Teaching of Astronomy in Asian-Pacific Region

Bulletin No. 9

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キリトリセン

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Syuzo Isobe

Pocket sundials

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1 Introduction.

We know students are very happy when they can make an object which they can see in a shop. Then,they believe it is possible know the value of their manual skills and their mathematical knowledge. It is possible to achieve this if students build a pocket sundial. I would like to talk to teachers of general science fields (mathematics, physics, biology, ...) and present two methods of producing a pocket sundial depending on students' levels, with or without trigonometry. To make a sundial it is necessary to know some data of the sun's movements.

2 Elemental astronomic knowledges.

To explain the basic concepts to students we use colloquial language. (For example, normally we speak about the Sun's movement around the Earth because this is clearer).

The basic ideas are:

- "Every day the Sun moves around the Earth's axis".

  We can imagine the Earth in the centre of the celestial sphere. The direction of the Earth's axis of rotation cuts the celestial sphere at the position of polar star. Perpendicular to this axis through the centre of Earth there is the equatorial plane which produces the terrestrial equator on the Earth's surface and the celestial equator in the celestial sphere (Fig. 1).

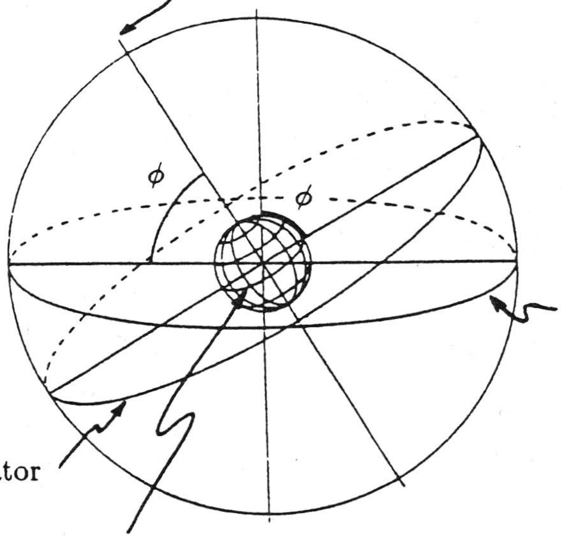

Figure 1: *The celestial sphere and the Earth. The altitude angle of polar star, above the horizon, is equal to the place latitude ϕ .*

If we want to consider the inclination of the direction of the Earth's axis we use the angle ϕ of place latitude, because the altitude angle of polar star, above the horizon, is equal to the place latitude (Fig. 1).

- "Every day the Sun follows a parallel to the equator".

On the first day of spring the Sun follows the equator, the second day it follows a slightly higher parallel, the third day again a little higher, etc..., until finally on the first day of summer it is at the highest parallel of the year. On the second day of summer it follows a slightly lower parallel, etc... until the first

day of autumn when the Sun follows the equator again, etc..., and finally on the first day of winter it is at the lowest parallel and starts to rise again (Fig. 2).

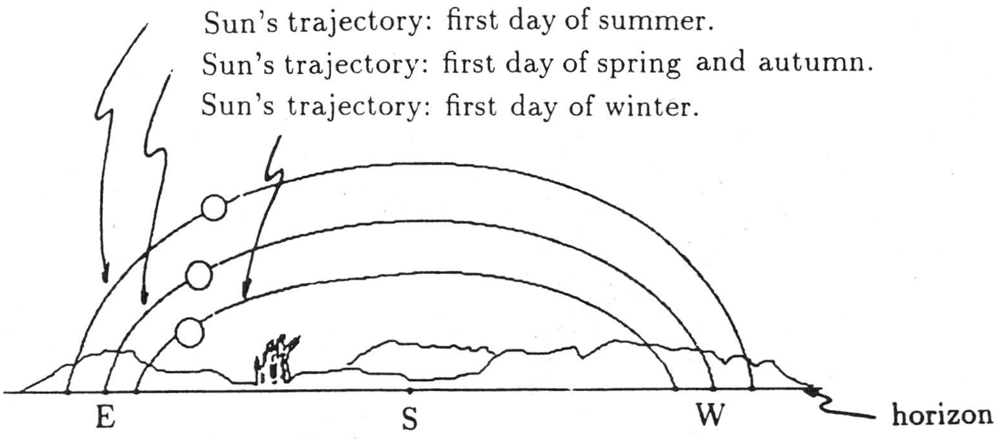

Figure 2: *Sun's trajectory during the year.*

- "Every day the Sun rises near the East cardinal point, crosses the South cardinal point at midday, and sets near the West cardinal point"

  In figure 2, we can see only two days when the Sun rises in the East cardinal point and sets in the West cardinal point. But every day the Sun crosses the South cardinal point at midday.

3 Equatorial dials.

After all this information, we can prepare the easiest sundial (equatorial dial). We have to put a stake or gnomon in the direction of Earth's axis (orientated according to the place latitude) and a plane situated like the equatorial plane.

To put the axis in the direction of polar star, we incline the stake or gnomon to agree with the place latitude (Fig. 3) and afterwards we only have to put the plane perpendicular to the stake and to orientate the kit.

To mark the hour lines on the plane we must remember, every day the Sun runs a complete circumference (360°), so every hour it travels 15°. So,

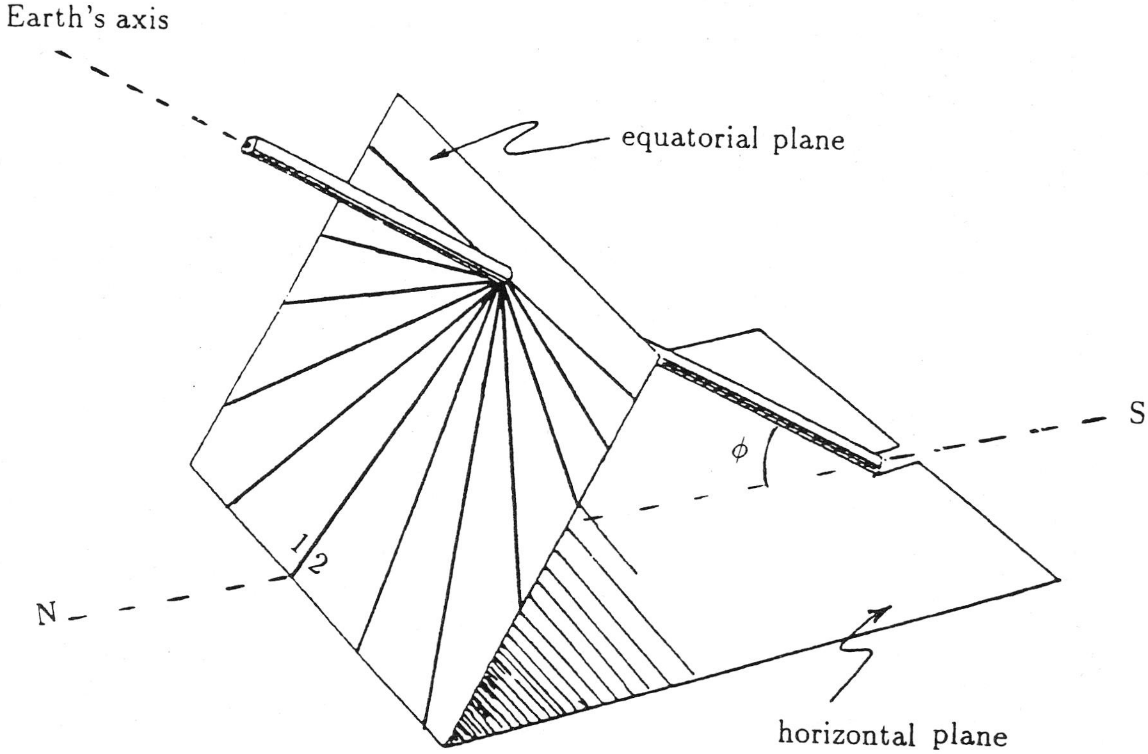

Figure 3: *Equatorial dial oriented in accordance with the Eath's axis.*

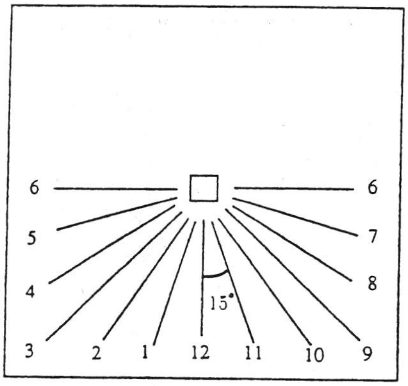

Figure 4: *Plane of equatorial dial.*

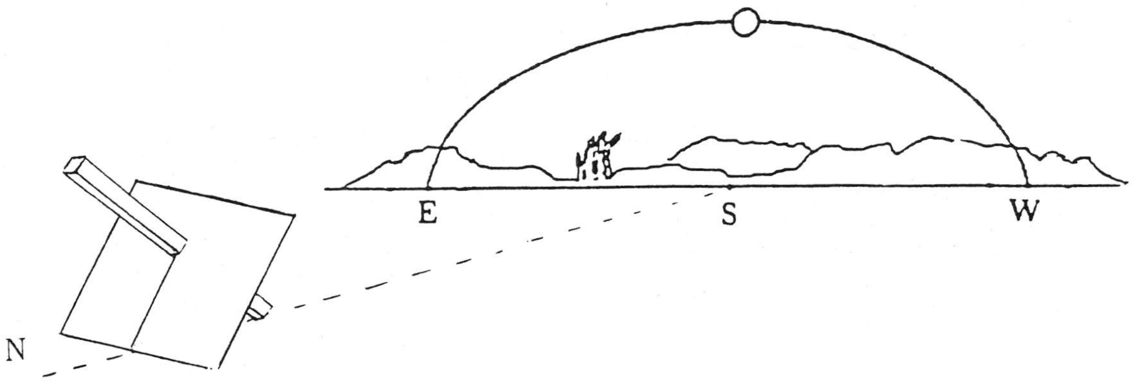

Figure 5: *The Sun crosses the plane meridian at midday.*

between one hour and another there will be 15° (Fig. 4).

We also have to orientate the 12 hour line to agree with the direction of the South cardinal point, because when the Sun is over this point it is midday (Fig. 5).

We now include a cutout sundial (Fig. 6). I would like to point out that it is necessary to orientate the sundial in accordance with the line North-South (it is possible use a compass).

