Teaching of Astronomy in Asian-Pacific Region

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Publisher's notice to stop publishing this Bulletin

At an occasion of the IAU Asian-Pacific Regional meeting held in Beijing, 1987, a Working Group for Astronomical Education in Asian-Pacific region was set up and requested to publish a journal for Teaching of Astronomy in Asian-Pacific region. Since Isobe was elected as its chairman, I tried to publish the Bulletin of Teaching of Astronomy in the Asian-Pacific Region, originally supported by a budget of the National Astronomical Observatory, Japan, and soon after that I had to use my own research fund. It needed some fraction of my available fund, but because of realization of an importance to continue its publishing, I had to look for new research budget time to time. Fortunately, I could succeed to continue its publication.

Now, it is much sorry for me to inform you that I can not continue its publication after the publication of this volume since my retirement date is March 31, 2004. Although I looked for someone who could carry this important work on, it was unsuccessful efforts.

I thank you very much for your interest in this Bulletin over 15 years and I sincerely hope this type of journal will restart again near future.

Finally, I hope your successful work in a field of the Astronomical Education.

Syuzo Isobe

Syuzo Isobe

2003-November-8

Interferometry of the Sun at 4 GHz

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Abstract

Two 2.5m f/0.3 sat-TV dishes have been set up, using commerically available receivers, to form an analog microwave interferometer on an 8m E-W baseline. This article reports steps in experimental procedure, the logging of data and its preliminary analysis using Fourier analysis techniques. It is shown how an observed interferogram's 'visibility', having predominant lateral ('u') angular frequencies of order 100-1000, can be interpreted in terms of coronal structure on the order of 10s of arcminutes.

1. Introduction

Preliminary testing of commercial (Echostar) LNBs to achieve interference effects from a bench-top signal generator were reported by Thresher *et al.* (2002). Further background on the development of the NZRG's solar microwave programme were also recently given by Budding *et al.* (2002). This work forms part of a ground-up learning programme for practical techniques and principles in observational radioastronomy as a prelude to developing research-level activities (Dodson & Budding, 2000). The present article continues this programme by presenting and discussing a solar interferogram observed at the Pohangina Valley radio-observatory in November, 2001.

2. Experimental procedure and result

Twin fiberglass microwave communications reflectors (2.4 m dia, 0.30 f/d) on identical polar axis mounts were fitted with commercial TVRO feedhorns and low noise amplifiers and block downconverters (LNB's) (Fig 1).

The LNB's (EchoStar model 950) are sensitive to a bandwdith of some 400 MHz centered at ~ 4 GHz. The local oscillator of one LNB was deactivated and replaced by an amplified signal that was sourced from the intact local oscillator of the other, fully functional LNB. In this way, a single mixed conversion frequency (~ 5.1 GHz) was used to shift the amplifier outputs to a 400 MHz band centered around 1.1 GHz. These downshifted outputs were fed into a passive IF combiner block. The common output was connected to a commercially available diode detector, designed as an aid for positioning of antennas for TVRO signal reception.

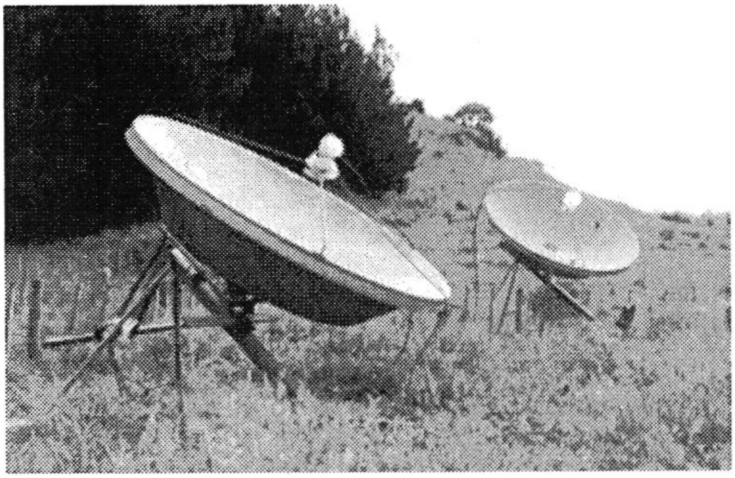

Fig 1: Set-up of two-dish interferometer at Pohangina Valley

The DC analog signal from the diode detector was modulated to 200 Hz and connected to the input of a computer soundcard. The data was then displayed and logged using the downloadable program "Radio Sky-pipe" (**http://www.radiosky.com/skypipeishere.html**).

The unamplified signal from the master LNB local oscillator was reduced by -15.6 db at the slave LNB. This included a cable loss of some 5.6 db (12 meters of FSJ4-50). Connecting to the existing GaAs FET increased the signal to ~ −9 db. Additional amplification was supplied by a single NGA-489 InGaP/GaAs HBT MMIC amp stage (refer to **http://www.stanfordmicro.com/pdf/gaas/nga/89/nga-489.pdf**) that brought the signal up to about +4 dBm before the LO phase shifter. Bench tests clearly showed standing wave interference patterns on a spectrum analyser connected to the common output of the passive IF combiner block.

The twin parabolic reflectors were positioned on an east/west line and pointed to face the Sun at true local noon. A small problem was encountered during the early phases of data collection. The slave LNB had a significantly stronger output than the master LNB. A simple solution was to fit circular pieces of particle board over the slave feedhorn, layer upon layer, until the output signals from the two LNB's were approximately equal. Three particle-board disks stacked in this way were effective to equalize the outputs.

Because the two reflectors were on an east/west line, they could easily be aligned to true north by adjusting their positions until they were in contact with a taunt string tied across the faces of the two dishes. The dishes were in the correct position when they were in contact with the string at four points, two on each dish. Data collection was started approximately 1 hour before the solar transit and continued for at least an hour thereafter.

Our first recorded solar interferogram (date: Nov 18, 2001), produced from this arrangement, is shown in Fig 2.

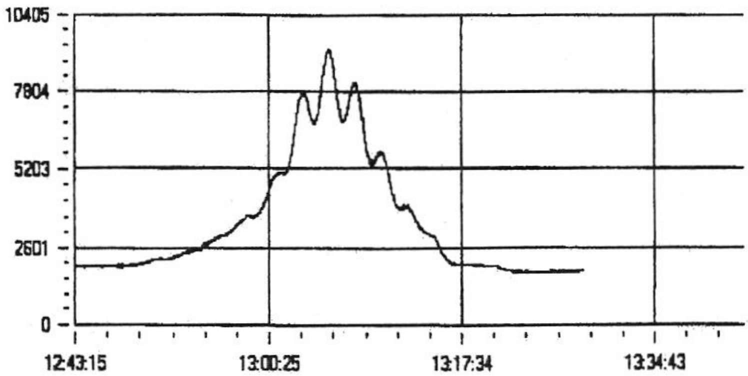

Fig 2: Nov 18 2001 solar interferogram.

3. Single baseline two-element interferometer principles.

The intensity versus scan-angle $I(\theta)$ form (where, during a scan, θ is proportional to time) of an interferogram, or 'visibility', can be regarded as the frequency-to-angle transform F of the cross-correlation X_C of the antenna's spectral window function w and the spectrum of the source σ, both dependent on the angular frequency u. Symbolically,

$$X_C(u) = w \otimes \sigma \quad , \text{ or}$$

$$I(\theta) = \mathsf{F}(w) \,.\, \mathsf{F}(\sigma) \quad , \qquad (1)$$

since the transform of a convolution (i.e. $w \otimes \sigma$) is the product of the transforms of the two functions involved in the convolution, according to the convolution theorem (cf. e.g. Pawsey & Bracewell, 1955). The transform of the window function $\mathsf{F}(w)$ is the antenna (far-field) response function, which, for a paraboloid reflector would, theoretically, be:

$$\mathsf{F}(w) = 4\,(J_1(\theta')/\theta')^2 \quad . \qquad (2)$$

where J_1 is the Bessel function of order 1 and argument θ'; the off-dish-axis angle, scaled by the ratio of wavelength to dish effective radius λ/a (Christiansen & Hogbom, 1969).

The transform of the source frequency spectrum $F(\sigma)$ is the solar intensity function

$$F(\sigma) = \Phi_{\odot}(\theta) \qquad (3)$$

Hence, to model the observed intensity variation by a practical procedure, we form the product of the response with the solar intensity function modulated by the interferometer frequency s/λ, and integrate across its angular bandwidth $B(\delta\lambda/s)$, where s is the baseline in wavelengths. The task of interferogram analysis is, given $F(w)$ and B, to determine what form, or 'map', of the source $\Phi_{\odot}(\theta)$, when modulated by the interferometer's scanning frequency, will give rise to the observed variation (Fig. 2).

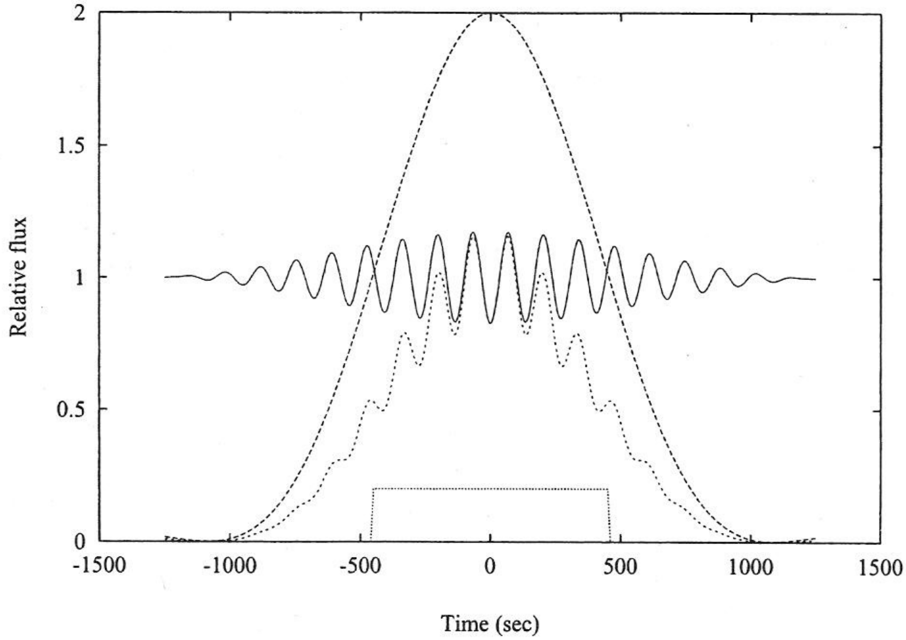

Fig 3: Modelling result showing response function (dotted, at double scale for clarity), undarkened solar intensity function (dashed, at bottom), the intensity modulated across the interferometer bandwidth (dot-dash, across centre) and the product of this with the response function (solid, which should correspond with what is observed).

4. Modelling results

A FORTRAN program was developed to evaluate and apply the foregoing formulae. The program first reads in an assigned number of time steps, the array spacing and dish effective radius in units of the nominal wavelength (7.5 cm). Also read in are the solar declination for the date of observation, and a provisional value for the zero phase shift $\Delta\theta_0$. The time of the main emission peak and its voltage, as well as that of the background level are also required. We allow for a finite bandwidth of the interferometer by assigning weights to an adopted wavelength region. In this way, the baseline actually becomes a small range of weighted baselines. The antenna radius similarly becomes a small range of weighted radii.

An algorithm supplied by Press *et al.* (1990) for the Bessel function J_1 was attached to the program as a subroutine. This was then used in calculating the response function (2) above. The program sums the product of this response and the solar intensity, modulated by the interferometer acceptance frequency integrated over its bandwidth. The time of each data point is converted to angular movement of the Sun in radians. The dish function is regarded as being swept through in time.

We have stopped short of fitting the interferogram of Fig 2, as the present work is essentially to explore procedures and get a 'feel' for what can be achieved. The main emphasis in our analysis has then been to experiment with different forms of $\Phi_\odot(\theta)$, and examine the results against the shape of Fig 2. A development would be to construct an optimization algorithm to recover $\Phi_\odot(\theta)$, keeping in mind the predetermined theoretical resolution limit of ~ 32 arcmin. We also included a phasing error parameter $\Delta\theta_0$, noticing the slight asymmetry in Fig 2.

