GNOMON

Newsletter of the Association for Astronomy Education

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This issue of 'Gnomon' has been sponsored by The Royal Astronomical Society

This enables the newsletter of the Astronomical Society of the Pacific, 'the Universe in the Classroom' to be included as pages 3–6 of this issue.
Please note that the renewal notice to the ASP does not apply to *Gnomon* readers.

Editorial Comment

One problem encountered by a quarterly publication (such as *Gnomon*) is that occasionally we receive useful and interesting material for publication which is too late for the next issue. By the time the following issue goes to press, the article is out of date.

This has happened to news of an astronomical weekend organised by the Webb Society. If only we had received this a few months earlier, quite a few of our readers might have attended the weekend. The weekend, in fact, was due to take place on 24/25 November, which is two weeks later than the date of writing this item. This is a great pity as the programme looks very interesting, including talks on the Victorian clergyman Thomas Webb, often referred to as the Father of Amateur Astronomy; Amateur Astronomy in the 19th century; George With (famous for his high quality telescope mirrors); deep sky observing, and the present state of amateur astronomy. A seminar for teachers interested in the National Curriculum rounds off the weekend.

This editorial comment is written in the hope that *Gnomon* readers unable to attend the Webb weekend are alerted to similar activities next year. Information on this can be obtained from the Webb Society, c/o The Haven, Hay-on Wye HR3 5TA.

ASE Annual Meeting: 4th – 7th January 1991 Birmingham University

Once again the AAE will have a presence at this prestigious event. We will share a display stand with the London Planetarium. Our Education group will be running two workshops for teachers, one aimed at the primary curriculum, the other at the secondary. If you have any special expertise in either of these two areas and would like to join the Education Group in running the workshops, contact Anne Cohen at 9 Hurst Lane, Bollington, Macclesfield, Cheshire, as soon as possible.

Bob Kibble

Physics Education – Special Edition

The Institute of Physics journal, Physics Education, occasionally includes several articles under a general theme. The January 1991 edition will be devoted to physics and astronomy. Members of the AAE have contributed to the articles. If you would like a copy, contact the Marketing Office, IOPP Ltd, Techno House, Redcliffe Way, Bristol BS1 6NX. Tel: 0272 297481. (I cannot give details of price at present.)

Bob Kibble

Astronomical News from Finland

We understand that cloudy conditions prevailed during the eclipse of 22 July 1990. The following was received *before* the eclipse, and we await news of these experiments.

Gravity tested during the Finnish eclipse

Twist in gravitation will be tested on July 22, 1990, when the Moon eclipses the Sun. The zone of totality begins in Finland and continues over the Arctic Ocean and Siberia.

Early this century, when Einstein was developing his general theory of relativity, physicists were interested in another aspect of gravitation, namely in the hypothesis of gravity shielding. When mass covers another mass, it absorbs part of the gravitational effect of the mass lying behind. This effect was studied by Q. Majorana who in 1919–22 performed a series of investigations and laboratory experiments. In spite of the fact that the results from Majorana's experiments showed a small effect, the scientific community did not become convinced of the existence of the shielding effect. Later, the effect has been studied by numerous physicists, for example, in connection with total solar eclipses.

The Majorana effect will be tested in Finland in July using different methods. A French group, led by Guy Berthault, will use a torsion pendulum. Any changes in the swing time of the pendulum would show a change in the gravitation of the Moon and the Sun.

The Finnish Geodetic Institute will use an absolute gravimeter (falling body instrument), a LaCosta-Romberg recording gravimeter and very long water tubes. "We can measure the gravity within 0.000000001 parts of the acceleration of gravity," says the director of the Institute, Juhani Kakkuri.

According to Kakkuri, the Finnish eclipse offers a unique opportunity to study gravitation. The eclipse occurs very soon after the sunrise which is the best situation for tests of horizontal effects caused by the change of gravity (but of course less than ideal for other eclipse enthusiasts). It is also seldom that accurate measuring stations, like those of the Finnish Geodetic Institute, happen to lie just on the middle line of a total solar eclipse.

