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From editor

After two volumes of the special issue for the first meeting of Teaching of Astronomy in the Asian-Pacific Region held in Beijing in October 1992, we publish the volume No.8 as for papers present to the editor. We are intending to publish 2 volumes per year. To keep this, we need many contributed papers time to time and encourage your contribution.

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Syuzo Isobe
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GETTING STARTED: AN ASTRONOMY HALL FOR A SCIENCE MUSEUM

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ABSTRACT

A new Science Museum has been built in Mexico City by the National University: *Universum*. It houses halls dedicated to biology, physics, chemistry and astronomy amongst others. In this paper we describe the general layout of the Astronomy Hall, its contents, and objectives, and general experiences, acquired during its construction.

INTRODUCTION

Mexico City, being one of the largest cities in the world, is in great need for Science Museums that will encourage a large amount of visitors to learn about science in an informal manner. Although Mexico has a great tradition in building art and history museums it has very few public spaces devoted to science; fortunately there seems to be a new trend and several Science Centers are under construction. The present administration of our National University built such a facility that houses a convolution between a formal museum and a science center whose leitmotif is evolution. In Figure 1 we show the main entrance to the Museum.

Several scientist were invited as advisors and a staff of 200 people has slowly been incorporated to the project over the past three years.

Since there is little tradition in this kind of museum in Mexico every hall had the chance to have a partial show of its displays in several populous places: subway stations, smaller universities, other cities. This gave the people working at the Museum a chance to try out their ideas with a wide variety of general public. In particular the Astronomy Hall has had an exhibit on planets and another on solar eclipses at metro (subway) stations (Fierro and Mateos, 1992, and Fierro and Doddoli, 1993).

One of the principal features of our exhibits is that they were built in Mexico. At the beginning this meant a serious handicap because it took a long time to have things made and they did not always meet the scientists idea nor the publics needs. But on the long run it has proven to be the correct thing to do because our apparatuses getting are better and specially due to the fact that maintenance depends solely on mexican facilities.

One of the features that characterizes the astronomical exhibits is that there is very little written information and that several booklets have been edited that people can purchase at reasonable prices so that they can read at home about any subjects they were interested in while visiting the Museum.

In this paper we will describe the astronomical general layout and comment on some of our experiences.

GENERAL PLAN

When the final project is completed three halls will be dedicated to astronomy. One will be on evolution, divided in three sections: astronomical, biological and anthropological evolution. The other is dedicated to general astronomy and is divided in four sections: solar system, stars, galaxies and astronomical instrumentation. And hopefully a third section will hold a planetarium and exhibits on astronomy history. The idea is to house hand-on exhibits in every section.

At present only the Astronomy Hall has been completed. It has two great sections, one painted in black and one in blue, like day and night. They hold displays on the solar system, eclipses, general physics, star properties and a small planetarium.

In order for the visitor to find the information he might need the Museum has a public library and a video rental station. The Astronomy Hall has several general astronomy books on display for people to look for information and several computer terminals with general information that the public can access to using hipertext. (We have both books and computers because we feel some people are "afraid" of manipulating computers). The idea of having books in the Astronomy Hall is so people can look up information they need at the moment it occurs to them, having help available encourages them understand the subject at hand. In Figure 2 we show the section of the blue Astronomy Hall where the computers are located.

MAIN OBJECTIVES

Science is accessible and can be fun

Our general feeling that was discovered by science center builders throughout the world (Tirado, 1990) is that people think science is a very formal business that can only be understood by a privileged group of intellectuals. We feel that *Universum*, the name of our Museum, has shown to thousands of people (we have about 2 000 visitors per day, 7 days a week), that Science can be understood and enjoyed by almost anyone.

National feeling

We feel that in general mexican public is unaware that science can be done in Mexico by mexicans. So as far as we could we had a mexican touch in our exhibits making use of as many native craftsmen as we could. We also have on display called: *What is an astronomer?* showing a mexican women astronomer in her daily

affairs.

Other halls also have such a touch, for instance the Mathematics Hall has a wonderful mosaic recreating Penrose's geometry (Figure 3).

GENERAL DEVELOPMENT

As mentioned previously we have been working at the Museum for three years. The staff has been growing steadily from 30 to about 200. *Universum* was dedicated on december 17th, 1992.

THE ASTRONOMY HALL

The Astronomy Hall is planned to have four major sections:
a) The Solar System
b) Stars
c) Astronomical Instrumentation
d) Physics

The historical sections and temporary exhibits (like eclipses or comets) will be placed in the Planetarium lobby (when constructed), cosmology will be covered in the Evolution Hall.

a) The Solar System

This exhibit features general properties of the different objects in our vicinity.

We have a display on relative sizes of the planets, with an explanation on tape; scales showing one's weight on the Earth, Mars, Jupiter, an asteroid and a neutron stars. The scales also show a picture of the body in question and one can "feel" the surface and lift up a quart of milk (that will weigh accordingly) in the particular object. See Figure 4.

Another apparatus shows the visitor how different objects might smell: Io like sulfur, or Titan like methane.

We have an exhibits on the orbits of the planets, on their densities, and on their internal structure, displays on meteorites and tektites, and on the variety of temperatures found on Earth.We show how wind and lighting are formed.

This exhibit shows planets through several of our senses: touch, smell, sight, ear. All the displays are interactive in one way or another.

b) Stars

This section shows general properties of stars: temperatures, sizes, proportions, chemical composition and their evolution. We also have equipment concerning constellations. We also have a panel for general properties of the Sun. All the constellations visible from Mexico are depicted in the night side of the Astronomy Hall.We have a special apparatus about the HR diagram where visitors are asked specific questions on stars general

evolution, and later these questions are answered in luminescent panels.

Figure 5 shows a candy deliverer that gives the visitor candy according to the proportion of stars of different colors and sizes, a few big blue candies and many small red ones; in a similar way as the luminosity function.

We have a Lottery Game which is very much enjoyed by children, an usher calls out different astronomical items at random, and recites a small poem about them, children fill out cards containing the items, the first child to fill out the card wins the game. (See Figure 6)

c) *Astronomical Instruments*

We have a small telescope that will be open to the public. Due to Mexico City atmospheric condition the Moon and the brighter planets will be good targets for observation as well as a few nebulae and star clusters.

We have a display about electromagnetic radiation with a recorded explanation about the different objects that produce the radiation and the detectors that are used to study it.

We have several exhibits on mirrors and the laws on reflection (Figure 7).

Hopefully we will expand this exhibit to show how astronomers use gravity to study the universe. We already have on display a "black hole".

d) Physics

We have several physics displays in the astronomy hall. They include temperature, weight, pressure. (Figure 8.)

These exhibits tend to show how physics is tightly related to astronomy.

CONSTRUCTING ONE'S EQUIPMENT

Our experience has shown as that it is a very good idea to built one's equipment.

At the beginning our staff of engineering was not skilled enough and we were tempted to buy the equipment. But after several years this staff has become very efficient and is able to produce the items we need.

The author has visited several Science Centers and Science Museums and thought some of the apparatuses should be bought, nevertheless experience has demonstrated the contrary, for two reasons.

1-Mexican Artisans have proven to be extremely creative, and having kept them away from other Science Museums has permitted them to give a very personal touch to the equipment.

2-Since it is always difficult to purchase items in a foreign

country maintenance of the equipment has been straightforward. The parts we have used can generally be found in a large hardware store in Mexico.
3-One builds precisely what one needs, in accordance to the idiosyncrasy of the most common visitors.

PUBLICATIONS

Unfortunately many school teachers send their students to mexican history museums and make them copy the exhibits labels. So when we planned the astronomy exhibit we decided to avoid them as far as possible and substitute them by written information people could carry home. After our first exhibit on the planets we realized a least a few are necessary. Consequently in order to have enough literature available for the different exhibits lots of written material has been produced.

List of publications

All the following publications were edited by Aaron Alboukrek of the Centro Universitario de Comunicación de la Ciencia of Mexico's National University.

1-Posters. We have two "glows in the dark" posters, one of the solar system and the other on the night sky.

2-Book Marks. We have 9 different models of bookmarks with a celestial object's picture and a brief description.

3-Booklets.
The solar system

4-Object-books
These are paper objects that have a little more than a book to them.
a) Mobile of the Solar System
b) Lottery game
c) Tell yourself a story (it consists of a small box shaped like a rocket containing three booklets with no words, about space travel so each child can make up his on story, even a completely blank one is included).
d) Fold out book on the constellations
e) Book for the very young. Mainly pictures of day, night, moon, stars, clouds, rain and a rainbow.

Since there is a general tendency for mexican youngsters to read less and less we feel it is important to offer them a wide variety of "interesting" books so they learn how fulfilling contact with books can be, beginning at a young age.

USHERS

We consider that having ushers at the exhibits has been important. First because as mentioned previously we would like to avoid students copying the labels and secondly because it has been found that having live shows prove to be a rewarding and lasting

experience for the visitors (O'Berry, 1990).

The ushers jobs is on one hand to answer questions, and do tours through the exhibits that need it and specially to encourage people to manipulate the hands-on objects. On the other to put on science shows and workshops.

Training
The training of ushers has consisted of informal talks on the topics of the exhibits and on books about the subjects (Fierro and Herrera 1988, Fierro *et al.* 1991). We realized this was not enough. Now, hopefully the ushers will get professional training by people dedicated to theater, we expect this will help them feel more comfortable with the public and give them more initiative. Of course the ushers that have natural skills exist, and some of them have proven to be great with the public.