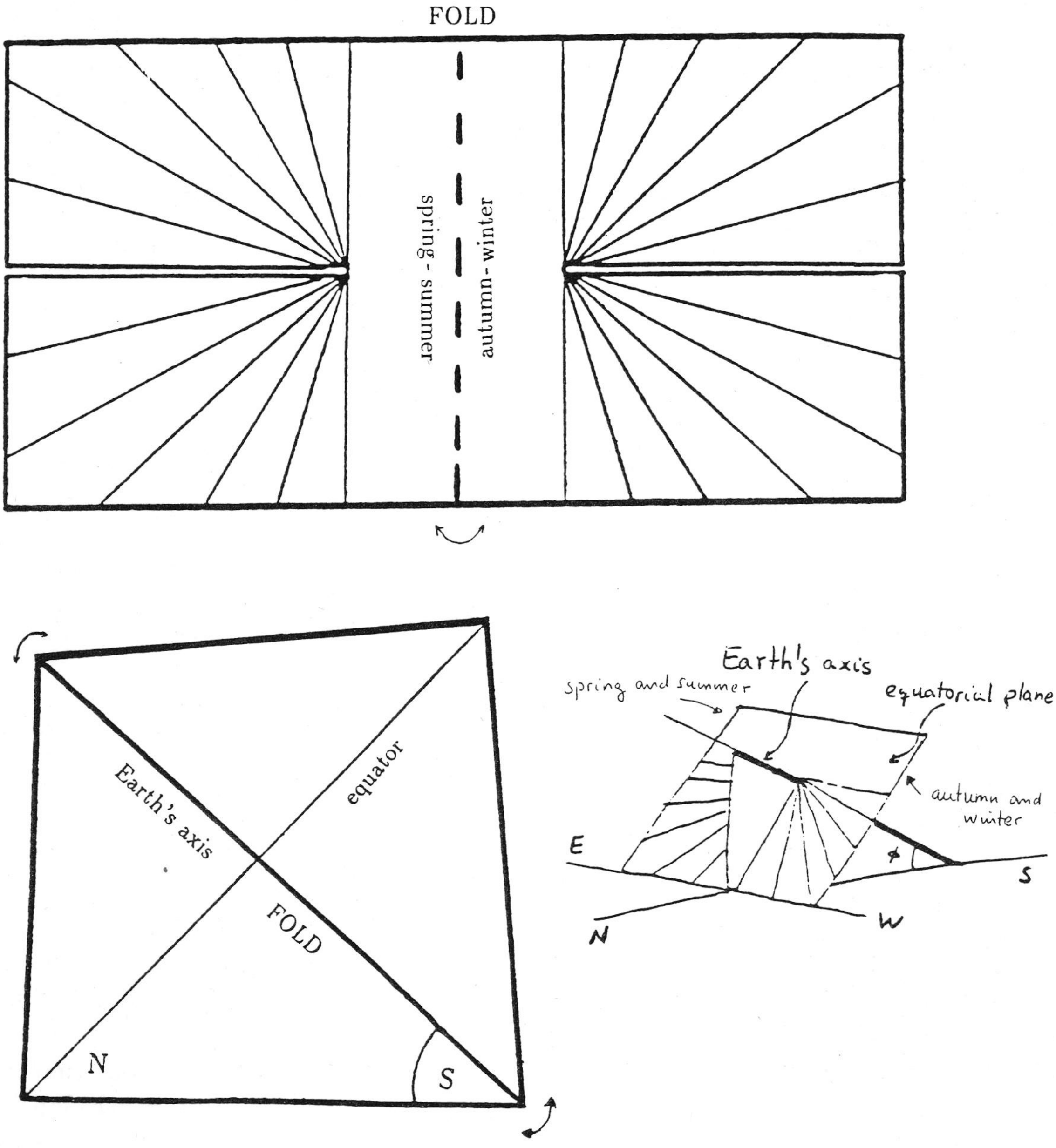

Figure 6: *Cutout equatorial sundial (place latitude* ϕ $= 42^o$*).*

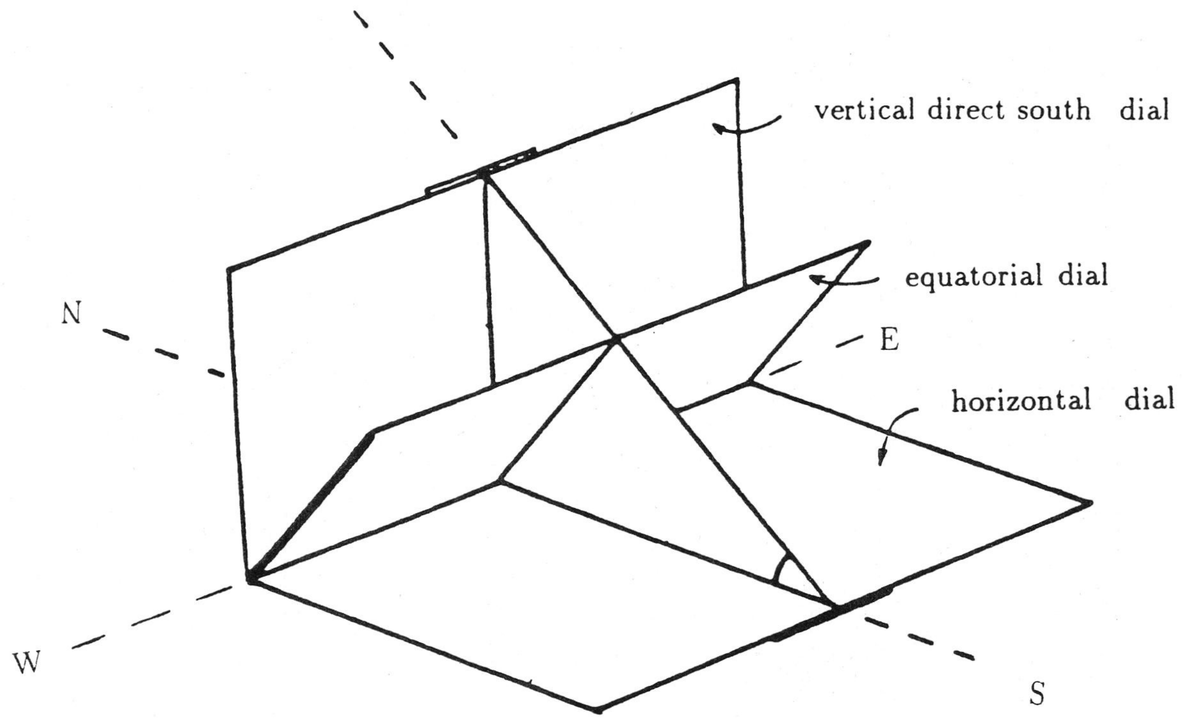

Figure 7: *Set of three dials : equatorial, horizontal and vertical direct south dial.*

4 Other sundials.

There are a lot of different sundials. We only present here horizontal dials and vertical direct south dials, because we propose to make a pocket dial and this is composed of the above-mentioned sundials.

The gnomon is always in the polar star direction (according Earth's axis). The only variable is the position of the horizontal plane (orientated according to the North-South line) or vertical plane (orientated according to the East-West line) (Fig. 7). Of course all the hour lines must always join up. So we produce them from the hour lines of the equatorial dial. From a didactic point of view, the following cutout dial (Fig. 8) makes it very easy to understand the relationship between the three dials (Fig. 7). To make the pocket dial we work from this cutout dial (the pocket dial is similar to this model but without the equatorial plane).

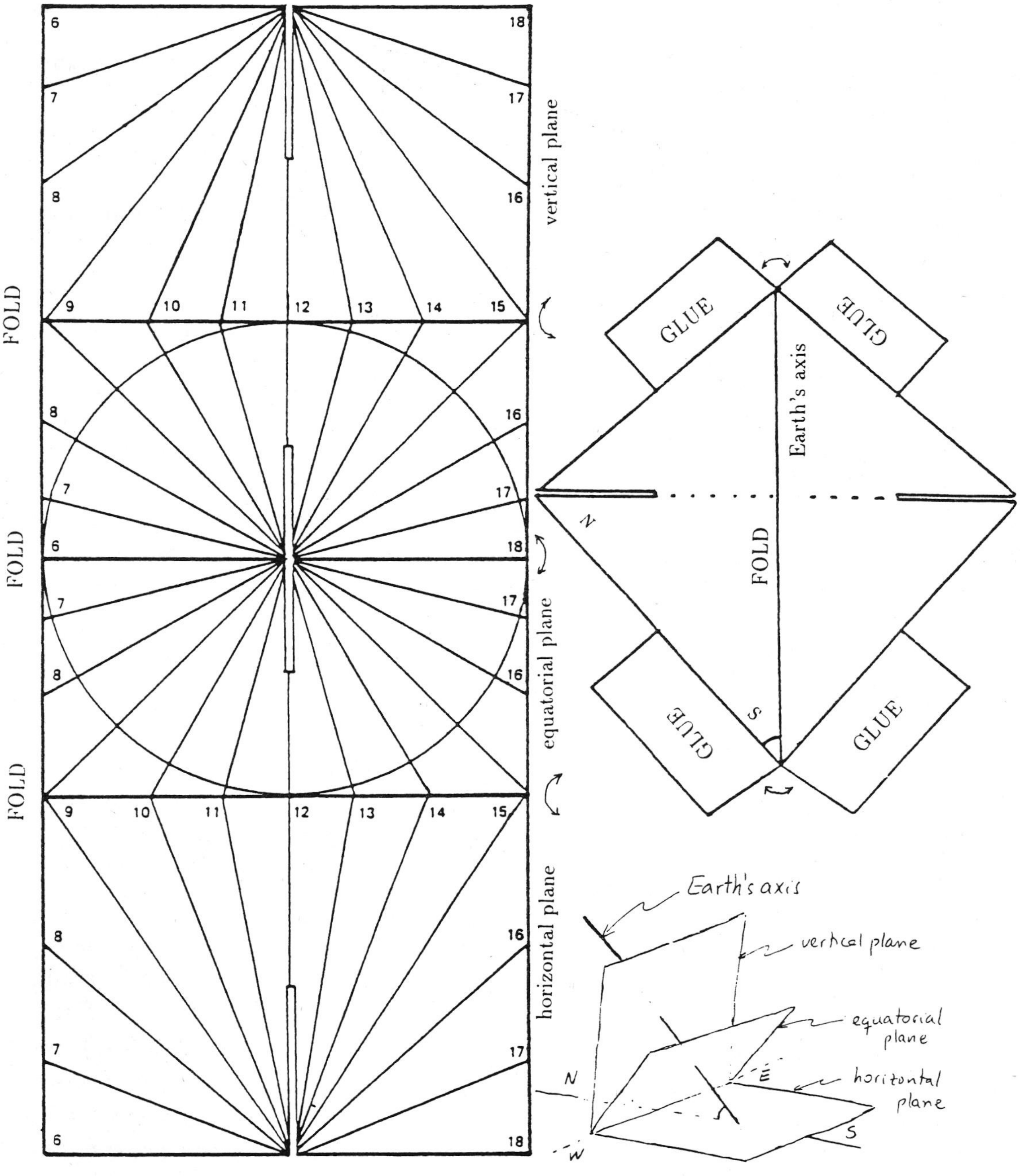

Figure 8: *Cutout sundials kit (place latitude phi = 42°).*

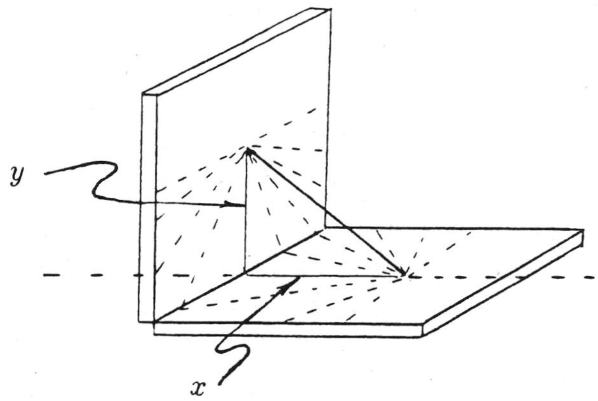

Figure 9: *Size of the pocket sundial.*

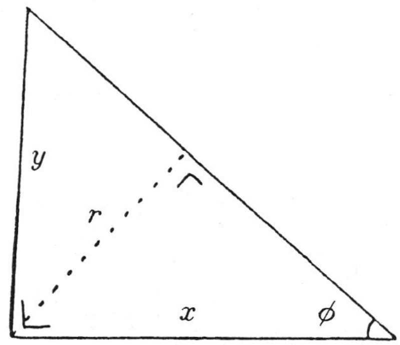

Figure 10: *Auxiliary rightangle triangle to relate horizontal and vertical direct south dials with the equatorial dial.*

To make a pocket sundial we have to make a horizontal dial and a vertical direct south dial. We present two different ways of doing it. The first one using geometric drawings and the second, using trigonometry and a computer program.

5 Pocket dial by geometric drawings.

Firstly we make the horizontal dial, then we need to decide the dimensions of our sundial. It will be x cm. (Fig. 9).