Also other scientific experiments will be conducted in Finland during the eclipse. Ursa Astronomical Association, a Finnish society of amateur astronomers, has arranged with scientists of the Helsinki University two experiments, in which hundreds of people will take part. In one of them, school children and other volunteers will study the effect of the eclipse (if any) on three animals and one plant: a dog, wagtail, ant and trefoil. In the other experiment, called Solrad 90, an attempt will be made to determine the radius of the Sun using timings of the duration of the totality of the eclipse.

For more information please contact:

Prof. Juhani Kakkuri, Finnish Geodetic Institute, Ilmalankatu 1 A, SF-00240 Helsinki, Finland. Telephone 358–0–410 433, Telefax 358–0–414 946.

Mr Markus Hotakainen, Ursa Astronomical Association, Laivanvarustajankatu 3, SF–00140 Helsinki, Finland. Telephone 358–0–174 048, Telefax 358–0–657 728.

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We hope to include results of these experiments in the next issue of *Gnomon.*

NEW PHYSICS WITH SPACE SCIENCE COURSE AT KENT

Following the success of the University of Kent's Physics with Astrophysics course over the last decade, a new course entitled 'Physics with Space Science and Systems' has been announced to take its first Student intake next year (1991). Its aim is to produce physicists who are knowledgeable in a wide range of Space topics including Astronomy, Science, Technology, as well as certain business and legal aspects. Students on this course, as well as the existing Astrophysics course, will, during their third year, undertake a mini-research project and be able to become involved in the Unit for Space Sciences' current space research projects. Amongst these is the analysis of material returned from LDEF (Long Duration Exposure Facility) – see photograph. LDEF was a space platform which exposed a variety of experiments to the space environment for $5\frac{1}{2}$ years before being retrieved by the Space Shuttle at the beginning of this year. The University of Kent's experiment was designed to study Cosmic Dust, the tiny solid particles which pervade space. The photograph shows a micrograph of the impact caused by one of these particles on the detectors. From this data, and using a variety of sophisticated analytical techniques, the researchers hope to derive a range of information about the original particle which was destroyed in the impact – including its mass, velocity and composition. It is increasingly likely that some of these particles are 'space debris' – particles resulting from Man's activities in space. It is quite feasible that undergraduate students on the new Physics with Space Sciences courses might find themselves analysing this millimetre size impact site to determine whether it is the result of a fragment from a satellite break-up or from a particle left over from the formation of the Solar System some $4\frac{1}{2}$ billion years ago!

Prospective undergraduates can apply now via UCCA – the course is so new that it does not yet appear in the main UCCA booklet. Course code is PhysSpSyst F365, or PhysSS(Eur) F364 for the option of an additional year's study at a European University.

For further details, contact the Senior Assistant Registrar, The Registry, University of Kent, Canterbury, Kent CT2 7NZ, or, for more specific details of the course, contact the Unit for Space Sciences, Physics Lab., University of Kent, Canterbury, Kent CT2 7NR (Tel: 0227 764 000 Ext 3788).