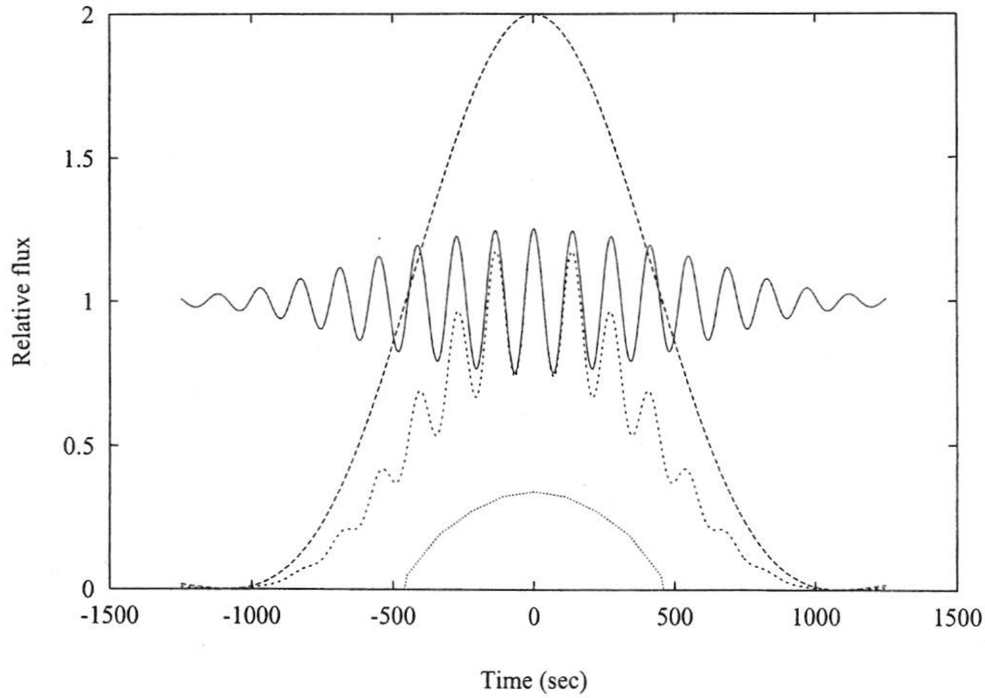

Fig 4 shows the effect of a limb-darkened source. Note the emergence of a central peak, and greater contrast in the output oscillations.

In Fig 3 we have set $\Delta\theta_0 = 0$, and represented the solar intensity function by a zero-limb-darkened five point distribution at $\theta = 0, \pm 15$ and 30 arcminutes. Fig 4 repeats this but with a complete (cosine law) darkening function. Fig 5 shows the effect of experimenting with both a zero time displacement for the phasing and also an asymmetric intensity distribution on the source. The more pointed source function has increased the contrast of the oscillations as might be intuitvely expected, while there may be parameter ambiguity or uniqueness issues in explaining just the asymmetry of the interferogram. Generally speaking, the results of such experimentation show considerable sensitivity to adopted parameters for the source intensity distribution and slight shifts of phasing.

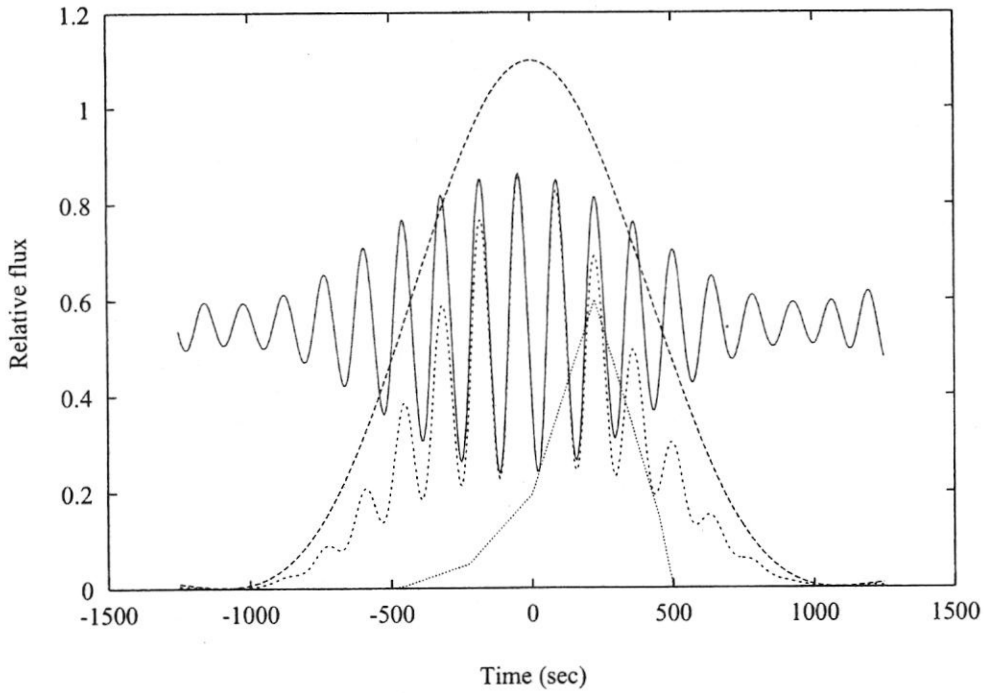

Fig 5: A more concentrated ('active region') source has been adopted here, together with a slight shift (0.1%) of the zero-point for the modulation phase referencing.

Fig 6 presents an interim comparison between the results of our preliminary modelling and the actual data. The source may be more extended than our representations, or there may be other factors relating to effective dish-size or imperfect phase-equalization along the two arms. These questions provide great scope for further development of this project.

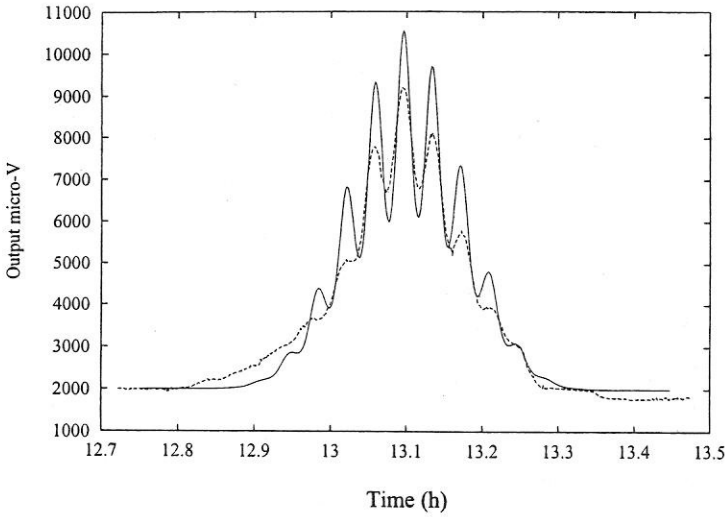

Fig 6: We present an interim modelling for the observed interferogram with a uniform source, but with a zero-point phase displacement of 0.1%.

5. Conclusions

This article has made the following points

1. That a microwave solar interferometer operating on a relatively short baseline can be built in a reasonably straightforward way using commercially available components that are not prohibitively expensive.
2. Such equipment can produce solar interferograms that conform to reasonable expectation with output data S/N levels of order 100.
3. On an 8m baseline at C-band such an interferometer resolves at less than the Sun's angular diameter and can, in principle, allow course discrimination of active longitude regions.
4. Practical experience of essential radioastronomy principles can be developed by such work.
5. The observed asymmetry in the peaks of the interferogram can be explained by a slight baseline phasing error. A comparison between Figs 3 & 4 also show that information on the source angular intensity distribution ('flux density') is derivable from the interferogram, although the problem of possible ambiguity about the source distribution is not addressed in this article.

The authors will be glad to provide further details to interested enquirers.

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Dodson, A., & Budding, E., 2000, *Southern Stars,* **39**, 21.
Pawsey, J.L. & Bracewell, R.N., 1955, *Radio Astronomy*, Oxford, UK, p 62 *et seq*.
Thresher, W., Wheatley, M. & Budding, E., 2002, *Teaching Astronomy in Asian Pacific Region*, **18**, 64

6. Acknowledgement

The conversion of one of the EchoStar model 950 LNBs, so as to allow its local oscillator to be sourced from the other, was carried out by J. Yaldwyn at 4RF Communications Ltd. of Wellington, New Zealand.

Associateship programme of Inter-University Centre for Astronomy & Astrophysics, Pune

Suresh Chandra[1]

Inter-University Centre for Astronomy & Astrophysics (IUCAA) has been established by the University Grants Commission (UGC), New Delhi under section 12 (CCC) of its Act No. 3 of 1956 and Regulations (establishment and maintenance of institutions) 1985 in the campus of the University of Pune on 29 December 1988. Its jurisdiction spans over all India, and with a provision of collaboration in research and teaching in Astronomy & Astrophysics (A&A) with other countries, particularly ASEAN, SAARC and African countries.

One of the prime objectives of IUCAA is to promote teaching and research in A&A in Indian universities. In order to realise its objectives, IUCAA has instituted professorships, other faculty positions, fellowships, research and technical positions, and scholarships etc. in its campus. For achieving the aforesaid objective, IUCAA is awarding Associateships of the Centre every year to the teachers having interest in A&A and working in colleges, university departments, and institutes which have the status of a university.

The first batch of associates was selected from July 1, 1990. In the first ten batches (from 1990 to 1999), there were two categories of associates: (i) Associates, and (ii) Senior Associates. In the year 2000, the Governing Board of IUCAA decided that from July 2000, all Associates and Senior Associates would be designated together as Visiting Associates. In the present communication, we have not distinguished between Associates and Senior Associates, and here-in-after we shall use a common word Associate for all categories of the associates.

An associateship is awarded for a term of three academic years, which can be renewed for the consecutive terms, depending on the performance of the associate. (An academic year is defined as a period from July to June next year.) When an associate has no more formal link with any of the institutions which come under jurisdiction of the associateship programme, then the associateship stands terminated.

An associate has to visit IUCAA at least one time during an academic year. There can be a maximum of three visits during an academic year, with a condition of maximum six visits in a term. Duration of a visit of an associate has to be of at least 15 days, and a maximum of 150 days can be spent by an associate at the IUCAA during an academic

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Visiting Associate of the IUCAA, Pune

year, with a condition of a maximum of 365 days in a term. All expenditures like T.A. and D.A. for the visits of an associate, as per Central Government rules, are borne by the IUCAA. As per directions issued by the UGC for the colleges and universities, absence of an associate from his/her parent institution is to be treated as ON DUTY.

Here, we have made an attempt to look into the associateship programme of IUCAA.

Associateships

Each year, from July 1, associateships are awarded by the IUCAA to the teachers in colleges, university departments, and institutions which have the status of a university. Since 1990, associateships are being awarded every year, and recently, thirteenth batch of the associates is selected from July 2002.

At the end of a term of three years, performance of each associate is reviewed by a committee constituted by the IUCAA and the associate may either be selected for the successive term or dropped from the associateship. An associate who has no more formal link with any of the institutions which come under jurisdiction of the associateship programme (may be due to his/her superannuation) is not selected for the successive term. In Table 1, we have summarised information about the number of associates year-wise. There are three batches of the associates at a time, and the total number of associates in these batches is given in the last column of Table 1.

Table 1. Number of Associates year-wise

Beginning of batch	New	Continued	Dropped	Total
July 1990	20	-	-	20
July 1991	10	-	-	30
July 1992	15	-	-	45
July 1993	16	11	9	52
July 1994	10	6	4	58
July 1995	16	4	11	63
July 1996	15	17	10	68
July 1997	11	8	8	71
July 1998	15	10	10	76
July 1999	18	19	13	80*
July 2000	10	9	10	80*
July 2001	11	17	8	84
July 2002	16	27	10	90

*One associate died

In a total of 13 batches of the associates, one associate could obviously be awarded maximum five terms. Table 2 summarises about the number of associates who have been awarded various number of terms. In total, IUCAA selected 171 associates in thirteen batches. Out of them, there have been 9 associates whose associateship was resumed after a break, and 2 associates whose associateship was resumed twice after breaks. Six associates are obviously retaining their associateship continuously right from the first batch of July 1990. The author of this article has been Associate/Senior Associate/Visiting Associate of IUCAA from July 1990 and his associateship is continuing up to June 2005.

