GNOMON

Newsletter of the Association for Astronomy Education

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Get the light pollution message across

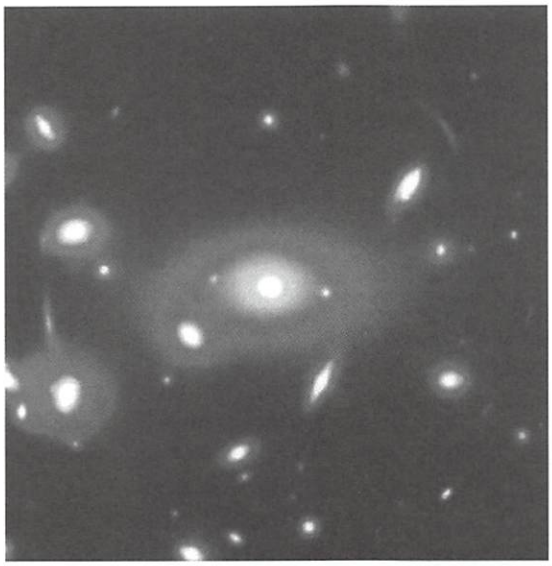
It is one of the saddest ironies in education today that legislators who, in1988, said in their introduction to the new and compulsory National Curriculum that "children will study the wider Universe", still allow 90% of our children - the town dwellers - to see little of that Universe. The lack of legislation on light trespass, light nuisance and skyglow is a subject which will have to be addressed and countered during the 21st century.

It is heartening that most children seem to have heard of the problem of light pollution, not least because of the furore surrounding the two "Blue Peter" lighting competitions of the last two years. For the first of these, Blue Peter invited Dr. John Mason, a committee member of the British Astronomical Association's vigorous Campaign for Dark Skies (CfDS), onto the programme to talk about light pollution, in an attempt to calm troubled waters and underline their good intentions in choosing a scheme which would not allow light to escape above the horizontal. The eventual choice of a structure to be illuminated was in the middle of London's Elephant and Castle roundabout, already saturated with light. The second competition lit up the Bourne Hall in Ewell, Surrey, and local astronomers are still smarting about the broken promise, made on screen by Blue Peter presenters, that there would be no light pollution.

The BAA CfDS and individual astronomers, in conjunction with the CPRE and other environmental bodies, will continue to press for legislation about obtrusive light.

How are we to educate children generally about the wonders of what most of them never see beneath the orange pall that hangs over every town, and an increasing number of urbanised villages in the UK? In a classroom or hall with a good blackout, it is easy enough to recreate what planetarium operators do to illustrate light pollution: "stars" can be projected onto the walls and ceiling through a perforated cover with a lamp inside. The smaller the lamp filament, the more starlike the points of light will be. The use of a separate, unshielded orange bulb (artificial log fires use ☞

Space warp



Part of one of the amazing Hubble Space Telescope photographs of a gravitational lens, in this case a distant huge cluster of galaxies turns the light from an even more remote group into a fantastic pattern of arcs. This is taken from the new Cambridge University Press book* Majestic Universe *by Serge Brunier. (Review on page 2)

GNOMON - definition from the **Concise Oxford Dictionary:**
Pillar, rod, pin or plate of sundial, showing time by its shadow on marked surface, column, etc. used in observing Sun's meridian altitude.

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

☞ them, and they are readily available in hardware shops), preferably fitted with a dimmer switch, will show how stars disappear as upward light increases.

For teaching purposes, images of the UK by night showing the vast amount of energy we waste upwards, are available from the BAA, on 0207-734-4145, or from Eva Hans at South Tyneside College Planetarium, on 01914 273589.

Local astronomical societies, whose addresses may be found in local libraries or on websites of some astronomical publications (try 💻 www.astronomynow.com) may well be able to provide speakers on the subject. If our children's children are to see a worthwhile night sky other than in picture books and on CD-Roms, we must act now and in large numbers to remind students of all ages what they are missing, since a whole generation has now grown up associating the Milky Way only with a chocolate bar.
Bob Mizon (Coordinator, BAA Campaign for Dark Skies)

A change for Bob Kibble.

This is a landmark year for Bob Kibble. He has moved to Edinburgh to teach teachers at Moray House, now part of the University. Every BEd student, 120 each year, will take a short astronomy course given by Bob (and every student makes a sundial! Surprise! Surprise!).

For nearly twenty years Bob has worked tirelessly for the AAE. He joined in 1980 and since then has been an AAE Council Member, the Secretary and latterly, the Treasurer. He has contributed many articles to *Gnomon* and in particular to "Curriculum Corner".

Bob is standing down from the Council and from writing articles but will continue to be a member of the Association. I understand that he will be devoting his energies to the ASE in Scotland.

On behalf of all the members I should like to thank Bob for his enthusiastic support of the AAE over this long time span. **Alan Pickwick**, President AAE.

Two important reminders

- Don't forget the two items from the last issue which may need your urgent attention. In November, educators will meet at CERN in Geneva to discuss and see presentations of the best in Physics Education for children of school age. Funding is sufficiently generous to cover transport and accommodation costs! Potential delegates should contact the Institute of Physics Education Department for more information.
Physics on Stage, Institute of Physics, 76 Portland Place, London, W1N 3DH. Tel: (020) 7470 4816. Fax: (020) 7470 4848.
- An open seminar, "Astronomy research projects for school and university students" will be held on August 18 at Manchester University, cost £10.

