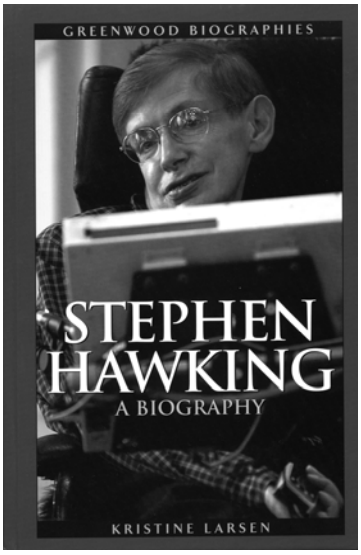
Each month has notes on points of interest among the stars and constellations that are prominent, and the main astronomical events of each month are also described for planets, and for the Sun and Moon. **RK**

Stephen Hawking: A biography. Kristine Larsen. £16.99. Hardback. ISBN 0 313 32392 5. Greenwood Press.

This book is part of a series of biographies published by Greenwood for high-schools and libraries specifically student use. The books are prepared by specialists with a subject area, length and format suitable for projects or assignments to meet the needs of educators and their students. The approach is intended to be factual rather than judgemental, and the books "are meant to be fun", according to the introduction. Each chapter has a bibliographic appendix of notes and references, allowing students to make their investigations as deep as required.

Professor Hawking needs no introduction! His life could be said to be two stories, the work of a prominent scientist, and a struggle against seemingly impossible odds in coping with a tragic handicap. To quote the man himself in the introduction to this book, "I would like to be thought of as a scientist who just happens to be disabled, rather than a disabled scientist".

Larsen evidently views Hawking with some awe following her first contacts with him when she was a graduate student in general relativity. She uses such phrases as "he lent an unmistakable presence to any gathering" and "we graduate students stopped short of throwing flowers in his path . . . . heads would turn as he rolled by, like



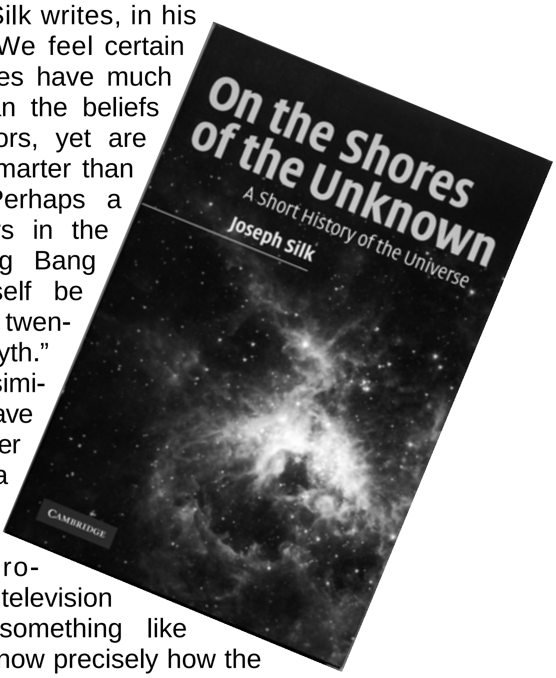
Caesar in a modern-day version of a chariot, flanked by his students, attendants and general followers". But she goes on to say that not all of what the reader will find in the book "is flattering, but it is honest".

The result meets her objectives: the mixture of the story of his life, his education, his University career, his first marriage and his family, the end of this marriage and the second marriage, and his surprising success as a best-selling author, is told with sympathy, and skilfully interwoven with the developments in Hawking's pioneering theories in cosmology, black holes in particular, and the search for a "theory of everything".

The book concludes with four appendices outlining the areas of General Relativity, the thermodynamics of black holes, inflationary cosmology and the AdS/CFT conjecture (and if you want to know what that is, you must read the book!). Finally, an extensive glossary, a selective bibliography and index are provided to complete an intriguing work. Early in her book the author says that Hawking does not like biographies, so would probably not read this one. Want a bet? **RK**

On the shores of the unknown: a short history of the Universe. Joseph Silk. £19.99. Cambridge University Press. ISBN 0 521 83627 1 (hardback)

The Kristine Larsen biography of Stephen Hawking and this book go well together! Hawking even wrote The *Universe in a nutshell*, which might also have been a title for these 246 pages.