Dr John Zarnecki

First Year

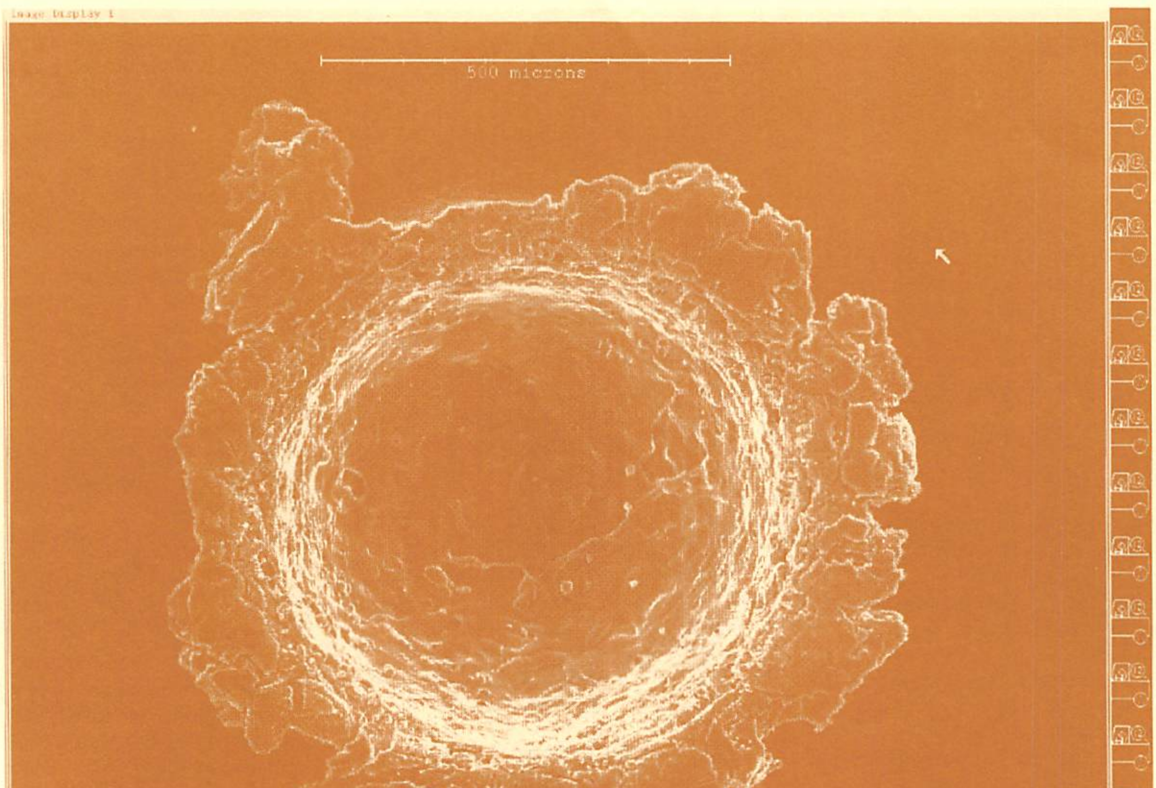
- Astronomy
  - Sun and Solar System
  - Stars and Stellar Systems
  - Introduction to Space Science
- Mathematics
- Mechanics/Properties of Matter
- Dielectric and Magnetic Materials
- Waves
- Thermodynamics
- Introductory Electromagnetics
- Electrical Circuits
- Electronics for Science
- Computer Control
- Fortran Programming and Applications
- Wave Optics
- Quantum and Statistical Physics
- Wave Mechanics
- Laboratory Experiments in Physics and Computing

Second Year

- Space Sciences 1
  - Introduction to Spacecraft Systems
  - Solar-Terrestrial Physics
  - Elementary Celestial Mechanics
  - Orbital Mechanics for Space Vehicles
- Mathematical Techniques
- Electromagnetic Phenomena
- Atomic and Nuclear Physics
- Laboratory Experiments and Space Science Workshop

Third Year

- Space Sciences II
  - Instruments and Techniques
  - Space Astronomy
  - Space Exploration
  - Project Management
  - Space Business and Law
- Space Sciences III
  - Manned Spacecraft
  - Special Topics
  - Spacecraft Systems:
    - Power
    - Propulsion
    - Structure
    - Materials
    - Environmental Design Specifications
    - Payload and Subsystem Accommodation
    - Communications
    - Test Facilities
  - Applications and Utilisation
- Classical Physics
  - Electrodynamics
  - Fluid Mechanics
- Statistical and Solid State Physics
- Elementary Particles
- Computing Systems and Languages
- History of Physical Science
- Research Projects: Individual final year projects in Space Sciences.



SOLUTION TO GNOBLEM 11

This problem has attracted more attention than any previous *Gnoblem.* On the face of it, a very simple one, but when one gets to grips with the problem, it soon emerges that this is not merely a calculation.

First of all, some individual solutions:

1. Rosemary Naylor of Todmorden, using a pocket calculator, realises from the start that the answer depends on the *accuracy* to which the periods of the three planets are quoted. Thus she assumes that these periods are 0.2400000, 0.6200000 and 1.000000 years respectively, for Mercury, Venus and the Earth. She calculates that after 8.7894736 Earth years, Mercury will have made 40.789473 orbits and Venus 15.789473. After working for hours, says Rosemary, using decimals to a variety of decimal places, she kept coming up with answers between 185 and 186 years. But on checking back to see how many orbits each planet had made, to see if they agreed on a whole number *plus the same fraction,* she found them scattered around the Solar System. It was obvious this would always happen, depending on how many decimal places were used.