SUCCESSFUL EXHIBITS

One of the most successful exhibits is the scales, where people can weight themselves in several astronomical objects, touch the possible structure and listen to probable sounds.

As many other people that run science centers throughout the world the most successful exhibits are the ones that involve the most manipulation and participation by the public.

NEAR FUTURE

NASA will let us display a Moon touchstone beginning next december. It will be housed in the main lobby. We will have a small exhibit there featuring the Moon's physical conditions and the story of its exploration, as well as future prospects.

CONCLUSION

There is a great need to increase knowledge in third world countries, informal education such as science exhibits can be great motivation for people to get involved with science.

It si difficult to construct interesting and durable equipment for such purposes, but once one gets started experience increases rapidly.

Having scientist directly involved with the staff, contrary to what other authors have suggested, has made the mexican museum extremely interesting to general public.

Acknowledgments: Building a Science Museum requires the work of many people. We am indebted to the staff of *Universum* and particularly to its Director Dr. Jorge Flores for all his support.

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Figure Captions

Figure 1. Main entrance to the *Universum*. On the right side is a parking lot. The cost of a ticket is $1.75 US for students and $3.00 for general public.

Figure 2. Two computers are in the Astronomy Hall where students can find general astronomical information or play a game about visiting Mars and the asteroids.

Figure 3. General layout of the Mathematics Hall showing a Penrose mosaic and giant kaleidoscopes where people can look at their own image.

Figure 4. Planets in the dark side of the Astronomy Hall of *Universum*.

Figure 5. This sphere delivers candies to visitors according to the luminosity function of stars. For each blue candy a few green and lots of red ones are delivered.

Figure 6. Biology Lottery game. The ushers shows different sets of slides and people have to recognize the objects and place a pellet on the ones he finds. The astronomy lottery is very similar to the one shown here.

Figure 7. This apparatus lets people produce air bubbles in a glycerin tube by activating a pump.

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SALAS DE ASTRONOMIA PARA UN MUSEO DE CIENCIAS

En breve se inaugurará el Museo de las Ciencias de la UNAM. Las instalaciones están en Ciudad Universitaria, cerca de Av. Imán. Cuenta con 13 espacios distintos dedicados a varias áreas del conocimiento: Biología, Física, Matemáticas, Química, etc. Además tiene una con biblioteca, librería, tienda de recuerdos, auditorio, cafetería, etc.

El Museo de las Ciencias es un museo participativo, es decir, que se espera que el visitante interactúe con los aparatos que allí se muestran.

Dentro del Museo existe un espacio para la Astronomía. Está dividido en dos: el lado "día" y el "noche". Allí se muestran algunas propiedades del Sistema Solar y de las estrellas, se tienen varios telescopios, experimentos sobre eclipses, salas de video, una biblioteca de consulta y varios equipos sobre física general.

La Sala cuenta con una serie de edecanes que podrán llevar a los grupos de visitantes al planetario, jugar con ellos a la "Lotería Astronómica" y aclararles dudas.

Para llevar a cabo una obra de esta magnitud ha sido necesaria la participación de cientos de personas a las cuales les estamos profundamente agradecidas.

