Gnomon

Newsletter of the Association of Astronomy Education

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GCSE Astronomy – another milestone passed!

This summer's cohort of students taking Edexcel's GCSE Astronomy examination represented the passing of another important milestone in the development of the qualification.

For the first time since the introduction of the GCSE in the late 1980s, over one thousand candidates sat the GCSE examination in Astronomy. This represents an acceleration in the healthy rise in numbers since the start of the millennium and shows every sign of continuing in the coming years.

This summer's largest ever cohort of GCSE Astronomers maintained the high standards of astronomical ability shown in previous years, with over three-quarters of students gaining an A* - C grade. Students' and their teachers' obvious enjoyment of the subject was once again evidenced by the coursework portfolios of observational, graphical/computational and constructional work.

As in previous years, a significant number of students had clearly been motivated to put in time and effort beyond the requirements of the qualification. This suggests that for many, the GCSE may be the start of a lifelong interest in astronomy.

As well as an increase in total numbers entering for the GCSE Astronomy qualification, there would also appear to be a gradual shift in the composition of the student cohort taking the subject.

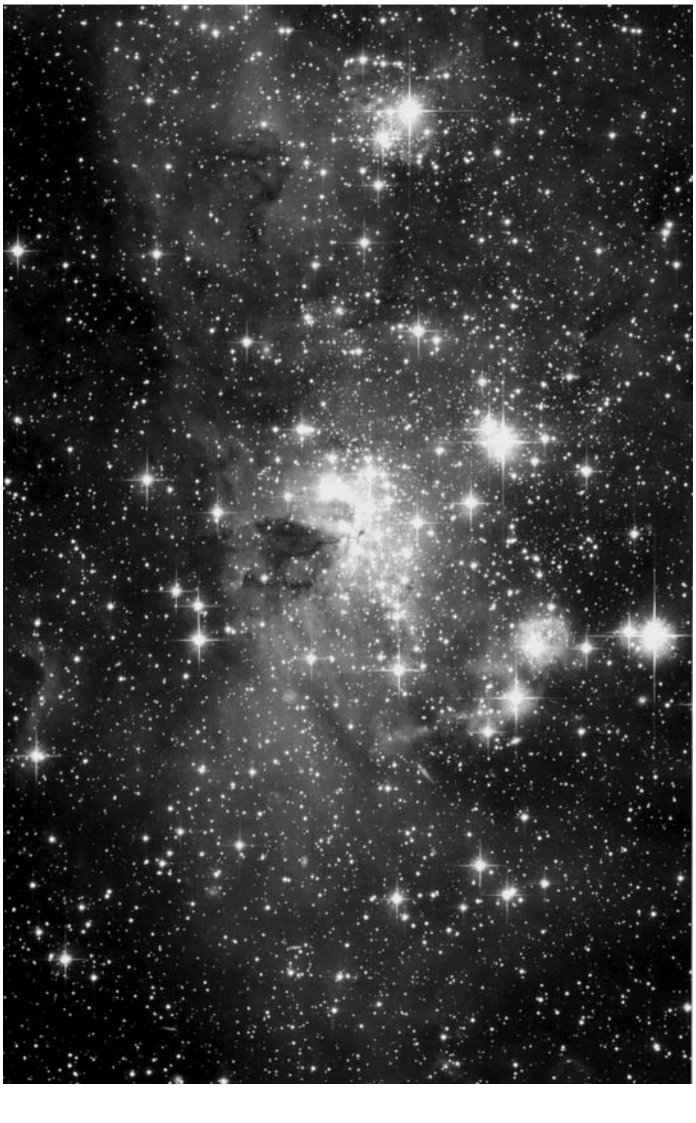
Although originally a qualification taken mostly by adults and sixth form students (years 12 and 13) the past few years have seen a steady rise in the number of secondary schools beginning to run the course as a GCSE option for Key Stage 4 students (years 10 and 11) or even as an 'early start' GCSE course for year 9 students.

For many schools this provides a popular component within a Science Specialist School or Gifted and Talented provision. Recent changes ☞

Stars cohabit happily

One of the latest (mid-August) photos from the Hubble Space Telescope, presented at the 2006 General Assembly of the International Astronomical Union in Prague shows a star forming region in the Large Magellanic Cloud. This beautiful image reveals a large number of low-mass infant stars coexisting with young massive stars in one of the hundreds of star-forming stellar systems, called "stellar associations", located 180,000 light-years away in the Large Magellanic Cloud. Earlier ground-based observations of such systems had allowed astronomers to study only the bright blue giant stars in these systems, and not the low-mass stars. This new view of the association known as LH 95 was taken with Hubble's Advanced Camera for Surveys allows a more accurate calculation of the stellar ages and masses. The Large Magellanic Cloud has relatively small amounts of elements heavier than hydrogen, giving an insight into star-formation in environments different from the Milky Way. Once stars have formed with a mass of more than about three times that of the Sun, they generate strong stellar winds and high levels of ultraviolet radiation that ionise the surrounding interstellar gas. The result is a nebula of glowing hydrogen that will expand out into the molecular cloud that originally collapsed to form these stars. The blue haze seen throughout the image around LH 95 is actually part of this bright nebula, known as DEM L 252. Some dense parts of this star-forming region have not been completely eroded by the stellar winds and can still be seen as dark dusty filaments. Such dust lanes absorb parts of the blue light from the stars behind them, making them appear redder. Other parts of the molecular cloud have already contracted to turn into glowing groups of infant stars, the fainter of which have a high tendency to cluster. There are at least two small compact clusters associated with such groups, one to the right, below the centre of the picture and one at the top, containing hundreds of infant low-mass stars. Such stars have also been found in the main part of LH 95 amongst its massive bright stellar members.