We make a rightangle triangle with the angle ϕ place latitude and the

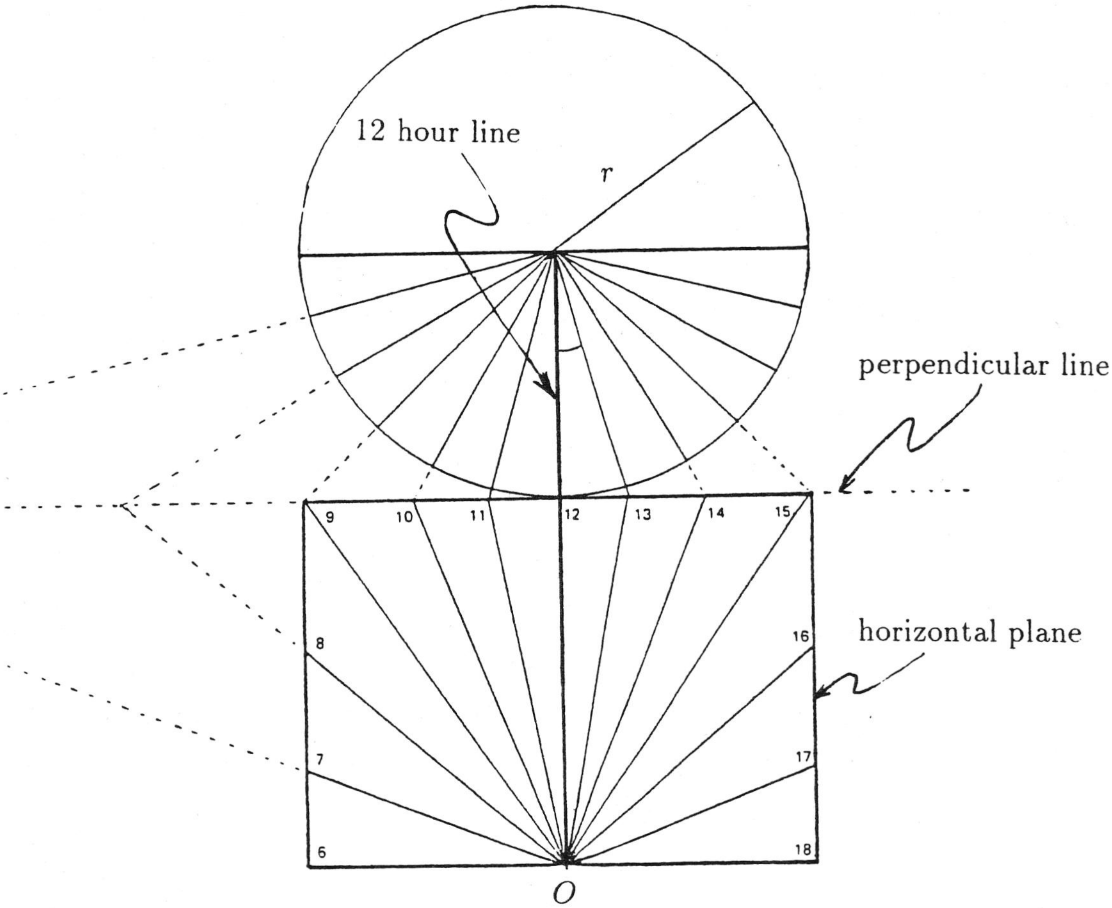

Figure 11: *Obtaining hour lines for the horizontal dial.*

side x (Fig. 10) and we take the distance r to draw a circumference with this radius.

We draw a straight line in the circle (the 12 hour line) and from this we draw lines at 15^o (Fig. 11) inside the circumference. We draw a line perpendicular to the 12 hour line and at tangent to the circumference. We extend all these hour lines of the equatorial dial to cut this perpendicular line. We extend the 12 hour line outside of the circumference by the distance x and we obtain the point O. We draw various straight lines from this point O to connect different points where the equatorial hour lines cut the perpendicular line. Then we select the square zone of our horizontal dial.

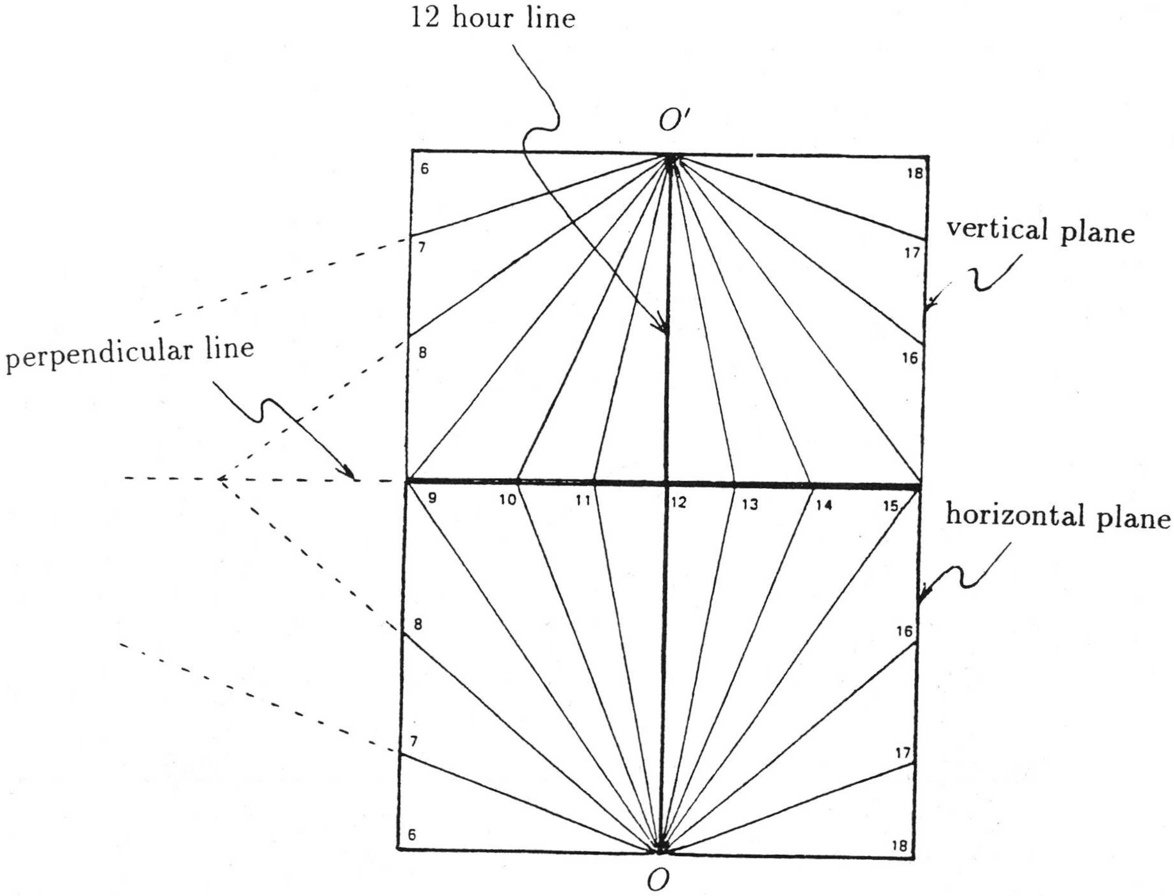

Figure 12: *Obtaining hour lines for the vertical direct south dial.*

Afterwards we make the vertical direct south dial. From figure 10 we also take the other side y and we make the square zone of the vertical direct south dial. From the horizontal dial we extend the 12 hour line outside the square zone of our horizontal dial by the distance y and we obtain the point O'. We only need to connect this point O' with the different points of the other hours on the perpendicular line (Fig 12).

Then we obtain the two sundials which form the pocket sundial (Fig. 13). To make the pocket dial, we only need to glue this figure 13 onto wood (or some other material) and put a twine from O to O' (Fig. 14) keeping the two planes perpendicular.

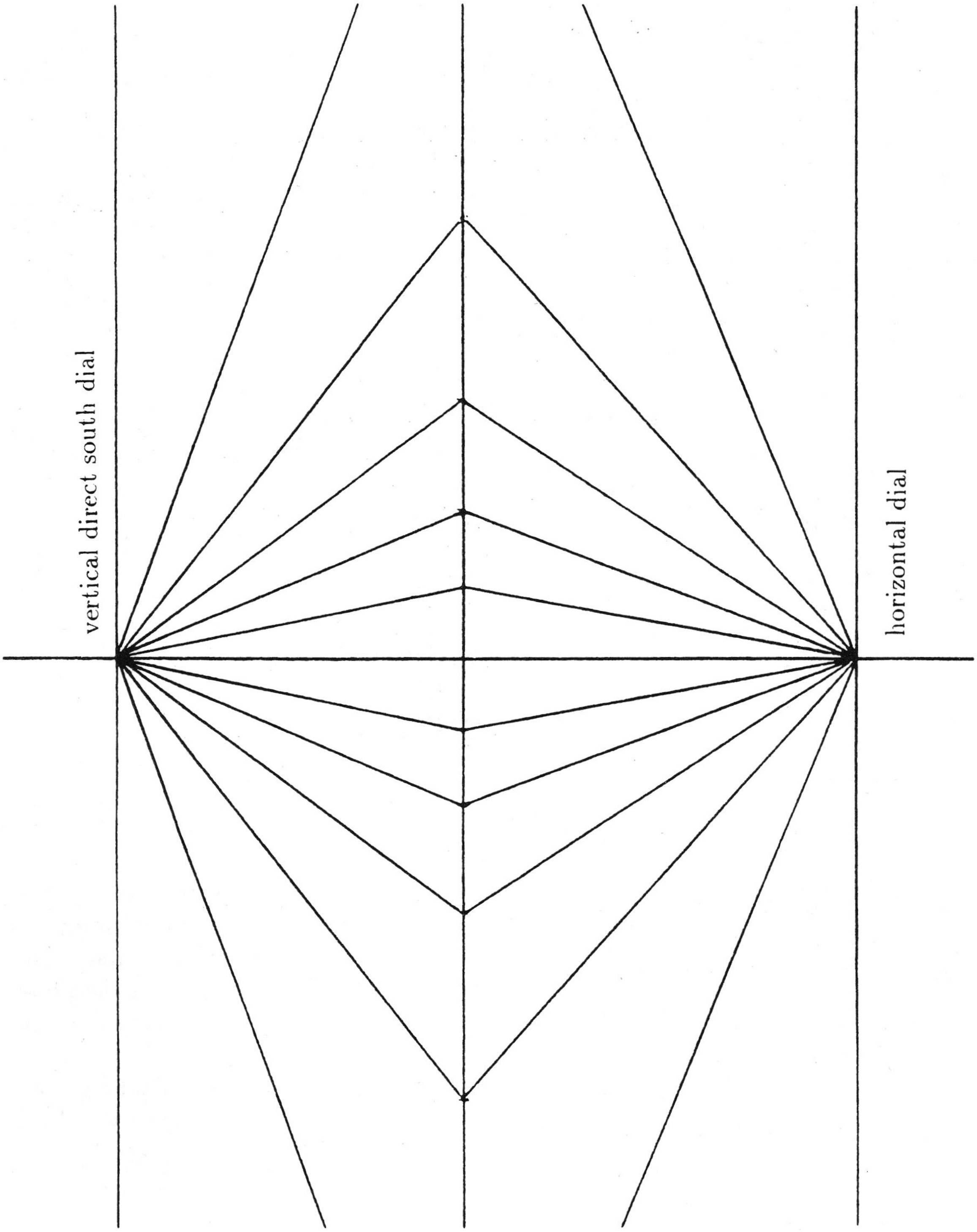

Figure 13: *Plane of two sundials which form a pocket sundial with place latitude* $\phi = 42^o$.