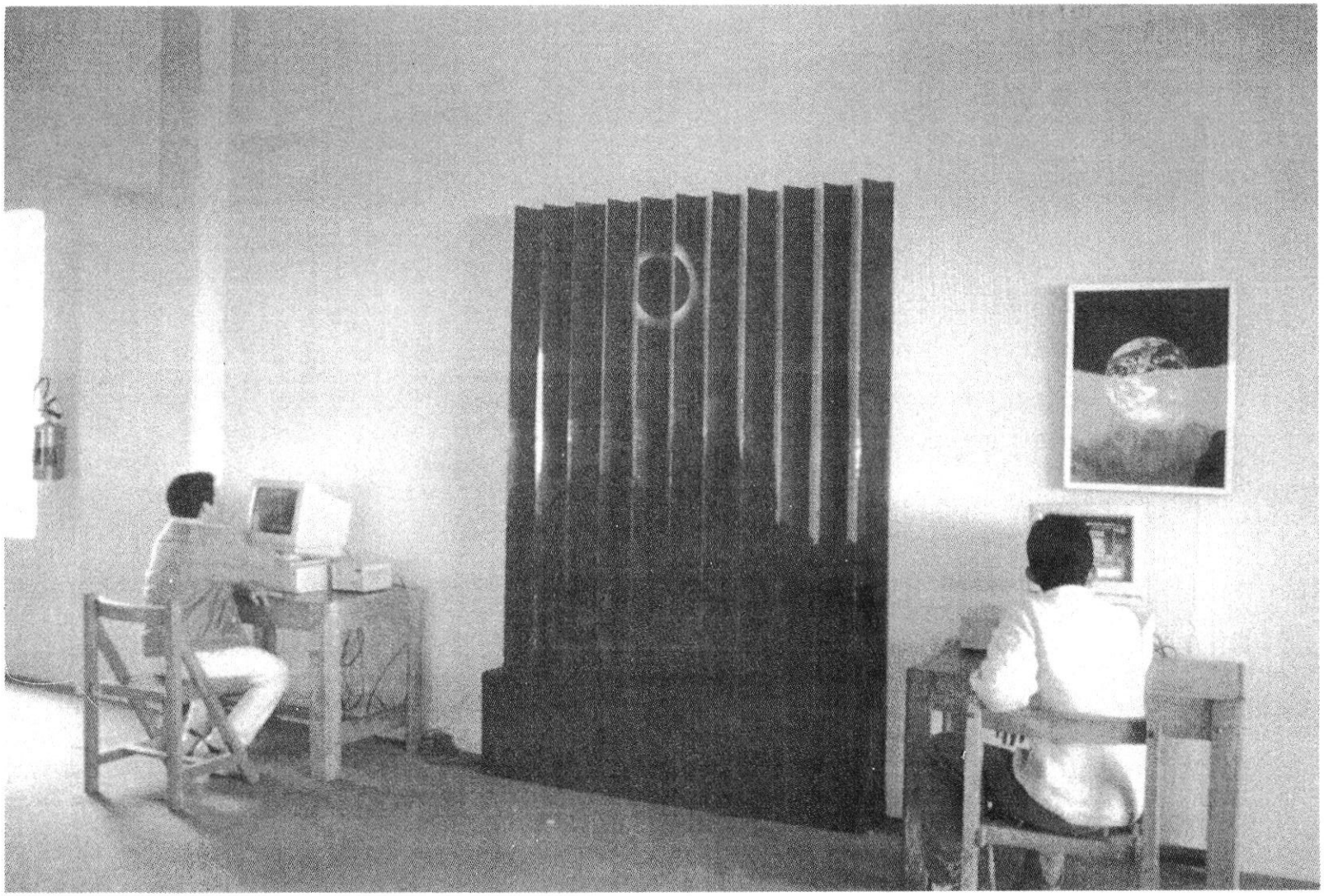


Fig. 1

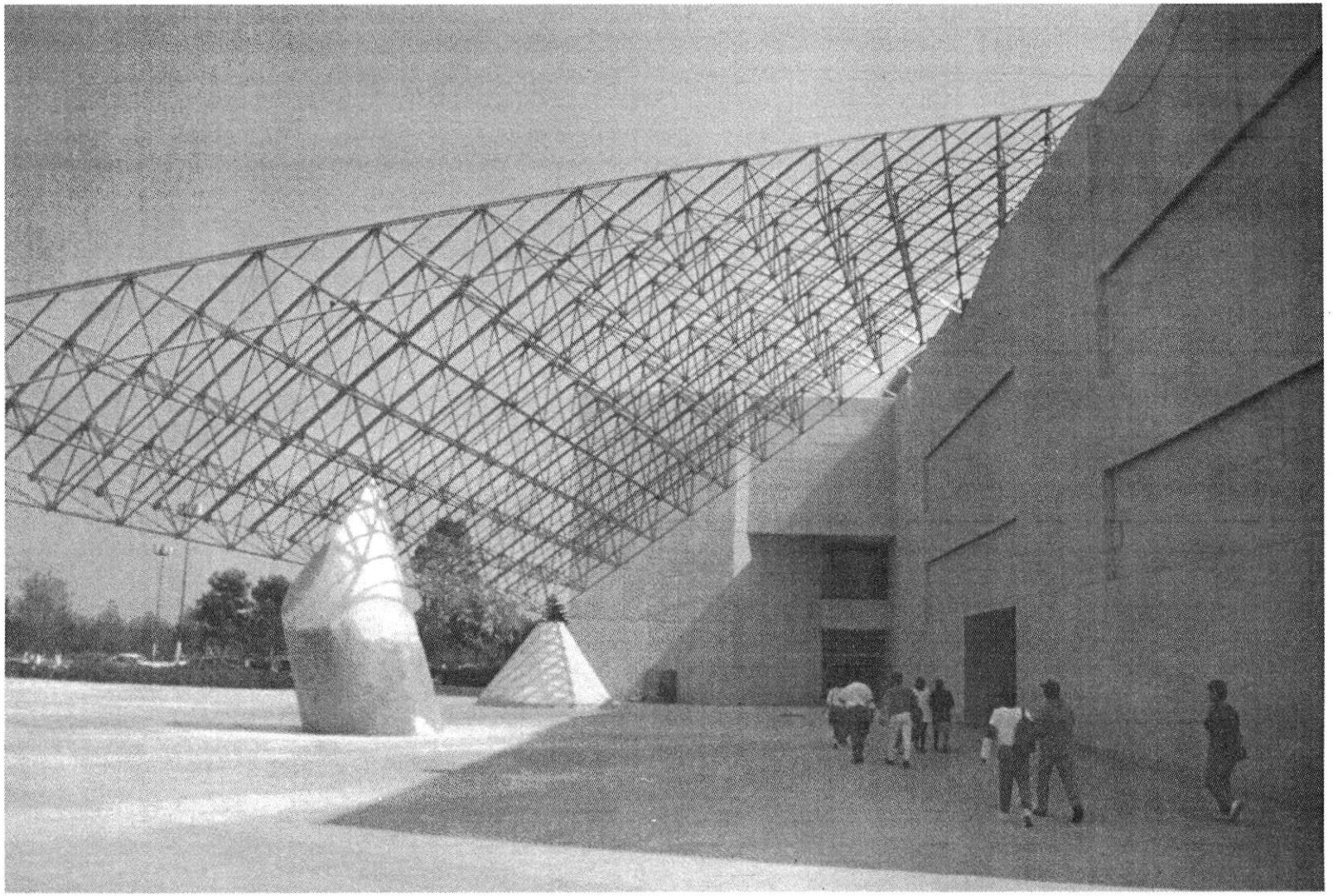
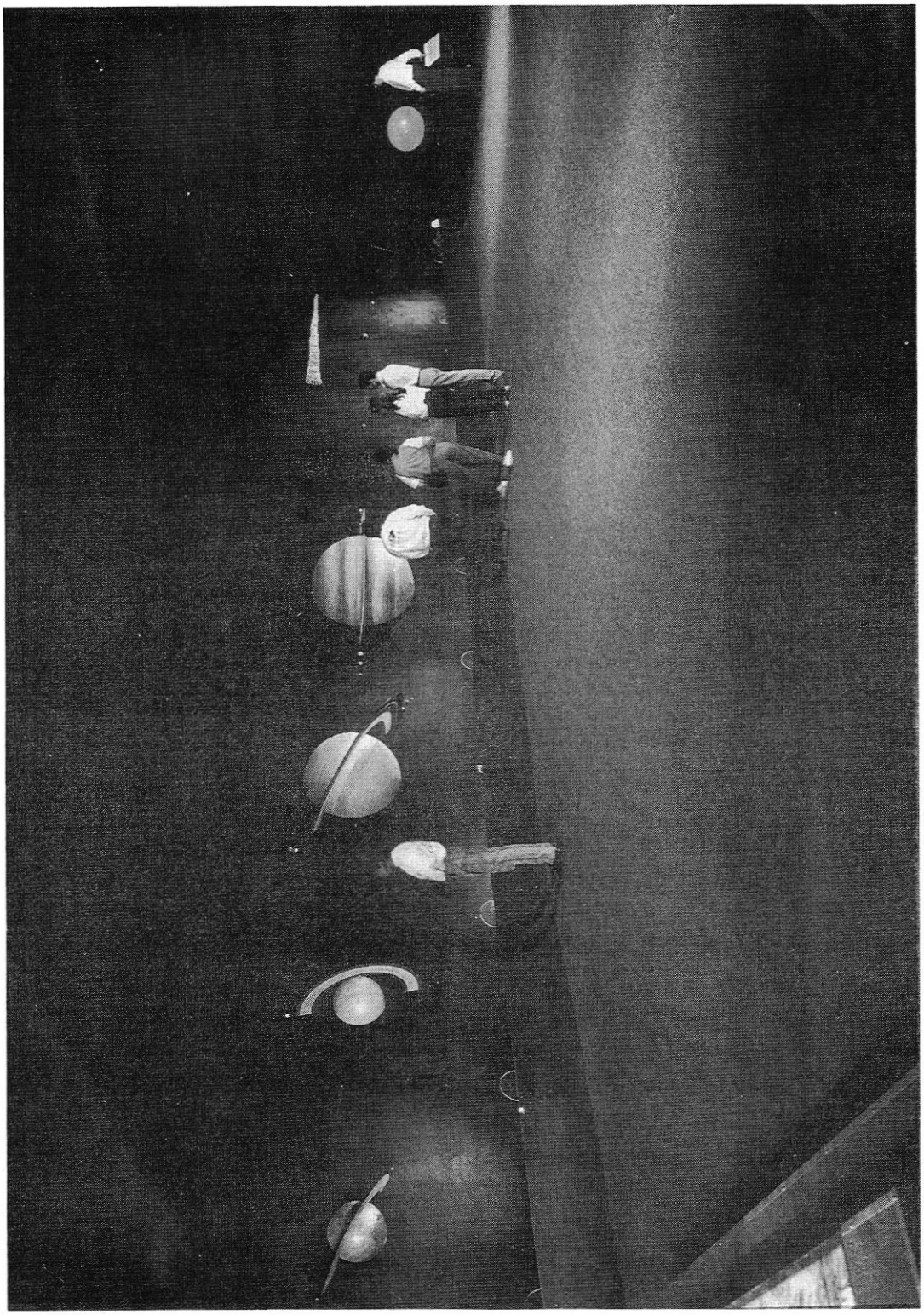


Fig. 2

Fig. 3



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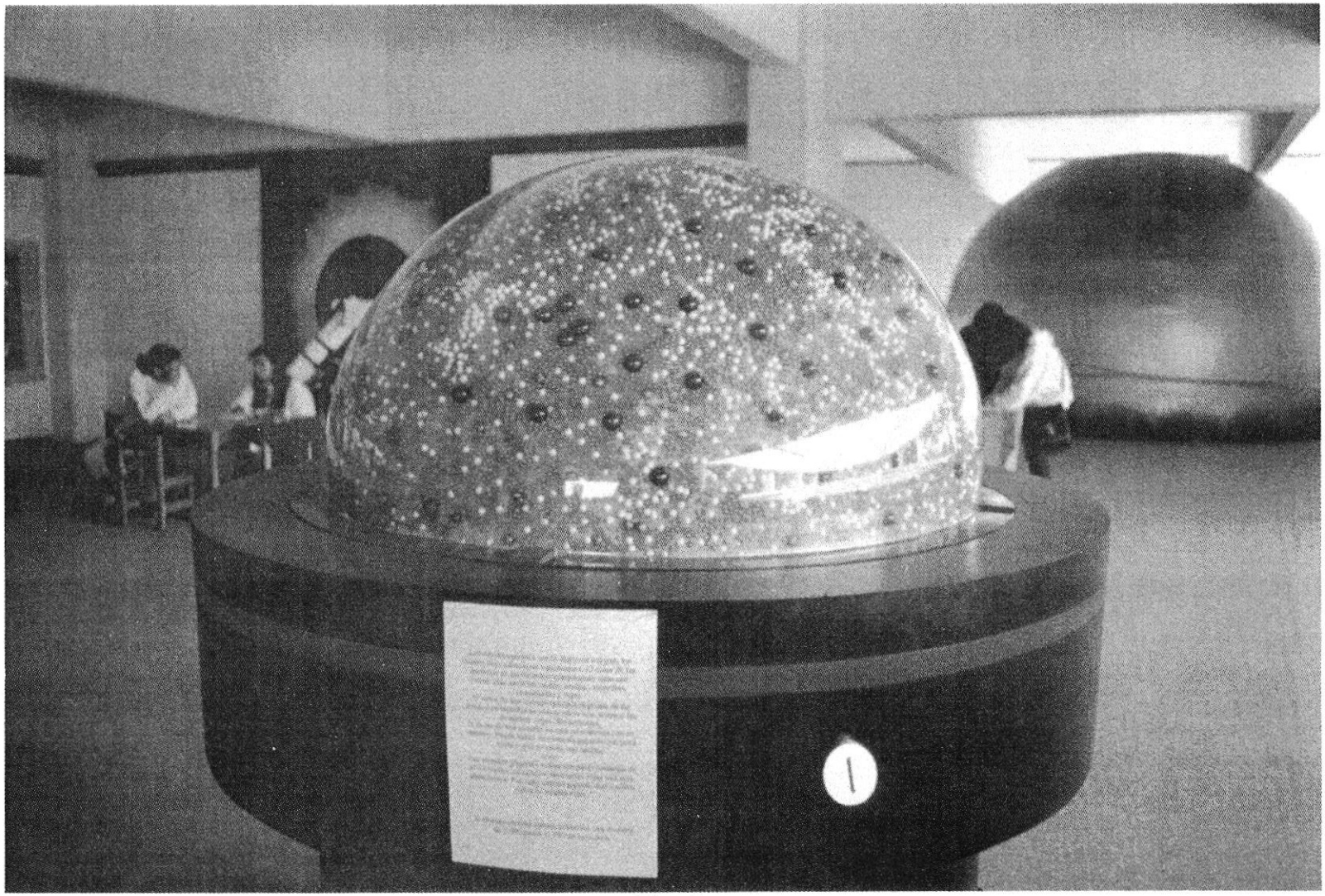