Key Stage 3 details on www

The Key Stage 3 schemes of work for science have been published on the Standards site:
💻 http://www.standards.dfee.gov.uk and they can be downloaded as pdf or MS Word files. The two documents most relevant to Astronomy are Unit 7L The Solar System and beyond and Unit 9J, Gravity and space. There is also a reference to Unit 21 in the History scheme of work - from Aristotle to the atom.

Space School UK 2000

The residential five-day course held twice a year at the University of Leicester will be held from July 30 to August 3, during the 2000 summer vacation.

Ten years ago Space School UK was founded to promote, educate and introduce teenagers from 14 to 19 years old into the world of the space age industry. Students are given an insight into the past and present exploration of our universe, and the industries and engineering that are involved in achieving the spectacular advances in space.

They may go much further! In the first course this year one of the follow-up activities involved writing an essay on one of the lectures. Fourteen students participated, and as a result Thomas Ormston and Estelle Tidey were invited to represent the UK at the International Space Camp held at the US Space & Rocket Centre Huntsville Alabama from July 28 to August 5. At the next course in July, Caleb Civyer will be joining as the winner of the Michael Harrison Space Essay Contest organised by the Space Education Council. The course includes topics such as satellite communications, manned space projects, rocketry and propulsion, the Solar System, travel to the stars (would you believe?), extraterrestrial life and space life science.

With opportunities to meet scientists and academics, and, not least, to sample life at a British university, Space School UK takes students from around the globe. The subsidised cost of the course is only £199 per head, including full board and materials for the course. Applications must be in by July 15.

For more information contact Head of Space School UK Jean Collins on (+44) (0)116 2522675, or visit web site
💻 http://www.star.le.ac.uk/scienceschool/

Spot more gaffes

In the last issue, readers were invited to spot the flaws in a photo and caption from a book of about 20 years ago. This excited a high quality responses from many readers.

The most important three clangers were:

- the photo was reproduced as a mirror image (reversed left to right, look at the Pleiades)
- Mars would appear as a star-like dot on any photograph taken, like this one obviously was, without telescopic enlargement. This is probably the Moon
- the date and time (which are also expressed in a peculiar way in the caption) are also wrong. Some rapid calculations will show that neither the Moon nor Mars were in the vicinity. The only Solar System body anywhere near at that time was Jupiter. This was in Taurus, but well outside the area of this photograph.

Thank you to all who sent me their answers. Nearly everyone scored three out of three, so pats on backs all round. And John Thompson can rest assured that his copy of *Redshift 3* is working properly. Such little puzzles obviously inspire people to think more critically about what they see. It inspired Mike Dworetsky to send another example, which can be used as a challenge for this issue – as well as setting Mike on the lucrative path to writing lurid fiction! Send your e.mailed answers to me please, *not Mike.*

Mike writes: from time to time, authors of popular fiction try to inject some astronomy into their plots, presumably as a means of enhancing the dramatic context. But in so doing, many authors get the astronomy completely wrong and have the opposite effect. Verisimilitude is not served in a bodice-

ripper with phrases along the lines of: "At midnight, the church clock struck 12, a huge full moon rose, and Wilbur, his heart beating wildly, knew his love would soon be there".

Here is an example from a recent novel about clandestine submarine warfare. See if you can spot the mistake. The story is set in the near future, and is about American efforts to prevent China acquiring Russian `Kilo Class' diesel/ electric submarines because they are so quiet that they could upset the balance of power in the Pacific. In one scene, the American hunter-killer submarine commander is spending a summer weekend at the end of July with his family at their home on Cape Cod, Massachusetts. It has been a wonderful Sunday, and as dusk falls the family lights the barbecue and he tells his wife that he will be off on another mission. There is an emotional scene, then: "In the far distance, the almost-full moon began to rise coldly over the boatsheds by the Osterville town bridge. And very soon, on this clear night, there would also rise out over the Atlantic one of the brightest constellations in the heavens . . . that of Orion himself. The other hunter." *Patrick Robinson,* Kilo Class *(Century, London. 1998).*

Please send me any samples of bad astronomy in text, or images in any other forms of art. Don't bother with stars inside the horns of the crescent Moon, or frames from movies showing the Moon rising over the village as Wilbur waits (Mike's book is an epic movie already!) and the Moon is clearly a photograph taken from space, or is a mirror image! There are too many such examples – Ed

For Your Library

Majestic Universe. Serge Brunier. Translated by Storm Dunlop. Cambridge University Press. 216pp. ISBN 0 521 66307 5; £25.00
This beautiful book concentrates almost entirely on astronomy on a galactic scale and on modern cosmology and cosmogony. These are not the easiest of topics to illustrate, but this book succeeds. It is physically big, as suits its scope, and the quantity, size and quality of the illustrations, not to mention their topicality, are just stunning.

Some of the latest pictures (as far as can be achieved in a printed book these days in competition with the internet!) from the Hubble space telescope, and from recent work on the world's most advanced telescopes is included. So are some of the most challenging ideas of modern cosmology are tackled more objectively than often happens in publications these days (no pretence that nearly all the problems have been sorted out).

The full range of illustrations, and their evident importance in the author's presentation are Some of the pictures that have been achieved showing gravitational lenses are worth buying the book for alone. Arcs and Einstein Crosses and Rings, perfect examples of how the theoretical predictions of the master are one by one coming to pass. The sample on page 1 of this issue is a small part of a large illustration in colour showing multiple arcs produced by a massive cluster of galaxies in Draco, produced by the resulting curvature of space that distorts the images of even more distant galaxies behind the massive cluster. Some of the light, such as this now being detected from Earth, is close to the observable limits of the universe. From the most profound considerations of the nature, size and fate of the universe, Brunier returns to Earth with a bump to review the development of technology in telescopy and space hardware, and to consider "where do we go from here?"