(Photo: NASA, ESA and D.A. Gouliermis)



☞ to the structure of GCSE Science at Key Stage 4 look set to increase the flexibility available to schools to offer Astronomy alongside GCSEs in Biology, Chemistry and Physics.

If this opportunity continues to be taken up, it may not be long before we pass our next milestone of over 2000 entries for GCSE Astronomy!

Julien King
Principal Moderator for GCSE Astronomy
Edexcel Examinations

A plea to Tony Benn

Bob Mizon some time ago wrote a letter to Tony Benn about an issue that will be familiar to most Gnomon readers: it certainly struck a chord with me! Bob has kindly invited me to include his letter in this issue. Ed.

Dear Mr Benn, I believe you may share my concerns about the over-bureaucratisation of the Adult Education system. I have been teaching both French and astronomy to people of all ages since 1970, as a mainstream teacher, a teacher-moderator for three examination boards, a tutor in Adult Education classes for various organisations and authorities, and currently as a travelling planetarium operator, taking a portable star-dome into schools and introducing the wonder and value of the night sky to children all over southern England (68,000 so far).

When I entered teaching, the reliance by employers on teachers' expertise, common sense and concern for pupils' progress was the dynamo which drove the system. If the teachers were not up to the task, their services were dispensed with. Now, in an age when the external image of organisations seems to matter more than the reality of what actually goes on (the "Mission statements" I see in most schools are a good example of this), each step of the teaching/learning process is dogged by paperwork, much of it repetitive and certainly considered by most students to be unnecessary, in my experience.

Should I be spending teaching time asking students to fill in forms about their aims, opinions, experience, among many other things? Do I need to fill out a lesson plan to deliver a talk which I have evolved over 34 years, and be "marked down" to merely "satisfactory" on inspection because I have not done this? Will a risk assessment form make a caring and sensible teacher any more aware of the duty of care?

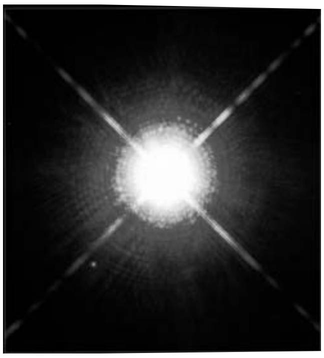
My career as a teacher of astronomy has been a great satisfaction to me over the years, and when an ex-pupil I encounter in the street tells me he is now a professional astrophysicist, I rejoice. When a nine-year-old tells me that my planetarium show is the best thing she has ever done at school, I feel the glow that fires teachers' will to persevere in a demanding profession.

Now, the sad paper-chase which adult education is becoming causes me to feel scrutinised and mistrusted rather than appreciated. I have decided to give up teaching adult classes. I fear that others may be thinking along the same lines.

I have never met *anybody* in this field, teacher, learner or administrator, who has extolled the virtues of such form-filling. I hope that, with your interest in the present and future of adult education, you will convey my concern, which I believe is shared by many, to those who might be able to influence the system. Can adult education survive?

Yours sincerely
Robert E Mizon

Weighing the Pup



Sirius B, the Dog Star's "Pup" has been photographed by the HST. The mass of this white dwarf star (seen at about 8 o'clock from Sirius) has now been determined with greater accuracy. Smaller than the Earth, the Pup has a mass 98% that of our Sun!
(NASA. ESA. Bond and Barstow)

⌨ gnomon_editor@talktalk.net

This is boring to relate, but there has had to be a change in the e.mail address of the editor again. So it is now as given above, and changed in the box below. My apologies to anyone who got an "unobtainable" reply if you used the old address after about the end of August.

Hitch for *Gnomon* contributor

Happy news! (Makes a change!). Our congratulations and best wishes go to our indefatigable correspondent from Down Under, Stuart Ryder, of the Anglo Australian Observatory, and Maria Elena (Marilena) Salvo, also an astronomer (who, therefore, may have to be bullied into sending copy to *Gnomon, as* Stuart will probably go on strike when he sees this photograph!)

They are getting married before the December issue of *Gnomon* is made up.

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

Observations

What a week this has been, what a rare mood I'm in, why it's almost like being involved.

We are now very familiar with policy U-turns happening so often that their frequency can conveniently be measured in kHz. We also now cheerfully ignore most official pronouncements of the blindingly obvious – usually trying to explain the latest U-turn. So it has been quite stimulating when a different bunch, who ought to know better, follow in our leaders' footsteps.

I felt really depressed when it seemed that the opinion I have been voicing to students for many years, namely that Pluto was really too small and badly behaved to be called a "planet", was apparently being officially refuted by the IAU. One might have argued that astronomers did not really need, and so would not give much attention to defining whether a body is called a planet, planetoid, planetesimal, minor planet, Kuiper Belt object, Pluton, Plutino, asteroid (now there's a misnomer if ever there was one, Sir William), damocloid, meteoroid, or just a speck of interplanetary dust! The boundaries between them are very blurred indeed, and could keep future IAU meetings busy for many years to come.

Now, they said, not just Pluto will remain a "planet" but we will add Ceres, Charon, and any others we might find that fit the bill. "Why are these new planets 'planets'?" came the cry. They are round – or so we think for some reason, even though we have not proved it; they orbit only the Sun – except Charon that orbits a barycentre it shares with Pluto; and objects like these will be found round other stars (except that we won't be able to detect them with any technique known to Man unless they are about the size of Jupiter at least).

Then the handbrake U-turn was applied: Pluto was out, along with Charon, Ceres, and Uncle Tom Cobleigh and all the other little guys (I bet you have never heard of the latter little damocloid!) The headlines should have read "*Gnomon* editor vindicated" or at the very least, "Gustav Holst got it right after all"! Can I now challenge the definition of a satellite? The criterion must be that, for the public to really really understand, the definition must not include the word "barycentre" or any of its derivatives.