Table 2. Number of Associates awarded various terms

Terms	Associates
One	88
Two	48
Three	19
Four	10
Five	6
Total	171

Table 3. Number of Associates dropped after some terms

Terms	Associates
One	58
Two	18
Three	5
Total	81

Table 2 includes those associates also whose term is continuing at present. In order to provide explicit situation about the number of associates whose associateship is no more continuing, the information is given in Table 3. Thus, 81 associates have been discontinued (some of them would have ceased their formal link with an institution where associateship could be awarded; may be owing to superannuation also). It obviously reflects that the IUCAA is playing leading role to encourage the teachers by awarding associateships and providing excellent facilities. But, later on, about half of them are not capable to retain their associateship.

Table 4. Number of academic staff at IUCAA

Financial year	Core faculty	Post-docs	Ph.D. student	Total
1989-90	4	-	-	4
1990-91	7	-	-	7
1991-92	8	-	-	8
1992-93	9	8	10	27
1993-94	10	11	11	32
1994-95	10	12	16	38
1995-96	12	12	16	40
1996-97	12	8	17	37
1997-98	11	12	15	38
1998-99	12	12	12	36
1999-2000	12	10	13	35
2000-2001	14	9	13	36
2001-2002	14	9	15	38

Research publications

Research progress as well as the quality of research work of an institution is judged through the research publications of its personnel. In Table 4, we have reported the number of core faculty members, postdoctoral fellows and Ph.D. students working in the campus of IUCAA. In Table 5, we have given the number of papers published in research journals and in proceedings of various scientific programmes by the academic staff as well as the associates. There, information is also given about the joint publications made by the associates and the academic staff. (Joint publication are not included in the individual categories.) After going through the publications of the academic staff as well as the associates of IUCAA, one can easily find out that quality of the research work carried out is appreciably good. Table 6 has information about the number of associates and academic staff involved in joint publications. Though care has been taken in preparation of the tables, but there may be some variations.

Table 5. Research publications* of IUCAA

Financial year	Academic staff	Associates	Joint
1989-90	11 + 6	-	-
1990-91	5 + 2	-	-
1991-92	9 + 7	-	-
1992-93	26 + 6	23 + 4	2 + 0
1993-94	27 + 14	29 + 0	3 + 0
1994-95	40 + 7	30 + 1	2 + 0
1995-96	34 + 18	26 + 3	2 + 0
1996-97	33 + 17	47 + 7	8 + 0
1997-98	37 + 17	46 + 0	4 + 1
1998-99	25 + 11	63 + 9	4 + 2
1999-2000	38 + 11	53 + 4	5 + 0
2000-2001	50 + 18	93 + 4	3 + 6
2001-2002	46 + 4	103 + 15	6 + 1

*Journals + Proceedings

Table 6. Personnel involved in joint publications

Financial year	Academic staff	Associates
1990-91	-	-
1991-92	-	-
1992-93	1	2
1993-94	2	3
1994-95	2	3
1995-96	1	2
1996-97	4	4
1997-98	3	3
1998-99	3	4
1999-2000	3	4
2000-2001	4	3
2001-2002	4	4

Discussion

Facilities in IUCAA are excellent, and at par with institutions of repute in India and abroad. IUCAA has good library pertaining to A&A, good computational facilities, accommodation with canteen facilities, and a well developed and maintained campus with a peaceful and academic atmosphere. In comparison to IUCAA, facilities at the colleges as well as in most of the university departments (from where associates are selected) are negligibly small. Whenever an associate visits IUCAA, he/she feels privileged to get access to the facilities required for his/her research work. The associates feel grateful to the authorities who conceptualised the idea to establish the IUCAA, in particular to Professor Jayant V. Narlikar, Director of the centre, who always encourages the associates.

UGC, New Delhi has issued a circular for parent institutions of the associates to encourage them to visit IUCAA and to treat their absence from the parent institution as ON DUTY. But, unfortunately, many times, Principals/Vice-Chancellors do not allow associates to visit IUCAA. Then the question arises how to make an understanding so that the associates could be encouraged to visit IUCAA for their research work. Owing to autonomy of the institutions, the UGC seems to be not in a position to do anything more than issuance of the circular which is not a binding on any institution.

Table 6 shows that a limited number of staff members of IUCAA have been collaborating with a limited number of associates. Most of the time, three core faculty members have been collaborating with three associates. Occasionally, one additional staff (varying from year to year) collaborated with one or two additional associates (varying from year to year). It shows that a large number of academic staff and most of the associates are doing their research work without much interaction between the two categories. Interaction between the academic staff and the associates is evidently very poor.

There is no dispute that the quality of research work being carried out by the academic staff as well as the associates of IUCAA is at par with that at national as well as international research institutions. However, we have not to forget that prime objectives of a Research Centre are different from those of an Inter-University Centre. The prime objective of an Inter-University Centre is to promote teaching and research in a particular discipline in Indian universities and colleges through collaborative programmes between the academic staff and the associates. There are a number of Research Centres in India whose prime objective is to contribute towards pure academic research. In these places, isolation and lack of collaboration could be justified. These research centres also have some collaboration with some teachers in colleges and university departments.

Now, an obvious question emerges how to improve the interaction between the academic staff and the associates of IUCAA so that a vivid distinction between a Research Centre and an Inter-University Centre could be realised. Improvement of the interaction would undoubtedly enhance the progress of the centre. The matter regarding improvement of the interaction is for consideration of all the concerned.

I am grateful to Prof. Jayant V. Narlikar and Prof. S.A. Suryawanshi for encouragement.

Domeless Planetarium (DLP)

Victor L. Badillo
Manila Observatory

The planetarium is recognized as a powerful and delightful tool in learning astronomy. But only a few big cities can afford one. The domeless planetarium (DLP) can do as much as and even more than a traditional planetarium, for less than 1% of the cost. If a room, computer, and screen are available, what is needed is a LCD projector and software. The software can range from a freeware diskette to CD-ROMs costing about $600.00. Prices of LCD projectors are dropping. Depending on the size of the room and the screen and the intensity of the LCD projector, the audience can range from a handful to a few hundred.

Any desktop planetarium program can be used. But the software I am at home with is SkyGlobe version 3.6 (SG) by KlassM[1]. Though a Windows version is available, the DOS version was used. It is desirable that what appears on the screen is what one sees in nature, just the sky and the heavenly bodies.

True, there is no full-sky sense. But in practice we look at a small particular area of the sky at one time. The eye cannot see the whole sky. In the domeless planetarium, instead of turning and/or lifting the head, we have the equivalent by having the virtual dome revolve around us or rise before us. Furthermore, the traditional planetarium requires looking upwards for extended periods. In the domeless planetarium, one is spared a stiff neck.

If a closer look is needed, one can zoom in various steps. Thus Mizar, and other doubles, can be split. The stars of Pleiades can be seen as one zooms, step by step. It is as if one changed eyepieces in a telescope. One can go seamlessly from naked eye viewing, to binocular viewing, to telescope viewing. One can change the extent of the field of view. The experience is equivalent to being in the field with a guide beside you. Someone to point out an object and whom you can interact with.

The elements of the method were explained in a Sky and Telescope article[2]. This article focuses on applications. A list of possible modules follows. Development of the topics is given further down below. The modules exemplify and illustrate the use of the different key strokes both in the manual and those not there.

1. What can be seen tonight?
2. How to recognize constellations: polar, zodiacal, etc.
3. Demonstrate star hopping technique.
4. Zoom examples: Mizar, Pleiades, etc.
5. Bunching of planets in May 2002.
6. Motion of moon with respect to the sun
7. Motion of moon with respect to the stars.
8. Sun's motion with respect to zodiacal constellations. Astrology.
9. Planets' motion with respect to fixed stars.
10. Retrograde motion of Mars
11. Rising points of the sun in the course of a year.
12. On-line drawing of the analemma by the sun.
13. Seasonal and diurnal motions of sun.
14. Land of the midnight sun.
15. Animated heliocentric solar system.
16. Precession motion of the celestial north pole
17. Precession of the vernal equinox
18. Effect of change of latitude on Polaris and other stars.
19. Dynamic viewing of Alt-Az and RA-Dec coordinate systems.

[1] Find where SkyGlobe can be downloaded by giving an Internet search engine the topic either KlassM or Skyglobe.

[2] Badillo, Victor. A flexible virtual planetarium, Sky and Telescope 102 (2001) 63-65.

Saved Configurations

Since SkyGlobe (SG) opens with all overlays and helps visible, it takes many steps to Initialize the way I want to. One has to press K, several function keys and K, and reduce the number of stars. Can this be done in one step?

To save a set up, press any number from 0 to 9. To call any saved configuration, press both the associated number N and Shift (Shift-N). A set up saved with the number 0 is what appears when SG is opened from scratch.

Suggested configurations.

Configuration 1. When SG first appears, adjust the screen controls so that the Milky Way is visible. Remove it (K) and all overlays (F3 to F10). Reduce number of stars. All that is seen on the screen are the sky and a few stars. Press 1, to save.

Configuration 2. Start with configuration 1. Toggle on horizon. Press UP key until there is no more effect. Zoom down so that what is seen is the circular sky with the horizon as the perimeter. Press Z to fill screen. Press 2, to save.

Locations not in L Menu.

Audiences like to see the name of their city (town, village, etc.) in the sky. How does one observe from a location not in the Location menu? To change to the exact geographical position of NewPlace, exit the L menu. Then, press ENTER. The Exact Value Menu below appears. Enter only the following:

Location	: NewPlace
Latitude	: 18.2
Longitude	: -120.55
Time zone 0-47	: 45
Daylight time? (Y/N)	:
Accept changes? (Y/N)	: Y

Note that East longitudes and South latitudes are negative numbers. Place 45 for "Time zone." Unfortunately, these coordinates cannot be saved for later use.

Another method is to first find a location nearest to the desired location, and then arrive at the desired latitude by pressing either Alt-N, or Alt-S. However the name of the starting Location is unchanged.

Development of the modules.

What can be seen in the real sky are just the stars. To make the software sky appear realistic it is good to have as few overlays as possible. Initialization can be done in a single step using saved configurations.

Module 1. What can be seen tonight?

A. View the whole sky. If E is pressed, the screen shows the sky in the east. Then move the view slowly to the right, reaching the south, and eventually back to the east. Attention can be given to every desired part of the sky.

Initialize. Configuration 1 (Shift-1). Toggle on the horizon (F5). Toggle on or off as needed the constellation lines (F10), constellation names (F9), star names (F8). Press E. Zoom a little so that the horizon line is not too curved. Let the image sink in for a while. Then use the direction key for 10-degree steps or Alt-direction key for one-degree steps.

B. Show how the sky changes in the course of a night. Open the upper left data box which shows the time. Press N. Then SPACE, t, to see the polar stars in the course of a night. Some time later, press S, then SPACE, t to see the southern stars. Then some time later press E, SPACE, t, to see the zodiacal and other constellations, planets, etc. rise one by one.

The viewer sees that stars, constellations, planets (if any) are rising in the east and setting in the west. The viewer also sees that patterns do not change. He sees why stars are called "fixed" stars, even as he sees them moving in the sky in the course of a night. This is obvious in the movement of the Big Dipper, of Orion, etc. This will be clearer when he meets the wandering stars below.

There are many occasions to pause to make comments, astronomical and historical, tell stories, ask questions, elicit participation. Some parts of the sky can be enlarged (Z) as needed. Exploit the uses of the mouse (pointer, data provider, etc.) Insert material and techniques from other modules below.

Module 2. How to recognize constellations: polar, zodiacal, etc.

What do the constellations look like? Some patterns are easy to see if constellations have enough bright stars to connect. In this module only a few easy ones will be considered.

Initialize. Configuration 1. Press F. Select Orion. Remove constellation names (F9). Let view sink into mind of audience. Point out the three stars in a line forming the belt of Orion. Zoom. Point out the other three fainter stars forming a line at an angle to the belt. This is the sword of Orion. Turn on F4 to show the Messier objects. In the sword of Orion is the Orion nebula, M42. Then point out that the belt is surrounded by four stars, Rigel, Bellatrix, etc. Trace with the mouse the quadrilateral.