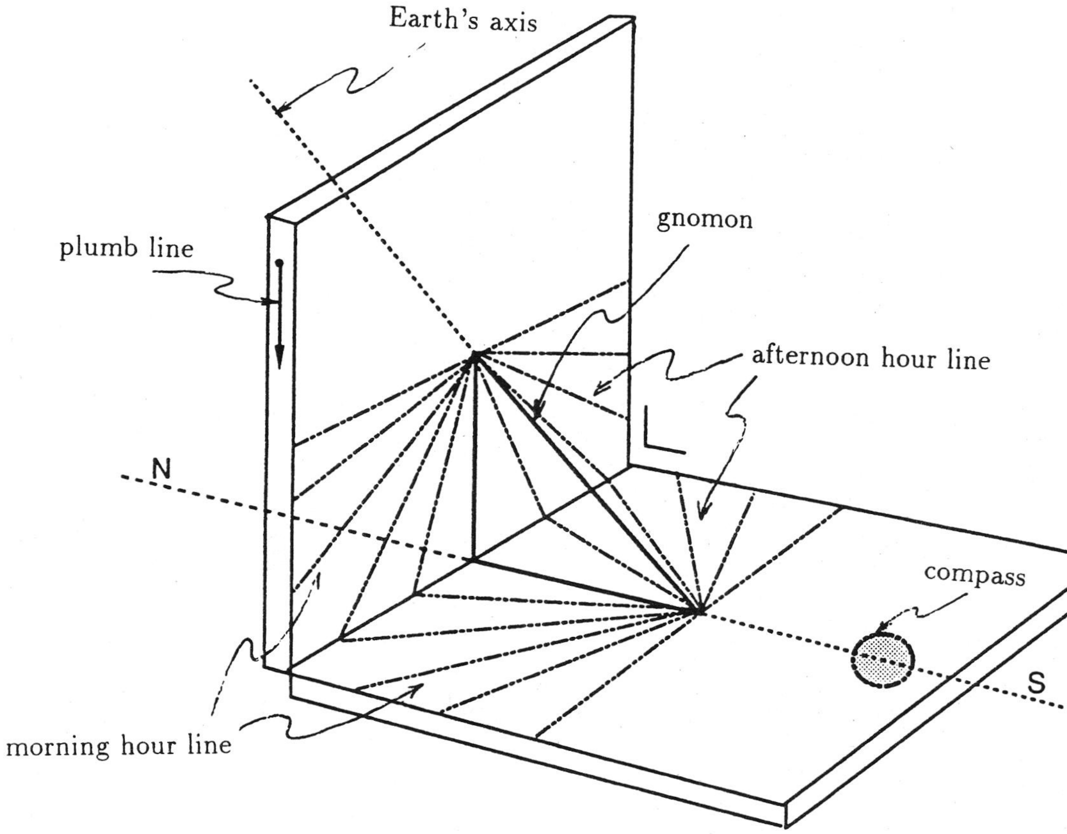

Figure 14: *Pocket sundial.*

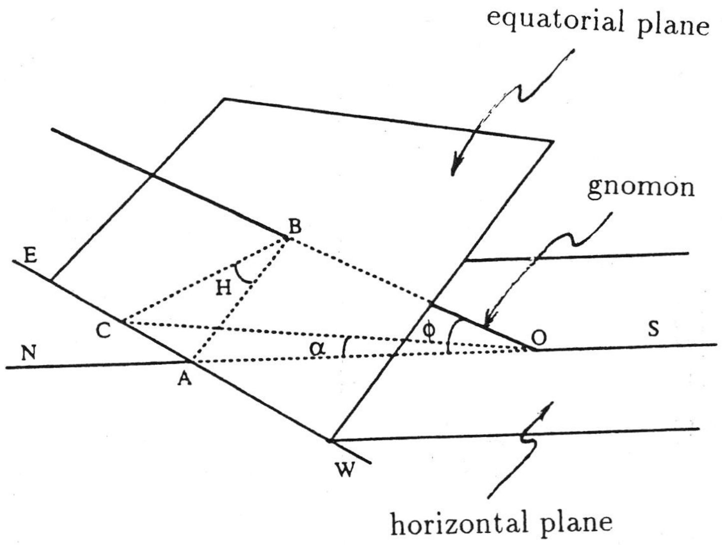

Figure 15: *Obtaining hour lines for the horizontal dial.*

6 Pocket dial by trigonometry and computer.

We begin by obtaining the angle α between two hour lines in the horizontal dial from the angles H between the equatorial hour lines. The line AB (12 hour line) in the horizontal dial and the line AO (12 hour line) in the equatorial dial are orientated to midday, to the North-South line (Fig. 15).

Using trigonometry definitions in rightangle triangles CAO, ABO and CAB, we obtain:

$$\tan\alpha = \tan H \sin\phi$$

where $H = 15^o, 30^o, 45^o, 60^o$ and 75^o, depending on the hour studied, and ϕ is the place latitude.

Analogous with the vertical direct south dial (Fig. 16), we obtain the angle β between two hour lines from the angle H between the equatorial hour lines. We also use the rightangle triangles CAO, ABO and CAB to obtain:

$$\tan\beta = \tan H \cos\phi$$

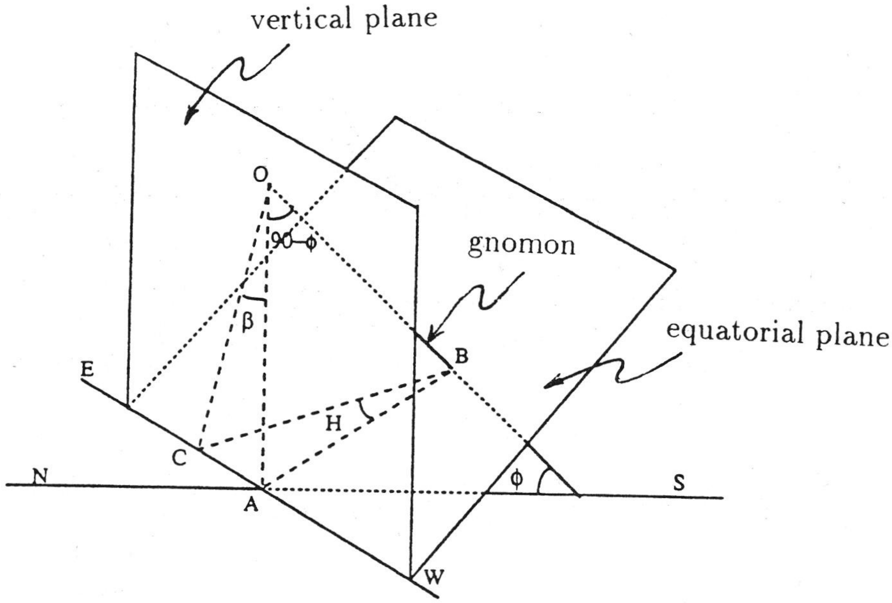

Figure 16: *Obtaining hour lines for the vertical direct south dial.*

where $H = 15^o, 30^o, 45^o, 60^o$ and 75^o, and ϕ is the place latitude.

We can make a program with the computer to calculate or to draw these angles α and β.

To relate both sundials, we decide the distance x (Fig. 9 and 10), the distance y is obtained using trigonometry definitions in rightangle triangle of figure 10,

$$y = x \tan \phi$$

where ϕ is the place latitude.

After drawing the two planes of the horizontal and vertical direct south dial (Fig. 13) we can make the pocket sundial (Fig. 14).

7 To make the pocket dial.

We take two rectangular pieces of wood or other material (with accurate perpendicular sides) and we put on two hinges. Perpendicular to the hinges' axis line, we draw, on each piece, the 12 hour line. In one of these pieces we have to cut a round hole where we have to put a compass (Fig. 17).

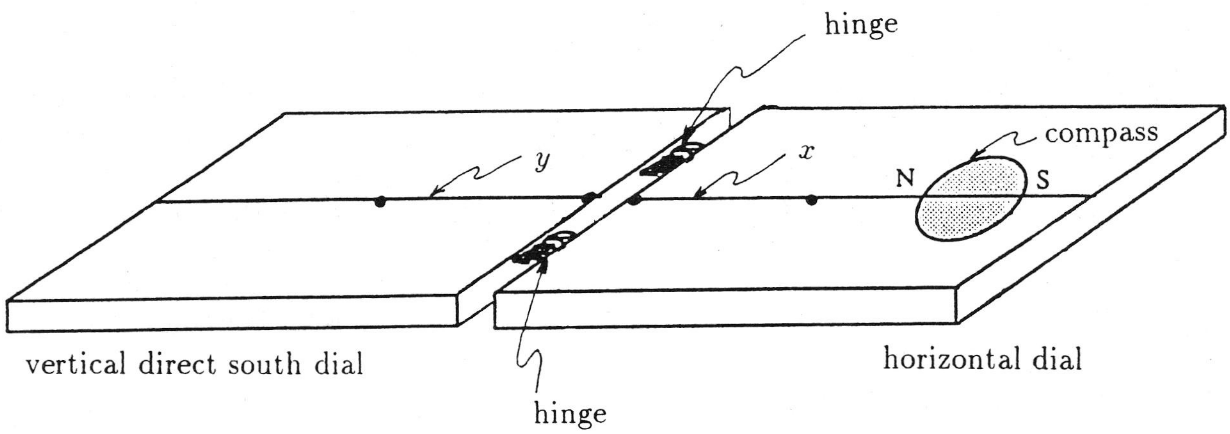

Figure 17: *Making the pocket sundial.*

It is also necessary to introduce a spirit level in the horizontal dial or a plumb line in the vertical direct south dial (Fig. 14).

When we use the sundial it is necessary to make it level and orientate it (compass to North).

8 Time equation.

Up to now we have considered that the Sun follows its orbit around the Earth at a uniform speed, but really it is the Earth which is moving. Now we consider the Earth follows its orbit in accordance with the Keppler's Law of Areas. So, the Sun does not have the same speed during the year. Of course, this produces irregular behaviour in solar time. The difference between the regular time of our watch and the irregular sundial time is called the time equation E. This parameter is in table 1, where we present the values which are necessary to add or subtract (according to the sign) from the sundial time.

It is a good idea to glue this table to the pocket sundial. The time equation changes approximately half an hour. If we forget this value E, on the time that we read will be erroneous, and the sundial will seem badly made.

day	January m s	February m s	March m s	April m s	May m s	June m s
1	+ 3 23	+ 13 35	+ 12 31	+ 4 4	− 2 53	− 2 23
2	+ 3 51	+ 13 43	+ 12 19	+ 3 46	− 3 0	− 2 14
3	+ 4 19	+ 13 50	+ 12 7	+ 3 29	− 3 7	− 2 5
4	+ 4 47	+ 13 57	+ 11 55	+ 3 11	− 3 13	− 1 55
5	+ 5 14	+ 14 2	+ 11 42	+ 2 53	− 3 19	− 1 45
6	+ 5 41	+ 14 7	+ 11 29	+ 2 36	− 3 24	− 1 34
7	+ 6 7	+ 14 11	+ 11 15	+ 2 19	− 3 29	− 1 23
8	+ 6 33	+ 14 14	+ 11 0	+ 2 2	− 3 33	− 1 12
9	+ 6 58	+ 14 16	+ 10 45	+ 1 45	− 3 36	− 1 1
10	+ 7 23	+ 14 18	+ 10 30	+ 1 29	− 3 39	− 0 49
11	+ 7 47	+ 14 19	+ 10 14	+ 1 13	− 3 41	− 0 37
12	+ 8 11	+ 14 19	+ 9 58	+ 0 57	− 3 43	− 0 25
13	+ 8 34	+ 14 18	+ 9 42	+ 0 41	− 3 44	− 0 13
14	+ 8 57	+ 14 16	+ 9 26	+ 0 25	− 3 45	− 0 1
15	+ 9 18	+ 14 14	+ 9 9	+ 0 10	− 3 45	+ 0 12
16	+ 9 39	+ 14 11	+ 8 52	− 0 5	− 3 45	+ 0 25
17	+ 10 0	+ 14 7	+ 8 35	− 0 19	− 3 44	+ 0 38
18	+ 10 19	+ 14 2	+ 8 17	− 0 33	− 3 42	+ 0 51
19	+ 10 38	+ 13 57	+ 7 59	− 0 46	− 3 40	+ 1 4
20	+ 10 56	+ 13 51	+ 7 42	− 0 59	− 3 37	+ 1 17
21	+ 11 14	+ 13 45	+ 7 24	− 1 12	− 3 34	+ 1 30
22	+ 11 30	+ 13 38	+ 7 6	− 1 25	− 3 30	+ 1 43
23	+ 11 48	+ 13 30	+ 6 48	− 1 37	− 3 26	+ 1 56
24	+ 12 2	+ 13 21	+ 6 29	− 1 48	− 3 21	+ 2 9
25	+ 12 16	+ 13 12	+ 6 11	− 1 59	− 3 16	+ 2 22
26	+ 12 30	+ 13 3	+ 5 53	− 2 9	− 3 10	+ 2 34
27	+ 12 43	+ 12 53	+ 5 35	− 2 19	− 3 3	+ 2 47
28	+ 12 55	+ 12 42	+ 5 16	− 2 28	− 2 56	+ 3 0
29	+ 13 6		+ 4 58	− 2 37	− 2 49	+ 3 12
30	+ 13 16		+ 4 40	− 2 45	− 2 41	+ 3 24
31	+ 13 26		+ 4 22		− 2 32	