All that *really* matters is what the public perception of a planet is. This really boils down to what the history books have taught us. After Sir William Herschel called the newly discovered objects that had been named Ceres and Pallas, "asteroids", it has had to be ever thus. If now one of these asteroids, the biggest of which could barely cover mainland Britain, was now to be known as a planet, not even Jean Luc Picard could "make it so" as far as the public's collective memory would be concerned. Why was Ceres alone to be so proudly promoted? Could it have been because it neatly fitted a missing space in the Bode/Titius series? Similarly (and fearlessly shooting down my own opinions expressed to students) Pluto has for 80 odd years been called a "planet", and that's a lifetime or more for most of us.

Both the original pronouncement of the IAU, and its replacement, were therefore most peculiar. They gave rise to some amazingly clever new mnemonics for remembering the redefined planetary family, and thanks for all the wry humour ("Pluto has now been reduced to a Mickey Mouse planet"), but they added nothing to science, on one hand, or to public understanding on the other.

Another outcome gives us something to which we can all look forward: the definition of a planet was needed among other things, it was said, so that when a body was added to the list of thingies discovered orbiting other stars, they could be properly classified. Well, in this quarter's *Sky Diary* there are some suggestions as to how you might find Uranus with the unaided eye over the coming weeks. If you find this difficult, imagine how quickly we are going to find lumps of rock smaller than Uranus' satellites going round stars that we cannot even see as a disc of visually discernible diameter (save one) with the biggest and best telescopes we have. What would Ceres look like at over 4 light years distance? **Richard Knox**

AND NOW FOR SOMETHING COMPLETELY DIFFERENT.

Talking about mnemonics, how about this one by Eric Idle, from *Monty Python's Meaning of Life*?

Just remember that you're standing on a planet that evolving,
and revolving at 900 miles an hour.
It's orbiting at 19 miles a second, so it's reckoned,
the Sun that is the source of all our power.
The Sun and you and me and all the stars that we can see,
are moving at a million miles a day,
in an outer spiral arm, at 40,000 miles an hour,
of a galaxy we call the Milky Way.

Our galaxy itself contains 100 billion stars,
it's 100,000 light years side to side.
It bulges in the middle 16,000 light years thick,
but out by us it's just 3,000 light years wide.
We're 30,000 light years from galactic central point,
we go around every 200 million years,
and our galaxy is only one of millions of billions,
in this amazing and expanding universe.

The universe itself keeps on expanding and expanding
in all of the directions it can whizz.
As fast as it can go, the speed of light you know,
12 million miles a minute and that's the fastest speed there is.
So remember when you're feeling very small and insecure,
how amazingly unlikely is your birth,
and pray that there's intelligent life somewhere up in space,
'cause there's b****r-all down here on Earth!

The things people ask

People ask impossible questions in the simplest way:

Q. *I am really interested to know how did matter or the energy form in the black hole at first place. Mhemet Ozcelik*

A. Dear Mehmet, black holes are concentrations of matter of near infinite density. Matter can acquire this condition when supermassive stars end their lives in colossal explosions. The core of the stars implode and the matter is compressed to those limits, equivalent to compress the entire planet earth to the size of a tennis ball if you can imagine that (I can not). Super massive black holes can also form by piling up together thousands or even millions of stars. This apparently happens at the centre of each galaxy, including our own Milky Way. Gravity is the dominating force, so strong that light itself can not escape from these places, hence their name. Francisco Diego, AAE Query Line

Then there are the practical posers:

Q. *On behalf of the West Wales Astronomy Group, where is the best place (or book) to obtain information on building a Radio Telescope ? We are a small amateur society on a smaller budget, so we would like to avoid anything very advanced or expensive. B rgds, Paul Conti*

A. Dear Paul, Try Google for 'cheap radio telescope'. I did and got for example, this contribution from the address:

💻 **radio.uindy.edu/cheap.htm**

☞

☞ There are many more, I am sure, exactly what you need. Good Luck! Regards, Francisco Diego, AAE Query Line

Query has some extraordinary questions too:

Q. *For my own personal benefit, I have commenced a research project on dark matter. The fact that it is unknown fuelled my interest (not because I have any knowledge in cosmology). I have perused several research papers and now have the simple knowledge that dark matter is the adhesive holding galaxies together. And dark matter "must" exist due to the constant rotational velocity even with increasing distance from the galactic centre. Here is my query: is there tangible proof for the existent of dark matter or is it inferred due to the fact that the force of gravity is deemed the only force at work in orbital patterns? What if another force is holding the galaxies together? Would the search for dark matter be discarded or is there proof for its existent even after omitting gravity from the picture? One more question: What does dark matter have to do with evolution, and if creationism is embraced instead of evolution, how does this effect the need for dark matter in the universe? Thank-you for your time. I hope I did not ask too many questions and I anticipate hearing from you. Sincerely, Derek McDonald.*

A. Dear Derek, It is inferred from keplerian motions due to gravity coming from unseen matter. One thing you can not do is to omit gravity from the picture. The evidence is overwhelming. Nothing to do with creationism, in fact the other way round: creationism has nothing to do with anything. In any case, I would not bring evolution into this. Dark matter is made out of 'exotic' particles, none of the ones that make up the atoms, but they do have mass and hence, gravity. The concept of 'need for dark matter in the universe' is meaningless. Whatever dark matter is, it is there for us to discover. Best regards, Francisco Diego, AAE Query

Q. *So that you know I am not some sort of a crank, I am 75, and have been a company director for in excess of 50 years, I am also a pilot having bought Beagle Aircraft and constructed 37 plane's My flat faces east and I get the morning sun as well seeing the Moon travel from north to south across the sky, most nights it is very clear. On the 20 November 2005 I could clearly see the Moon at 11:00 am but it appeared as a white ball, I could not see the surface as usual. On the face of the Moon at 4:00 about one third from the centre there was a black dot, it was not on the Moon but it was travelling with it, as the Moon moved across the sky so did the dot in the same position until the moon disappeared behind a block across the road. I took a video of this phenomenon and have transferred it to a video tape, it is clearly something travelling with the Moon but what. Is there somebody with better equipment than I have in the London area that can check to see if there is an explanation. Yours sincerely, Michael Collins.*