In complete contrast with its modernity, the book's appendices contain the most comprehensive list of star *names* that I have seen for a long time. Considering the joyless catalogue numbers to which most of them are reduced these days, it is wonderful to see Vindemiatrix, Kornephoros and Kaffaljidhmah in a very modern book. So how did HR 4140 get on the list?

Did I forget the large print? With pages measuring 250 by 355mm it is a joy to have print that is clear and as large as in Gnomon! Considering also the price of many books these days, this one is very reasonable. This is a valuable addition to any library.

Richard Knox

One Universe Neil de Grasse Tyson, Charles Liu, and Robert Irion. Joseph Henry Press - ISBN 0-309-06388-0
Although this has the large format common to coffee table books, it is a serious and valuable contribution to the literature. It aims to give a lay person a better understanding of modern theories concerning the universe.

The introduction tells of stars and galaxies and tries to portray the immensity of space. The main content has four sections, dealing in turn with motion, matter, energy, and "frontiers" (the limits of motion, matter and energy). The "motion" section shows how everything is in motion, from atomic particles, planets, our Sun, our galaxy, and all the galaxies taking part in the general expansion of space.

"Matter" explains the stuff of the universe, hydrogen, the most abundant element, and how it is used as fuel in the stars, being slowly converted into helium and heavier elements by the nuclear reactions that power the enormous output of light and heat energy of the stars. These heavier elements are spread across the universe when a star explodes as a supernova, and become part of the dust and gas cloud pulled into the gravity field of other stars.

"Energy" tells of how the universe is powered, how potential energy changes to kinetic energy; how energy has many forms, light, heat, electrical, magnetic, mechanical, and so on.

The final part, "Frontiers", asks whether matter plus energy equals life. It asks where and how the universe came into being, expounds "string theory", the "steady state theories" and the "big bang theory", and finally the postulated ends of the universe. Although I have reservations about the "big bang", (and even the authors call it a bizarre theory) it is obvious that the authors firmly believe it is how the universe came into being.

The book is published in America, so there are some terms with which English readers may not be comfortable, such as "a bowl of Jell-O", and "a space as large as the interior of the Louisiana Superdome" and others. But the text makes sure such terms are easily understood.

The book is very well presented, being profusely illustrated throughout with reproductions of deep sky pictures from the Hubble Space Telescope and others, and numerous diagrams. There is a short chronology of advances in cosmology, with portraits of the astronomers concerned.

Altogether a good read and highly recommended!

Cliff Shuttlewood

Curriculum Corner

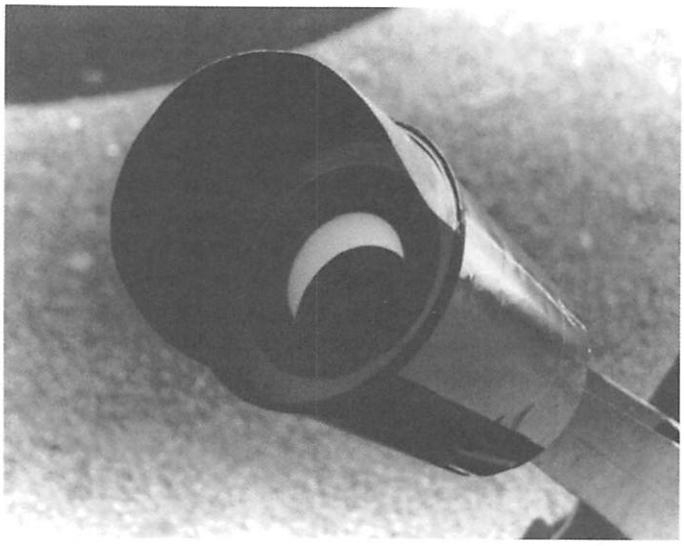
The Sun in a flower pot

At the BAA Exhibition meeting of 1999 June 26 a "Plant Pot" solar projector was exhibited by one of the participating societies, I had heard of this method of solar projection but had not at that time seriously considered the construction of one.

On seeing this model it was clear that such an instrument would be very useful for demonstrations to school children and other groups of young people. This proved to be so, and indeed, surprisingly to me, people of all ages were very interested to see the image of the Sun it produced, including the members of the Leicester Astronomical Society.

During the 1999 August 11 eclipse it was used very successfully to show the progress of the Moon over the disc of the Sun to the 93% partial phase viewed around Leicester.