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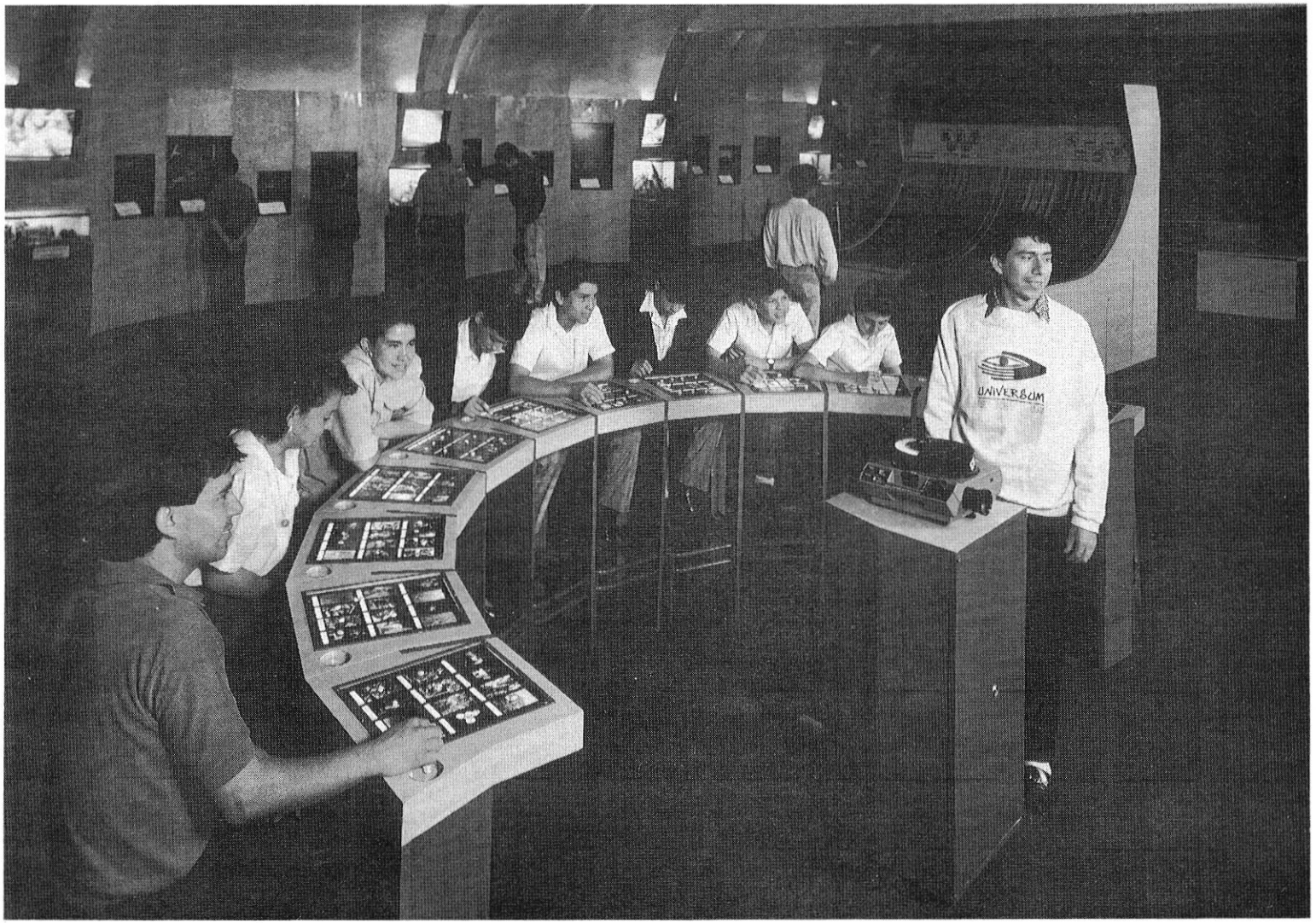

Fig. 6

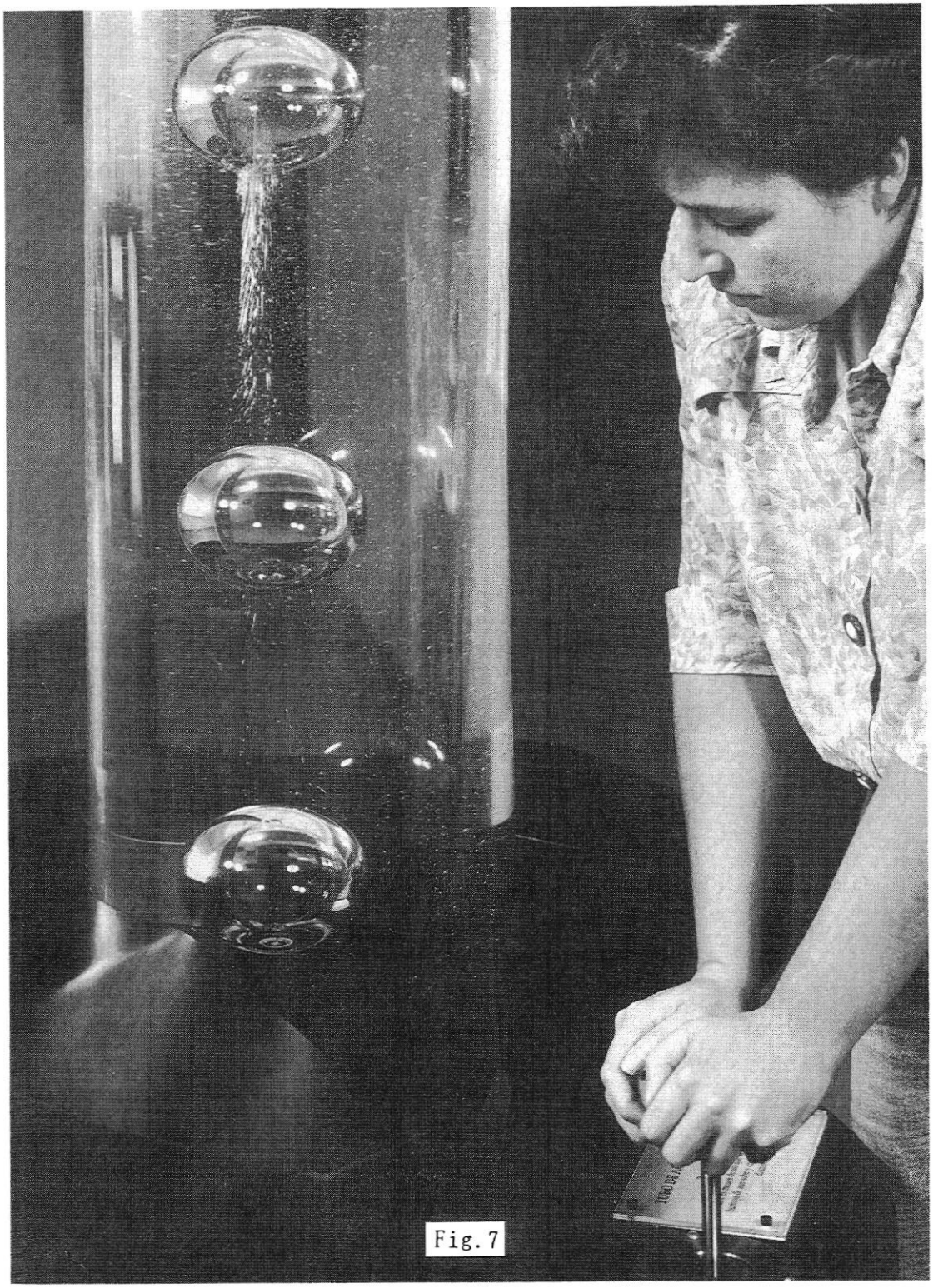

Fig. 7

ASTRONOMICAL ACTIVITIES IN VIET NAM

Nguyen Dinh Huan
Vinh University

Viet nam is situated in low latitude (8°-23° N) with 200_300 days of sunshine yearly, which makes it very suitable for astronomical observations, especially of the Southern sky. Observation conducted in Viet nam would enrich those in South East Asiá and supplement the astronomical network in the world.

After 30 years of war (1945_1975), Viet nam is facing many difficulties, many institutes, universities and scientific buildings were damaged and until now they have not been entirely restored. Equipment and material facilities are also insufficient.

Phu lien observatory (φ= 20°40 N,λ= 106°43 E) was a beautiful site built at the beginning of the 20th century.It is situated on a 100 m hill, near the seaside. It was equipped with equatorial and meridian cirde for the observation of the Sun to offer a time service. Now it is dormant.

Now in Viet nam astronomical activities are being promoted only in some Universities, Pedagogical Institutes, Technical University of Mining and Geology,Army Institutes, where Astronomy is being taught and studied.

At Vinh University, Astronomy has been taught for a long time for both graduates and postgraduate students. There are 5 astronomers_teachers at Vinh University, 2 of them are professors Ph. Dr of Astrometry and Celestial Mechanics.

The teaching of Astronomy is a compulsory course for all Physics students, lasting one or two semesters. It lasts typically 90 hours, 60 of which are in the form of theoretical classes, 6 hours in seminars and 24 hours of practical activities. There are small telescopes and other material for teaching.

Some of the Physics students plan to start a career in Astronomy after finishing the Physics course. They will continue to research and to write their master' s theses in a period of 2 years at Universities. These postgraduate courses are also offered for secondary school teachers, who have to deal with this science. In a postgraduate programme, Astronomy is the main subject, but Physics and Mathematics are necessary for the studying of modern Astronomy. After the general course in Astronomy, students who are good at Physics and Mathematics continue postgraduate courses. Master's programmes can be roughly outlined as:

-General education courses:

Philosophy, Pedagogic, Mathematics, Quantum Physics.

-Foreign language courses:

English, French, Russian.

_Astronomical education courses:

Astrometry, Celestial Mechanics, Astrophysics and Cosmology.

_Graduate work.

Graduate work for graduate students corresponds with their research fields. At Vinh University these are only special topics of Astrometry and Celestial Mechanics.