A. Dear Michael, No idea! It will be useful to see your footage. Please send me a copy. PS. Your name is the same of the commander of Apollo 11. Francisco Diego, AAE

South Tyneside's *Name a Crater* competition

The latest competition for children visiting the South Tyneside College Planetarium was inspired by a recent observation of a meteoroid striking the Moon and forming a new crater, writes Eva Hans. Such impacts happen frequently, but most of the incoming objects are quite small and make craters usually only a few centimetres up to, as in this case, a few metres across. The interesting thing about this one is that it was observed, which is unusual. Most meteoroids strike at the Moon when no one is looking! It was explained that lunar craters are named in honour of famous scientist, philosophers, mathematicians, etc.

The children were then asked to think of a name for the new crater and give a reason for choosing to honour that particular person. The entries mainly nominated pop stars and footballers, with the odd prime minister, or a relative, but here are a few of the more thoughtful ones. *(Warts and all. Ed.)*

- *Crater name:* Christian

Reasons: Because Christmas has just come and it is a beginning of a new crater on the Moon.

Steven, 11 years old, Whytrig Middle School

- *Crater name*: HOOSSF LOGFM

Reasons: Because it's an anagram of one small step for man one giant leap for mankind

David Stanners, 12 years old. Whytrig Middle School.

- *Crater name*: Eifel

Reasons: Because he gave us structures so we should give him something in return.

Daniel Hastings, 12 years old. Whytrig Middle School

- *Crater name*: Albert Einstein

Reasons: Because he was a great scientist. The best one I know.

Curtis Lowes, 11 years old. Sugar Hill Primary School

- *Crater name:* Dr. Jenner

Reasons:

Kirsty Allen, Sugar Hill Primary School

- *Crater name*: William Herschel

Reasons: Because he was the first person to discover a planet. He discovered Uranus in 1781 after it had been thought to be a star in 1690. He discovered Uranus while surveying the stars at night using a telescope that he had built himself. He also discovered two of the moons of Uranus (Titania and Oberon). To be the first person to do such an amazing thing he deserves to have something named after him.

Ellie Labron, Sugar Hill Primary School

- *Crater name*: Doctor Barnardo

Elissa Tray, 10 years old. St Anne's C. of E.Primary

- *Crater name*: Neil Armstrong

Reasons: I think the crater should be called Neil Armstrong because he deserves the honour, as he was the first man to walk on the Moon and to see the true reality of it. He is renowned for this bravery risking his life so we can further our knowledge about the Moon and its craters.

Joanna Jennings,10 years old. Cent. Newcastle High

- *Crater name*: Doctor Susan Greenfield

Reasons: I chose Doctor Susan Greenfield because this in an extremely important person. She was a Trustee of the Sciences Museum and in 1994 she was the first ever woman to give the Royal Institution Christmas Lecture. She has also written and presented a six part series 'Brain Story' which was broadcast in July 2000. Harpers and Queen also named her as one of the '50 most inspirational women in the world' and in 1998 she received the Michael Faraday medal for making the most significant contribution to the public understanding of science. She is still alive today and deserves a crater named in the Moon to be named after her!

Beth Andrew, 10 years old. Central Newcastle High

- *Crater name:* Mrs Thomas

Reasons: Because she is my science teacher. She is great at it and I enjoy her lessons.

Molly Bell, 11 years old. Central Newcastle High School

- *Crater name*: The Wallace and Gromit creators

Reasons: Because they could make movies about Wallace and Gromit on the Moon.

Philip Kevin Weedy, 9 years old. Lord Blyth Primary S

- *Crater name*: Sir Bobby Robson

Reasons: He is a Sir and has done loads of great things in his life and was a brilliant manager for Newcastle.

Laura Blakey, 12 years old. Whytrig Middle School.

Curriculum Corner

The Cross Staff

Materials: two pieces of ramin moulding (rectangular or D-section, for example) with at least one flat side about 20mm wide, one 60cm long (approx), and one 100mm long. Four round-headed (preferably white) mapping pins. The principle of the cross staff is that of similar triangles: if the line from your eye through two sighting pins line up with two stars, then the angle between the two stars is the same as the angle between the two pins. By simple geometry, the angle between the ends of the cross bar, marked with a pin at each end so that the heads are exactly 100mm apart, is marked along the axis of the staff, so that by sliding the cross bar along the staff until the two stars line up with the sights, you can read the angle between the stars on the axis of the staff. **Be careful - if you walk about in the dark with the staff held beneath your eye, you could injure yourself if you bump into something!**

Mark the following angles (in degrees) at the distances given from the “eye end”. The distances are in millimetres from the eye end:

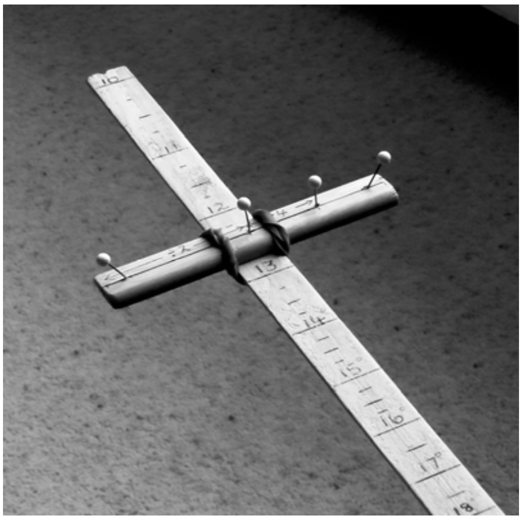
Mark Angle (deg.):	140°	130°	120°	110°	100°	90°	80°	70°	60°	50°	40°	38°	36°	34°	Cont.
At dist from eye end (mm)	18	23	29	35	42	50	59.5	71.5	87	107.5	137	145	154	163.5	Cont.