day	July m s	August m s	September m s	October m s	November m s	December m s
1	+ 3 36	+ 6 16	+ 0 9	− 10 8	− 16 21	− 11 9
2	+ 3 48	+ 6 13	− 0 10	− 10 27	− 16 23	− 10 46
3	+ 3 59	+ 6 9	− 0 29	− 10 46	− 16 24	− 10 23
4	+ 4 10	+ 6 4	− 0 48	− 11 5	− 16 24	− 10 0
5	+ 4 21	+ 5 58	− 1 8	− 11 23	− 16 23	− 9 36
6	+ 4 32	+ 5 52	− 1 28	− 11 41	− 16 21	− 9 11
7	+ 4 42	+ 5 46	− 1 48	− 11 59	− 16 19	− 8 45
8	+ 4 52	+ 5 39	− 2 9	− 12 16	− 16 16	− 8 19
9	+ 5 1	+ 5 31	− 2 29	− 12 33	− 16 12	− 7 53
10	+ 5 9	+ 5 22	− 2 50	− 12 49	− 16 7	− 7 26
11	+ 5 18	+ 5 13	− 3 11	− 13 5	− 16 1	− 6 59
12	+ 5 26	+ 5 3	− 3 32	− 13 21	− 15 54	− 6 32
13	+ 5 33	+ 4 53	− 3 53	− 13 36	− 15 46	− 6 4
14	+ 5 40	+ 4 42	− 4 15	− 13 50	− 15 38	− 5 35
15	+ 5 47	+ 4 31	− 4 36	− 14 4	− 15 29	− 5 6
16	+ 5 53	+ 4 19	− 4 57	− 14 18	− 15 19	− 4 38
17	+ 5 59	+ 4 7	− 5 19	− 14 31	− 15 8	− 4 9
18	+ 6 4	+ 3 54	− 5 40	− 14 43	− 14 56	− 3 39
19	+ 6 8	+ 3 41	− 6 1	− 14 54	− 14 43	− 3 10
20	+ 6 12	+ 3 27	− 6 23	− 15 5	− 14 29	− 2 40
21	+ 6 16	+ 3 13	− 6 44	− 15 15	− 14 15	− 2 10
22	+ 6 19	+ 2 58	− 7 5	− 15 25	− 14 0	− 1 40
23	+ 6 21	+ 2 43	− 7 26	− 15 34	− 13 44	− 1 10
24	+ 6 23	+ 2 37	− 7 47	− 15 42	− 13 27	− 0 40
25	+ 6 24	+ 2 11	− 8 8	− 15 49	− 13 8	− 0 10
26	+ 6 25	+ 1 55	− 8 28	− 15 56	− 12 51	+ 0 20
27	+ 6 25	+ 1 39	− 8 48	− 16 2	− 12 32	+ 0 50
28	+ 6 24	+ 1 23	− 8 9	− 16 7	− 12 13	+ 1 19
29	+ 6 23	+ 1 4	− 9 19	− 16 12	− 11 52	+ 1 49
30	+ 6 21	+ 0 46	− 9 49	− 16 16	− 11 31	+ 2 18
31	+ 6 19	+ 0 28		− 16 19		+ 2 47

Table 1: Time equation.

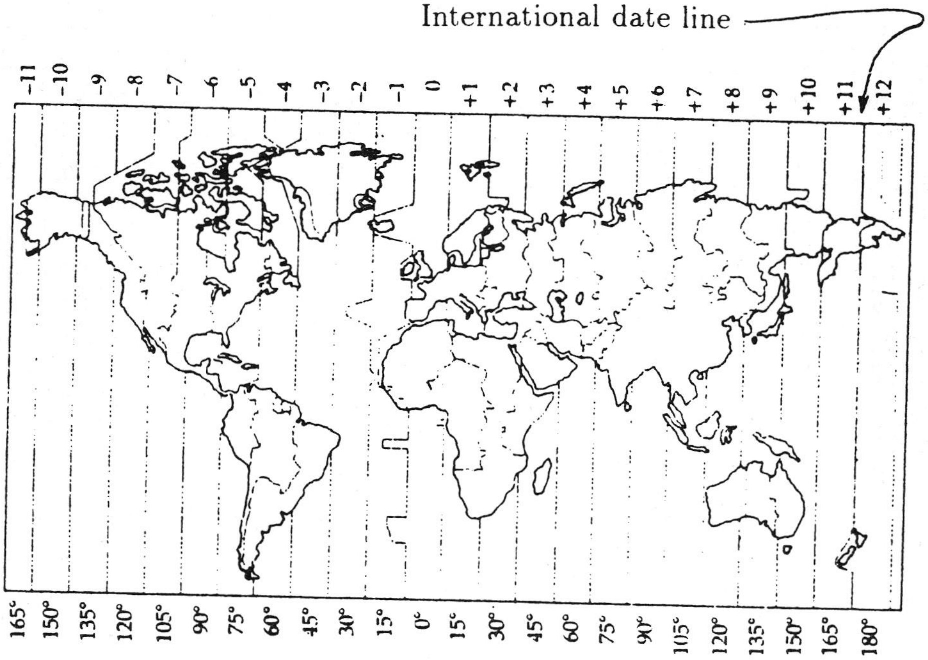

Figure 18: *Earth's surface divided in to 24 time zones.*

9 Sundials depend on the place.

We saw during the previous explanation that it is necessary to introduce the place latitude ϕ in the sundial (to orientate the gnomon). The sundial depends on the place where we would like to use it. But of course we can use the same sundial in all the places of Earth along the same parallel.

But it is also necessary to read the hour of the longitude of the place where we use the sundial. The value of the place longitude tell us the distance, in hours, between the Greenwich meridian (zero of longitudes) and the place meridian.

The sundial shows solar time. But our watch does not show either solar time or Greenwich time, normally our watch shows the hour of our time zone (Fig. 18). Theoretically, each time zone is in accordance with a zone of 15^o of longitude, and all the places of this zone have the same time, though these

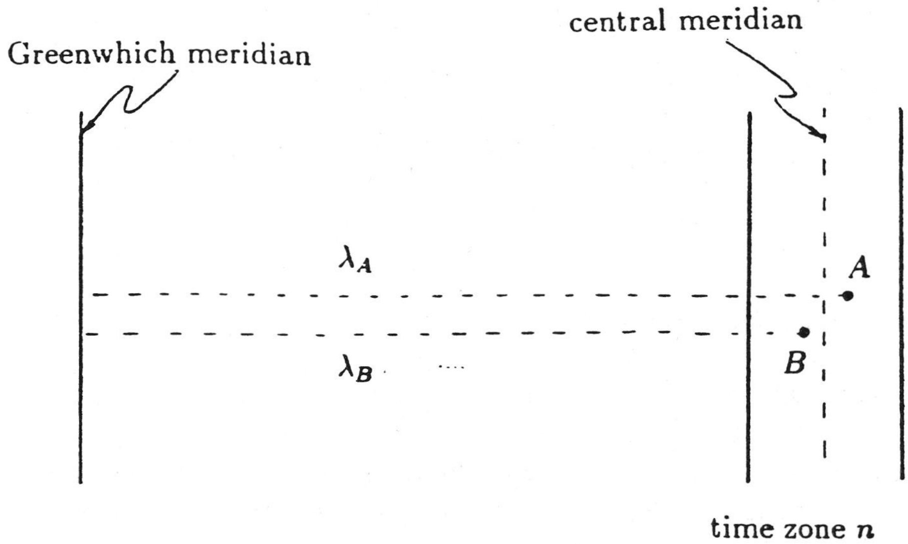

Figure 19: *An example of the relationship between West longitudes and time zones.*

places have different solar times. In practice, the time zones are distorted according to the conventions of each area. We have to note there are countries and areas with local deviations from the time adopted in the time zone.

Our aim is to obtain a relationship between the time given by our watch and by our sundial.

We name n the difference of hours between the time zone where we use the sundial and the Greenwich meridian. Let λ be the latitude where we are situated. We introduce the relationship between the watch time and the sundial time through an example.

If we are in place A, with West longitude λ_A hours, situated inside the time zone with n hours, when the Sun is over the Greenwich meridian (12 hours on the Greenwich sundial) the time in our time zone is $12 + n$ hours and the sundial time is $12 + \lambda_A$ hours, because the Sun passes firstly over A, then over the central meridian of the time zone (which assigns the time to the time zone) and finally over Greenwich. So to compare the watch time with the sundial time, we have to add $n - \lambda_A$ hours from the sundial time (Fig. 19).

Then the relationship is,

$$Watch\ \ time = Sundial\ \ time + E + (n - \lambda)\ \ \ to\ \ West$$

On the analogy of places with East longitude, the relationship is,

$$Watch\ \ time = Sundial\ \ time + E - (n - \lambda)\ \ \ to\ \ East$$

10 Final comments.

According to section 5 or 6, our students can make a pocket sundial and they can use it according to sections 8 and 9.

We believe that following this experiment our students will be more attracted by astronomy. In this case, it will be interesting to complete the section 6 using a computer to include a calendar (lines of the zodiac) in the pocket sundial.

11 References.

BROMAN, L., ESTALELLA, R., ROS, R.M., *Experimentos de Astronomía*, Editorial Alhambra, Madrid, 1988.

JENKINS, G., BEAR, M., *Sundials and Timedials*, Tarquin Publications, Norfolk, 1987.

ROS, R.M., FABREGAT, J., *Some kinds of conics shadows*, Teaching of Astronomy in Asian - Pacific Region, 8, 19, 27, Mintaka - Tokyo, 1994.

SOLER, R., *Diseño y construcción de Relojes de Sol. Métodos gráficos y analíticos*, Colegio de Ingenieros de Caminos, Canales y Puertos, Turner Libros S.A., Madrid, 1989.

The Use of APTs in the Development of Astronomy

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Abstract

The development of an automatic photometric telescope (APT) at the Kotipu Place Observatory is summarized. This project has interesting implications for low-budget contexts, e. g. amateur and school groups.

Its application to useful astronomical research programs is briefly reviewed, with some recent results presented.

The parallel directions of skill development in fields such as computer programming, mechanical and electrical engineering and cybernetics are also noted.

1 Introduction

For stages in the development see e.g. Loudon *et al.* (1992), Hudson *et al.*, (1993) and Hudson and Hudson (1994), and references cited therein. Some general background remarks on this type of facility are also in Budding (1993).

Key points:

(i) LOW COST.

(ii) AUTOMATION — implying the production advantage of e.g. bulk industrial component assembly.

(iii) RESEARCH — photometric data gathering capability for stars brighter than ~10th magnitude, and lesser capability for fainter stars.

(iv) NETWORKING potential — INTERNET connectivity. E-mail requests in standardized format can be processed.

2 Costs

The basic set-up, which included mostly ready-made components (apart from the observatory itself), has probably cost ~ **\$20000(US)**. There seems no major reason why the central links in the main control loop: computer → drive stepping motors and photometer (with prearranged signal level criteria) → computer; cannot be contrived with **home built units, drastically reducing costs** to those relevant for the **amateur or school-group budget — say, few×\$1000(US)**.

The funding for the capital items in Carter Observatory's APT, sited at the Kotipu Place Observatory some 30 km north of Wellington, was provided, for the most part, by the New Zealand Lotteries Commission (Lottery Science).

3 Astronomy

SU Ind

Observations of the southern eclipsing binary system SU Ind (= HD198827, SAO 230428) were reported in *IBVS* 3979 (Budding *et al.*, 1994a). It is a good example of those less conspicuous variable stars, well to the south on the celestial sphere, which have been **generally neglected** compared with northern counterparts.

The only older published light curve appears to be that of Hoffmeister (1956), which has very incomplete coverage of the secondary minimum. This has given rise to some unfortunate misimpressions (cf. Giuricin *et al.*, 1983). Budding *et al.*'s (1994) symmetric light curves (Figure 1) indicate the system to be probably composed of two almost identical stars, whose mutual eclipses are of closely comparable depths.

R CMa

Attention was again called to the peculiarities of this system by Budding *et al.* (1992), where it was stressed that **more observations**, particularly timings of the eclipse minima, could be **useful** in helping understand its **unusual close binary configuration** (low mass ratio *and* low period).

An interim summary of the system was presented by Budding *et al.* (1994b), in which observations from the Kotipu Place APT were included. These data were gathered with a solid state PIN diode detector, incorporated in an Optec 3 (tradename) photometer. The relatively poor precision — particularly at the shorter *B* and *U* wavelengths — was evident from comparisons with near-simultaneous *UBV* photometry of conventional type using a tube photomultiplier.