Viet nam has a group of some twenty astronomers, who were trained in Eastern Europe and Russia, most of them are post graduates with many years of experience. They are dispersed in different offices around the country. Their fields of research are: Astrometry, Celestial Mechanics, Ephemerides, Solar activity, Astronomical Education and Time Service.

At present, Viet nam is facing many difficulties to promote astronomical activities and needs the help of the IAU, other organization and developed countries.

In order to develop Astronomy in the country, Viet nam is planning to build an astronomical training and studying centre at Vinh University or at Ha noi Pedagogical Institute. First of all, Viet nam needs to train an astronomical scientific contingent and to build material facilities for training, studying and dissemination of astronomical knowledge (planetariums, telescopes audio visual and demonstration equipment).

After the visit of Prof. Y.Kozai, when he was the IAU President in April 1991 and the visit of Prof. A. H. Batten _ Chairman of the Working Group for the Worldwide Development of Astronomy of the IAU in October 1993, Vietnamese Astronomers hope that with the generous assistance and cooperation of the IAU and other organization, we will find our position in the International Astronomical Community in the near future.

Meeting of Astronomy Society of VIETNAM

ON THE FOUNDATION OF THE VIETNAMESE ASTRONOMICAL SOCIETY

PHAM VAN DONG
Hanoi Pedagogical Institute
Member of V.A.S

The Vietnamese are now busy overcoming the difficulties created by the aftermath of long drawn-out wars for national defence. The State budget allotted the development of science and technique is understandably very limited. On the other hand, as a result of an erroneous conception of astronomy as a science with little impact on every daylife astronomy in Vietnam is paid almost no attention.

At the present, astronomy is not officially taught in secondary shools, it is taught only in Teachers Training Colleges and a number of vocational schools. In the country, there is no planetarium. The former obseratory was entirely damaged and has not been restored. The teaching of astronomy only deals with theories - no practice and no visit is organized, yet students have shown no little interest. It is a pity that we have no condition to do better for them !

With a deep sence of reponsibility Vietnamese astronomists convened on April 22, 1993 a general assembly in Hanoi to found the Vietnamese Astronomical Society with a view to providing initial elements to change the above-described situation. The general assembly elected an executive committee, with Professor Pham Viet Trinh as its president, Doctor Le Minh Triet as Vice-President, and Researcher Nguyen Mau Tung as Vice-President-cum-secretary.

In the actual state of things prevailing in Vietnam, the target set for the activities of the Society at this stage is not high. The Society is to muster its members and the lovers of astronomy to promote and give assistance :

- The vulgarization of knowledge on astronomy among the people and work for the building of a planetarium ;
- The teaching of astronomy in general education schools and the establishment of a centre for training specialists in astronomy ;
- The mobilization of international assistance to build an observatory as a basic for the development of astronomy in Vietnam.

Since the general assembly was held, the Society has been creadited with a number of achievements. The vulgarization of knowledge on astronomy in mass media has increased. The proposal on teaching astronomy in general education schools has been accepted for consideration.

The Society has determined an appropriate place for the building of an observatory. It will be on the top of Mount Bana located at meridian 106^{O} East, parallel 15^{O} North, 1600m above sea level and 30 km away from Da Nang City on the Eastern Sea. It will enjoy a very big number of clear days in a year. Our Society would like to present this location to international public in a hope to receive assitance in the building of the observatory, also to fill a gap in the system of observatories in the world.

We are looking forward to receiving assistance and support from the International Astronomical Union and national astronomical societies in the building of the science of astronomy in Vietnam. Documents to vulgarize astronomy, and on the teaching, conducting reaserch on and training experts on, astronomy would be welcome.

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Some kinds of conics shadows

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Introduction

To present conics by looking for an example in the real world we propose to use the sundials. We can show to students photographs of differents kinds of sundials in their own city or to go to the classroom with some pocket sundials, then they can observe in the sundials straight lines and also curved lines which tell what time it is and what season it is.

General Contents

We reduce our study of sundials consistent of a plane and a gnomon. We can observe in the sundials straight lines (hour lines) which tell what time it is, and also curved lines which tell what season it is. It seems normal to observe straight lines in the sundial because at the end we observe the shadow of a stick, but, why does the end of the gnomon follow a curve? What kind of curves are there? What relation are there between the different kind of curves and the place's latitude ?. We will be able to present a intuitive process to answer all this questions.

The Sun always follows the equator or a parallel over or under it every day. Then the easiest sundial is a gnomon in the direction of the Earth's axis and a plane like the equator. Every 24 hours the Sun turns 360°, so every hour it moves 15° and passes by the south at 12 o'clock. We have to remember the latitude of the place, where the sundial is situated, is like the elevation of the Earth's axis over the horizon (Fig. 1).

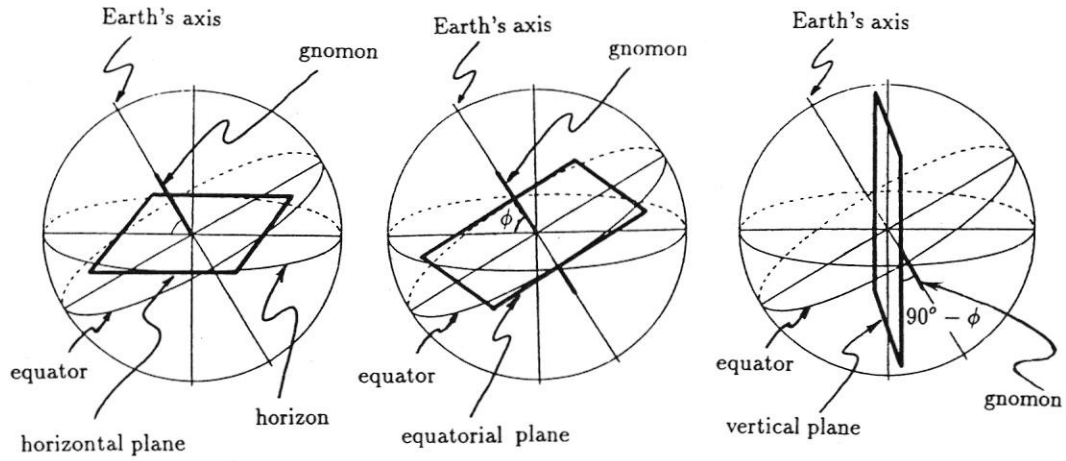

Figure 1: *In short, horizontal dial: gnomon like Earth's axis and plane like horizon; equatorial dial: gnomon like Earth's axis and plane like equator; vertical direct south dial: gnomon like Earth's axis and plane like vertical in relation to horizon and faces to south.*

When we project the structure of an equatorial dial over the horizontal plane or over the vertical plane (vertical in relation to horizontal which faces exactly due south), then we obtain respectively "horizontal" and "vertical direct south" dials (Fig. 1). In every case the sundial tell us what hour it is.

In addition, sundials can inform us about what season it is. To facilitate the deduction, we can suppose the Sun only sends a single ray of light. The Sun's ray arrives at the end of the gnomon and produces a shadow. When the Sun follows its round trajectory, during a day, this Sun's ray generates a conical surface whose rotation axis is the Earth's axis (Fig. 2). The sections produced by the plane of the sundial form a curve every day. Usually, only the curves of every first day of every season appear on the sundial: spring, summer, autumn and winter (sometimes they appear for every sign of the zodiac).

Of course we can suppose the length of the gnomon is zero in comparison with the distance from the Earth to the Sun. Then it is possible to suppose

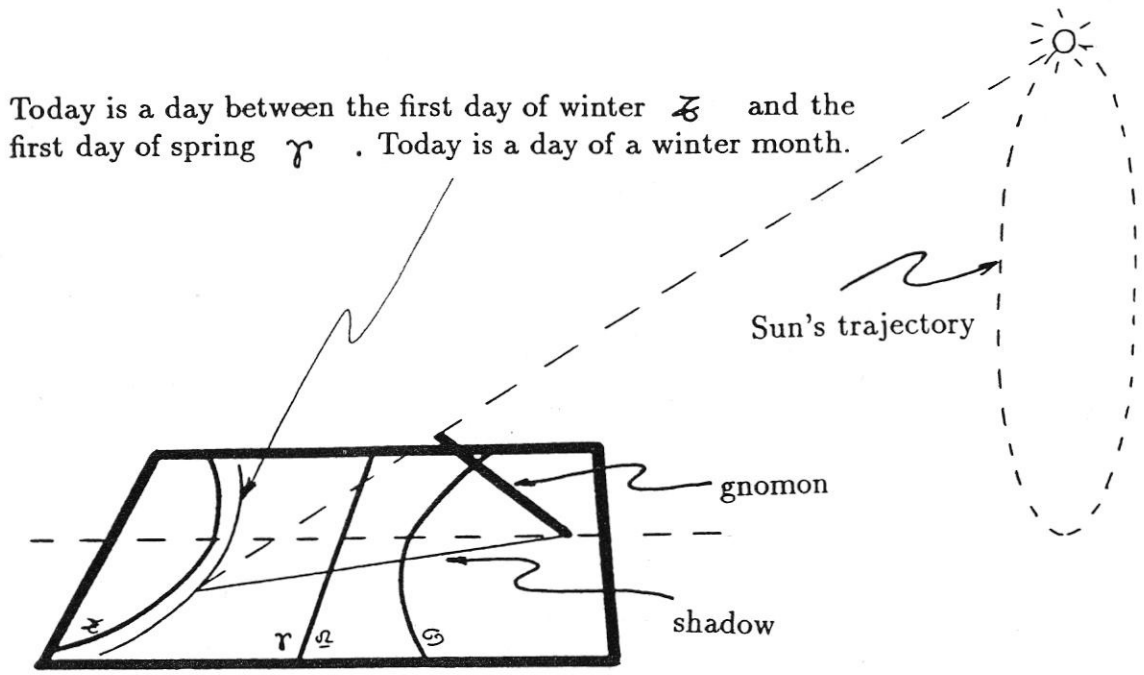

Figure 2: *Cone's surface determinate by the Sun's trajectory.*

the gnomon and the Earth are only a point in the center of the celestial sphere.