...	32°	30°	28°	26°	24°	22°	20°	19°	18°	17°	16°	15°	14°	13°	12°	11°	10°
...	174.5	187	201	217	235	257	284	299	316	334	356	380	407	438	476	518	572

You can interpolate the missing figures or fractions of a degree - but remember that the scale is not linear. Or you can use the same mathematical expression as was used to work out these figures to fill in other angles. If the distance along the axis from the staff is x, and the angle to mark on the staff is Θ, then $x = 50/\tan(\Theta/2)$. Example: to find the distance for an angle on the scale for 10.5 degrees, $x = 50/\tan(5.25)$, $x = 50/.09189 = 544.1$mm. So you can mark 10.5° at a distance of 544mm from the eye end, and so on. Finally, make a small notch in the “sky” end, nearest the 10° mark, so that you can locate that end in the dark to get the staff the right way round!

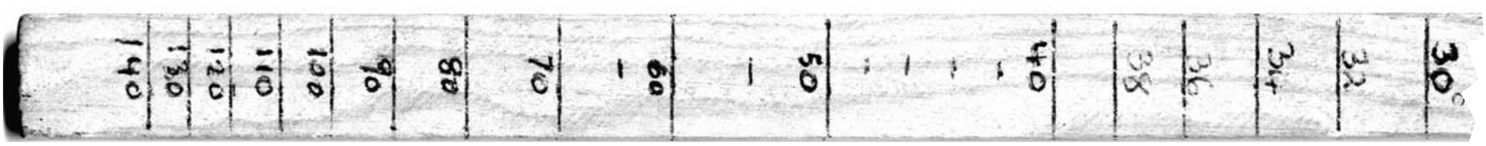
The cross arm centre line should be drawn along the top and undersides. The underside must be a flat side. A mapping pin should be stuck in the top centre line of the cross bar at each end so that the centres of the heads are as closely as possible 100mm apart. The cross arm is put on the staff using an elastic band loosely (see photo) so that it is free to slide along the staff at right angles to it. In the dark, holding up the cross so formed is also useful for warding off any vampires about the place.

To measure an angle between two points, put the staff gently touching your face beneath one eye, with the notch at the far end. Then slide the cross arm along the staff till the two objects coincide with the outer pin heads. Read the angle from the cross arm using the underside centre-line’s position on the scale on the staff. Insert another pin in the cross arm half way along the top centre line, i.e. 50mm from each of the two outer pins. Using either outer pin and the centre pin will give an angle half of that marked on the scale. Another pin, half way (25mm) between either outer and the centre pins (i.e. one quarter of the length of the bar from the end) will allow even smaller angle to be measured. For example, using the quarter and centre pins, you find the cross arm reads 10° . So the angle you have measured is 2.5°.



(Left) One end (with a notch, so it is NOT the eye end) of the assembled cross staff, showing how the elastic band holds the cross arm at right angles to the staff, also showing the mapping pins’ positions

(Right) The cross arm, roughly full size, showing the positions to insert the four pins, and the scale factors for each. Note the centre line, which should also be drawn on the underside of the cross arm



(Above, top) the “eye -end” of the staff, showing scale details, reproduced roughly full-size.
(Below) The “sky end” of the scale (also shown full size) is distinguished by the little notch in the end. This is the end featured in the photograph (top left)

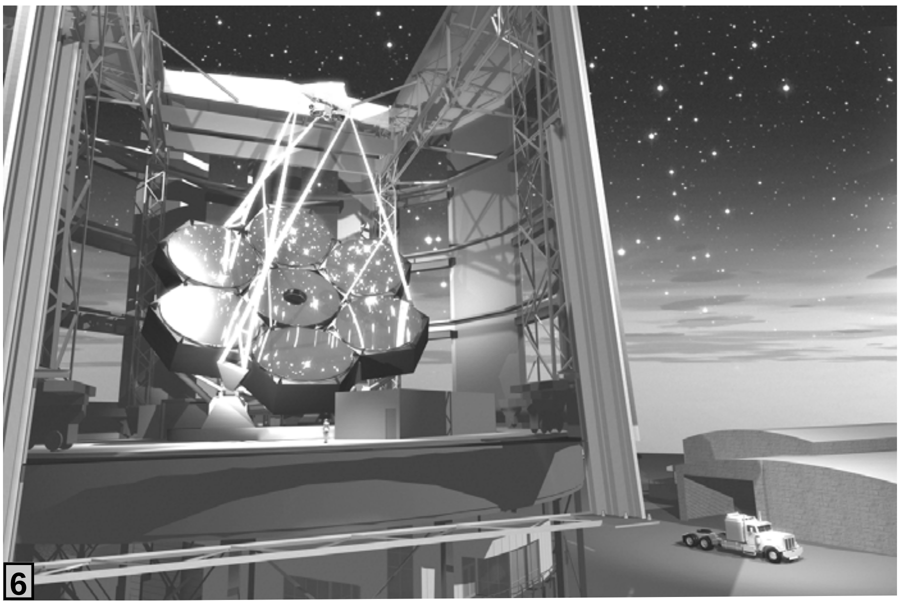
Letter from Down Under

No sooner have Australian astronomers begun to get used to having ready access to optical/infrared telescopes with 8 metre diameter mirrors via their share in the international Gemini Observatory, then it's time to start preparing for the next generation! Already, there are several consortia around the world with plans for telescopes with apertures of 20 metres or more already on the drawing board. Unless Australia joins one of these teams soon, it risks being left at the starting line (as it was at the dawn of the 8 metre era), with no chance to influence the design, or participate in their construction. But which team should it join? What are the chances of that telescope (or any of these "Extremely Large Telescopes", or ELTs) ever being built?