A photomultiplier type photometer (Optec 5) has recently replaced the photodiode one, and *UBV* observations of R CMa were continued over the last season. Corresponding improvements in data precision can be discerned in Figure 2.

With regard to the possibility of a gravitational interaction mechanism giving rise to the presently observed configuration, on the basis of a third body subtracting

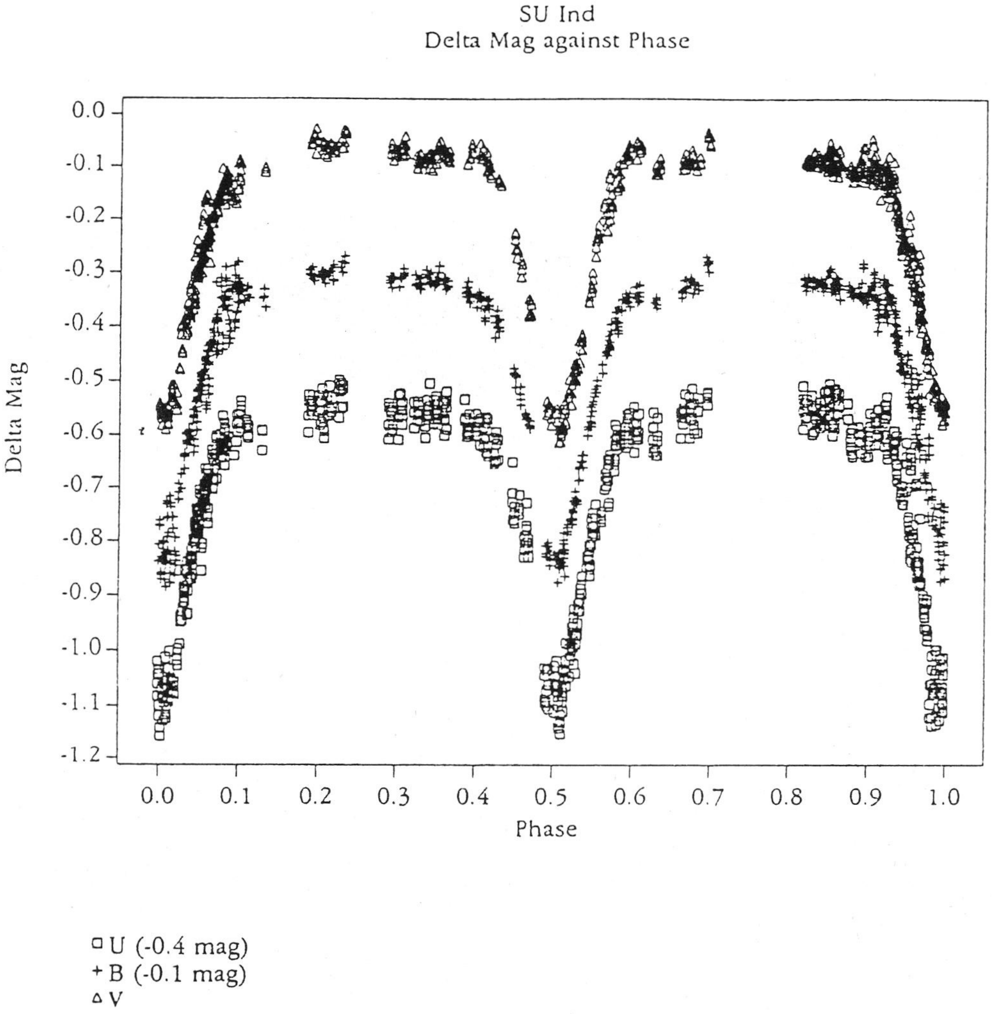


Figure 1: UBV Light curves of SU Ind

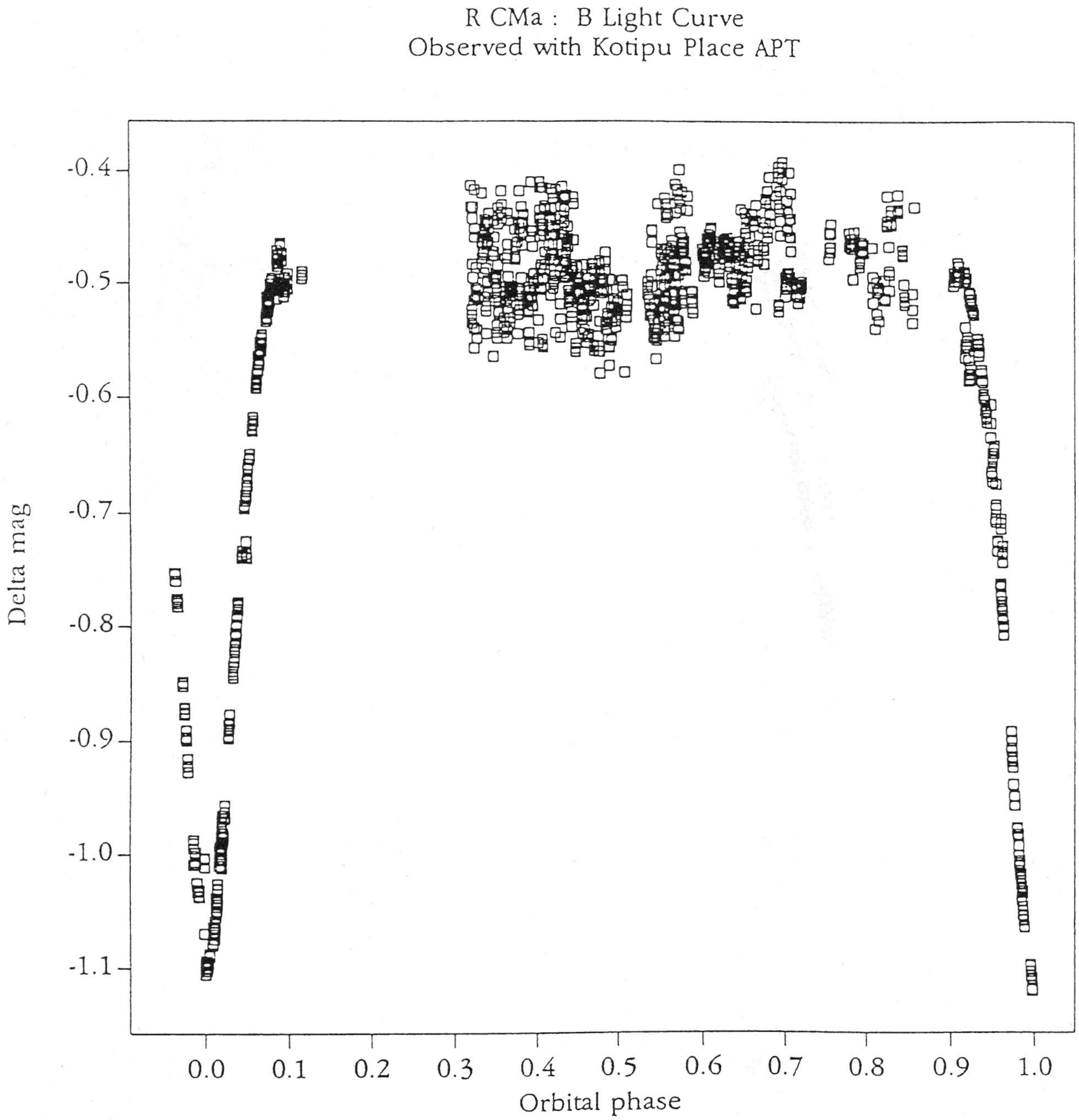


Figure 2: B light curve of R CMa. 1415 raw data points, observed in 1992,3 and 1993,4 summers, are plotted here. The primary eclipses were only observed in 1994 with the APT. The 1992,3 summer data were mostly made with the Optec SSP3 photometer, which has significantly bigger scatter (up to ~0.1 mag — e.g. phase ~0.3) in this data than the SSP5 (~0.03 mag in fair weather — e.g. phase ~0.58 and primary minima).

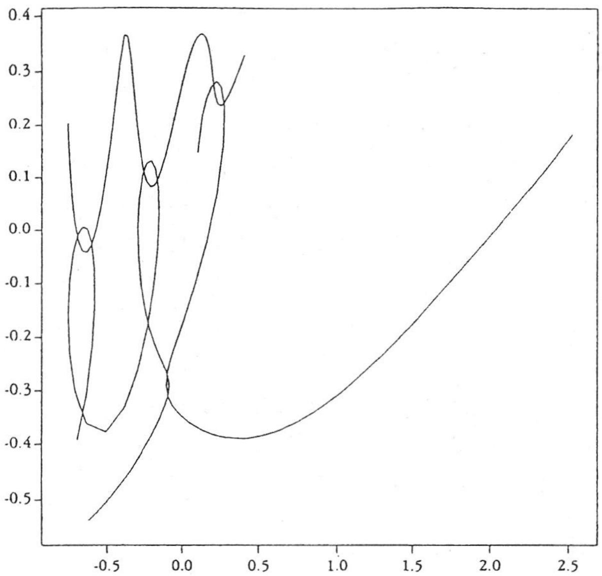


Figure 3: Three body interaction calculated according to the code of Alexander (1986). The centre of mass of the three body system is at the origin. The horizontal scale is much compressed compared with the vertical. The original binary moves to the right and encounters a third body, which 'exchanges' with the less massive component of the original binary.

some of the potential energy of the central binary system (Budding *et al.*, 1994), the 'recalcitrant' tendency of 'hard' binaries on encounters with third bodies has been noted, for example, by Lynden-Bell (1969). We mention here the possibility of Monte Carlo type testing of the hypothesis. This uses the code devised by Alexander (1986) (see also Stryker, 1993) to compute fully self-consistent 3 body dynamical interactions. Because of the inherent complexity of the problem in analytic terms, scattering experiments which suitably sample feasible starting configurations play a useful role. These statistically check the likely outcome of particular three body interactions by following the motion through to a stable end state, which may take different forms, e.g. 'ionization' of one of, or 'exchange' between, the components. Such tests have been started. We show a preliminary example in Figure 3.

4 Education

In order to arrive at productive APT data delivery, a number of developments have to occur. In our case we had to devise programs capable of 'talking' to the dedicated microcomputer ('CCT') which controlled the stepping motors of the original machine. Some awareness of the requirements for fast control code execution are entailed in such operations. This implies suitable **programming skills**, perhaps at assembler language level.

Strongly influencing overall APT performance criteria are its **mechanical**

and electrical tolerances. Low-costs will, unfortunately, usually impinge on this. Thus, the small, non-spring-loaded worm and wheel drive of our telescope has a locational accuracy, for an assigned RA position, of only ~0.5 arcminute. The **sampling rate** for the **microcomputer control** lines also influences this. In practice, we can only work with a 1 arcmin diaphragm on our photometer. Of course, this feeds back into achievable astronomical targets.

If we invert this issue it becomes a **design problem**. We may then ask what are the requirements, in electrical and mechanical engineering terms, necessary to achieve preassigned astronomical goals. The answer implies some **education** in these other disciplines for the amateur astronomer, and can engender some learning about learning itself, as the next Section shows.

5 Cybernetics

Our APT is a **very simple robot astronomer**. We 'tell' the robot what to do, and then leave it to carry on. As with other such simple computer controlled system, it cannot think for itself, and **follows any 'silly' instructions** that the programmer didn't fully think through.

Nowadays, **artificial intelligence** designers are utilizing such concepts as 'fuzzy logic' and 'network circuitry' (cf. e.g. Veitch, 1993; Charniak, 1985; Goldberg, 1989). to allow more complex electronic devices to 'learn' from their experiences. In the present context this concerns **dealing with certain extraordinary situations** which may arise. For example, how and when to close down, or temporarily cease data collection in a variable weather environment; to avoid observing at too large air masses or notice line-of-sight obstacles; not to twist cables or bump into objects; and so on.

The experience gained with human tending of the APT through such operations offers interesting glimpses into the large and complex world of cybernetics, and allows the basis of planning for **smart control**.

6 References

Alexander, M. E., 1986, *J. Computational Phys.*, **64**, 195.

Budding, E., 1993, *Introduction to Astronomical Photometry*, Cambridge Univ. Press, Cambridge.

Budding, E., Wood, F. B. and Chen, K-Y., 1992, *Inf. Bull. Variable Stars* #3734.