Professor Silk writes, in his introduction, "We feel certain that our theories have much more truth than the beliefs of our ancestors, yet are we so much smarter than they were? Perhaps a thousand years in the future, the Big Bang theory will itself be regarded as a twentieth-century myth."

Thoughts similar to this have troubled me ever since I heard a prominent American astronomer pronounce on a television documentary something like "We may not know precisely how the Universe began or how it will end, but we will certainly do so during my lifetime". Contrast this with the quotation above from Professor Silk. Contrast this with the concluding words in James Jeans' book The mysterious Universe of 1930: ". . .our main contention can hardly be that the science of today has a pronouncement to make, perhaps it ought rather to be that science ☞ **Cont. on page 7**

Curriculum Corner

GCSE Astronomy – Coursework

Following the introduction to GCSE Astronomy in the last edition of *Gnomon*, this article looks in more detail at the Coursework portfolio which candidates prepare for this qualification. In particular, it highlights some of the most popular project titles which students submit.

As experienced teachers of GCSE Astronomy will already know, the coursework is one of the most popular parts of the course. It involves students in making their own astronomical observations or producing astronomical resources or instruments.

Candidates submit two pieces of coursework, one observational and a second either graphical or constructional. This article focuses on the observational coursework, with the graphical/constructional projects being covered in the next issue of *Gnomon.*

OBSERVATIONAL COURSEWORK

Most candidates choose to submit a project from the list of eight suggested titles available in the Specification for GCSE Astronomy. These allow students who have access to nothing more sophisticated than the naked eye to gain credit on an equal footing with those who are able to make use of the latest computer-guided telescopes with digital imaging. The most popular project titles include:

Moon phase diary – This project requires students to keep a diary of the Moon phase, based on naked eye observations. Patient students who observe for several months are often able to assemble almost a complete set of observations of the lunar phases.

Constellation drawing – Although an apparently straightforward naked eye task, this project rewards students who are able to produce accurate drawings of three of the major constellations, including details of stellar colours and magnitudes. Candidates can also follow in the footsteps of the pre-photographic astronomers by estimating magnitudes using reference stars.

Observing a meteor shower – This project involves students in plotting the trails of meteors on a star chart and thus deducing the radiant of the shower. Given the unpredictability of the weather in the UK and the variability of meteor flux, this project cannot always be completed by students. The relative position of the Perseids shower within the academic year can also complicate matters!

Shadow stick – By taking observations of shadow direction and length around local noon, students use their data from this project to deduce the exact time of local noon and thus their longitude. This project is often very effective as an introductory task, helping to make students more aware of the apparent motion of the Sun in the sky.

Drawing/photographing lunar features – This project is designed for students who have access to a telescope or a camera. Since candidates are required to list the equipment being used, the highest scoring projects are not always submitted by those with the most sophisticated equipment. Carefully completed and accurate drawings of lunar features can be produced with binoculars or a small telescope. Candidates are also encouraged to produce drawings or photographs which compare the appearance of certain lunar features at different phase of the Moon.

Drawing/photographing three celestial objects – Popular objects for this project include the Orion Nebula, the Galilean moons of Jupiter and the rings of Saturn. In recent years, a number of candidates have extended the range of objects within their grasp by using one of the robotic telescopes available via the Internet.

Sunspots – Although one of the less popular observational projects available, (perhaps as a result of the weather between September and May!) a number of candidates each year are able to produce a series of sunspot observations and thus determine the solar rotation period.

Star trails – In this project candidates use a long exposure photograph centred around the North Celestial Pole to determine the length of the sidereal day. By combining values calculated from a number of star trails within the same photograph, many candidates are able to produce accurate values.

As the above descriptions show, these projects allow students to gain experience of some of the basic observational techniques in astronomy. A number of the projects also allow students to make calculations from their observational data.

Full details of and further guidance on all the coursework project titles available for GCSE Astronomy can be found in the Specification which can be obtained by following the links to GCSE Astronomy on the Edexcel website: www.edexcel.org.uk.