Use the mouse to learn the names and magnitude of the principal stars. Read aloud. What is the magnitude of the brightest star? Of the second brightest star?

Find (F) another constellation. Point out its distinctive shape. Do for Scorpius, Canis Major, Star Dipper, Swan, Great Square, Leo, Corvus, Southern Cross, Cassiopeia, Gemini, etc.

How do we identify stars? It is hard to identify isolated individual stars if there is no context provided by surrounding stars.

Module 3. Demonstrate star hopping technique.

How do we find the constellations and stars? One way is by pressing F and selecting the constellation or star. The other way is by the star hopping method.

Initialize. Configuration 1. Toggle on F2 and F11 (Upper left data box and mouse). Reduce number of stars to about 1,000. Find Orion (F, Orion). Press E. What is the brightest star outside Orion? Where is it? Use the mouse to check the magnitudes of two or three outside stars. The brightest has magnitude of negative 1.5, a number smaller than zero. What is the name? Read from lower left data box. This is the brightest of all the stars. It is in the constellation Canis Major (CMA) or Big Dog. We have star hopped from Orion (ORI) to CMA. Point out the five bright stars of CMA. Can you see the tail of the dog? Etc. Toggle on and off F10.

Look in the sky to find two bright stars close to each other towards the lower left of Orion. What is an identical pair? Latin for twins is Gemini (GEM). Turn on F9. Use mouse to get names (Castor and Pollux) and magnitudes. Toggle on and off F10.

Point out the bright star below Orion between GEM and CMA. Use the mouse to get its name and magnitude. Procyon. Brightest star of Canis Minor (CMI) or Small Dog. Toggle on and off F10.

Look at bright star above Orion. Use mouse. Aldebaran is the brightest star in constellation Taurus (TAU). Turn on F6. The ecliptic passes through Taurus and Gemini. Taurus and Gemini are zodiacal constellations. Toggle on and off F10. Turn on F3, to see any planets or moon or sun. You cannot see planets far from ecliptic.

Almost near the top of the screen above Aldebaran is a faint smudge. It is the Pleiades. A group of stars very close together. Use mouse to find names. Turn on F4. Pleiades is M45, one of the Messier objects. To the left of Orion is a bright star. Capella. In constellation Auriga (AUR).

We star hopped from Orion to CMA, to Gemini, etc. Note that M45, Aldebaran, the belt of Orion and Sirius are almost in a straight line. A hexagon (or the Winter Circle) can be formed by joining GEM and the other five first magnitude stars. Find or invent other pointers helpful for finding one's way in the sky.

Star hopping does not mean starting with Orion. The principle to start from the known to the unknown. This process is useful for the software and the real sky.

Unknown stars, nebulae, etc. can be found starting with known stars, using the star hopping method. Demonstrate with DLP how to find Andromeda Nebula (M31), Beehive (M44), Omega Centauri (NGC 5139) Crab Nebulae (M1), etc.

Module 4. Zoom examples: Mizar, Pleiades, etc.

Mizar. Initialize. Configuration 1. Only sky and few stars are to be shown. Press F. Select Ursa Major (UMA). Star Dipper is an asterism, i.e., only part of the constellation. Center the asterism. Put the mouse on the star that is in the middle of the bend of the handle. What is its name, and magnitude? Mizar. Right click on it to fix it. Keep your eye on it as you zoom little by little. Stop when you can see two stars. Press ESC to unfix the mouse. Use mouse to find name of second star, Alcor. What it its name and magnitude? It is a test of good eyesight to be able to see that Mizar is a double star with naked eyes in the real sky.

Pleiades. Initialize. Only dark skies and a few stars. Press F. Choose Taurus. Use mouse to point out Aldebaran. On one side of Aldebaran is the constellation Orion. On the opposite side of Aldebaran is a tight bunch of stars, the asterism Pleiades (M45). This is a beautiful sight. After you have seen it you cannot forget it. It looks like a little cloud. People with good eyes can distinguish six or even seven stars. Keep your eye on it as you zoom up. Adjust arrow keys to keep it centered. More and more stars appear. These are also called the Seven Sisters, or the Seven Daughters of Pleio. Use mouse to get names: Atlas, Alcyone, etc. Read aloud names and magnitudes. What is the shape of the asterism? Toggle on the horizon line and the upper left data box. Experiment to see what are the dates and times that Pleiades is visible.

Some other uses of zoom are illustrated in the other modules.

Module 5. Bunching of planets in May 2002.

Initialize. Configuration 1. Put on horizon (F5) and planets (F3). Open upper left data box. Press W. Set time at 5:30 P.M., sunset time. Set the date to May 15, 2002. What do you see? How many planets can you see? Five? Seven? What is the elevation of the highest one? Use mouse and lower left data box to find out.

Press D. What happened? Press D again. Pause. Repeat. What did you see? Go back to May 15. Do again, step by step with suitable pauses. There are many things going on. How quickly the planets rearrange themselves. What is the date when the planets are most compressed together and visible after sunset?

Module 6. Motion of moon with respect to the sun

Initialize. Configuration 2 (Shift-2). Put in upper left data box. Press S. Set date to Dec 20, 2002, date of a full moon. [At full moon, the sun and the moon are furthest apart.] Toggle on: the planets, ecliptic, a few constellations, and a few constellation names. Set the time to 6:24 A.M. so that the sun is just above the eastern horizon. The moon is just above the western horizon. Note the appearance of the moon icon. The sun is in what constellation in Dec 20, 2002? In Sagittarius (name not seen). In what constellation is the moon? In Taurus (name not seen). What is maximum number of zodiacal constellations visible?

Adjust zoom so that the sun and moon are at very borders of the screen. Press D. What happened to the moon? To the sun? Press D again. Same questions. What happens to the appearance of the moon icon? How many days does it take for the moon to reach the sun? (Start from the beginning and count aloud, with the audience.) What is the appearance of the moon icon then? What is this phase of the moon called? How many constellations did the moon traverse in its trip to the sun? We covered only one half of the orbit of the moon about the earth, when the moon is visible. Use DLP to determine how many days it takes from one full moon to the next full moon, when it first reappears in the west. In the second half, the moon is not visible. Start from the beginning. Count aloud each step, one, two, etc. We do not arrive at a whole number. We cannot use H to determine the fraction of day, since the sun will disappear from the screen. One method is to count the number of days for TWO lunations. Start from the beginning: one, two, etc. Count aloud, with the audience. When you reach 55 slow down the count. After you have reached the final count, you can determine the length of one cycle.

This period of time is called the lunar month, or one lunation. In a lunar calendar the year is made up of twelve lunations. The first day of each lunar month is the new moon. This is so for the various lunar calendars: Muslim, Chinese, Jewish, etc.

Module 7. Motion of moon with respect to the stars.

Initialize. Configuration 2. Toggle on F3 (planets) and F6 (ecliptic). If needed, press D until the moon appears. Zoom to get E (east) and W (west) to the screen's edges. Toggle on F10 (constellation lines). Press C as needed to add constellations along the ecliptic. These are the zodiacal constellations, Aries, Taurus, etc. Toggle on and off F9 to see constellation names. Press D or Shift-D to move the moon back and forth between E and W. What are you seeing? The moon moves from one constellation to the other. The moon is in Aries on such a date, and is in Taurus in some other date. How many days does the moon stay in a constellation?

Move the moon close to a constellation in the middle of the screen. Press M (month). What happened? The length of a lunar cycle will be determined in another module.

Homework for the audience. Draw roughly the twelve zodiacal constellations. Each night look at the real moon, and put in the drawing where the moon is and indicate the date.

Module 8. Sun's motion with respect to zodiacal constellations. Astrology.

Initialize. Configuration 2. Zoom to bring the East and West to the borders. Put on the upper left data box. Add constellation lines (F10) and planets (F3). Center the sun by setting the time to noon. Isolate the sun by varying Y to move out a close planet. Toggle on the ecliptic. Press C, as needed, to put in the Zodiacal constellations. Put in constellation names (F9) and boundaries (G). Set the month to February. Read aloud the names of the constellations along the ecliptic. Vary D in single steps to bring the sun to the boundary of Pisces (PSC). Note and read aloud the date. Note and read aloud the date when the sun leaves Pisces. Compare these observed days with those designated by the astrological signs given below. Do for several constellations. If there is a difference, what is the reason? This is one effect of the precession of the equinox, the topic of a module below.

Aries	(3/21 - 4/21)
Taurus	(4/21 - 5/22)
Gemini	(5/22 - 6/22)
Cancer	(6/22 - 7/23)
Leo	(7/23 - 8/23)
Virgo	(8/23 - 9/23)
Libra	(9/23 - 10/23)
Scor.	(10/23 - 11/22)
Sagit.	(11/22 - 12/22)
Capri	(12/22 - 1/21)
Aquarius	(1/21 - 2/20)
Pisces	(2/20 - 3/21)

At the present time the sun is in Pisces during the days that the horoscope says that it is in Aries. How can one born when the sun is in Pisces be an Aries person?

Module 9. Planets' motion with respect to fixed stars.

Initialize. Configuration 2. Put on the upper left data box. Add constellation lines (F10) and planets (F3). Toggle on the ecliptic. Press C, as needed, to put in the Zodiacal constellations.

The motion of Mercury and of Venus. Set the time to noon, for Mercury is close to the sun. Watch Mercury as D is varied. Make sure the audience is with you. Do the same with Venus. Compare their speeds. Which is faster? Why is the innermost planet called Mercury? Why is Venus named after the goddess of beauty? What were the moon and sun doing in the meantime?

The outer planets Mars, Jupiter and Saturn are slower planets. One has to vary the month (M) or even the year (Y) to appreciate their motion with respect to the stars.

How many naked eyes planets or wanderers are there? Five? Are not the sun wanderers (planets) too? What were the seven ancient planets? What does the number seven bring into our mind? Where do we meet daily the names of the ancient seven planets?

How do we tell if an object you see is a comet? When a comet is far away it has no tail. It is just a fuzzy circular object like nebulae and galaxies. The suspected fuzzy has to be watch for a few nights. If it moves against a background of fixed stars, then it is a comet. Some comets can be seen to move in a single night.

Module 10. Retrograde motion of Mars

Initialize. Configuration 1. Press E. Put in upper left data box (F2). Set date for April 15, 2003. Set Zoom = 1.75. Put in RA lines (F7). Find Mars (F, Mars). Set time to 5 am. [Mars should be at top of the screen]. Put in constellation lines (F10). Set mouse at RA 22H. [This will serve as reference to see direction of motion of Mars.]

Keep your eye on Mars. Press Shift-R to start. When Mars nears the bottom of the screen, press Shift-R to stop.

Ask audience what they observed. Mars looping the loop! Let them ask questions. Planets move eastward. This is called prograde motion. If a planet moves westward, or in the reverse direction, that motion is called retrograde motion. Superior planets, those further from the sun than the earth, exhibit retrograde motion. The date April 15, 2003 was chosen, a few months before opposition, so that one can see the "normal" direction of Mars' motion first. The ancients observed this retrograde motion of the superior planets. Not in a single session but over a period of time.

The Ptolomaic or geocentric model of the solar system needs a complicated system of epicycles to explain the retrograde motion observed by the ancients. The heliocentric model provides a simple explanation.

Shift-R starts the sidereal day auto mode. The time is changed in units of 23 hours and 56 minutes, the length of the sidereal day. Unfortunately there is no step by step motion. If a step by step motion is wanted, this can be done by pressing D, i.e., incrementing in units of 24 hours. The step by step method may be needed to answer questions like: When did the prograde motion stop? When did the retrograde motion stop? One has to press t or shift-t to keep Mars from getting off the screen.

The planetary data in earlier versions of SkyGlobe 3.6 may not reach as far as 2003. From the following Mars oppositions, choose the one appropriate for the planetary data available to you. Start the module about two months before the opposition date.

2/26/80;	4/ 5/82;	5/19/84;
7/16/86;	9/22/88;	11/20/90;
1/ 3/93;	2/11/95;	3/20/97;
5/ 1/99;	6/21/01;	8/27/03;
11/ 7/05;		

Module 11. Rising points of the sun in the course of a year.