We may think the Sun's trajectory provides a cone every day except for the first day of spring and autumn when it provides a disc (Fig. 3).

The central angle of the cone α depends on the parallel (or declination D) which follows the Sun (Fig. 4). The cone's angle $\alpha = 90^\circ - D$, and every day it changes.

We can summarise the relative position between the cone's angle α, the angle of the sundials plane elevation β and the kinds of conics. If $\alpha < \beta$ we obtain ellipses ($\beta = 90^\circ$ circumferences), when $\alpha = \beta$ solutions are parabolae, and finally in the case $\alpha > \beta$ hyperbolae (Fig. 5).

We know the cone's angle verify $\alpha = 90^\circ - D$ and the gnomon direction is like the Earth's axis, then the angle between the gnomon and the plane of sundial is equal to angle of the sundials plane elevation β. In a equatorial dial $\beta = 90^\circ$ (the Eart's axis is perpendicular to equatorial plane) in a horizontal dial the elevation of the gnomon over the plane is the latitude $\beta = \phi$ and in a vertical direct south dial the angle of the gnomon is the colatitude $\beta = 90^\circ - \phi$ (Fig. 1).

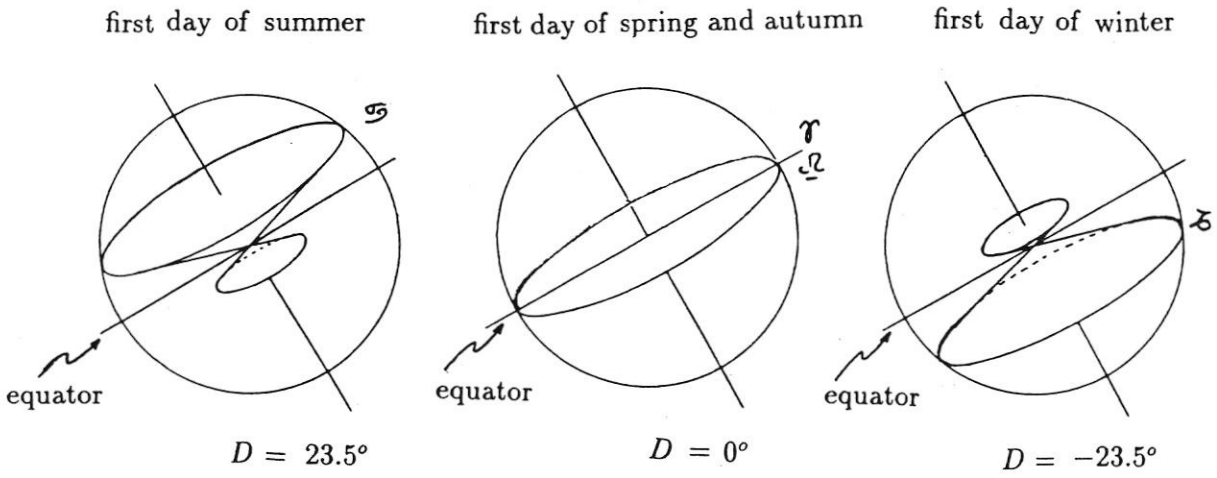

Figure 3: *Differents kinds of cone's surface for every seasons.*

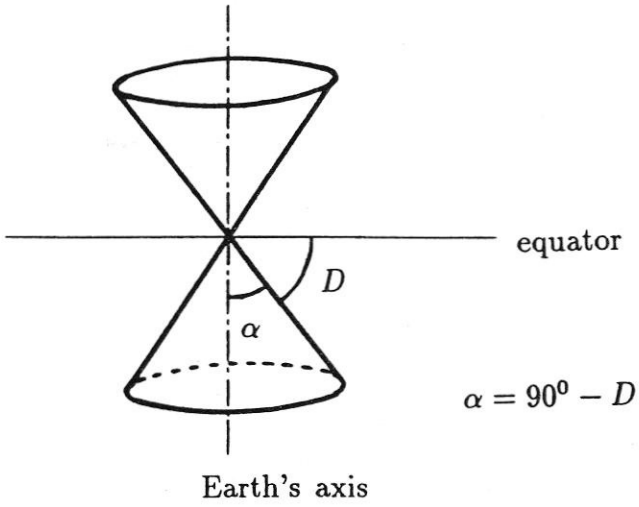

Figure 4: *Cone's angle and its relation with the declination D.*

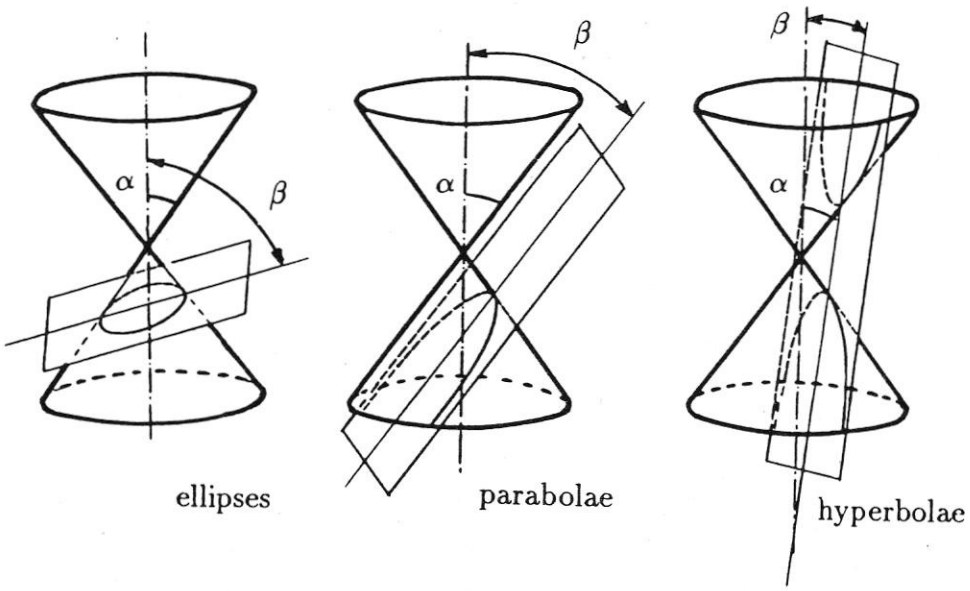

Figure 5: *Differents kinds of conics sections. If* $\alpha < \beta$ *ellipses, if* $\alpha = \beta$ *parabolae, and if* $\alpha > \beta$ *hiperbolae.*

With all this information we could prove the classification of curves of sundials depending on the cone's angle α or the declination D and the angle of the plane's elevation β or the latitude ϕ.

For our city we can summarise the information about the different kinds of curves of every first day of every season which appear on the plane of the sundials (Fig. 6). It is very important to use sundials of the city of the students to promove the connection with the real world.

On horizontal and vertical direct south dials there are straight lines for the first days of spring and autumn and curves for the other seasons. On equatorial dials there are curves for the first days of summer and winter and there are anything for the first days of spring and autumn. We could prove the classification of conics depending on the cone's angle or declination D and the angle of plane's elevation which is equal to the latitude of place, ϕ.

The first day of spring and autumn the cone's angle is reduced a disc like the equator. Then the intersection with the plane of a horizont dial or a vertical direct south dial is only a straight line (Fig. 6). The first day of summer or winter the declination of the sun is $|D| = 23.5^o$ then $\alpha = 66.5^o$.

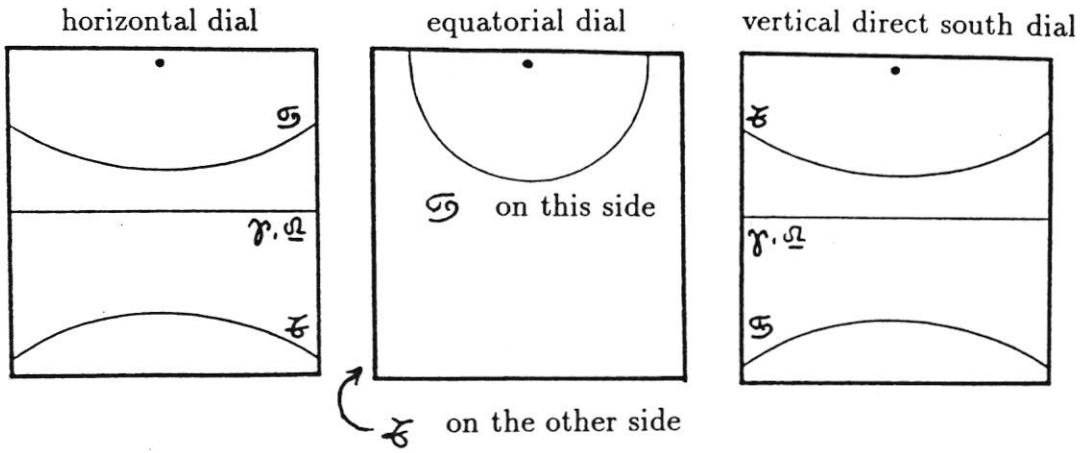

Figure 6: *These are the dial's planes in latitudes like Barcelona ($\phi = 41.5^o$) where students lives. If is possible, it is better to show photographs.*

We have to study the differents sundials apart. To the horizontal dial $\beta = \phi$ and then if $\alpha = 66.5^o$ we can clasificate (Fig. 5),

$$\alpha = 66.5^o < \beta = \phi \Rightarrow \textit{ellipses}$$

$$\alpha = 66.5^o = \beta = \phi \Rightarrow \textit{parabolae}$$

$$\alpha = 66.5^o > \beta = \phi \Rightarrow \textit{hyperbolae}$$

In short, if the latitude is $\phi > 66.5^o$ are ellipses, if $\phi = 66.5^o$ are parabolae and if $\phi < 66.5^o$ are hyperbolae (in our city, Barcelona, $\phi = 41.5^o$ and the curves of summer and winter are hyperbolae (Fig. 6)).