   So she changed over to 'good old-fashioned fractions' and made use of the formula:

   $$\frac{1}{\text{sidereal period of planet}} - \frac{1}{\text{sidereal period of Earth}} = \frac{1}{\text{synodic period of planet}}$$

   Thus we have:

   For Mercury: $$\frac{1}{0.24} - \frac{1}{1.00} = \frac{1}{\text{synodic period of planet}}$$
   which gives a value of $^{6}/_{19}$ years for the synodic period

   For Venus: by a similar calculation, the synodic period works out as $^{31}/_{19}$ years.

   We now have to find the lowest number into which these synodic periods divide: this is $^{186}/_{19}$ years.
   In this time Mercury makes 40.789... orbits and Venus 15.789... (and the Earth makes $^{186}/_{19}$ orbits, taking 9.7894736 years).

   Thus the answer is $9^{15}/_{19}$ years (i.e. 9.789... years).

2. An identical answer, $9^{15}/_{19}$ years is obtained by Trevor Burton from Leeds.

   Mercury and Venus will line up again as a pair after a time equal to Mercury's synodic period, he says. Using the same formula for synodic periods as in the previous solution, he obtains a value for the synodic period as $^{186}/_{147}$ years. An identical argument for Venus and the Earth gives a synodic period of $^{31}/_{19}$ years. We must now find the shortest time interval which is an exact multiple of these two times. If in this time period there are N_1 synodic periods of $^{186}/_{475}$ years and N_2 synodic periods of $^{31}/_{19}$ years, then:

   $$N_1 \times \frac{186}{475} = N_2 \times \frac{31}{19}$$

   or $$\frac{N_1}{N_2} = \frac{31}{19} \times \frac{475}{186} = \frac{25}{6}$$

   Thus $N_1 = 25$ and $N_2 = 6$ are the smallest integers possible.

   The time which has elapsed in this interval $= N_1 \times {}^{186}/_{475}$
   $= 9^{15}/_{19}$ years

   Trevor calculates that in 186 years, all three planets will be lined up again, but in their original positions.

   He notes, like Rosemary, that the answer is very critically dependent on the accuracy of the given periodic times. Thus (he calculates), if the period of Venus were 0.61 years, instead of 0.62, the conjunction period of $9^{15}/_{19}$ years becomes 366 years! Figures for these periods given to much greater accuracy in the BAA Handbook give an answer of 7.41 x 10 years!

3. L.M. Dougherty of Halifax obtains the same answer (186 years) for the next triple conjunction. This is a very brief calculation:

   The three periods are 0.24, 0.62 and 1.00 years.
   The integral lowest common multiple of these numbers is the same as the LCM of 24, 62 and 100, divided by 100. We thus need the LCM of 8 x 3, 2 x 31 and 4 x 25, divided by 100.
   This gives (8 x 3 x 31 x 25) ÷ 100 = 186 years.
   He has also made the calculation by computer and reaches the same result.
   But, is this the *original* line-up, as described in the previous problem?

4. Fiona Vincent from the Mills Observatory, Dundee, has submitted the following argument:

   The solution to the problem is 186 years, after which time Mercury would have completed 775 revolutions and Venus 300.

   However, the orbital periods are given with only limited accuracy, and the error becomes significant over such long time-intervals. Taking Mercury's period to be 0.24085 rather than 0.24, and using 0.61520 instead of 0.62 for Venus, we find this 'solution' is not valid. After 186 years, Mercury would have completed 772 revolutions and be 99° into the next one, and Venus would have gone 302 revolutions and 123°. Thus Mercury, Venus and Earth would definitely not be in a straight line!

   However, after 283 years, Mercury would have gone 1175 revolutions and 7°.8 and Venus 460 revolutions and 5°.4 – quite a good approximation.