Julien King
Principal Moderator for GCSE Astronomy
Edexcel Examinations

(☞**Catch a star . Cont. from page 4**). Category 2 - Prizes include astronomy DVDs, CD-ROMs, and posters.

Category 3 - This category is a drawing contest. Prizes include astronomy T-shirts and posters.

Registration is by December 15, 2005.

www.eso.org/outreach/eduoff/edu-prog/catchastar/

Or contact Alan Pickwick:

Alan_C_Pickwick#btinternet.com

All our yesterdays

An amazing follow up to the plea in the last issue for back copies of *Gnomon* to enable us to complete an archive - we have made it! I now have a complete set from issue 1 to date! Many thanks indeed to Teresa Grafton, Dr.David Clarke (*Gnomon*'s first Editor) and Ken Stevens for their help in enabling us to complete this collection so rapidly. It is hoped that, eventually, we will be able to make them available via the AAE website.

How to learn about Faulkes telescopes

The Faulkes Telescope Project has been busy in recent months running training days for teachers. The training is funded by the Dill Faulkes Educational Trust, the Particle Physics and Astronomy Research Council and Department for Education and Skills. The training days enable teachers to get hands on experience of using the Faulkes Telescope interface as well as the software recommended for use with the various science projects being run. Please contact

david.bowdley#faulkes-telescope.com

A run round the Armagh Observatory human Orrery

Opened in November 2004, a large outdoor exhibit in the grounds of the Armagh Observatory shows with precision the elliptical orbits and the changing positions of the planets and other solar system bodies with time. People play

the part of the moving planets. Users can gain a better understanding of the working of the solar system through games and activities. Kepler's laws can be established by direct measurement and concepts such as planetary alignments, conjunctions and transits can be demonstrated, as well as the directions to more distant objects in the Universe and the fact that the Sun passes through *thirteen* ecliptic constellations in the course of a year.

The Human Orrery is as simple to use and as versatile as a sundial. Variations on the basic model can be constructed in many ways, for example using chalk or paint on a playground or string and tent pegs on a playing field. Temporary objects, such as bright comets or spacecraft trajectories through the solar system can also be included. The key to the Human Orrery, however, lies in the accuracy which objects are placed on the ground.

In the case of the Armagh Human Orrery, the first such exhibit to be constructed with precision, the base was made of compacted hardcore covered with bitmac, while the orbital tiles and other fixtures are embedded in a top layer of fine resin-bonded gravel. The model is 25m across and shows the six classical planets, the main-belt asteroid (1) Ceres and the two comets 1P/Halley and 2P/Encke. It contains more than 200 individually engraved orbital tiles that show the positions of each object at fixed 16-day intervals (or multiples of 16 days). Each tile is located on the ground to an accuracy of better than 1 cm. The scale of the model, one metre per astronomical unit or 1:150 billion, was primarily chosen to fit the available space. On this scale the diameter of the Sun, indicated by a yellow disc at the centre of the "Sun-tile", is 0.93cm. The tiles for the terrestrial planets, asteroid and comets have a diameter of 16 cm and those for the gas giants a diameter of 32 cm.

One idea is to encourage friends or a family group to play the game of "Walking the Orrery". People walk around the orbits at a steady pace, moving from one tile to the next and demonstrating the different distances traveled by the different planets during a given fixed time interval. The time steps can be called out by a group leader. Returning to the "zeroth" tile indicates the completion of one revolution or one "year" for that object. For the comets, the zeroth tile corresponds to their most recent perihelion passage, and the 11 tiles for Mercury represent two complete revolutions for that planet (which has an orbital period of 88 days).

The speeds of the planets in different parts of their orbits can be measured and compared with the results from celestial mechanics, and the distances from one object to another can be readily determined. In fact *all* of Kepler's laws can be rediscovered by direct measurement on the ground. More advanced students may use the shapes of the orbits to investigate the properties of conic sections. Determining the positions of the planets at any time (e.g. today's date, or when you were born) may if you wish lead to the investigation of "Leap Steps" (or Leap Stops) and their relationship to our modern calendar and leap years, and to mathematical concepts such as "clock" or modular arithmetic.