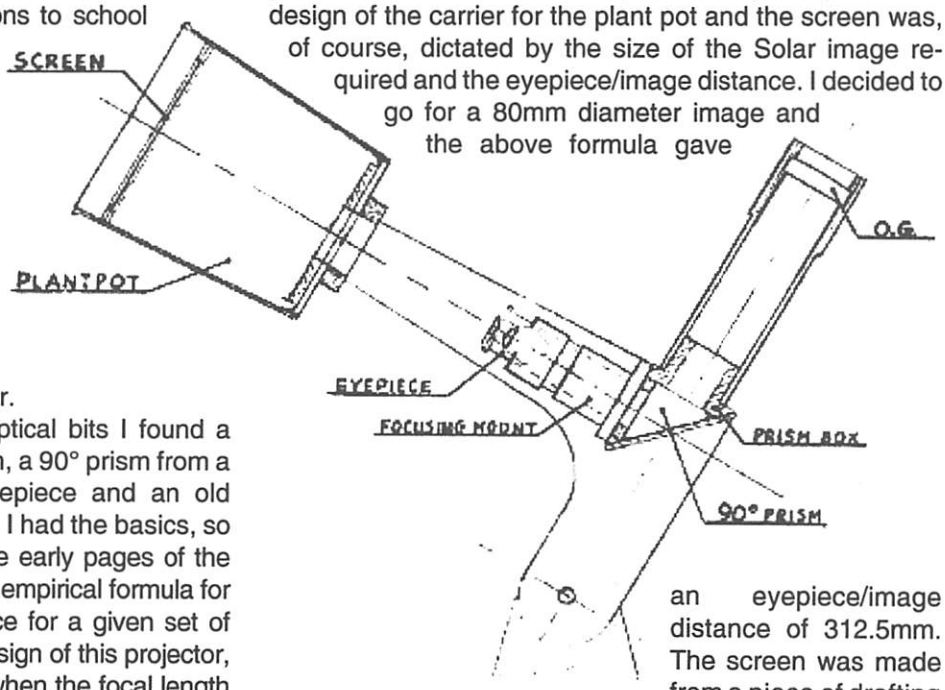
Searching through my remaining optical bits I found a 60mm objective of 320mm focal length, a 90° prism from a Porro pair, a 12.5mm Ramsden eyepiece and an old RAS-threaded helical focusing mount. I had the basics, so now I could get down to design. In the early pages of the Solar Astronomy Handbook there is an empirical formula for calculating the eyepiece/image distance for a given set of optics. This formula was used in the design of this projector, but note that the formula applies only when the focal length of the eyepiece is very much less than the distance between the eyepiece and the screen.



The partially eclipsed Sun of 1999 August 11 seen in the plant pot solar projector. Note the shade which enhances the image contrast and directs the eyes away from the axis of the optical train.

The design of this compact little instrument was quite easy. I used a piece of plastic tube from a redundant vacuum cleaner for the objective-mounting tube, with a thin rubber packing ring to make a snug, but not tight, fit for the lens. It was retained by a further plastic split ring. I have the advantage of owning a wood-turning lathe, and so was able to turn part of the prism box to fit into the end of the objective tube. The block was then cut to 45° and slotted out to house the 90° prism. The prism was held in place by packing blocks and with a retaining plate screw fixed to the 45° face of the prism box.

The helical focusing mount was modified to take the Ramsden eyepiece by fitting a plastic liner (actually a coupler for electrical conduit plastic tube) and fitted to the prism box. So I now had the optical set-up complete. The design of the carrier for the plant pot and the screen was, of course, dictated by the size of the Solar image required and the eyepiece/image distance. I decided to go for a 80mm diameter image and the above formula gave



an eyepiece/image distance of 312.5mm. The screen was made from a piece of drafting film, as used in many drawing offices now instead of paper. I had a small sheet of this left over from my design office days (so long ago !!). It was mounted between two cardboard rings to hold it flat and rigid, with a diameter chosen to fit neatly about 20mm inside the mouth of the plant pot.

The plant pot I used has a depth of 180mm and the diameter at the mouth is 152mm. Wooden discs, with 32mm diameter central holes, were fitted each side of the base. The hole in the pot's plastic base had to be increased to give clear passage for the projected image. The block outside the pot has flats to which the extended arms from the prism box were attached. The length of these arms is such that the eyepiece/image distance is automatically set.

The screen assembly was glued into place on three equally spaced distance pieces glued around the inside of the plant pot. This completed the assembly. All that remained was to see if it worked! The opportunity

Empirical formula for estimating eyepiece to screen distance

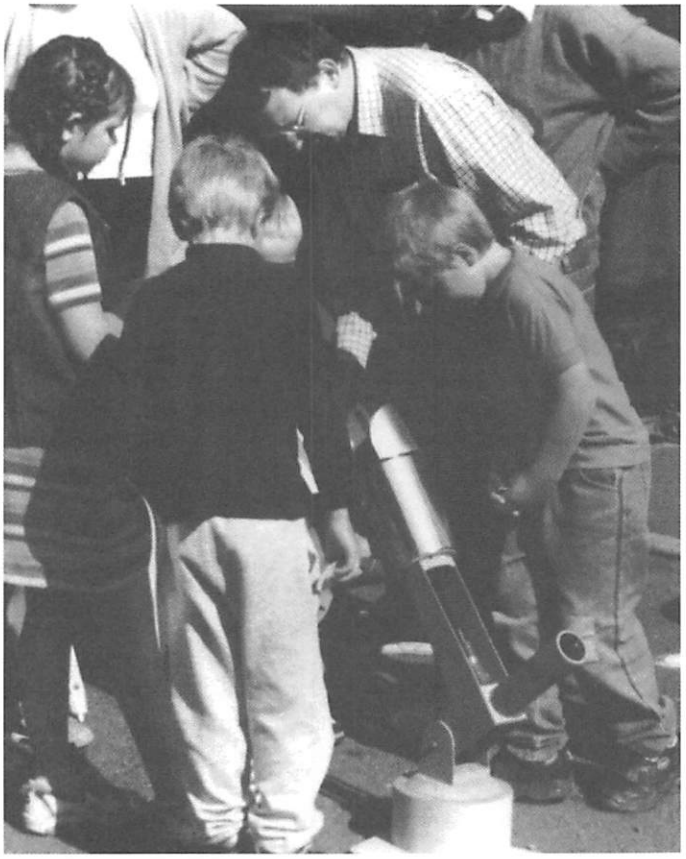
Note: the formula given here is suitable only when $f_{EP} << A$

$$A = \frac{B_1 \times f_{EP}}{B_0}$$

Where A = eyepiece to screen distance
B_0 = focal length of objective X 0.01
B_1 = diameter of solar image
f_{EP} = focal length of eyepiece

In the author's instrument, B_1 = 80mm, f_{EP} = 12.5mm and B_0 = 320mm.

$$A = \frac{80 \times 12.5}{320 \times 0.01} = 312.5\text{mm}$$



A fascinated young audience watches the partial phase of the eclipse in the flower pot projector

came at a public exhibition where the Society had various instruments on display as part of the science exhibit. The Sun made a brief appearance during the afternoon on that day, and I was pleased (and relieved) to see the calculated size image, complete with sunspots, appear on the screen.