The Research School of Astronomy & Astrophysics at the Australian National University (better known to many of us by its home at the Mt Stromlo Observatory) has recently taken the bold step of joining a group of other prestigious universities in the USA in the design and development phase of the "Giant Magellan Telescope" (GMT)*. Scheduled for completion sometime after 2015, the instrument will consist of six 8.4 metre diameter mirrors surrounding a seventh central mirror. It will have the equivalent light-gathering power of a single mirror 21.4 metres across, but the resolution (ability to see fine detail) of one 24.5 metres in size. The telescope will most likely be built on Cerro Las Campanas in Chile, already home to the twin Magellan 6.5 metre telescopes, and reputed to have the best "seeing" (atmospheric stability) of any observatory site in Chile. The moving mass of the telescope will be close to 1000 tonnes, and it will sit within a rotating cylindrical enclosure some 65 metres tall.

Besides the Australian National University, other partners in the project are the Carnegie Institution of Washington, Harvard University, Massachusetts Institute of Technology, the University of Arizona, the University of Michigan, the Smithsonian Institution, the University of Texas at Austin and Texas A&M University. The University of Arizona operates the Steward Observatory Mirror Lab, which has successfully "spin-cast" large honeycomb borosilicate mirrors for the Magellan telescopes, the Multiple (now Monolithic) Mirror Telescope, and the Large Binocular Telescope. One of the major factors in the length of time needed to build the Giant Magellan Telescope is the two to three years needed to cast, cool, then polish each of the 7 mirrors. To get a bit of a head start, and demonstrate the techniques needed to produce the six off-axis mirrors, the first mirror was cast in mid-2005.

The dawn of a new era? This is a computer-generated view of the Giant Magellan Telescope opening up in twilight, sometime late next decade. Note the six off-axis mirrors located around the central mirror, and the tripod mounting for the secondary mirrors. The human figure at the telescope base gives a sense of the huge size. *(Courtesy Giant Magellan Telescope – Carnegie Observatories)*



Although it has passed its Conceptual Design Review which lays out what it might look like and be capable of, the project now enters a design and development phase in which a detailed design and proof of concept have to be delivered, before construction proper begins in 2009. In the meantime, the project partners will be busy lining up their share of the funds necessary to build the telescope, estimated at anywhere upwards of US$500 million!

So what kind of science results would be worth spending that much money on? Among the key questions targeted for investigation are:

- How common are planets around other stars, and what fraction of them may support life? The telescope may be capable of imaging planets around nearby stars directly, or at least the dusty disks from which they could form, and could search for the signature of oxygen or vegetation in their spectrum.
- Do black holes lurk at the centres of all galaxies, and what feeds them? Magellan will be able to probe deep inside the often crowded and dusty nuclei of galaxies and look for signs of supermassive black holes, both dormant and active.
- Which formed first: stars, or galaxies? The telescope will attempt to capture the birth of the first stars, objects so distant that their optical light is redshifted way out into the infrared regime (where the instrument performs best).
- What is the source of the "dark energy" which we now realise makes up more than 70% of our Universe, and causes the rate of expansion to accelerate? The telescope will map the clustering of galaxies in the early Universe, and use supernovae as yardsticks to measure distances to galaxies, both of which will show how the acceleration has changed and shed some light on the nature of dark energy.

Not surprisingly, the foundation partners also hope to get some of their investment back, both in the kudos that comes with having access to one of the world's largest telescopes, as well as in contracts to help design and fabricate key parts of the telescope. The newly-opened Advanced Instrumentation and Technology Centre on Mt Stromlo (built to replace the workshops destroyed in the 2003 Canberra bushfires) will play a key role in the design, principally in the suite of instruments which will sit behind the mirrors.

Magellan is not the only extra large telescope project happening in the USA – Caltech, the University of California, and the national observatories of the USA and Canada have joined forces to build the Thirty Metre Telescope out of 700 individual mirror segments. Not to be outdone, European astronomers have set a goal of building a European telescope of at least 30 metres, and perhaps as big as 60 metres. No-one knows which (if any) of these projects will come to fruition, but the race to build the world's biggest telescope is well and truly underway!

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* Sorry, I can't stand re-defining "GMT" - Ed.

For your library

The Cosmos – a historical perspective. Craig G. Fraser. Greenwood Press. Dist. Harcourt Education.181 pages, halftones and diagrams. Hardcover £36.99. ISBN 0-313-33218-5.

The expansion of the Universe has taken a new turn in recent years. Contrary to logic, the gravitational forces that should be trying to reverse the expansion of the cosmos are failing in the fight against a force (?) that is accelerating the universal expansion. Maybe. Einstein's famous "greatest blunder" - the mysterious cosmological constant λ, that was originally needed to keep the Universe static - may not have been a blunder at all! The whole subject is now in a state of flux.

So this most readable, concise historical perspective on the whole question of the nature of the Universe is very welcome. The author divides cosmology into five periods: the mythological; the emergence of Greek science; the Copernican; the Newtonian; and the extra galactic. It says something about the author's thorough approach that it is not until halfway through the book that he reaches Olbers' Paradox. What do we learn from those early ideas? Perhaps when we see how great advances were made at the turning points of each of the five periods listed, and several more in the course of each of them, it may help us see the present paradoxes with a little more humility. Perhaps not all, but nearly all things are still possible. Find a new concept, or a new interpretation of an existing phenomenon, or apply a new tool (the "Giant Magellan Telescope", for example – see news from Down Under on page 6) and each time it's back to the drawing board.