To the vertical direct south dial $\beta = 90^o - \phi$ and in consequence (Fig. 5),

$$\alpha = 66.5^o < \beta = 90^o - \phi \Rightarrow \textit{ellipses}$$

$$\alpha = 66.5^o = \beta = 90^o - \phi \Rightarrow \textit{parabolae}$$

$$\alpha = 66.5^o > \beta = 90^o - \phi \Rightarrow \textit{hyperbolae}$$

In short, if the latitude is $\phi < 23.5^o$ are ellipses, if $\phi = 23.5^o$ are parabolae and if $\phi > 23.5^o$ are hyperbolae (in our city, Barcelona, $\phi = 41.5^o$ and the curves are hyperbolae (Fig. 6)).

Finally we present the equatorial dial because it is different. The first day of spring and autumn it is not possible to produce shadow and, the others days we obtain always circumferences because $\beta = 90^o$ and then it is not necessary to study more differents cases.

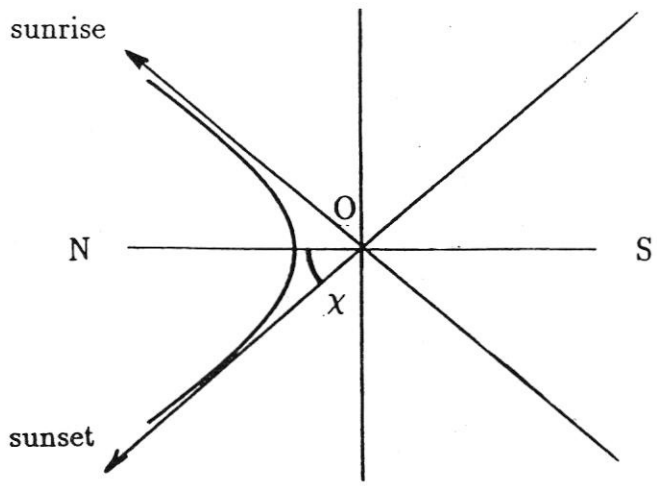

Figure 7: *Asymptote slope of a hyperbolae curve in a horizontal dial.*

Specific Case

When the topic about conics finished and the students know the concept of eccentricity, we could consider the conics of the sundials in the other time. Now our students know in your city the solsticials curves are hyperbolae, and then the eccentricity is $e > 1$, we want to obtain a relation between the place latitude ϕ and the declination D.

To facilitate this proces we consider only one of the possibilities, the horizontal dial. For the vertical direct south dials the proces is similar.

When the Sun go to the sunset or when the Sun went from the sunrise the hyperbolae go to the asymptote, and the slope m [1] of this line is $m = \pm\sqrt{e^2 - 1}$, but if we consider the angle χ, this slope (Fig. 7) verify,

$$m = \frac{1}{\cos\chi}$$

then, we obtain,

$$\pm\sqrt{e^2 - 1} = \frac{1}{\cos\chi}$$

We can connect the sundial drawing with the situation of the Sun in the celestial sphere (Fig. 8). According to Bessel's formula in the spherical triangle,

$$\cos(90^\circ - D) = \cos 90^\circ \cos(90^\circ - \phi) + \sin 90^\circ \sin(90^\circ - \phi)\cos\chi$$

[1] if the hyperbola equation is $\frac{x^2}{a^2} - \frac{y^2}{b^2} = 1$ the asymptote equation is $y = \pm mx = \pm\frac{b}{a}x$ where we can introduce the eccentricity because $b^2 = c^2 - a^2 = a^2(e^2 - 1)$

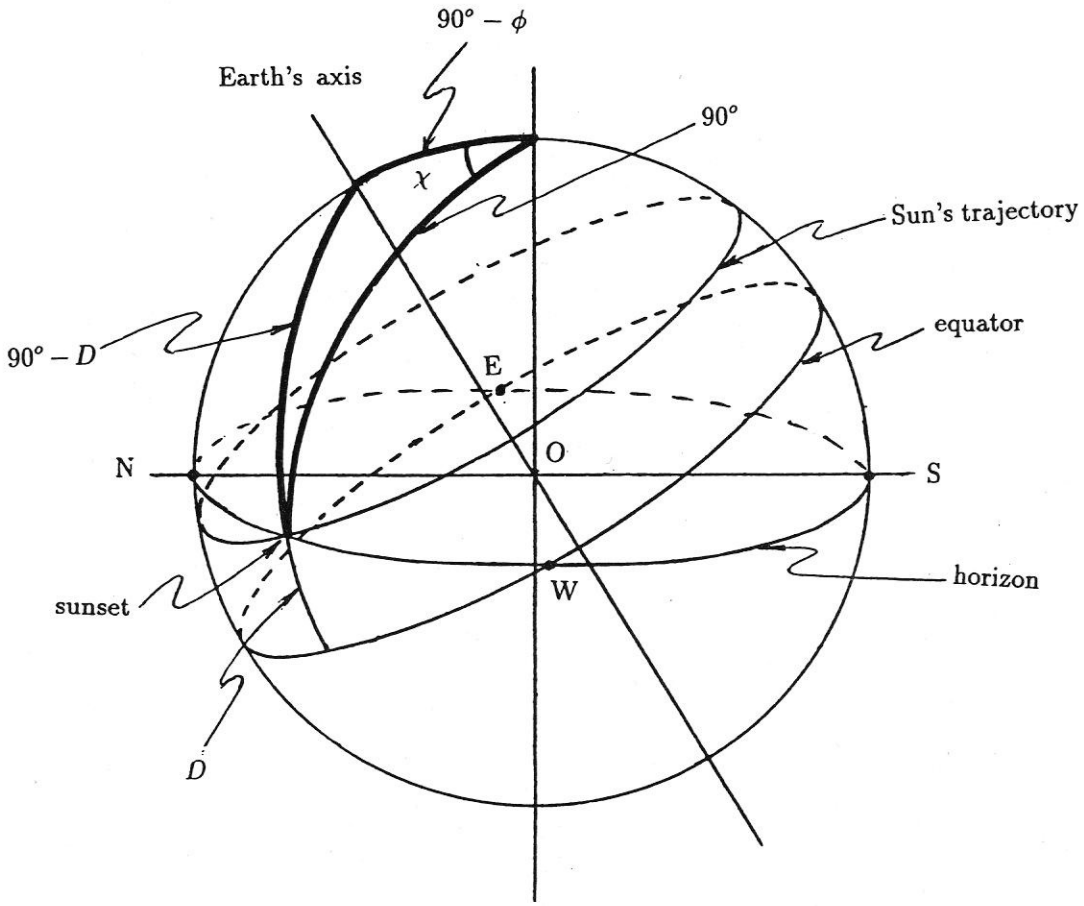

Figure 8: *Relation between the celestial sphere and the sundial plane.*

In consequence,

$$\sin D = cos\phi \cos\chi$$

Therefore,

$$\pm\sqrt{e^2 - 1} = \frac{1}{\cos\chi} = \frac{\cos\phi}{\sin D}$$

For hyperbolae $0° < |D| \leq 23.5°$, we can deduct the eccentricity of the hyperbolae of horizontal sundials in Barcelona ($\phi = 41.5°$) where we carried out this experience, for differents days, depending on D, because,

$$e = +\sqrt{\frac{\cos^2\phi}{\sin^2 D} + 1}$$

then we obtain

$$2.13 < e < +\infty$$

evidently hyperbolae, d'agree with above mentioned latitude.

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Swedish university courses in astronomy for everyone

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Fifteen years ago, the Gothenburg University inaugurated a new type of courses in astronomy. These courses are open to most categories of people, even to those who have never before had the privilege of higher education.

Today, changes in employment and pattern of living give rise to new fields of interest among people. With fewer working hours, a growing number have now got time for intellectual pursuits.

At the same time, public understanding of science is important for the democratic processes fully to work and for the economic potentials of a country to be utilized. Although scientific literacy is highly desirable in modern society, the access to knowledge is not always easy. University education, for example, has normally been restricted to those who have obtained a certain standard in basic subjects.

In order to adjust to the changing demands, the Swedish universities received new statutes in 1977, which meant that new sections of the population could now gain admittance. In addition to their traditional role as centres for higher education and research, the universities were now also made responsible for promoting public interest in scientific research, for furthering the knowledge of new achievements in science and for countering the spread of pseudoscientific ideas.

At the Section of Astronomy at the Gothenburg University, we decided to initiate a new set of courses to implement these objectives. Astronomy already enjoys a widespread popularity. Although the study of cosmos has little immediate relevance to daily life, the immensity of space and the human endeavour to fathom it hold great attraction for most people. Astronomy should lend itself admirably to the new goals of university education.