Initialize. Configuration 1. Observe from the Equator (L, More locations, Equator), where the sun rises at 6 AM every day. Toggle on the horizon. Use DOWN key to make eastern horizon almost straight. Put in planets. Put in upper and lower left data boxes.

Set time at 6 A.M. Vary D, what happens to rising location of the sun? Try continuous mode (SPACE, D). At what day does the sun rise exactly east? This is called the equinox. When this happens in spring, this is the vernal equinox (VE). How many days does it take for the sun to travel from one VE to the next VE? This period is the solar year. At what day is the rising point furthest from the east? This is called the solstice. What is the corresponding azimuth during those days? Is this true only for the Equator? Get the answer by trying other latitudes. What are some consequences of the changing rising point of the sun?

Module 12. On-line drawing of the analemma by the sun.

Initialize. Configuration 2. Put in upper left data box. Set time to noon (12:00 P.M.) Put in planets. Ask the audience: "Where is the sun?" Define: Meridian is the line running from north to south passing through the zenith. Point out the zenith. Define zenith. Go to the Equator (L, More Locations, Equator). Zenith is now in the center of the screen. Zoom to about 3.05. Focus on the sun alone as you press D and see result. Press D again. Several times. What is happening to time? To date? To the sun?

Define: Meridian transit is the moment when a heavenly body crosses the meridian. Compare true noon with clock noon. What time is noon on February 6? On March 6? Etc. Use DLP to answer the questions: At what date(s) is noon before 12 PM, at 12 PM, after 12 PM. As the days vary how does the meridian transit vary? After you see the effect step by step, now set SG to automode (SPACE, D). What is happening to the sun? What is the shape of the line that the motion of the sun is generating? What is the equation of time? What is an analemma? Where have you seen an analemma before? Where are analemma useful? What time does a sundial indicate? Sky and Telescope (June 1979) featured the photograph of an analemma obtained by multiple exposures of the sun over a year. www.analemma.com is devoted to this topic.

Module 13. Seasonal and diurnal motions of sun.

Book answers can be given to the questions below. In this module, situations are set up in the domeless planetarium (DLP) so that the viewer can find the answer himself.

A. Why is there snow in Tokyo but none in Manila?

B. When is the shortest day of the year?

C. In Manila, on what days is the sun at the zenith (90, Az)?

D. When the sun rises in the east in Manila, where will it be at noon?

E. How does the time of sunrise vary with latitude? With time of year at one location?

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A. Why is there snow in Tokyo (latitudes) but none in Manila (latitudes)? Initialize. Put on the upper left data box. Put on the planets. Set the date for Dec. 22. Set the time for 7 AM. Press T or Shift-T to set the sun on the east horizon, then on the west horizon. Note the times. From these determine the length of the day, and the length of the night. Having done this for Manila, do the same for Tokyo (L, More Locations, Tokyo). Compare the length of the two nights. What can we conclude?

B. When is the shortest day of the year? Begin by guessing Dec 21. To get the exact day, write down a matrix. Column heading are: Dec 21, Dec 22, Dec 23, while Row heading are: sunset and sunrise. Get the times of sunset and of sunrise on 12/21, 12/22, and 12/23. Express the number in 24 hour notation. Calculate the lengths of daytime.

C. In Manila, on what days is the sun directly overhead, at the zenith (90, Az)? Turn on the ecliptic line and the planets. With your eye on the ecliptic line, vary the day (by pressing D) until the ecliptic hits the zenith. Vary time to put the sun at the zenith. Determine the days that this happens in Manila. In Tokyo, on what days is the sun directly overhead? Experiment with the DLP. In what places is the sun never at the zenith?

D. When the sun rises in the east in Manila, where will it be at noon? Put in the planets. Put the sun on the horizon exactly East (0, 90), by pressing D and T as needed. Then press T to put sun at the meridian. Read the altitude (?, 180).

E. How does the time of sunrise vary with latitude? With time of year at one location? Experiment with DLP. From the data, make your conclusions.

Module 14. Land of the midnight sun.

A. Initialize. Configuration 1. Put in upper and lower left data boxes. Observe from Dawson, Canada (L, More Locations, Dawson). Read aloud the latitude of the Dawson. We need a location with a more northern latitude. In the list provided by SkyGlobe the only one higher is the North Pole. Press Alt-N several times, until the latitude reaches about 70 degrees North. Lands within the Arctic Circle (66.5 N degrees) experience the midnight sun.

B. Put Horizon (F5). Press DOWN key until the horizon is straight. Press E. Set date for June 21, 2003. [Actually, any year]. Set time at 6:00 A.M. Put in the planets (F3). If there is a planet very close to the sun, change the year (Y) so that you have the sun clearly by itself. Set zoom to about 1.35. This will keep all the events within the screen. Where is the sun? If the location were Manila, where would the sun be at this date and time? And what would its altitude be?

C. What does the sun do in the course of a single day? How is its altitude changing? How is its azimuth changing. We find out by changing the time minute by minute. Or we can go into continuous mode. Press SPACE, then t. To stop, press SPACE. Press the direction key as needed to keep the sun in the screen. At what time does the sun set, i.e., go below the horizon? Where does it set? What is the highest altitude of the sun? After you have gone through 24 hours, what can you say? [If we had stayed at Dawson, the sun would have set in June 21. This could be another presentation, if desired.] The questions should not be: "At what time will the sun rise?", but "At what date will the sun rise?" and "At what date will the sun set?" Use DLP to find the date when the sun first goes below the horizon. First vary M. Then fine tune by varying D. What is the behavior of the sun on September 21? What is the behavior of the sun on December 21? How many days (months!) is the length of daytime at 70 degrees North? At the North Pole?

D. Repeat the demonstration, so that the phenomenon is clearer to the viewer. But first put in RA and Declination lines (F7). Then do paragraph C above. What did you notice about the declination of the sun? Its Right Ascension? You can answer the above questions without using the mouse. What did you notice about the system of the RA and declination lines? How do you connect this with the tilt of the earth's axis?

E. Try for different months. F. Observe from the Pole.

Module 15. Animated heliocentric solar system.

In a real sky we cannot see stars if we can see the sun. So the SkyGlobe software is defective in that respect. However this defect is what makes this demonstration possible.

Initialize. Configuration 1. Put on the planets. If the sun is not on the screen, press H as needed to make it appear. Place the mouse exactly on the sun, and right click on the mouse. The sun is now locked. It should not move as time is varied.

Keep your eye on Mercury. Keep pressing D until Mercury starts returning to the sun. This point should be within the visible screen. Press D and watch the motion of Mercury with respect to the sun. How long does it take for Mercury to make a complete cycle? Note the date when it is next to the sun. Note the date after it has completed a cycle. Subtract to get the number of days. Use zoom as needed.

Now keep your eye on Venus. Press D and watch the motion of Venus with respect to the sun. How long does it take for Venus to make a complete cycle? In getting the starting and ending dates, include the year. Use zoom as needed.

Among the planets further than the earth from the sun the closest is Mars. What happens if we examine the behavior of Mars? First we have to zoom down since Mars is far from the sun. After we have placed Mars on the screen, press D. After pressing D enough times, what happens?

When you keep pressing D, Mars eventually disappears. We cannot see it turn back the way Mercury and Venus did. Anyway, after pressing D enough times, Mars reappears but from a direction opposite to the direction it disappeared. Why is this so? Mars is farther than the earth from the sun. So at some part of its orbit we are between the sun and Mars. Since we are facing the sun, we cannot see that what is back of us. How long is a Martian year? Use DLP to find out.

The motion of the moon is similar to that of Mars, namely, at some point the moon disappears and reappears from the opposite direction. At some part of the moon's cycle, the earth is between the sun and the moon. Note the date and hour when the moon is close to the sun. Note the date and hour when the moon is again close to the sun after having disappeared and then reappearing from the opposite direction. The number of days between those two times is the length of the complete journey of the moon around the earth.

Mercury and Venus are the inner planets, i.e., planets closer to the sun than the earth. In the real sky Mercury and Venus do not climb to the zenith, only some distance from the horizon. Also, at some parts of the year, Mercury can only be seen at sunset and at other times only before sunrise. The same is true of Venus. Depending on when we see Venus, we call it either the morning star or the evening star. Mercury is always close to the sun. Thus Mercury is hard to see due to the sun's light and the haze on the horizon.

We can demonstrate this using the DLP. Toggle on the horizon. Press W. Mercury is visible only when it is above the horizon and the sun is below. Press D and watch Mercury. Watch its behavior. It is alternately visible and invisible. Use the mouse to determine the Altitude of Mercury when it is farthest from the sun. Do the same with Venus. Compare with Mercury.

Module 16. Precession motion of the celestial north pole

Configuration 2. Observe from North Pole (L, More Locations, North Pole). Put in upper and lower left data boxes. Add stars (+) up 4,500. Put in RA-Dec lines (F7). Put in constellations (F10). Put in constellation names (F9). Zoom up a few times. Read aloud the declination of Polaris? How far is Polaris from the celestial north pole? Press C to add constellations until you see Draco (DRA). Press C until dotted lines appear in DRA. Add star names (F12) until Thuban appears in dotted lines of DRA.

Zoom up again to about 3.3. What happens to Polaris and Small Dipper as we vary: (a) Y? (b) J? (c) U? We can see past and future North Pole stars? Go to the past by Shift-U. When the year is about 2800BC, use shift-J for fine tuning. When was Thuban in Draco the North Star?

What we see is a consequence of the precession of the axis of rotation of the earth.

Module 17. Precession of the vernal equinox

Initialize. Configuration 2. Turn on upper and lower left data boxes. Set date for March 21 (any year). Set time for 12:00 PM. Put in RA lines (F7). Put in ecliptic (F6). Where the ecliptic and the RA line intersect is the Vernal Equinox (VE). The RA line going through VE is zero hour RA. Check with mouse. The declination line passing the VE is zero declination or the celestial equator. Check with mouse. Put in planets. Where is the sun? The point where the sun intersects the celestial equator is called the VE. March 21 is determined as that day when the sun is at the VE at midnight. The VE marks the beginning of spring. In the early days March was the first month of the calendar. This explains why September, October, November and December were literally the seventh, eighth, ninth and tenth month of that calendar. What is the other Equinox called?

Add the constellation boundaries (G). Add the constellation names (F9). In what constellation is the VE in 2003? Pisces (PSC). Why is the VE called the First Point of Aries when the VE is not in Aries (ARI)? Move backward in time. Press Shift-J. What happened? Repeat the process. In what year is the sun just entering ARI? Toggle off G and F9. You may need to press D to get the sun at the VE. What is the date? If it is not March 21, then that day is to set as the March 21 for that year.

The movement of the equinox due to the precession of the earth's axis is called the precession of the equinox.

Module 18. Effect of change of latitude on Polaris and other stars.

Initialize. Configuration 1. Toggle on: horizon (F5), constellations (F10) and RA-Dec lines (F7). Choose Manila (L, Manila). Make horizon straight. Press DOWN, until there is no more effect. Press N. What is the altitude of Polaris? What is the latitude of Manila? Press SPACE, then t. Watch 24 hours pass by. Stars that do not set are called circumpolar stars. Press SPACE to stop. Press S, SPACE, t. Can the Southern Cross be seen in Manila?

Press N. Press Alt-N several times. What is the effect on Polaris? On the latitude? Press Alt-N until the latitude is 36 N degrees (the latitude of Tokyo). Are the circumpolar stars of Manila the same as those of Tokyo? Can the Southern Cross be seen in Tokyo? Use DLP to find out.

Try for the North Pole. For the Equator. For places south of the equator.

Module 19. Dynamic viewing of Alt-Az and RA-Dec coordinate systems.

A. Alt-Az system. Initialize. Configuration 2. Turn on the upper and lower data boxes. Tell the audience to read aloud the Alt wherever the mouse stops. Move the mouse towards the center marked +. Each time you pause, ask the audience to read aloud the value of Alt. + marks the highest point of the sky. It is called the zenith. Approach the zenith from various directions.

A little distance above the eastern horizon, move the mouse slowly to the north. At each pause, ask: "What is the value of Az?" Move the mouse to the western horizon? What are the values of Az? Move mouse in a straight line from zenith to the horizon at N. Watch values of Alt and Az. Now move from zenith to any point on the horizon in a straight line. Watch and read aloud the values of Alt and Az.