Professor Fraser writes: "The subject of this book is how conceptions of the universe's origin and large-scale structure developed and changed throughout history. What is of interest is how assumptions about cosmology influenced astronomical work and how astronomical work in turn generated cosmological beliefs and constructions. The development of pre-scientific cosmologies, such as the creation story of the book of Genesis or the mythology set out in the Babylonian epic *Gilgamesh,* are representative of a literary and religious outlook of considerable interest, but they fall outside the scope of an inquiry devoted to the history of scientific cosmology.

By the end of the book the story is very much up to date. But the picture that is emerging is taking on some of the flavour of those early mythologies and leaves the reader with a niggling doubt over the very definition of "scientific cosmology". Such a doubt is possibly the result of the way Professor Craig juxtaposes these ancient and modern ideas. But his concluding paragraph does draw attention to this. After all, he points out, the father of the Big Bang theory was the Abbé Lemaître, who became scientific advisor to the Vatican, and he concludes his book: "modern cosmology has become a kind of secular theology, coming as close as rational investigation ever can to uncovering the ultimate mysteries of the universe".

This is a thought-provoking book. Easy to assimilate and, of course, harder to digest. It will give you much to think about over many a long day.

Richard Knox

Observational astronomy. 2nd edition. D.Scott Birney, Guillermo Gonzalez & David Oesper. Cambridge University Press. 312pp.diagrams and half tones. Hard cover. ISBN 0-521-85370-5. £30.00.

"Observational" may suggest the sort of thing star-gazers do, and that's fair enough, but most astronomy that's not theoretical is observational. This book is a thorough coverage of the essentially practical aspects of the subject, with full physical and essential mathematical backgrounds, achieved with commendable brevity. This textbook is aimed at astronomy students at an upper level undergraduate standard. It starts at the basics of positional astronomy and time, continuing into charts, databases etc. It then reviews the physics of light and optics, describes the atmospheric influences on seeing, and observations. It covers instruments from telescopes to spectroscopy, solar observation, CCD applications and it discusses basic statistical methods.

Chapters are supported by a range of graduated problems and suggestions for further reading. **RAK**

Sky Diary Autumn 2006

There are many obscure areas of sky that most of us ignore. What with the problems of poor seeing conditions in a world lit all night with megawatts of energy (that at the same time we are told is scarce and its production deleterious to the environment) and the lack of obvious patterns to follow, we don't usually get round to it. That is a pity because, if you take advantage of the rare dark, clear nights that still manage to occur from time to time, there are ways to train yourself in finding your way round any part of the sky.

How William Herschel found Uranus, the first new planet to be found by an astronomer, is the more remarkable when you realise that at the time of its discovery it was immersed in the Milky Way near the Taurus/Gemini border. There are so many stars of like magnitude in that area that "needles" and "haystacks" come to mind!

Since Herschel discovered Uranus (1781 March 13) the planet has orbited the Sun only just under two and three quarter times! At 84 years per revolution, hardly anybody gets the chance to see it in the same position in the sky more than once (ignoring fleeting local effects like retrograde motion). I was lucky enough to spot the planet, and watch it over a year, in the early 1960's when it was passing from Cancer into Leo. It was possible to detect it with the unaided eye in this sparsely populated part of the sky because the line of the ecliptic from δ Cancri to Regulus extends only about 20° and Uranus was about half way along this line. Well, for the rest of this year at least there is another good chance to spot Uranus with the unaided eye, and to watch it during its retrograde motion (opposition was on September 5).

First, find λ (lambda) Aquarii. This is a good exercise in itself! The Aquarius region of the sky is pretty barren to look at, except on a really excellent night. Bear in mind that the Moon is full at the end of the first week in October, so perhaps the end of September, or towards the middle of October would be a more auspicious time to have a go. The chart is drawn for 2006 October 15days 21.30hrs UT, an occasion when Fomalhaut is at its highest in the south, only about 8° above the horizon, depending on where you are in the UK, but that's as high as it can get! Alpha Pegasi (the star marking the south-west corner of the Great Square of Pegasus) is at about altitude 50°, also almost due south, and λAqr (with Uranus just ½° beneath it) is at an altitude of about 30°, is on the same line.

The western side of the Great Square of Pegasus makes a useful "Pointer" to the bright star Fomalhaut, one of the farthest south stars that are still easy to see from the UK. So let's do a short tour down this imaginary line. The line is a little to the east (left) of the 23hr meridian shown faintly on the diagram overleaf. You can use this meridian, if you like. it will be a lot easier to find your way if you use your cross-staff. You have not made one? ☞

☞ Shame on you then! Go to *Curriculum Corner* (page 5) immediately and get the situation rectified. So you will have to use you hand at arm's length as an approximate angular guide. The distance across the outer knuckles of the clenched adult fist at arm's length is about 8° - 9°, and,

Moon phases for the last quarter of 2006

	New Moon	First Quarter	Full Moon	Last Quarter
October	**22**	**29**	**7**	**14**
November	**20**	**28**	**5**	**12**
December	**20**	**27**	**5**	**12**

very roughly, 3° per knuckle. The spread-eagled fingers extend over about 20° at arm's length.

Just over 10° south of αPeg and slightly to the east (left) of our line is one of the few features of the constellation of Pisces that one can find with not quite so much difficulty, a circlet of six faint stars (the four brightest are around magnitude 4!). These represented the head of one of the two fishes that are conjoined by their tails in ancient illustrated star maps of Pisces. The south-east ("bottom left") corner of this circlet is only about 3° west and 2° north of the point in the sky at present marking the Vernal Equinox (shown with a small cross).