One simple activity is to locate the position of the planets at today's date. Then, standing on the Earth tile, one can look towards the "Sun" in order to identify whether Mercury and Venus might be visible as morning or evening stars, to the right or left of the "Sun" (and the real Sun) respectively. Looking away from the Sun tile shows which planets are visible in the night sky. The result can be checked in the real sky on the next clear night. These activities help people make the connection between what is seen on the model and what is seen in the sky. It can develop a deeper understanding of the Earth's motion and position in space – quite literally bringing astronomy "down to Earth". For more information contact:

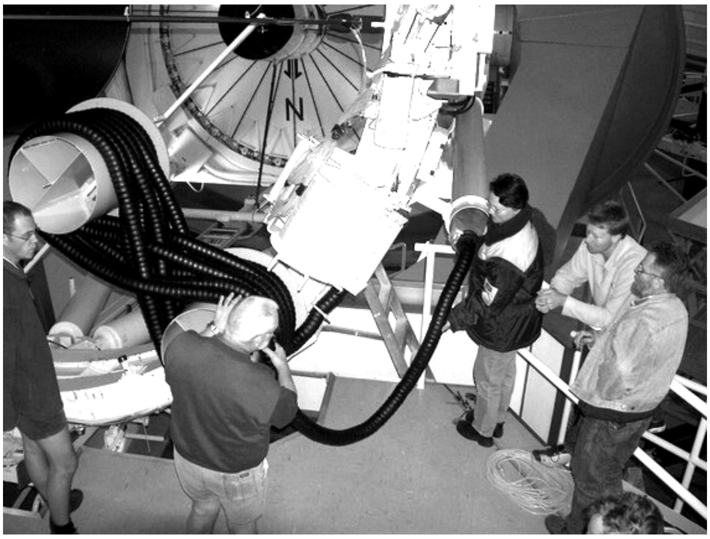
http://star.arm.ac.uk/orrery.

Anne Urquhart-Potts and Mark E. Bailey

From an article by Mark Bailey, David Asher and Apostolos Christou of the Armagh Observatory, published in Astronomy and Geophysics*, Vol.46 Issue 3, June 2005.*
Images courtesy of Miruna Popescu (Armagh Observatory).

Letter from Down Under

It's a hectic and nerve-wracking time at the Anglo-Australian Observatory, as we commission the AAT's first new instrument in four years. AAOmega is a new general-purpose optical spectrograph for the 21st century, designed and assembled by the AAO's in-house engineers and technicians, and fabricated mostly in Australia. It combines the lessons learnt in the past decade while designing multi-fibre optical spectrographs for the AAT



AAO optical technician John Stevenson (left of centre) passes the optical fibre "snake" from its storage capstan on the 2dF top-end of the AAT, to Kristin Fiegert (right of centre) who feeds it into a pipe that carries it down to the AAT mirror cell, thence into the equatorial horseshoe mount. The AAT's primary mirror covers can be seen in the background.

(2dF), VLT (OzPoz), and Subaru (Echidna) telescopes, with the latest technology in optical fibres, diffraction gratings, CCDs, and anti-reflection coatings.

What is AAOmega, and how does it work? Let's start with the name. One measure of a telescope's productivity is the product of its mirror aperture A (hence the more light it collects) with the solid angle (Omega) on the sky it can see at one time (hence the more objects that can be observed simultaneously). The AAT is virtually unmatched anywhere in the world for its "AOmega", thanks to a 3.9-metre aperture, and a 2° field of view. While there are many 8-10 metre size telescopes around, most have fields of view of 0.5° (the size of the Full Moon) or less, so the AAT is still a factor of 2 or more ahead by this criterion. Playing to the AAT's advantage in AOmega is therefore what AAOmega is all about.