Now put the mouse on a prominent star. Read out its Alt and Az. Then press t. What happened to the numbers? To the star? The Alt and Az of a star change with time. In the Alt-Az system THREE sets of numbers are needed. With the RA-Dec system, time is not needed.

B. RA-Dec system. Press N. Now turn on RA-DEC (F7). Put the mouse at one intersection of the lines. Read aloud RA and Dec. Try the next intersection going upward. Read aloud RA and Dec. Read aloud RA and Dec of other intersections. Where is zero RA? Where is zero declination? Just as towns and cities can be located by latitude and longitude, stars can be located by celestial latitude and celestial longitude. Celestial latitude is called declination while celestial longitude is called right ascension (in hours).

Put the mouse at a faint star. Read its name, magnitude, RA and Dec. Change the time. What happened to the star. Put the mouse on it again. What data changed? What did not change? Can we explain discrepancies between what we read and what we expected? Why was the mouse put on a faint star and not on a bright star? Answer by putting the star on a bright star and go through the process above. We could locate objects by using the stars or constellations as the reference system. Examples. The sun is in Taurus. Or we could be more detailed. Examples. The sun is in the eye of Taurus.

Conclusions.

The modules are of unequal lengths and treatments. Each module concentrates on a single topic. Concrete presentations are made up of various combinations of elements of the various modules. Many different presentations can be provided to the same audience. What have been shown are the possibilities. Hopefully other topics were stimulated. The development has been limited to producing skeletons, the sequence of key strokes to follow. Other and better sequences are encouraged. The bare bones have to be fleshed with script, with commentaries, stories, erudition, humor and strategies to produce interaction. The Domeless Planetarium can be used as a City Planetarium, for Schools, Classrooms, Clubs and as a travelling Planetarium. There is no excuse for not having a Domeless Planetarium. How a presentation can be automated is left to the reader.

Comments, questions, and new applications can be send to badillo@admu.edu.ph

Urban Astronomy in the Philippines

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Rizal Technological University

Introduction

The study of astronomy is almost non – existent in the Philippines. No school in the country is offering astronomy as a course. It is not even included in any curriculum as a separate subject but only a part of the more general courses in earth science.

Among the thousands of higher education institutions here, very few have telescopes; in fact this researcher could count only two in the Metropolitan Manila area where the biggest universities can be found. The two universities are the University of the Philippines and the Ateneo de Manila University which has the Manila Observatory in its compound. The UP has a 400 – mm observatory type telescope of the Cassegrain design donated by the Japanese government. It is the 2nd biggest telescope in the country in terms of aperture, the biggest being the 450 – mm Cassegrain installed in the Astronomical Observatory of the Philippine Atmospheric, Geophysical and Astronomical Services Administration (PAGASA) of the Department of Science and Technology. This telescope is also a donation of the Japanese government. While the 400- mm in UP is often used by students during astronomy seminars, the 450- mm in PAGASA is being used mostly for CCD imaging of variable stars. The Manila Observatory has an assortment of equipment used mainly for solar and atmospheric observing.

Other than the telescopes owned by the above universities, most telescopes in the country are owned by very few individuals who are members of the Philippine Astronomical Observatory. Most of these telescopes are small refractors and some small homemade reflectors. The biggest amateur telescopes here are some Schmidt – Cassegrains of the 8 – inch and 14 – inch apertures.

As mentioned, the biggest universities in the country are situated in the Metropolitan Manila are which sprawls to a sizable portion of the provinces bordering it to the north, east, and south. Artificial lighting in those areas are most visible at air during night where an astronomer, upon seeing the bright urban areas, might wonder if any dark site remains for a satisfactory conduct of astronomical observations.

This researcher, being an amateur astronomer and a faculty member of the Rizal Technological University (RTU), found out one day that an observing site is available in one of the university's campuses. This state – owned university has two campuses, namely, the Mandaluyong City campus which is right in the geographical middle of Metropolitan Manila, and the Pasig City campus which is a few kilometers to the east. The site this researcher has chosen is on the roofdeck of the Pasig City campus building.

The Observing Site, A Description and Analysis

The RTU Pasig Campus is located in a thickly populated urban center about four kilometers to the east of the high rise buildings of the Ortigas center. Adjacent to the south of the campus is a general hospital whose administrators put on several thousand – watt halogen spotlights to illuminate the hospital's building. On the north side of the campus is a park and a church. The park is often well – lit to allow sports aficionados to train in its track oval. Further north is the newly – developing commercial center in Libis, Quezon City where establishments attract customers by means of search lights pointed skyward.

Seeing

These search lights and the general heavy light pollution in that direction limits observations to the three brightest stars of Ursa Minor, or a limiting magnitude of +3.0 up to about +2.5 degrees.

Fortunately, no commercial centers are located in the east and southeast of the campus, allowing observations to be made in those directions up to zenith. The northern sky is still observable particularly if the targets are double and multiple stars and single stars. Deep sky objects, however, should be allowed to rise to at least 50 degrees before any satisfactory observation can be made of them.

In the south, the open clusters of the major constellations such as Puppis, Lupus, Centaurus, Vela, Carina and Crux Australis still reveal a fine view, but such excellent objects such as 47 Tucanae, the Magellanic Clouds, and the Tarantula Nebula, are beyond reach because they are always too low in the horizon.

In addition to light pollution, there is a heavy air pollution in the area. Often, the researcher would find the site heavy with smell of burning garbage. Air pollution causes additional disadvantage as the suspended particulates reflect the urban lights.

Analyzing the seeing in the site through the Antoniadi Scale, it could be said that the site's seeing ranges from III (moderate seeing, with large air tremors), to IV (Poor seeing, with constant troublesome undulations) to V (very bad seeing, scarcely allowing the making of a rough sketch).

The Antoniadi Scale, however, may not be perfect to the urban observing site. The researcher, therefore, has devised an Urban Astronomy Scale which he hoped, would help him categorize the seeing on any given night: The Scale is as follows:

I Best seeing with the lights from the residential and commercial centers down; the air is satisfactorily transparent; a hint of the Milky Way could be glimpsed in the Scorpius-Sagittarius region; moonless and cloudless

II Good seeing with the air being satisfactorily transparent but lights in commercial and residential areas still on; moonless and cloudless

III Moderately poor seeing with high or fast moving clouds revealing patches of transparent sky but light in commercial and residential centers are down; moon waxing crescent

IV Poor seeing with high or fast moving clouds; lights in commercial and residential centers are still on; moon waxing crescent

V Bad seeing with haze; lights in commercial and residential centers still on; limiting magnitude is 3.0; first quarter moon

VI Very bad seeing with haze or clouds almost covering the entire sky; heavy air and light pollution; moon first quarter or bigger; limiting magnitude ranging from +2 and +3.

After years of observing, the researcher has found out that different types of objects can be observed in all observing conditions in the Urban Astronomy, such as as follows:

I. Galaxies down to magnitude 10 provided they have high surface brightness; the brighter planetary nebulae such as the Blinking Planetary, M57, the Blue Snowball; bright nebulae; globular clusters to magnitude 10 to 11; open clusters; planets.

II. Bright galaxies to magnitude 9; bright globular clusters and open clusters; the brightest nebulae such as M42; planets

III. Bright open and globular clusters; double and multiple stars; planets; crescent moon

IV. Moon and planets; bright open clusters

V. Moon and planets; bright single and double stars

VI. Moon and planets; bright single and bright double stars

Time of Observations

The researcher really cannot choose his time of observing. Often, students regardless of major would troop to the observing site (the Roofdeck). The researcher obliges by showing them the "sky's greatest hits" for that particular night. Even when the researcher does not feel like observing such as when conditions fall under V or VI, the more dedicated students would ask him for even an hour of observing the planets or the moon. Seeing which fall under I, II, and III, however are quite rare so the researcher together with the more dedicated student- observers take the opportunity to conduct overnight observing sessions. The more dedicated student – observers are usually those taking courses in education regardless of major. But physical fatigue after a full day of teaching and doing administrative work take their toll on the researcher. The key to success in finding and studying objects in Urban Astronomy is to observe as often as possible even for short periods lasting up to 2 hours only, and to have lots of patience in waiting for those moments when faint objects will finally reveal themselves.

Objectives of the Research

After the numerous observing sessions with students, the researcher has noticed that interest in astronomy is kindled among even the most casual student – observers based on the questions they ask about the objects they have seen, and even about related scientific fields of interest. Most touching, and bothering, is when the more diligent and curious among them pursue additional information only to find the RTU library bereft of books which will give them the information they need.

Also, the researcher found out that a good number of objects can be observed even in the urban area and what only remains is for those objects to be catalogued and described. As mentioned, the biggest colleges and universities in the Philippines are located in the Metropolitan Manila area and in other urban centers. Consequently, the great majority of Filipino students do not have access to dark sites if they wish to study astronomy through observations. The researcher felt that if we persist on the notion that astronomy cannot be done in light – polluted areas, this science would remain hidden and inaccessible to our students.

The researcher therefore decided to catalogue and describe the objects which can be observed in the light – polluted urban area, and to print such catalogue hoping to at least give the students something to read about astronomy, to prove that astronomy can be done in light – polluted urban areas, and in so doing convince schools in urban areas that they need not hesitate to teach astronomy to their students and that they can even build modestly equipped observatories without having to bother looking for a dark site.

Lastly, the researcher hopes he is contributing to the development of scientific consciousness among his countrymen. The five volumes of work he has written are already in the libraries of the National Research Council of the Philippines, the Manila Observatory, the UP – National Institute of Science and Mathematics Education, the Library of the Commission on Higher Education, the National Library and others.

Methods

Most of the observations were done with students who were either just curious to peek through the telescope or assist the researcher by describing what they see or to do actual sketches. Visual astronomy, it would seem, is best done when the observer shares what he sees, especially if they are students.

Plans are made before the observing sessions to list the targets for the night, which are often not followed because clouds choose to congregate in the intended area of observation. If this happens, the researcher chooses whichever object may be observed depending upon the sky condition. When the most interesting objects are hidden from view, singe stars would somehow satisfy the unquenchable curiosity of the students.

EQUIPMENT

The RTU itself does not own any telescopes. The researcher uses the his own telescopes and other equipment, which are the following:

1. 8 – inch Schmidt – Cassegrain in fork mount fitted with an 80 – mm finder and bulls – eye target finder
2. 4.25 – inch f/4.5 Newtonian reflector
3. 102 mm f/10 refractor
4. 10x50 and 7x50 binoculars

The researcher also brings several books containing data on astronomical objects for ready reference to answer all those questions by students.

All the equipment are non – computerized.