   Still using the same values, after 1263 years we have Mercury going 5244 revolutions and 0°.4, and Venus 2053 revolutions minus 0°.2. I let my computer continue to search over the next 50,000 years and it didn't come up with anything closer.

   Of course the improved values for the orbital periods are still of limited accuracy. By 1263 years ahead, we could in fact have a spread of over 5° instead of less than 1°. Over a sufficiently long period of time, the orbital periods will in fact change slightly anyway, due to the perturbations of one planet on another. I would say there is no perfectly correct answer to this question.

   It has occurred to me that the problem did not state specifically that the three planets must be lined up with the Sun, though I assume that is what is meant. I do *not* fancy the job of calculating when they might be in a non-radial line!

   Thanks for the mental exercise!

Footnote: Is it possible that for one set of figures, given extremely precisely, there will *never be* another line-up?

Thanks to all other readers who sent in solutions – giving different answers!

GNOBLEM 12

Amongst the various schemes which have been suggested as a source of 'alternative' energy is the harnessing of tidal power. We know that it is largely the Moon, but also the Sun, which is responsible for the tides: these are caused by the gravitational pull of the Moon on the water in the oceans. The Moon is doing *work* by raising the water against the Earth's gravity, but this energy is fed back to the Moon as the tides decrease. (This is similar to the situation in alternating current theory where the voltage and current are 90° out of phase – over one complete cycle, no work is done by the current.)

But when we start harnessing the tides, we shall use up part of this energy, and the amount left to be fed back to the Moon is reduced. As a result, the overall effect is to take energy from the Moon, continuously. The result of this will be a reduction in the kinetic energy of the Moon – that is, it will progressively slow down. This means the Moon will drift further and further away from the Earth!

In due course, we may lose our Moon.

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Gnoblem solvers are invited to comment on the plausibility of this hypothesis.

BOOKS

Night Sky – a discovery guide, by Brian Jones. Published by Salamander Books Ltd. ISBN 0 86101 495 2. Price £6.95.

Here is a book for every school library. With the raised profile of astronomy and space in the National Curriculum, more young people will be wanting to find out about comets, stars, planets etc. Brian Jones takes the reader on a journey of discovery through the night sky and into deep space aided by a large number of colour diagrams and photographs.

The written style is concise and encyclopaedic with a host of facts crammed into the rather small print. As such, this is an armchair reference book rather than a practical guide. The yellow on white star finder charts do not work well and will serve to confuse. References to historical discoveries are made where appropriate and plenty of numerical data are given without exploring mathematics to any degree.

The text makes the book most suited to the 11–16 age range. These are the very people who want to know how to become astronomers or what the latest technical hitch with the space telescope is. They will have to search elsewhere for these answers, as they will for ideas on practical projects for their coursework assessments. But no single text can serve all masters and 'Night Sky' does a good job in introducing the young reader to everything, from solar eclipses to Seyfert galaxies, in a colourful and comprehensive style.

Bob Kibble

'Space Exploration', by Brian Jones. Published by Belitha Press, 1990. Hardback. ISBN 1–85561–008–6. Price £7.95.
'Space' (based on an original text by Brian Jones). Published by Belitha Press, 1990. Hardback. ISBN 1–85561–011–1. Price £7.95.

According to the publishers, Belitha Press, each of these books forms part of a thematically organised information series for children; 'Space Exploration' is from The Belitha Information Library, aimed at 9–12 year olds; 'Space' forms part of My First Reference Library, suitable for 7–9 year olds. Both books are based on a single format, with identical headings and illustrations. The text, however, is adapted to the needs and abilities of the targeted reader.

Some publishers in this area treat children as a homogeneous group, failing to take into account different reading and comprehensive levels, and I applaud Belitha Press's attempt to remedy this. However, in this case, strict adherence to an identical layout for both books results in 7–9 year-olds being presented with a series of schematic diagrams showing the difference between the cassegrain and classical newtonian configuration, surely an esoteric subject for this age group. But this is a minor cavil only, because these books are an excellent information source for young readers.