Over the past 30 years, a number of optical spectrographs have been attached to the AAT for a variety of purposes. The main workhorse in that time was the RGO Spectrograph (built by the Royal Greenwich Observatory while it was located at Herstmonceaux Castle), which was good for medium-resolution spectroscopy of single objects. More recently, the SPIRAL instrument allowed spectroscopy of not just one or two objects along a slit, but anywhere within a rectangular array of lenses (integral field spectroscopy). The jewel in the AAT's crown in the past decade has been the 2° field (2dF), which uses a robot to position up to 400 optical fibres over a 2° field, then feed the light into two separate spectrographs riding atop the telescope. While each of these three instruments has provided sterling service, it has long been recognised that none of them delivered the best possible image quality, stability against flexure and thermal effects, or throughput of light. The goal of AAOmega therefore has been to replace the functionality of all three with a single versatile, but optimized facility.

Although 2dF was up to the task of measuring redshifts for 220,000 galaxies, and 22,000 quasars, the quality of the spectra has never been as good as hoped. At the time of its design in the early 1990s, optical fibres suffered from significant losses (especially at blue wavelengths) and the longer the fibre, the more light was lost.

It was therefore decided to mount the spectrographs directly on the top-end ring of the AAT, so as to keep the fibre lengths as short as possible. Inevitably, this meant the spectrograph design had to compromise stability, wavelength coverage and optical quality to be kept light-weight and compact enough.

Today however, thanks to the demands of telecommunications companies, the amount of light lost even over kilometers of fibre is almost negligible. This means that AAOmega could be located completely off the telescope, in a mechanically and thermally stabilised enclosure. It does however mean that feeding the 40m long, snake-like bundle of optical fibres from 2dF to AAOmega is quite an operation, as can be seen! (left)

Once inside the spectrograph room, the fibres are aligned to project the light onto a collimator which makes the beams parallel. The light then hits a specially-coated glass plate called a "dichroic", which reflects light shortward of 557nm, but allows light redder than this to pass straight through. The blue and red beams enter separate "arms" of the spectrograph, enabling the optical design, coatings, and CCD sensitivity to be optimised for each.

Each beam passes through a volume phase holographic (VPH) diffraction grating, which splits the light up into a spectrum. These VPH gratings are produced using a laser, and have far better throughput than traditional reflecting diffraction gratings, or prisms.

The astronomers have a range of VPH gratings to choose from, depending on what resolution and central wavelength best meets their needs. The spectra are imaged by a Schmidt camera and CCD, both of which ☞

The head of the snake arrives inside the AAOmega spectrograph room, where it is "wrestled" by Instrument Scientist Will Saunders. The large bulbous cylinder on the left houses the "blue" camera.
(Images courtesy Steve Lee, AAO)

☞ are coated to optimise their response in either the red or the blue part of the spectrum .

The other main mode of AAOmega will be the integral field mode, where light from each of the SPIRAL lenses will be fed from the AAT's cassegrain focus into the spectrograph room via a second optical fibre bundle. This way, spectra covering a large region of a galaxy or a nebula can be taken simultaneously, enabling their motions and chemistry to be better understood.

Already, large teams of Australian and UK astronomers are planning AAOmega observing programs which would consume more than 1500 nights of AAT time in the next three years. Since other instruments and programs will be seeking their share of AAT time as well, the competition will clearly be intense! Once again, placing a state-of-the-art instrument like AAOmega on a comparatively "old" and "small" telescope like the AAT has opened up whole new opportunities to do groundbreaking science in the years ahead.

Stuart Ryder
sdr#aaoepp.aao.gov.au

☞**(For your Christmas stocking cont. from page 3)** should leave off making pronouncements: the river of knowledge has too often turned back on itself".

Without much more ado, Silk plunges into an excellent outline of the main theories of the origins and fate of the Universe, as they now stand. He later goes into the astrophysical background to these, with a review of what is known about the life of stars and the conjectures that arise from this. Similarly, he outlines the state of modern subatomic particle physics and the possibilities of superstring theories. No mean feat in 246 pages!

The text is readable, and sight is never lost of the many problems that face the theoretical astrophysicist and cosmologist (unlike the unnamed American astronomer roughly quoted above!)