OBJECTS CATALOGUED

The following are the objects catalogued during the two years of urban astronomy observing (from January 2000 to March 2002). They are embodied in five volumes of work consisting of 300 Observation Reports:

a. Supernova remnant. Only one of this type was found, namely M1.

b. Open Clusters. The research so far has catalogued 161 open clusters observable from the urban location. Some of them are the most famous such as M45 (the Pleiades), M44 (Praesepe), M47, M6, NGC 6231. However, they are many other obscure open clusters the researcher and his student have found for themselves, such as some Collinder, Pismis, and Ruprecht open clusters. Students delight in doing connect – the – dots on these objects.

c. Galaxies. These are some of the most difficult objects to see in urban astronomy. Type I or II conditions are needed before they could even be glimpsed, and the urban astronomer must have to content himself with the fact that he saw them. Very few galaxies show detail such as M64 (the Black Eye Galaxy) and M81. Most of them appear like ghostly patches of light. Some have bright cores. Some can easily be mistaken for compact globular clusters or of planetary nebulae. But the students are nevertheless delighted that they could see objects millions of light years away.

d. Globular Clusters. The researcher has catalogued 44 globular clusters in the first five volumes of this work. Some of them are the best such as Omega Centauri, M13, M22, M92, and M5, but many are pale and obscure such as the globular clusters scattered in the Scorpius-Sagittarius and Ophiuchus regions. Students are wondering if their stars do not touch each other until the researcher explained their nature.

e. Planetary Nebulae. We have so far catalogued 14 planetary nebulae. The best known among them is M57 (the Ring Nebula), M97 (the Owl Nebula), NGC 2392 (the Eskimo Nebula) and NGC 3132 (the Eight-Burst Nebula). Planetary nebulae always look bluish to the researcher. Many students, however, see them as green! It would seem that observers belong to two camps when it comes to planetary nebulae: the Blue camp , and the Green camp.

f. Bright Nebulae. We have catalogued only 8 of this kind owing to light pollution. The best moment to observe them in the urban area is when the lights from most establishments are down, but that means having to observe starting at 1:00 am to about 3:00 am. M42 however, is the Great Orion Nebula and it fits its name. Students exclaim with admiration upon learning that it is an active star-forming region.

g. Double and Multiple Stars. To many students, these are some of the most fun- to- see objects. Some of them are the most colorful such as Beta Cygni (Albireo), Alcor-Mizar, Alpha Herculis, Epsilon Bootis, and many others. Some students wonder if a bridge can be built between the two stars of a double system until their true distances are explained. Some delight in knowing that Alpha Geminorum, for example, is actually, a 6-star system.

h. Variable Stars. These are the most difficult and frustrating objects to observe in urban astronomy. The observer really cannot visually follow the light variations of even the short- period variables because of the highly erratic Philippine weather. We have listed 20 of this type in the catalogue but we are not sure if their variations can really be observed.

i. Asterisms. While these objects are said to have limited scientific value, students place much preference for them for the shapes they present to the imagination. We have catalogued 12 of them. The researcher explained to one curious student that asterisms are important in committing to memory the patterns in the sky, like constellations do. Any object which would appear which is not part of the pattern must be a supernova or a comet.

j. Single Stars. When all deep sky objects are not observable, the researcher finds enough consolation in showing the students the single stars. They pack enough marvels. Betelguese, Mu Cephei, Capella, Canopus and even the most ordinary –looking single stars never fail to fascinate the students with their properties.

Conclusion and Recommendation

While the objects catalogued are still incomplete, they represent a good sample of astronomical objects which can be studied even in light – polluted urban areas. The researcher plans to continue studying these objects and additional ones to add to the catalogue in the next few years. Therefore, light – pollution is really not a hindrance to a determined study of astronomy.

In the field of education, schools in the Philippines should start acquiring fundamental telescopes which are designed for a general introduction to astronomy among their students. However, prospective teachers must first be trained to observe, and to be taught astronomy since very few indeed are those who can teach even the most rudimentary aspects of the science. The Philippines is light years behind in astronomy education and if there is any good time to start, it is now.

Government support to astronomy education should start by providing funds for this purpose. If astronomy in the Philippines would be of any value, its power to kindle scientific interest and consciousness among the students would be a great motivation.

Lastly, the researcher finds deep satisfaction in doing astronomy in the city, and most importantly, in sharing its wonders to young minds eager to learn. He feels he is contributing to the future to make it bright. Already, several groups of students are planning to conduct visual observations themselves as their undergraduate thesis project. These are a far cry from the researches undergraduates conduct in advanced countries but for the Philippines it is a step towards a bright future. They are tiny steps but we will take many of them.

Our Attempts in Astronomy

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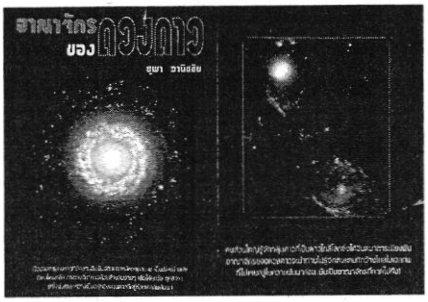
Introduction

During the last decade of the 20th century, updated Thai astronomical articles were very rarely published, only constellations and classical astronomy were easily obtained. A pocket book titled "Empire of Stars" was purposely written and proceeded to printing in August 2000 while a Thai astronomical website, www.darasart.com, began independently in September 2000. It was the first cooperation from 2 computer programmers, Mr. Sukit Boonnarungsee and Mr. Paritat Theanthong, who chatted in internet about lacking modern astronomical articles.



"Empire of Stars" pocket book was written by me, telling about modern astronomy: interacting galaxies, mergers, clusters and superclusters of galaxies, structures of voids and cosmic strings etc. in summary and in consequence path in order to be easy for most readers. After having read the book, Mr. Boonnarangsee contacted me in April 2001. When he was young he used to read my astronomical articles in "Taksa" scientific journal. We later joined together to improve the website which now is the most popular Thai website in astronomy and being rewarded in January 2003 by a national institute for children.

Appreciating www.darasart.com, Mr. Kraiseeh Petchpornprapas, has become a sponsor of www.darasart.com. His intention is developing science education for Thai students by selling and/or building science instruments in low price. Astronomy is a branch that he willingly works hard with. He was trained the process of constructing big telescopes in developed countries. The first observatory with telescope 600-mm reflector, made by Thais, started building in October 2001 under his control. Moreover, the first small telescope made in Thailand, YUPA 150-mm reflector Dobsonian, is a product for sale in low price since November 2002. The telescope, first aimed for student's observation, is also successful among amateur astronomers. He anticipates more processes of optical and telescopic technologies done by Thais.

Our attempts are also accidentally coincidental with new nationally educational plan, which astronomy courses will be likely as weighty as other science branches in schools. From the beginning of the 21st century, astronomy in Thailand looks more extensive than the past.

About Thai Astronomy Websites

Introduction to www.darasart.com

"Darasart" in Thai language means astronomy. The website www.darasart.com looks nice with many branches of astronomy and modern astronomy articles which can benefit to all level. The webmaster, Mr. Boonarungsee, an amateur astronomer being keen in sky observation often arranges star camping.

My first article in this website appeared in June 2001. I have written special articles from translation, reformation into my words and style. Attempting art into scientific writing is challenging and funny for me. Other articles are written by amateur astronomers: Congin's articles are about UFO, Space Exploration and Solar System, Rook writes news, Mr. Boonarungsee writes celestial objects for observation.

Since 1977 I have written more than 300 astronomical articles in Thai scientific journals, namely: Srinakrarinth Bangsaen, Vittayasart Thai, Taksa, Chaipuk, Rurobtoa, Mititee 4, TAS, and Burapha, in different contemporary. Most of these journals are not published nowadays. Since 1990s, new editors haven't needed astronomers for writing astronomy articles, only translators have been enough for them. Main information of modern astronomy lacked for many years until September 2000. Since then Thai updated articles in astronomy have been easily searched from www.darasart.com.

The contents of www.darasart.com

Astronomy news, astronomy special articles, astronomy vocabulary, webmasters answer astronomy questions from readers, 2 boards for asking about astronomy and instruments, introduction to Thai planetaria and observatories around the world, linking other astronomy websites in Thailand and websites from aboard, astronomy instruments from sponsors, photos from aboard and Thai observers, photos from foreigner websites, technique of taking astronomy photos, introduction to young observers instruments and building telescopes, daily weather prediction, constellation this month, solar system, monthly planetary positions, observation and camping,

Introduction to www.vittayasart.net,

The intention of Mr. Petchpornprapas, the owner and webmaster of www.vittayasart.net is as followed:

" Our website initially intended to serve mainly the local Thai astronomers, fundamental science instruments and education toys market therefore, many of webpages are in Thai. However, we are working on a project that involve international cooperation and webpages of this project are mainly in English. If you are supplier of products related to our field of activities , we will be glad to know more about your products and services. Together, we can make things happen! "

The website contents: scientific articles written by Mr. Petchpornprapas and me, (He has written scientific articles alone in his website then I joined the website with my first article started in July 2002.) telescopes, lenses and accessories in many sizes from many countries, education toys, solar energy cells, microscopes for sale in low price with anticipation to improve qualities of science education for children, etc. Science camping for children is another new project devoted to the country education.

Because of vittayasart.net attempt, Thais have built small and big telescopes for the first time. Though the website is rather small, but his initiation and intention is very interesting and hopeful for scientific education especially in astronomy. There are other 2 agent shops selling telescopes from aboard, TS and TMK .

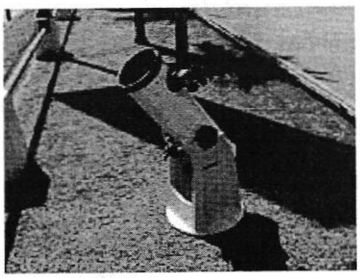
At least other 17 Thai astronomy websites can be linked from *www.darasart.com*. Some are small websites about specific projects such as a website for UFO, a website for Saturn and a website for building telescope yourself, etc

These websites are Thai Astronomical Society (TAS), Kirdkuo Observatory, FAH-4, Various Stars, UFO Searching Project, Astronomy, Yindii School Zone, Unlimited Universe, Star Park, Saturn Survey, Building Telescopes Yourself, Skywatcher, Seeing Stars.Com, Bangkok Deep-sky Object Observatory, Sirindhon Observatories, Darasart Kid, Thousands of Stars

There are other Thai websites about science, which some parts are occasionally helpful in astronomy education. Some of these are www.vcharn.com, www.pantip.com and www.nstda.or.th etc.

The First Telescope Product Made in Thailand

Dobsonian Telescope Model: YUPA 150
made by Mr. Petchpornprapas from www.vittayasart.net,
Primary : 150 mm., focal length 750 mm., f/5, low expansion mirror, aluminum coated, 93% reflectivity, spherical hand ground in China.
Secondary : 35 mm. secondary mirror
Focuser : Rack and Pinion type , 1.25":
Eyepieces : one Kellner eyepiece 1.25" , 25 mm.
Finder : 6x30 finder



Price: 230 US$

Packing: Box 1: Telescope Tube: 38x69x32(h)cm^3 : 9 kgs.

Box 2: Wooden Mount : 40x40x53(h)$cm.^3$: 10 kgs

Website: www.vittayasart.net

The telescope plan was first announced for sale in June 2002 while the procedure and testing was going on. The first one was finished in November 2002. Bigger telescopes may be possible in the future.

Testing Yupa150 by the expert, Dr. Martin Trittelvitz

It is a very fine instrument for an astronomical beginner or a good choice for an advanced amateur. The mirror has been Ronchi tested. The mirror shows good surface, no zones and no turned down edge. Inside focus it shows a light shape perfect! The mirror is neither spherical nor parabolic. It is something about 65% for a perfect parabola. The pictures are much better than with a sphere, not as sharp in the center as a parabola but very even over the whole field. The telescope would be fine for taking photographs, because the film does not resolve more than the telescope can do. The moon looks bright and clear showing a lot of details. The shadows appear sharp, the focus snaps in, as expected with a good mirror. Jupiter appears sharp with four moons, no halo visible. Its moons pinpoint in the 10-mm eyepiece. Two bands of cloud on Jupiter in bright orange can be seen. The picture of Jupiter is much better and more detailed as expected. Great Orion Nebula M42 is a fine view, dark cloud and detailed bright structures. The telescope shows advantage of the short focal length. With its150-mm diameter and 750-mm focal length it presents bright images. The coma does not appear, the overall image does not suffer, in contrary with lower magnification the picture gains from the "missing" coma. The focuser is basic and can take eyepieces of 1.25 inch, but it works precise. The mirror cell is very sturdy and precise, like the whole telescope appears to be of high quality. The use of the telescope is easy, no difficulties. The Dobsonian mount made of wood makes the telescope look really fine and shows good craftsmanship. Very helpful is the weight of the lower side of the tube for different eyepieces. This outstanding little instrument will be a worthy companion for his future excursions.

The First Observatory with a Telescope made by Thais

ROTAR 1: Robotic Telescope for Thailand's Astronomy Research 1

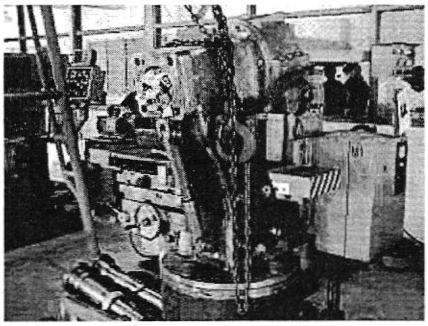
A 600 mm. (24") Newtonian Telescope for Songkhla Observatory

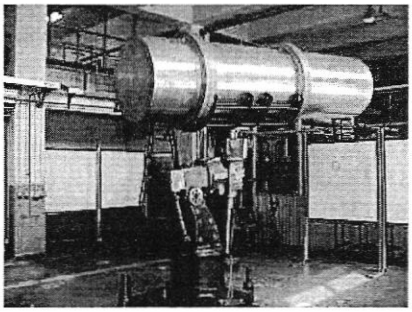
f/4.5, focal length 2,700mm. with a 4" Motorized Focuser on a heavy duty German Equatorial Mount with GOTO motion controller.