The shade was added because the best view of the projected image is slightly from the side. If you look directly in line with the optical train all you see is a bright patch with no detail because you are looking directly at the Sun through the optical train, with only the screen between. So beware, and view from the side.

The device is very useful and well worth the time and effort put into construction. The photographs show the device in action, showing the partially eclipsed Sun on 1999 August 11th, and a general view of the completed projector.

Cliff Shuttlewood

The Solar System is like - a fried egg!

Children often have difficulty in imagining the form of the Solar System. The following activity certainly has impact and makes a lasting impression.

Ask the students their ideas about the shape of the Solar System. What is in its centre, and what circles around that centre? Tell them that the Solar System may be thought of as a fried or poached egg. That should cause some amusement! Take a frying pan and break an egg into its centre. Fry (or poach) until hard.

Ask the class "What does the yolk represent?" (The Sun). "What does the white represent?" (The orbit of the planets). With a felt-tipped pen the orbits of some of the planets can be drawn around the yolk on the solid white. (Don't try to do this to scale!!)

Now hold the bottom of the frying pan tilted at the angle approximately equal to your latitude. This represents the view of the Solar System and the position of the sun and the planets from your place. You can then decide what to do with the egg, whether it needs salt and pepper and so on, when your demo is over!

Eric Jackson

THE THINGS PEOPLE ASK!

What is the nearest star to the Sun and how far is it?
(David, a beginner amateur astronomer, asks)

For an up to date answer to this we can use highly accurate data from the Hipparcos satellite. You can learn more about Hipparcos and its mission to measure the motions and positions of stars with high accuracy by visiting website:

http://astro.estec.esa.nl/Hipparcos/site-guide.html

The nearest star to the Sun is a faint red dwarf called Proxima Centauri, an 11th magnitude object in the southern sky (at magnitude 11 this star is about 15 times fainter than the planet Neptune appears to be in our sky). The distance to Proxima, according to the Hipparcos parallax measurements, is 4.22 light years. Parallax is the tiny apparent annual shift in a star's position in the sky, against distant background stars, caused by our changing viewpoint as the Earth orbits around the Sun. It is very difficult to measure the parallax of stars because they are so far away. Even Proxima's parallax is less than one second of arc. A second of arc is 1/3600 of a degree, which is the apparent size of a £1 coin at a distance of 4.5km! You can see why special instruments are needed to make such precise measurements.

About two degrees away from Proxima is the bright double star Alpha Centauri (the third brightest star in the night sky, but also invisible from British latitudes), which is also called Rigil Kentaurus ("Foot of the Centaur"). This consists of two stars, one very similar to the Sun, and a somewhat fainter and cooler companion, orbiting around each other with a period of 79.92 years. This pair of stars is at a distance of 4.40 light years.

It was thought that Proxima was in a very slow orbit around Alpha Centauri. But astronomers now think that Proxima and Alpha are moving through space in nearly the same direction and with nearly the same speed. They are quite close to one another in space but the speeds and directions are sufficiently different that we are probably seeing simply a close passage of one star past the other, rather than an orbit. They probably belong to a group of stars, all moving in roughly the same direction in space.

The next nearest star after Alpha Centauri is called Barnard's Star, 5.94 light years away from us. It is a faint 9.5 magnitude star in the constellation Cygnus.

Query

Does the universe now appear to be expanding forever and its ultimate fate the "heat death" when every star has lived its life cycle? Will there be, or *appear* to be, a total nothingness?

☞ 5

Are galaxies rushing away from each other, or is it the expansion of space that is separating them increasingly? I thought that all galaxies, clusters and superclusters were being drawn towards a massive great attractor. Can you clarify please. *(Bob Smith asked these questions)*
In essence, this is a correct summary of very long-term predictions based on current understanding of cosmology and the origin and evolution of the universe. Current estimates of the age of the Universe are around 12-14 billion years. At present, we are still in the phase of the universe when galaxies and stars have formed and are still forming. But the end result of the evolution of every star is either a white dwarf or a neutron star (or stellar-mass black hole). Eventually (after a long time - much longer than the present age of the universe) there will no longer be enough free gas or dust to make contracting clouds and form stars.

Over another very long time, the galaxies will slowly radiate away their gravitational energy, with the dead remnants slowly spiralling together. Eventually, each one will be a gigantic black hole. Entire clusters of galaxies will coalesce to form super black holes. This will take an unimaginably long time, say a billion billion times the current age of the universe.

So it will never become a "nothingness", but it will get awfully thinned out. The universe will continue to expand forever (according to the best available data) at a rate that will slowly diminish but never quite stop. Eventually, the black holes will radiate subatomic particles *(Hawking radiation)* but the time that will have to pass before any significant amount of particles are emitted is unimaginably long.

Distant galaxies appear to be rushing away because their spectral lines are red-shifted by the expansion of the Universe, but they are being carried along by the expansion of space itself. It now appears, intriguingly, that there may actually be a "repulsion" force in the form of a "non-zero cosmological constant" that helps to drive the expansion (much smaller than gravity, by the way - we could never detect it directly). But the matter is still being debated and tested.