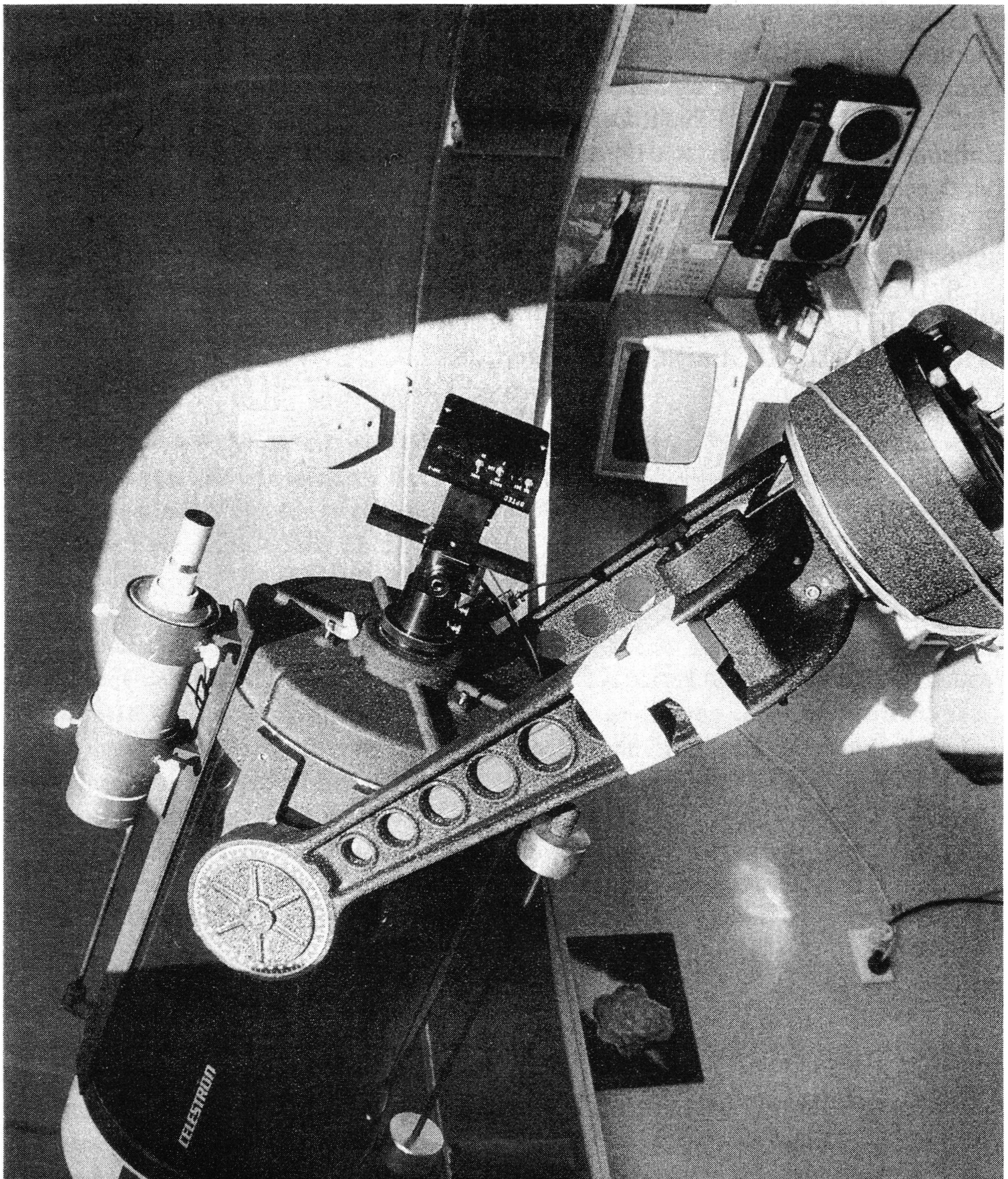
Budding, E., Hudson, G., Hudson, R. and Priestley, J., 1994a, *Inf. Bull. Variable Stars* #3979.

Budding, E., Chen, K-Y., Hudson, G., Hudson, R. Thomas, M. and Wood, F. B., 1994b, *Experimental Astron.*, (in press).

Charniak, E., 1985, *Introduction to Artificial Intelligence*, Addison-Wesley Publ. Co.

Goldberg, D. E., 1989, *Genetic Algorithms in Search Optimization and Machine*

Learning, Addison-Wesley Publ. Co.
Guiricin, G., Mardirossian, F. and Mezzetti, M., 1983, *Astron. Astrophys. Suppl. Ser.*, **54**, 211.
Hoffmeister, C., 1956, *Veröff. Stern. Sonneberg* **3**, 1.
Hudson, G., Hudson, R. and Budding, E., 1993, in *Proceedings IAU Coll. 136*, ed. C. J. Butler and I. Elliott, Cambridge Univ. Press.
Hudson, G. and Hudson, R., 1994, *Experimental Astron.*, (in press).
Loudon, M., Priestley, J. and Budding, E., 1992, *Astron. Soc. Pacific Conf. Ser.*, ed. S. J. Adelman, R. J. Dukes, C. J. Adelman, **28**, 41.
Lynden-Bell, D., 1969, in *Astrophysics and General Relativity Vol. 1*, ed. M. Chrétien, S. Deser and J. Goldstein, Gordon and Breach, New York, p1.
Stryker, L. L., 1993, *Publ. Astron. Soc. Pacific*, **105**, 1081.
Veitch, N., 1993, *CU Amiga*, April Issue, p28.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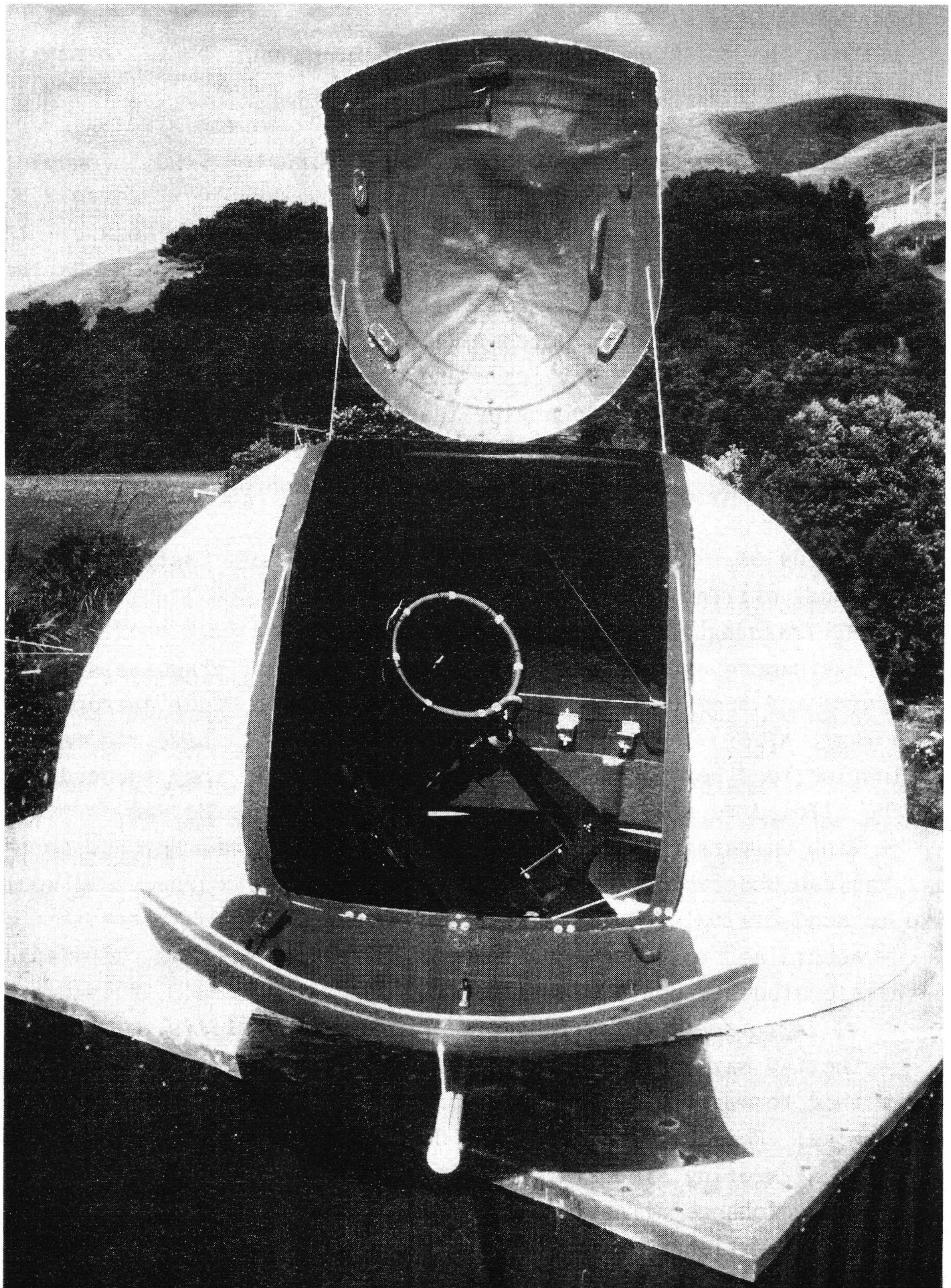

PROMOTION OF ASTRONOMY IN VIET NAM

Nguyen Dinh Huan
Vinh University

Recently, Vietnamese Astronomers have tried to find the way to promote Astronomy.

According to the memoranda on the visits by Prof. Y. Kozai, IAU President to the Vietnam in April 1991 and Prof. A. H. Batten, Chairman of the IAU Working Group for the Worldwide Development of Astronomy to Vietnam in October 1993; after the International Conference on "Particle Physics and Astrophysics" in Hanoi in December 1993; and after exchanging ideas with Prof. Y. Kozai, Prof. A. H. Batten, Prof. S. Isobe, Prof. N. Q. Rieu and other colleagues, we have some proposals for the propotion of Astronomy in Vietnam as follows:

1- Fields of training and improvement of Astronomers' professional skills:

** Training Vietnamese graduate students:*

- Vietnamese Astronomers will select the best graduate students of Physics and send them to French Universities to study Astrophysics for a year. After one year studying, they will have to take an examination together with French colleagues. If they succeed,they will be allowed to study another three years towards the PhD.
- Vinh University will send a graduate student of Physics to the next Vatican Observatory Summer School. After this course, we would like to send him to study a master's programme.
- According to Prof. Y. Kozai, Director of NAO of Japan, Vietnamese students could be trained in Japan.

** Improvement of Astronomers' professional skills.*

- The IAU may award grants to qualified Vietnamese Astronomers to enable them to work, practise and improve their professional skills in Astronomical Research Centers in developed countries, to attend Astronomical meeting symposia, colloquia of the IAU and support them through the exchange of Astronomers' Programmes.
- The traditional forms of the Visting Lecturers Programmes or International Schools for Young Astronomers may have to be modified for Vietnam. In the mean time, the Vietnamese should be encouraged to go on sending people to any ISYA that is held feasonably close to our country.

- Vietnamese Astronomers would like to visit laboratories in developed contries in order to get familiarized with modern Astrophysics, including the technical aspects such as the problems of telecommunication, teledetection, detectors and receivers.

- Foreign scientists could also participate in writing Astronomical books and teaching Astronomy in Vietnam together with the Vietnamese professors.

- On October 24th, 1995 there is to be a total eclipse of the Sun. We would like to invite Astronomers from North America, France and nearby countries to a meeting timed to coincide with this eclipse.

2- Building material facilities for training and studying proposes.

- With the help of Prof. A. H. Batten, Vietnamese Astronomers have received "Sky and Telescope", "The Quarterly Bulletin of Solar Activity", the Astronomical Almanac for 1995 and a set of posters of NASSA.

- The building of the National Observatory can well wait until after the year 2000. Now, we need teaching telescopes in the range of aperture from 0.15 to 0.3 m for Vinh University and Hanoi Pedagogical Institute.

- In order to develop Astronomy in Vietnam, we are planning to build an Astronomical training and studying center at Vinh University.

At present, Vietnam is facing many difficulties to promote Astronomical activities and need the help of the IAU, other organization and developed countries.