October 2001 : Initial plan was set up to build the telescope.

The telescope was designed and built by Thai astronomers, engineers from Rajabhat Institute Songkhla, Chiang Mai University, Rajamangala Institute of Technology. The site of the telescope building process is at Rajamangala Institute of Technology, Rangsit, Thailand.

The leader of the project is Mr.Petchpornprapas of www.vittayasart.net





Astronomy Causes in Schools

There are 12 grades from Pratom 1-6 to Mathayom 1-6. Previous astronomy education in schools was neither intense nor consistent. Even astronomy teaching started in primary schools but secondary schools in science branch didn't include astronomy course. In new adaptive education program starting from 2003, astronomy education in secondary schools would be significant as physics, mathematics, biology and chemistry for science students. There are compulsory courses in astronomy for Pratom 4-6 to Mathayom 1-3, and optional courses for Mathayom 1-3 to Mathayom 4-6 as in the following table.

Pratom 4-6 Compulsary courses	1) The sky: planet, star and satellite classification 2) Sun, the important source of life and energy on earth, 3) Earth rotation, day and night, sun and star rising 4) Revolution of earth, the inclination of earth axis, season 5) Moon orbit, waxing and waning moon 6) Solar and lunar eclipse 7) Evolution of space technology, living in space and observing celestial object
Mathayom 1-3 *Compulsory courses*	1) Constellation, star cluster 2) Technology for space exploration and observation, satellite for weather prediction and natural resource and communication.
Optional courses	1) Position and path of star rising and setting, celestial equator, celestial north and south pole 2) Earth revolution, zodiac, ecliptic coordinate
Mathayom 4-6 Optional courses	1) Characteristic of sun surface 2) Sunspot, solar wind, earth's magnetic field, solar storm 3) Stellar fusion, mass, volume, distance, magnitude, luminosity 4) Analyzing stellar spectrum for composition, temperature and lifetime, redshift and blueshift, stellar motion 5) Type of star analyzing from H-R diagram 6) Stellar birth and death 7) Tide on Earth 8) Big bang, universe and galaxy 9) Remote sensing

General Review

Many schoolteachers, rarely learnt astronomy in universities, may be firstly self-studied. It is time to improve astronomy for science teachers. Understanding correctly classical and modern astronomy is required. Training programs in short period for upgrade schoolteachers are frequently arranged in many universities. New education program, Master of Science in Education, is provided in at least 2 universities, Burapha and Narasuan, for schoolteacher requirements in teaching development. Astronomy is an optional subject in physics branch.

Unlike physics books, modern astronomical books are lacked. It is difficult to write an updated astronomical book in consequence because its contents follow observations and researches that fluctuate frequently. Teaching modern astronomy in all level is not easy without modern astronomy books. Yet, astronomy books are neither enough supportive nor encouraging to printing. However the website www.darasart.com can fill some gaps and partly subserves the aim forwards.

"The Development of Multimedia Computer-Assisted Instruction Program on Earth and Star" is a student's project in Educational Technology department, Burapha university. This project belongs to Mr. Theera Disayarat, e-mail: Theera-pui@yahoo.com. It is helpful to be self-studied for students before beginning real sky observation.

Two planetaria are located in Bangkok and Ayudhaya where students can also understand universe outside classroom. Another new one in Pratumtanee has been problematic which will not be finished. Astronomical observation in private observatories and star camping, which arranged frequently by amateur astronomers can be helpful to observe real sky. Small telescopes made in Thailand with low price also assist in observation and rousing curiosity of more students to follow their astronomy. Observatories with big telescopes from www.vittayasart.net may be possible in schools that will tend to expand deeper observations and experiments in astronomy. However, guidance from real experts is requisite for real improvement of building. Except planetaria, others are private attempts that must be self-supported.

In the complicated development around the country, the spirit of Mr. Petchpornprapas is recommendable for real development, at least he tries to approach the best education with Thai pride. His initiation and intention is great, sincerely devotes to the country and the kingdom. His propensity to look after fundamental to advanced astronomy and other fundamental science of the country, is not easy for any man who mostly supports himself. Whether the target will be accomplished or not, yet depends on wisely competent and good cooperation among co-workers in real progressive insight. Encouragement, support and approval from educators in schools for their students are also important and necessary.

Science Teaching in Indonesia: Syntheses of Issues

by

Bambang Hidayat*

Why are we here today, at this critical time in our country's history, discussing science and technology education? Does the scientific community have credibility problems? Or, is it the uncomfortable feeling that we recognize that science and technology has not been able to elevate our nation to an appropriate level of scientific lliteracy in this "civilized" world? Or do we understand our failure to transmit the new knowledge which is needed to transform our basically agricultural society into a science and technology-driven culture?

There are certainly a multitude of problems to be solved which involve both time and space. Indeed, the elements of time and space are extremely important parameters for us in Indonesia. Our society is a very fine and fragile fabric consisting of various ethnic and cultural identities as well as different philosophical views. There are various levels of sophistication and these are woven into a beautiful and intricate tapestry which should be a source of pride and strength (This include the management of prejudice, which has been outlined by Dr. Buchori). Unfortunately time (and perhaps opportunity) limits my assessment by providing only some normative answers, rather than giving a detailed deliberation. Before doing this allow me to offer one or two vignettes which serve to illustrate our inadequate teaching practices which have failed to bring about the scientific explanation of natural phenomena. These are:

1. The appearance of a comet. When the comet West appeared in April 1970, and was followed by the passing away of President Sukarno in June 1970, many people believed that the preceding cosmic phenomena signified the later event. Again in April 1997, when the comet Hyakutake adorned the evening sky, in Indonesia some people asked what this sky phenomena would tell us. Would it be a bad or a good omen? We joked that the appearance of a comet would signal the change of a dynasty. The point is whether that change would manifest itself as a good or bad future. In fact there were two sides: good because the "dynasty" collapsed a few months later but bad because the

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* Presented at the lauching of books of Dr. M. Buchori, by the Jakarta Post (Marcht, 15, 2001), in Jakarta

**Bosscha Observatory, ITB, and the Dept. of Astronomy, ITB. Member of the Akademi Ilmu spirit of the dynasty is still in existence. Also, in the case of the earlier comet not only did the great man Sukarno pass away, but between April and June 1970 thousands of beggars and innocent people died unnoticed.

2. We are currently in a state of confusion stirred by the problem of BSE (Bovine Spongiform Encephalopathy); madcows; transgenic plants or genetically modified organisms. Some elements in society have argued emotionally that GMO; genetically engineered plants, might generate weed problems and would affect non-target organisms. But measuring the risk is the necessary step to confirm or to refute the hypotheses. Why? Sound science is the best possible way to answer such a question in order to present with rigour the certainties (or uncertainties) of knowledge. We should not employ the "precautionary principle" only or vote by legislators or by demonstration (in the case of Ajinomoto) in the proccess of decision making on strategic issues. Scientific consciousness should be at the forefront. I truly believe that the public should be involved in the formulation of public-related topics rather than merely being consulted on "draft proposals". Herein lies the importance of education and the mass teaching of scientific principles in order to build a rational way of argument and reason.

The human society of the 21st Century faces the daunting yet inspiring task of forging a relationship with the natural world. New concepts emerge about global trends in population, development and environment. Within these concepts it is implied that meeting current human needs is paramount, while at the same time preserving the environment and natural resources needed by later generations. We encourage the integration of academic research into market demands with a price on the role and credibility of scientists, academics and administrators. This is important as to build up the integrity of scientists, legislative and society leadership in making decisions.

Education must also respond to the new age. Attempts to revise, reorder, restructure, reshape and otherwise modify curricula should adapt to the sweeping changes now taking place in contemporary society. The highly complex post-industrial society demands new knowledge and skills and the flexibility to adapt to and meet the conditions of urban life. To be proficient in science our students must be able "to think like scientists" and engage in scientific inquiry. This ability may be acquired by focusing on the development of intellectual skill labelled as "processes of science". This includes observing, classifying, knowing space-time relationship, using numbers, inferring, predicting and communicating. (The last subject has been nicely developed in one of the articles written by Dr. Buchori. Here I emphasize his use of precise language without obfuscation or double meaning). These are worthy skills when taught in the context of a problem which is meaningful to students. It is less useful when taught as an independent or isolated skill. Needless to say proficiency in the Indonesian language is a necessify and we have expressed our view that a written account is necessarily distinct from an oral one.

Any reform of education in the sciences is meaningless unless it is responsive to today's demand and to our emerging knowledge-intensive society. Of equal concern is the failure of school science curricula to respond to changes in the image and ethos of postmodern science. Therefore reforming a curriculum would not be a simple affair but needs visionary judgment.

We know for example computer courses have been established everywhere. We should also recognize that computers are an essential part of a modern research team. Computers can summarize what is known or not known very quickly, out line problems, prepare models derived from data, and continuously organize additional data from other research teams which may be scattered around the globe. This pooling of the minds serves to broaden the context for generating a flow of ideas and for extending the significance of any findings. Examples of natural and social scientists working together are already found in problems related to the management of our natural environment, stabilizing the world's human population growth, controlling the AID pandemic and genetic treatment of human diseases. Cooperation in this case will never become redundant in the coming world.

We remember clearly how many disciplines were integrated to help mitigate the disaster caused by El Nino and La Nina. The atmospheric phenomena was not anly of concern to meterologists but was the business of people from many walks of life as its impact affected many sectors of society. Therefore the single discipline solution would not be the most adequate one. Social values and ethical issues are seen as relevant dimensions to our scientific conduct in the coming decades. These attributes are observable in the research on problems related to biotechnology, human behaviour and how human organisms interact within the social environment. I would caution here. In response to increasing demands one should not forget the maxim of becoming an expert first, and a generalist later. Not the other way around! (We should not be trapped by Chairman Mao's dictum of the 70's: red first, expert later). One must be able to show an identity or a firm track in life before synthesizing phenomena or problems. This is equally true in the process of filling a cabinet post (I am thinking aloud).

One purpose of science education in the 21st century should be identified as the development of responsible citizenship in dealing with problems that embrace dimensions in science and technology such as those related to the environment. This is in fact the ethics of the 21st century: health, energy and agriculture. Teachers should be concerned and prepared to teach their students about their experiences in a context that extends beyond the laboratory and the boundaries of disciplines, but still remains within the realm of scientific validity. In a geography lesson, for example, it is not enough to tell the students that the Ciliwung runs through Jakarta. Instead they must also impart their knowledge of biochemistry, of the possible bacterial content of the Ciliwung and the problems of pollution.

A critical dimension is the nation's transition from an industrial economy to one that is knowledge-intensive. Those who master the knowledge will ultimately become the winning race. We must be ready preparing new minds for a new age which will require a new model of science curriculum development, one that is more holistic in conception. Here science teaching will emphasize "the optimal utilization of knowledge and blur the present distinction between schooling and the real world. It will be a vision of science education that presents science and technology as a part of the lives of our young people.

Thus the essential of the educational policy is characterized by a greater emphasis on introducing the process of scientific endeavor, rather than on memorizing or facts alone. It involves greater participation and involvement by the lay public and establishment of science as a social institution. A major goal of science education becomes enculturation in which education in the sciences is linked to the prevailing science-and technological-society. The students should have a strong desire for more information, rather than a purely passive role in listening to the boring facts. They should be trained to argue not on the basis of "I am right", but trained to accomodate the views of their opponents. They should be trained to accept partnership not on the basis of "like or dislike", and should be able to see clear goals.

Allow me to raise a question? Who cares about this "big picture", sketched with a very rough brush? I believe that we who have benefited and enjoyed life in this free society should be responsible for the future generations. There are young "adolescents" of today who will become a full citizen of our beloved country of tomorrow. They should not become a pariah or a second class citizen in the global world in the 21st century. Our task is to usher them into the world of competition with the skills and knowledge which will refuse to acknowledge conventional geographical boundaries.

Jakarta, March 14, 2001
Bambang Hidayat

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