The chapters start with the "Building blocks of the cosmos", dealing with the main cosmological principles, the building blocks themselves (stars, galaxies, gas etc.), and the implications of Olber's Paradox. From this, he goes on to consider the history of, and the nature of the expansion of the Universe, including the search for the Hubble Constant, and the Steady State theories. This leads on to the discovery of the cosmic microwave background its isotropy and its implications. The current theories describing the history of the Universe, from the first 10^{-43} s the matter/anti-matter problem, the formation of fundamental particles through to helium synthesis takes another two chapters. The role of dark matter is thoroughly described, including WIMPS and MACHOS (Professor Silk might have explained how such whimsical acronyms came to be!), brown dwarfs, black holes, and the makeup of the interstellar medium. This brings us to dark energy and the possible acceleration of the expansion of the Universe. Finally the book looks at the structure of galaxies and clusters of galaxies. It concludes with some thoughts on what we don't know, and what we might find out eventually.

I am still mindful of those words: "the river of knowledge has too often turned back on itself".

Richard Knox

Sky Diary Winter 2006

The good news is that the Winter sky is splendid in the Northern hemisphere: the bad news is that it is a cold pursuit stargazing at this time! The practical advice should be to pay particular attention to the extremities (hands, feet and head). Standing still is not the best way to keep warm, but telescope users have little choice. So insulate your feet from the ground. Stand on a duck board, or as close to something like that as you can get. Wear warm socks and boots, a ski hat, and thermal gloves (thin, but warm). There! That's all Nanny has to say about that for now!

The first quarter of 2006 is well-endowed with planets in the evening sky, with Mars in the west, Saturn south and Jupiter rising in the east. Venus makes her way into the morning sky. Mercury is at greatest eastern elongation on February 24 at 5:00hr, and may be spotted some 9° south of the extremely thin crescent Moon (only just over 40 hours since New Moon) in the early twilight of the evening of March 1. Either or both may be tricky to spot, but the ecliptic is almost at its steepest angle to the horizon at the time, maximising the chances of a good view. A photograph would be nice, if you can find the best conditions and get the exposure dead right. With a frairly fast film (say 400 ASA) an exposure of about 1/50th second at f.2 ought to be enough. As always with such subjects, it would be better to take a number of exposures both faster and slower. Don't forget the tripod, by the way.

Venus disappears from the evening sky when it approaches inferior conjunction on January 13, and soon appears in the morning sky, where it remains relatively low in the twilight through the year until superior conjunction in October. Not a special year for Venus then! But although low, it will reach greatest brilliance (magnitude –4.5) in mid-February, when it will be easy to find low in the south-eastern part of the sky.

Mars too will become a poor show compared with the spectacular appearance throughout the Autumn this year. But Mars has by far the longest synodic period of all the planets, a soupçon less than 780 days, or more than two years, compared with Venus' 584 days (1 year and seven months). Both these are long enough to make the (very) casual observer forget about either planet in their turn. Venus also makes a comparatively miserable show every other year anyway, so the spectacular dark-sky evening appearances (for example) are about two years apart (March 2007 and March 2009, for example, are the next two such occasions).

Mars has a similar wait between oppositions, and even longer between favourable northern ones! But this Autumn, and the Spring of 2006, will see Mars chasing ahead of the Sun, which will only overtake it finally in October. Mars will also be left behind the Earth in their orbital processions, with the brightness we have become used to over the last few weeks fading quite noticeably from magnitude 0 at the beginning of the year, to 1.1 by the end of March, by which time the planet will have climbed high to the north of Orion.

Jupiter moves deeper into the southern sky in Libra, so that it does not rise until just before midnight until the end of the quarter (by which time the clocks in Britain will have been set to BST once more, making it even later!)

Saturn plods on southwards in Cancer, having closed with Præsepe on February 1 during its retrograde motion (it does so again at the beginning of June, but this will be swamped by summer twilight). Præsepe is well worth examining in binoculars, and will be very easy to find with Saturn pointing the way. Binoculars resolve a large number of stars in the cluster, which is very different ☞

☞ from the Pleiades, another famous binocular cluster. It does not contain the nebulosity of the Pleiades, and is made of much fainter stars. Galileo discovered the nature of the cluster and estimated that there were over 40 stars. It was known to Ptolemy as a naked-eye fuzzy patch, it was known variously as the "Gate of Men" to the ancient Greeks (the window through which human souls descended to Earth from heaven), and the "Exhalation of piled-up Corpses" to the ancient Chinese! Præsepe means the "Manger" but has a more modern name of the "Beehive" after the swarm it so well resembles. Being close to the ecliptic, the cluster is frequently visited by Solar System objects.