Vietnamese Astronomers hope that with the generous assistance and cooperation of the IAU, other organizations and developed countries, Vietnamese Astronomers will find our position in the International Astronomical Community in the near future.

Extramural courses in Astronomy in Sweden

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In 1977, courses of a new kind were introduced in astronomy at the Gothenburg University. The new courses were designed to be accessible to a wide range of people, including those with no previous experience of higher education. These courses have been described by the author in the journal *Teaching of Astronomy in the Asian-Pacific Region, Bulletin No 8, p 28-35 1994* under the heading *Swedish university courses in astronomy for everyone.*

The new courses have proved exceedingly popular, attracting students from a large area around Gothenburg. In order to better serve the educational needs of people living too far from the university to attend classes, it was decided to offer the most sought-after courses to a number of communities outside Gothenburg.

To begin with, the courses *Structure of the universe* and *Interstellar contact* were given in alternating years at different localities in western Sweden. Later, the course *Interstellar contact* was replaced by one with wider appeal, *Life in the universe,* which

Table 1. Characteristics of enrolment and pass rate for the extramural courses compared with those given in Gothenburg.

Year	Place	Population	Course	Extramural Enrol-ment	Extramural Pass rate	Gothenburg Enrol-ment	Gothenburg Pass rate
1982	Karlstad	76 000	*Structure of the universe*	47	43%	80	39%
1983	Mariestad	25 000	*Interstellar contact*	17	47%	69	29%
1984	Åmål	13 000	*Structure of the universe*	33	45%	80	41%
1985	Strömstad	11 000	*Interstellar contact*	9	100%	41	59%
1986	Vänersborg	37 000	*Structure of the universe*	15	87%	69	49%
1987	Åmål	13 000	*Life in the universe*	11	100%	46	43%
1988	Kristinehamn	26 000	*Structure of the universe*	18	33%	44	32%
1989	Borås	102 000	*Life in the universe*	34	38%	44	43%
1990	Skara	19 000	*Structure of the universe*	40	53%	66	42%
1991	Lidköping	36 000	*Life in the universe*	27	89%	66	48%
1992	Lysekil	15 000	*Structure of the universe*	16	88%	80	43%
1993	Skene	17 000	*Life in the universe*	11	100%	71	56%
			Mean values	23	59%	63	44%

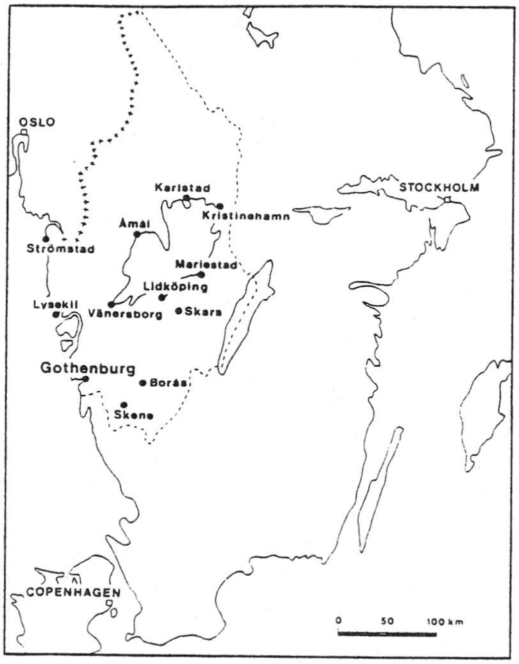

Figure 1. Locations of extramural courses in astronomy in relation to Gothenburg.

better caters to the interests of women. Further details of the extramural courses are given in Table 1.

The extramural courses are normally given in cooperation with the school-board at the place chosen for the course. The board provides lecture rooms and teaching aids while the university bears all other costs including travelling expenses for the teacher.

The courses run parallel with the same courses given in Gothenburg. They are taught by the same teacher and they comply with the same high standards of teaching. The examination tests are also the same.

The enrolment in the extramural courses is proportionally much higher for small towns compared with large ones. Figure 2 shows a fairly smooth correlation between the number of students and the population size of the towns involved in the extramural program. The high figure of attendance for Skara is readily explained by the fact that this town is an important ecclesiastical and administrative centre. On the other hand, the pronounced industrial character of the regions around Skene and Vänersborg considerably lowers the expected enrolment at these places.

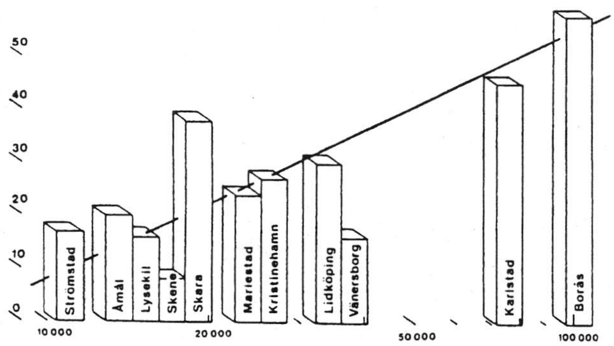

Figure 2. Enrolment figures for extramural courses corrected for yearly variations in towns of different population sizes.

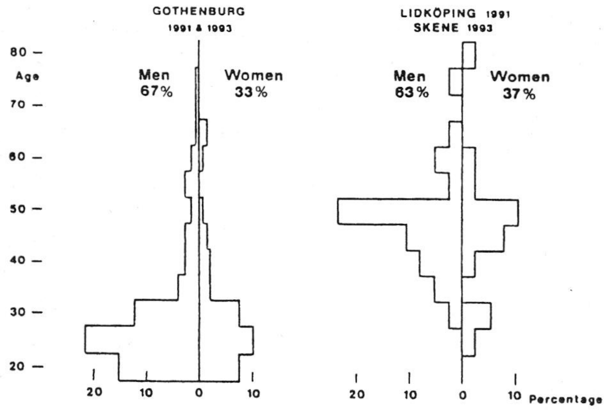

Figure 3. The age distribution of students in the course *Life in the universe* in Gothenburg compared with the same course given as extramural course.

There was no significant difference in the proportion of women taking part in an extramural course compared with the one given in Gothenburg. In both cases, courses attracted nearly twice as many men as women. However, the age distributions of extramural and intramural students were entirely different, as can be seen from Figure 3. While about half of the students in the courses in Gothenburg were under 28 years, only three per cent of the extramural students were in this age group. This might be an effect of the fact that in provincial towns most young people who are intellectually inclined have left home to study at a university.

The motivation to pass an examination is usually rather high among students in the extramural courses. For some, the chance of obtaining academic credits might be just once in a lifetime. The social pressure to succeed is strongly felt in a small town where everybody knows everybody. The small size of the classes helps to foster the spirit of comradeship essential in assisting each other to pass the courses together. In the smallest towns, as a rule, everyone passes the examination, but as soon as the class size grows beyond about fifteen students the pass rate falls off sharply.

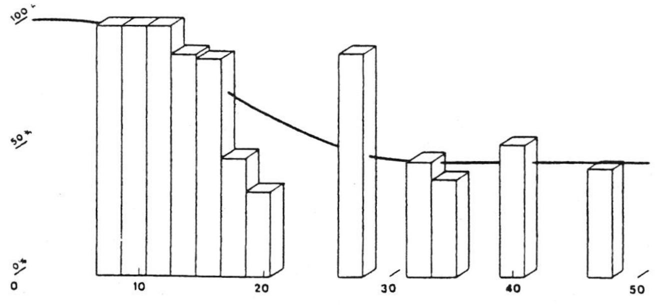

Figure 4. Pass rates for classes of different sizes.

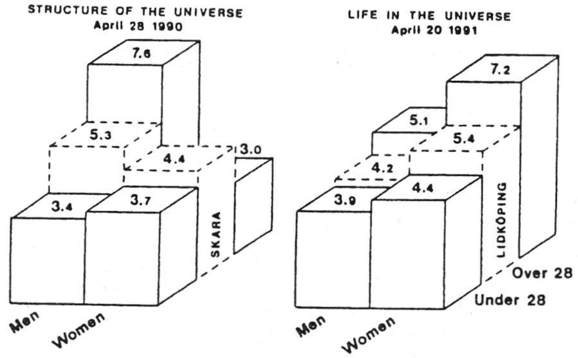

Figure 5. Mean examination marks on a ten point graded scale obtained by different categories of students in the same courses when given in Gothenburg (continuous line) and as extramural courses (dashed line).

Although the pass rate is higher among extramural courses, their students do not normally reach the same level of achievement in the examination tests as the students of the same age group in Gothenburg. This might be due to a lack of experience in answering written examinations on the part of students in the extramural courses. The examination results show, however, the same pattern between men and women, both for extramural students and students in Gothenburg. It is for example clearly evident, as shown in Figure 5, that men achieve better results than women in the course *Structure of the universe*, while the opposite is true for the course *Life in the universe*.

To some it may appear an extravagance to offer academic courses far away from the university to groups as small as ten students in a subject like astronomy. However, university education must not be seen as an exclusive right for people living in or near big cities. Although study of the cosmos has little immediate relevance to the problems encountered in the daily life of a small town, astronomy has a great attraction for many people. This attraction gives an opportunity for promoting the knowledge of new achievements in science and for countering the spread of pseudoscientific ideas.

The Jupiter-comet collision: an educational view

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In July 1994 the scientific community enthusiastically witnessed a unique astronomical event and observations of it will keep scientists busy for some years. Can physics and astronomy teachers use that event in the classrooms to stimulate fruitful discussions? Indeed they can do this but in doing so, I believe, they will face some difficulties also. I would like to explain how such a discussion will meet with a difficulty, called the A/C paradox, which I have already discussed in the context of the planetary motion /1,2/.

As Jupiter has 16 moons, an inevitable question from pupils is the following: "Is there any possibility of a fragment colliding with the moon of Jupiter?" This possibility can not be ruled out and therefore, I think, it is unfortunate that not a single fragment of the comet Shoemaker-Levy collided with the moon of Jupiter. Nonetheless, this possibility can be used by teachers to stimulate the discussion on future probable events. This possibility will require us to refer an to important but less known fact about these moons that some of them are prograde in nature and some are retrograde in nature. This fact gives rise to the question "Will the fragment collide with a prograde moon or with a retrograde one?" Let us see why the A/C paradox will cause difficulty in discussing this second question.

In the introductory courses, we do discuss planetary motion, motion of moon of earth etc. but, unfortunately, all these bodies are moving around the respective bodies at the centre in one and the same direction. On this background, students will greet this fact about moons of Jupiter with awe. Subsequently, I believe, they will defy our usual assumption that the gravitational force provides the centripetal force - which leads us to the equation of orbital velocity of a planet or a moon - and raise the same difficulty, which I have discussed already in the early issues of this Bulletin. I appeal teachers to have this point in mind while leading the discussions in classrooms. In addition, I appeal authors, who are preparing books for students and teachers of 21st century, to include a discussion on the A/C paradox in books at appropriate places, to make teachers aware of this problem.

References

1. Sathe, D.V. (March 1991) Bulletin #3, p. 22.
2. ----------- (October 1993) Bulletin #7, p. 82.

Vilanova i la Geltrú
March 9th, 10th and 11th, 1995

Seminari Permanent d'Astronomia

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Aims

To provide an exchange of knowledge among teachers and researchers at primary, secondary and university in order to encourage the developement of astronomy in the various curricula.

Structure

The conference will be based on plenary sessions (1 hour), talks (15 minutes) and posters.

Guest profesores

Plenary sessions by:

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Nicoletta Lanciano
Università "La Sapienza" di Roma, Italia
Guillermo Lusa
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John Percy
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Blai Sanahuja
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Call for papers

Those interested in presenting talks or posters should send their abstracts –typed in English in accordance with the model enclosed– to the Secretary of the Conference before 15th December.
The talks and posters may be presented in either English or Spanish. Simultaneous translation will be provided.
Certificates will be given to those presenting talks and/or poster.

Location

The conference will take place in Vilanova i la Geltrú; a coastal city between Barcelona and Tarragona. It is 20 minutes from Barcelona airport and 30 minutes from Barcelona.

Registration

Registration fee: 25.000 PTA.
For those registering before 15th January: 20.000 PTA
The registration fee covers provision of conference proceedings and participation in the social programme.
Participants will receive a certificate of attendance.

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Registration and information

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