The brightest and westernmost of the six circlet stars is magnitude 3.7 γPsc. Some 3° (adjacent knuckles) to the west (right) of the circlet is βPsc almost on our line (which, according to one source I found is blest with the name *Fum Al Samakah* – this is probably rude if translated!). This star is at the western end of a trail of faint stars leading through the circlet eastwards south of (below) the Great Square for about twice the width of the Square till it curves down to mag.4 αPsc. This marks the point of a large V where one fish is tied by the tail to the other (an even harder to spot ragged trail of faint stars straggling northwards between the eastern side of the Square and Aries. But I digress.

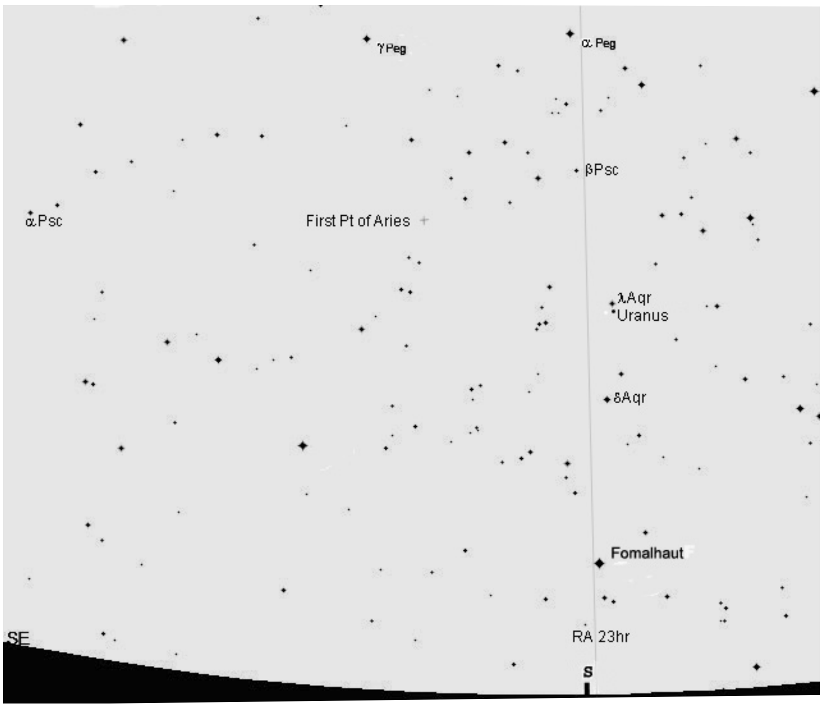
Lambda Aq. is about half way along the line from Alpha Pegasi to Fomalhaut. If you found the circlet described in Pisces, you may also be able to find a little pattern of stars to the east of lambda that resembles an elongated star cluster trailing north. It is an asterism, the three faint stars forming the base of which are psi 1-3 Aquarii (ψ^1, ψ^2, ψ^3 Aqr). Lambda Aqr is to the west of this little group. It is also about halfway along the line to Fomalhaut, or 22° south of α Peg. (a good stretched-out-fingers span at arm's length). Uranus should be just visible closely below lambda, fainter but possibly not twinkling much, and separated from lambda by only half a degree (a Moon diameter). If all else fails, try your binoculars until you are confident you have found the planet, then see if you can see it with the unaided eye.

If you continue your slide south towards Fomalhaut, about 6° below λ Aqr you will find two stars, the brighter being 5th magnitude τ^1 (tau1) Aqr (that has a 6th magnitude companion, τ^2 not shown on the chart 1° south west). Another 3° or so brings you down to 4th mag (positively brilliant!) δ (delta) Aqr. This is called *Skat*! Finally, another 10° brings us down to Fomalhaut. This is a first magnitude

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

	October 15		November 15		December 15	
	Rise	Set	Rise	Set	Rise	Set
Sun	06h 36m	17h 18m	07h 31m	16h 21m	08h 13m	16h 00m
Mercury	09h 12m	17h 45m	06h 12m	16h 00m	07h 11m	15h 14m
Venus	06h 16m	17h 19m	07h 58m	16h 33m	09h 14m	16h 44m
Mars	06h 51m	17h 23m	06h 50m	16h 02m	06h 51m	14h 57m
Jupiter	09h 23m	09h 23m	07h 59m	16h 37m	06h 37m	14h 57m
Saturn	00h 56m	15h 40m	23h 01m	13h 43m	21h 05m	11h 46m
Uranus	16h 06m	02h 52m	14h 03m	00h 47m	12h 06m	22h 47m
Neptune	15h 15m	00h 35m	13h 14m	22h 29m	11h 17m	20h 34m

star class A3 rated 18th in the bright star league tables. At declination -29° 37' it is just over 3° further south than Antares and might be described as the most southerly star seen from the UK without optical aid.



A diagram showing the "watery area" of the sky round the First Point of Aries. The 23hr meridian is shown due south, and one or two features are labelled to help in your search for Uranus, about ½° south of λ Aquarii.

All these constellations have a watery theme: Fomalhaut is in the Southern Fish; Aquarius is the water carrier; Cetus (to the east and south of Pisces) is the Whale (or sea monster) and Pisces itself is two fishes. The line we have just moved along is approximately the meridian of right ascension 23 hours. To the east, roughly passing through β Cassiopeiae (the brightest end of the W) and the eastern side of the Great Square, is the meridian of right ascension zero.

Mercury will make a relatively favourable morning apparition in late November, and a difficult, but interesting, almost triple close conjunction will occur on December 10, and 11th between Jupiter, Mars and Mercury. They will be low in the morning twilight, and Mars will be magnitude 1.5 only, but well worth having a look with binoculars about 7:30hr just above the horizon in the south-east. The three planets will be within about 1° of each other.

The turning point of the quarter is the northern winter solstice, which occurs at December 22nd 00h 22m. Meteor showers due include the Leonids (November 15-20th, maximum at 17th)which are returning to normal after some enhanced displays around the turn of the millennium, and the Geminids, due at maximum on December 14th – but around from 7th to 16th.

Richard Knox