The so-called "Great Attractor" appears to be a large and massive supercluster of galaxies) is a locally dense spot in the universe, towards which our own galaxy and the other galaxies in our local corner of the universe appear to be moving. But this is a local effect, not something that applies to the entire universe. The difficulty in locating and measuring the actual cluster of galaxies that forms the Great Attractor was (as I understand it) due to it being in a direction which is hidden behind dust clouds in our own Milky Way Galaxy. **Query**

I am trying to find the name of the 'Point' which is any one of the points between the earth and the moon at which a small third body can maintain an orbit *(wrote Andrew Stevens).*
They are called *Lagrangian points*. These are places in the vicinity of two orbiting bodies where total acceleration due to gravitation and centrifugal acceleration add up to zero. If you have a small satellite at one of these points, it will remain there. In practice, perturbations from other bodies may make the points quasi-stable instead of truly stable, so a spacecraft might still need to do station-keeping rocket firings.

Three of the points are co-linear along the axis joining the two main bodies (e.g. Earth-Sun): L1 just outside Earth's orbit, L2 just inside Earth's orbit, and L3 on the far side of the Sun (possibly inside the Sun!). The Soho Spacecraft is at L2; the proposed location of the Next Generation Space Telescope is at L1.

There are two other Lagrangian points are, for an orbiting planet in a nearly circular orbit, 60° ahead of and behind the planet, L4 and L5. The Trojan asteroids are located near the Lagrangian L4 and L5 points of Jupiter's orbit. The Earth-Moon system would have analogous points, but possibly only the L1 and L2 points would be stable. It is possible that the eccentricity of the Moon's orbit combined with solar perturbations means that these points are not really stable, but I don't know whether this is the case. I don't think the Moon's L4 and L5 points are stable but I know that investigations to search for small objects at these locations have been carried out (without much success!). **Query**

Ask an Astronomer

The Things People Ask!" is selected from the many questions received, and answers given by the Association of Astronomy Education's "Ask and Astronomer" Service conducted by Dr. Mike Dworetsky, University College, London. *Query* reminds senders of e.mail that plain text format is preferred, not Microsoft Word documents which can transmit computer viruses. The service is available to members of the AAE by e.mail:
query@ulo.ucl.ac.uk, or via the AAE home page:
http://www.star.ucl.ac.uk/~aae/aaehomep.htm.

I would like some information about Caroline Herschel, for a school project. She lived from 1750 till 1845. At the time she discovered eight comets, and she assisted her brother William Herschel. In 1828 she was awarded a gold medal from the Royal Astronomical Society. *(From Astrid Swinkels)*
Caroline Lucretia Herschel was the younger sister of the eminent Hanoverian astronomer Sir William Herschel, who moved to England as a young man. Caroline was not officially a full member of any society (except possibly the Royal Irish Academy) because at the time women were not permitted to be members of scientific societies. She was made an honorary fellow of the Royal Society and a member of the Royal Irish Academy.

Caroline's observational and telescope-making work was carried out mainly with William, at their house in Bath. Later they moved to Datchet and Slough, west of London, to be near Windsor Castle following William's appointment as the King's Astronomer). Here, they constructed and worked with large telescopes at Observatory House. The house and telescope are no longer there.

There are several sources of biography on the Internet; a search on "caroline herschel" turned up the following:

http://starchild.gsfc.nasa.gov/docs/StarChild/whos_who_level2/herschel.html
http://cannon.sfsu.edu/~gmarcy/cswa/history/herschel.html
http://www.agnesscott.edu/lriddle/women/herschel.htm*
http://www-groups.dcs.st-and.ac.uk/~history/Mathematicians/Herschel_Caroline.html

The last one these four was better researched than the others. **Query**

* This one has an error: William Herschel discovered Uranus with one of his smaller telescopes, a 6in reflector of length 7.1ft [3.35m] which he built himself. He did not discover the planet with his 20ft telescope.

LETTER FROM DOWN UNDER

G'day! I am typing this letter while observing at the "Grand Old Lady" of Australian astronomy, the Parkes Radio Telescope. Nestled amongst farmland in the Goobang Valley, this 64 metre (210 ft) antenna has been at work scanning the southern sky for almost 40 years, as well as playing a major role in NASA's Apollo, Voyager, and Galileo missions. It has also participated in "Project Phoenix", the search for extra-terrestrial intelligence run by the SETI Institute in California.

Since February 1997, a team of about 30 astronomers from Australia and the UK has been carrying out one of the last great surveys still to be done in astronomy - a map of every single cloud of neutral hydrogen in the southern sky out to a distance of 500 million light years.

Most of these clouds of hydrogen are associated with known spiral galaxies, including our own Milky Way, but astronomers have long suspected that there may be enormous concentrations of gas out there with no optically visible counterpart. Such "invisible" gas clouds may be the building blocks from which galaxies formed, and may also help solve the "dark matter" problem.

A thorough search of the entire southern sky for hydrogen gas had never before been attempted, since even if the telescope was used 24 hours a day, 7 days a week, it would require in excess of 10 years to complete with the existing receiver system! Enter the "Parkes Multibeam Receiver", an array of 13 individual receivers clustered together. When mounted in the focus cabin high above the dish surface, the Multibeam allows observers to "comb" the sky at a much faster rate than before, making possible surveys such as:

- an all-sky search for neutral hydrogen, using the Parkes Multibeam in the south, and a similar system on the Lovell telescope at Jodrell Bank to cover the northern sky;
- a search for hydrogen in galaxies which lie forever hidden from optical view by the plane of our Galaxy (the so-called *zone of avoidance*);
- the deepest search yet for pulsars in our Galaxy, which has already lifted the number of known pulsars to more than 1000.