A broad range of topics is covered, from a brief historical overview of astronomy to some speculative chapters dealing with alien life, and what the future may reveal in this exciting science. Along the way, in traditional sequential order, the Earth, Moon, Sun, planets, stars and galaxies, are described. Also included are chapters on telescopes, the night sky, and that unfailing favourite with children, spaceflight. So comprehensively and logically are these subjects treated, that it is obvious that the author is a keen astronomer.

However, from my perspective as a primary school teacher, I regret the omission of any 'go-out-and-see' exercises. Although I understand that these books are intended as parts of junior reference series, I would be pleased to see some practical or fieldwork included, e.g. recording observations of moon phases, noting earth's diurnal rotation with reference to the changing position of the heavenly bodies, etc. At this stage, concrete activities are an important, even necessary, part of the learning process.

But this is not to detract from the overall excellence of both of these books, the presentation of which is of a high standard, with quality colour reproductions and attractive, easily-understood diagrams. The text is clear and accessible to the intended age-groups. A useful glossary is included in both books.

In conclusion, although children's publishing is by no means a neglected field in this science, I consider these books to be a valuable addition to any school library and, with the approach of Christmas, would make an excellent stocking-filler!

Gerard Moloney

1991 Yearbook of Astronomy, edited by Patrick Moore. Sidgwick & Jackson Ltd, 1990. 208 pages. £8.99. Paperback. ISBN 0–283–06033–6. Also in hardback. ISBN 0–283–06032–8.

This is the 29th edition of the popular handbook detailing the predictable celestial event of 1991. Star maps, which remain unchanged from year to year, are given for observers in both hemispheres. As these are each intended for use over a five month span, e.g. March 5th at 5.00am through to July 21st at 8.00pm, no attempt is made to show the position of the planets, which this reviewer thinks detracts from the usefulness of the sky maps. Monthly sky notes explain where to find the planets and give meteor showers and other important events. Of special interest in 1991 will be the 'very long eclipse' of the sun in July. This will attract many to travel to Hawaii and Mexico, but let us hope they are not misled by the misprint which gives the maximum duration of totality as 6hr54sec. (Would that it were!)

In addition, there is a good mix of articles from first class authorities on: The Supernova of 1987; the Biggest Structures in the Universe; Jeremiah Horrocks and the transit of Venus; the ROSAT mission;; the Stars of Intergalactic Space; Recent Novae and Comet Austin.

As ever, the book concludes with addresses of local astronomical societies. This is a useful feature but should be treated with caution as little attempt is made to keep it up to date.

If you regularly buy the Yearbook, you will want a copy of the 1991 edition.

Rosemary Naylor

LETTER

Dear Editor,

The origin of the name Boötes (Gnomon autumn 1990) is something that I looked into when writing Star Tales. I consulted John Ebdon, that noted Graecophile, and he agreed with the explanation in R.H. Allen's Star Names, viz. that it comes from a Greek word (βοητης) meaning noisy or clamorous, referring to the herdsman's shouts to his animals. Alternatively, it could come from the ancient Greek meaning ox-driver, from the fact that Ursa Major was sometimes visualised as a cart pulled by oxen. Adrian Room agrees with these two deviations in his Dictionary of Astronomical Names.

I pronounce it Boh-oh-tease.

Yours sincerely,
Ian Ridpath

TEACHERS' PACK

There has been some confusion about the Primary Teachers' Pack. Prospective purchasers should make out their cheques to The London Planetarium, not the AAE. The price is £3.00, plus £1.20 to cover postage and package.

Addresses for Correspondence

Secretary: Bob Kibble, 34 Acland Crescent, Denmark Hill, London SE5 8EQ – for all general enquiries. (Tel: 071–274 0530)

Treasurer: Nick Steggall, 38 Victoria Crescent, Birkdale Road, Dewsbury, West Yorkshire WF13 4HJ – for all financial and subscription enquiries (Tel: 0924–454718)

Editor: Eric Zucker, 35 Gundreda Road, Lewes, East Sussex BN7 1PT – for all enquiries concerning the Newsletter. (Tel: 0273–474347).

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Quarter page	£30
Inserts	£75 *

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Build your own Planetarium
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