Moon phases for the first quarter of 2006

	New Moon	First Quarter	Full Moon	Last Quarter
January	**29**	**6**	**14**	**22**
February	**28**	**5**	**13**	**21**
March	**29**	**6**	**14**	**22**

The telescopic planets are too close to the Sun to be of great interest during this quarter.

The Sun climbs north to reach the zero point of celestial longitude, the northern Vernal Equinoctial position, on March 20 at 18hr 26min. The Sun's climb northwards is at roughly 1° per day along the ecliptic as usual, but, because the ecliptic crosses the celestial equator at its angle of about 23½°, the Sun's easting is reduced to the cosine of 23½°, that is 0.9171° per day. The result is that the Sun is apparently crossing the sky eastwards at about 92 per cent of the rate at which it moves eastwards at the solstices. The same effect occurs at the Autumn Equinox. So, the mean rate of the Sun's easting is somewhere between the two values, very approximately 360° divided by 365.25 days times the average of 92 and 100 per cent, which comes to about 0.946°/day.

Because the measurement of true solar time is a function of the Sun's daily progress eastwards, sundials will lose (by the clock) at the equinoxes and gain at the solstices. This produces a sinusoidal function that has two cycles per year that causes sundials to gain or lose according to the "mean Sun". In addition, the Earth accelerates to the point of its closest approach to the Sun, perihelion, in early January, and slows down until it reaches aphelion in early July, according to Kepler's second law. This results in another sinusoidal error, that has a frequency of one cycle per year. The two functions add together to form the Equation of Time, the Sun fast/slow correction that should be added to sundial time (true local solar time) to obtain mean solar time.

In addition to all these influences, shadows are changed throughout the year by the altitude of the Sun, which varies as the Sun's declination changes. As a result, if we take a snapshot of the Sun at any one time of day by Universal Time throughout the year, the combined effects of the Equation of Time and the Sun's declination produce a slim figure of eight shape called an anelemma, which is sometimes seen in the shape of the gnomon on some really smart sundials that tell the exact mean time!

The Sun will be involved in the most spectacular visible astronomical event of the quarter, the total eclipse. This is the first since a very difficult to observe event in Antarctica in 2003, or the much easier one in Australia in 2002. To see this one on March 29 you will need to be somewhere along the path of the Moon's shadow between Ghana, the Sahara Desert, Chad and Libya, the eastern Mediterranean, Turkey, on into Russia and Siberia. In the UK there will be a partial eclipse, less spectacular than this year's, which is centred about 10:00 UT.

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

	January 15		**February 15**		**March 15**	
	Rise	Set	Rise	Set	Rise	Set
Sun	09h 13m	17h 29m	08h 27m	18h 25m	07h 26m	19h 16m
Mercury	09h 04m	16h 39m	08h 59m	19h 47m	06h 58m	18h 43m
Venus	08h 29m	17h 44m	06h 11m	15h 25m	05h 39m	15h 03m
Mars	12h 39m	04h 06m	11h 08m	03h 22m	10h 02m	02h 52m
Jupiter	03h 45m	13h 07m	02h 00m	11h 13m	00h 07m	09h 24m
Saturn	18h 30m	10h 06m	16h 14m	07h 58m	14h 15m	06h 04m
Uranus	10h 57m	21h 28m	08h 58m	19h 36m	07h 11m	17h 55m
Neptune	10h 11m	19h 25m	08h 12m	17h 30m	06h 24m	15h 45m

Richard Knox

The evening sky on 2006 February 14, looking towards the south at 22:00hr, as shown in the new **Stargazers' Almanac 2006,** ***published by Hawthorn Press (see review on page 3). Canis Major can be seen at its best at this time. Mars in close to the Pleiades and Saturn even closer to Praesepe in Cancer around this date.***