Already, the surveys for neutral hydrogen (in which I have been involved) has gone some way towards helping us understand our nearest galactic neighbours, the Large and Small Magellanic Clouds. A quarter of a century ago, using the Parkes telescope, Don Mathewson and Martha Cleary discovered a "stream" of hydrogen gas running between the two Magellanic Clouds in a great arc. Two theories have been proposed to explain this "Magellanic Stream" - either the gas was pulled from the Clouds themselves by the gravitaional pull of our own Galaxy, or else it has been stripped out during numerous passages of the Clouds through the denser gas of our Galaxy.

If the Stream was due to the tidal forces of our Galaxy, then there ought to be a "leading arm" of gas stretching away from the Clouds, but none had been seen. That is, until a PhD student named Mary Putman sat down and examined the first "shallow" Multibeam survey of the southern sky, and noticed a continuous ridge of gas running in precisely the direction expected of a leading arm. So thanks to the Parkes Multibeam, we now know that our Galaxy is guilty of "harrassing" the Magellanic Clouds!

In an era when most new radio telescopes under construction are made up of arrays of smaller dishes linked together to synthesise a much larger telescope, the advent of the Parkes Multibeam (and the nearly-completed Green Bank Telescope) makes it clear that the age of the large, single-dish radio telescope is far from over. Surveys like those being carried out at Parkes are crucial to completing the census of our local Universe, and showing us what mysterious objects lurk right here in our own backyard.

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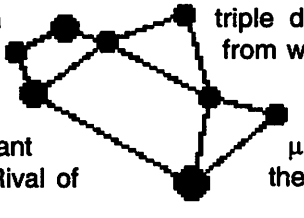
SKY DIARY SUMMER 2000

The sky chart shows a larger area than usual (in these pages) looking south at two hours before midnight in the middle of the summer quarter from a position "somewhere in the middle of England". Partly this is to show the positions of Pluto, Uranus and Neptune again, and the constellations of Scorpius and Sagittarius, which got quite a bit of coverage in the last issue.

Among the e.mails with which I was deluged since the last issue, well I had at least one, which referred to my comment on my imagination of the Sagittarius "teapot". The constellation is the most southerly of the zodiacal groups, and so is at opposition to the Sun at the northern summer solstice when astronomical twilight lasts all night. But it can be seen earlier in the evenings later in the quarter when the twilight is fading at a reasonable hour, or in the early hours of the morning in the spring quarter. The same applies to Scorpius, which is really not much better since most of the Scorpion is to the south of the ecliptic, and the ecliptic passes through more of Ophiuchus than the zodiacal constellation.

The Scorpion is easy to spot: the bright red giant star Antares (a name of Greek origin meaning "Rival of Mars") marks the heart of the beast, and has sometimes been called Cor Scorpii, and is unmistakable. From Antares, the Scorpion's claws appear to radiate (so I'm ignoring the normal Scorpion anatomy!) and the body curls away below the horizon.

Sagittarius, on the other hand, needs a closer look to identify with certainty. The "teapot" is copied into the small diagram (below). The alternative characteristic pattern is the upside down "dipper", the Plough shorn of one star, very much smaller and inverted (right). All but one of the stars are in the lid of the teapot!



When you have gone to the trouble of identifying the constellation, then it is worth looking for the many points of interest in this region. This is the home of the famous Triffid nebula, M20, a fine sight in a wide field, where the star cluster M21 may be found in the same view. The triple division of the nebula from which it gets its name is difficult to make out, as the object is so low in the sky from British latitudes. Find it from μ Sag. the magnitude 4 star marking the end of the handle of the inverted

Approx. rising and setting times: lat. 52N; long 3W						
	July 15		August 15		September 15	
	Rise	Set	Rise	Set	Rise	Set
Sun	04h 10m	20h 24m	04h 56m	19h 34m	05h 47m	18h 26m
Mercury	03h 39m	19h 05m	04h 08m	19h 30m	07h 37m	18h 15m
Venus	04h 57m	20h 57m	06h 35m	20h 15m	08h 14m	19h 11m
Mars	03h 45m	20h 16m	03h 25m	19h 10m	03h 27m	17h 50m
Jupiter	00h 49m	16h 35m	23h 02m	15h 00m	21h 10m	13h 13m
Saturn	00h 44m	16h 02m	22h 49m	14h 11m	20h 49m	12h 13m
Uranus	21h 28m	06h 49m	19h 24m	04h 04m	17h 20m	02h 32m
Neptune	20h 48m	05h 32m	18h 44m	03h 25m	16h 41m	01h 20m

dipper. From this star move 2° south and 2½° west.

From M20, you can then move another 1½° south and a mere ¼° east and you will find the Lagoon Nebula, M8, which is a great binocular object as well as a superb rich-field telescope object. The cluster NGC 6530 is embedded in the glowing gas of the nebula.

About 5° west of γ Sag., the star marking the point of the teapot's spout, is the Galactic Centre, with M6 and M7, both galactic clusters, but these are situated too far south in British skies to be worth much trouble in finding.

More rewarding is M17, the Omega (or Horseshoe) Nebula, which also might have been called the "Swan" or the "figure 3" nebula, as it resembles these in telescopes of increasing light grasp. It is well to the north of the other objects mentioned, being closer to the faint "dunce's cap" triangle of Scutum (most stars of which are too faint to appear on the chart). Scutum points south along the Milky Way between Altair (the southern point of the Summer Triangle, just left of centre in the chart) and Sagittarius. From the south point of Scutum (γ Scu.) move 1½° south and 2° west, or from μ Sag. move 5° north and 2° east. There are many more clusters and nebulae in Sagittarius and southern Ophiuchus, making the whole area well worth while browsing with a telescope or binoculars.

If you are lucky enough to have access to a 250mm aperture telescope or larger, this quarter provides a fair opportunity for trying to spot Pluto. The planet (if it can be graced with such a name) is close to the star ζ Ophiuchi as shown in the main chart. On August 15 (not a good night, with a Full Moon close by) it is about 1° southeast of the star. Three stars of about magnitude 7 may be found in a fan south east of ζ and vaguely resembling the claws of Scorpius upside down. The most northern star of these three is SAO 160057, and it is just over 1° east and ½° south of ζ. Pluto will be almost at its western stationary point following its regression during the year since mid-March, and *may* be idenfiable from the mass of similar magnitude stars in this region by careful sketching of the star field on successive nights. On August 15 it will be almost ½° west of SAO 160057.

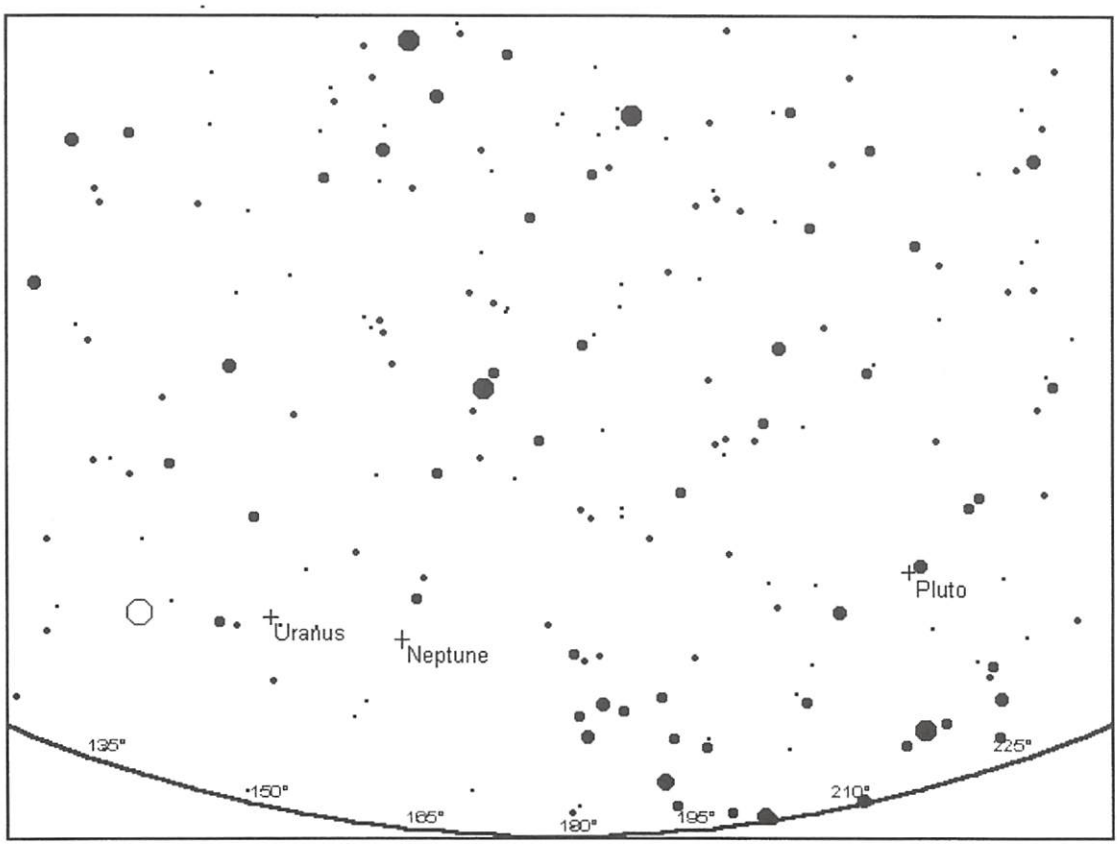
Uranus and Neptune continue their slow progress through Capricornus, Uranus closely northeast of ι Cap. (seen within the U of the planet's name on the chart). Neptune will be approximately on the line through α and β Cap. Extended south by some 4° below β.

This quarter includes the second eclipse period of the (unusual) three this year. But alas you will not see the lunar eclipse of July 16, nor the partial solar eclipses that precede and follow, on July 1 and

Moon phases for the third quarter of 2000				
Month	New Moon	First Quarter	Full Moon	Last Quarter
July	1 & 31	8	16	24
August	29	7	15	22
September	27	5	13	21

southern latitudes respectively. During July Jupiter and Saturn will reappear, this time in the morning sky with Jupiter furthest east. By the end of September the pair will be in Taurus, Saturn rising some 20 minutes before Jupiter. "Naked eye" photo opportunities for the three months include the pair of giant planets equidistant from the Pleiades in the morning sky of July 18 and both near the Moon and Aldebaran on September 18. Venus and the very young Moon will be in the evening sky soon after sunset on August 30 and together again, with Mercury also close by very low in the southwest on September 28. The Perseid meteors, which are due to reach maximum on August 12, will be largely spoiled by the bright Moon.

Richard Knox



Looking south on 2000 August 15, about two hours before midnight