The new courses were to be open to all present and former university students regardless of which faculty they belonged to. We decided that other persons could also gain admittance provided they had reached 25 years of age, had been working for four years - which included military service and care of own children - and knew some elementary English. The last point is important as textbooks in English are used on most courses.

In choosing subjects, it seemed advisable to focus on topics that lend themselves to visual as well as written presentation and thus would be accessible to students unfamiliar with the natural sciences. We have normally avoided issues that are difficult to discuss without invoking a good deal of mathematics. In order to bridge the gap between the arts and the sciences, we have made special efforts to find subjects that appeal to men and women alike and to both the younger and the older students.

It was also felt appropriate that the courses should not resemble the often over-specialized and stereotyped curriculum to which so much university education seems bound. The aim was set to convey the meaning and importance, and the beauty and excitement of science, rather than to provide a body of dry and static elementary facts. Instead of giving the students the task of memorizing the results of scientific research, we wanted to develop their abilities to follow the evidential reasoning and logical analysis that is so special to the scientific approach.

It was agreed that formal lectures would be the best medium for teaching the new courses. Formal lectures are valuable for giving a broad exposition of a topic, for presenting the latest developments in science and for suggesting points of view still on the frontiers of thought. They afford a great stimulus to students when they meet a lecturer who is the master of his subject. The danger of individual students feeling lost and non-participant in the anonymity of a large group is offset by a teacher alert to the varying backgrounds, interests and ambitions of his students.

The courses were developed as quarter-time courses. They run for the whole length of a term but each course is only expected to require five weeks of full-time studies. For the convenience of those who are studying or earning a livelihood during the daytime, classes meet in the evening for four hours once every other week.

In order to reach a varied menu, altogether eleven courses were set up to cover a broad range of subjects. Some of these courses are unique to Gothenburg and are not given anywhere else. Four courses are best described as pure astronomy or science courses. They discuss the *Structure of the universee, Life in the universe, Space exploration* and *Interstellar contact.* Their principal aim is to report on recent advances in astronomical research.

Four other courses can be classed as interdisciplinary. Their main object is to explain the role of astronomy in the history of our culture. They are named *Ethnoastronomy, Archaeoastronomy, Astronomy and art* and *History of astronomy.* One course of each category is given each term in a rotating two-year schedule. It thus

takes a period of two years before a course reappears on the lecture list.

The remaining three courses are meant to supplement the above mentioned courses. They cover miscellaneous fields like *History of navigation, Ancient technology* and *Astrology and pseudoscience.* They alternate from time to time with one of the interdisciplinary courses.

A few words should perhaps be said about the inclusion of a course on *Astrology and pseudoscience.* The prevailing view among most university teachers is that our students are so thoroughly familiar with the requirements of science that there is no need to deal with fringe beliefs like astrology. This is unfortunately not true. Belief in astrology is not confined to people with an inadequate understanding or a negative attitude toward science. It is just as important to tackle and to correct public confusions about science as to report on new advances.

The courses attract a large audience. The most popular courses draw up to 200 applicants even though entrance is limited to 80 students.

The pure science courses have proved slightly more popular than the ones of interdisciplinary nature. This is probably an effect of the hard science nature of astronomy has been allowed to dominate our educational system for so long. It should thus come as no surprise that the basic astronomy course *Structure of the universe* tops the popularity list ahead of the human oriented course *Life in the universe.* One would, however, expect a course like *History of navigation* to fare better in popularity than to be placed at the end of the series. Gothenburg is a large seaport situated on the Swedish westcoast inside a lovely archipelago perfect for pleasure sailing.

The number of applicants varies over the years - see Figure 1. The high figures when the courses were new can be seen as a long felt need for courses of this type. After the novelty had worn off the demand for these courses appears to be correlated with unemployment in the Gothenburg region. This is rather unexpected as learning in these courses primarily is its own reward. That the rise in entrance applications in 1989 comes two years before the onset of unemployment is probably partly an effect of a massive campaign launched by us to halt the long previous downward trend.

The success of the courses to appeal to those with little or no background in the natural sciences is attested by the fact that nearly half of the applicants, even for the pure science courses,

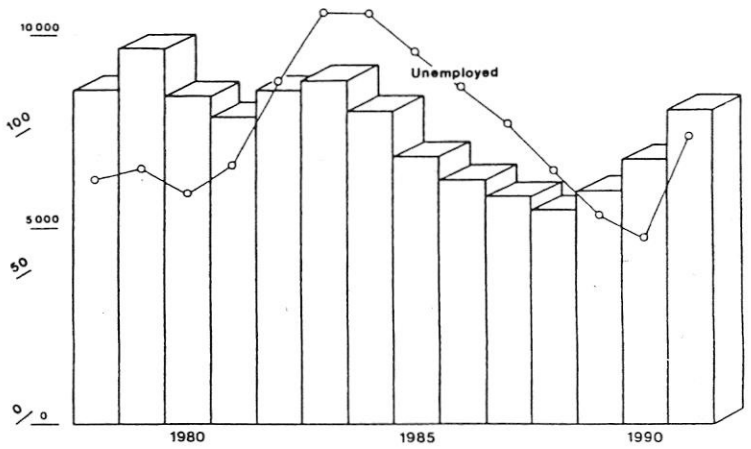

Figure 1. Number of entrance applications for the new courses compared with unemployment figures for the Gothenburg region.

belong to the arts faculty. On the other hand, the number of applicants who have not previously studied at a university but are now entitled to do so is disappointingly low or barely 15 per cent of the relevant age groups. Information of the new possibilities for higher education should by now be widespread, but the psychological obstacles may feel overwhelming to someone with only secondary schooling to join a university course.

The courses provide for life long learning. The students span over a wide range of ages, from 18 to the early 80s - see Figure 2. The median age for all courses taken together is 29. Only a quarter of the students are under 25, an age when most undergraduates finish their university education.

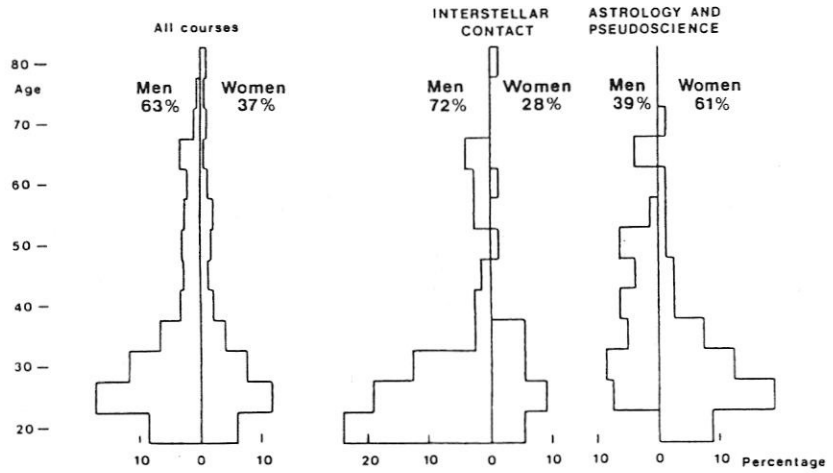

Figure 2. Age distributions of students enrolled in the new courses.

The age distribution varies between the courses. The prospect of interstellar contact in the near future exerts a strong hold on the young generation of men. Their median age in the course with this very name is only 24 - see Table 1. On the other hand, very few young men feel attracted by the course *Astrology and pseudoscience*. The high proportion of women who attend this course clearly demonstrates that astrological belief is strongly related to gender, especially for young people. No other course in astronomy can show as high a proportion of women as 61 per cent.

Astronomy, like most natural sciences, is traditionally a male dominated subject. The proportion of women is only 37 per cent for an average course. We have therefore in each course made a great effort to find topics that also interest women. In the course *Interstellar contact*, for example, the attention is focused on human implications of space travel and contact rather than on technical problems. Despite our efforts, the percentage of women who attend the courses *Space exploration*, *Interstellar contact* and *History of navigation* remains despairingly low at around 27 per cent.

Table 1. Characteristics of enrolment, median age and pass rate for the new courses.

Courses	Enrolment		Median age		Pass rate	
	Total	Women	Men	Women	Men	Women
Pure science courses						
Structure of the universe						
Spring 1992	80	41%	26	24	44%	38%
Interstellar contact						
Autumn 1991	78	28%	24	27	46%	36%
Life in the universe						
Spring 1991	66	39%	29	24	45%	50%
Space exploration						
Autumn 1986 and 1988	34	24%	28	23	44%	31%
Interdisciplinary courses						
Archaeoastronomy						
Spring 1991	71	35%	30	28	39%	36%
Astronomy and art						
Spring 1992	68	44%	33	26	37%	43%
History of astronomy						
Autumn 1991	67	34%	26	27	50%	35%
Ethnoastronomy						
Autumn 1988	43	40%	34	48	27%	35%
Miscellaneous courses						
Astrology and pseudoscience						
Autumn 1982 and 1984	40	61%	35	29	36%	39%
Ancient technology						
Spring 1988 and autumn 1990	39	36%	33	30	51%	43%
History of navigation						
Spring 1986 and 1990	29	28%	31	30	36%	44%

The proportion of women who study the pure science courses is substantially the same among both arts and science students, as demonstrated by the *Structure of the universe* course in Table 2. The situation is quite different for the interdisciplinary courses. Women are here often in majority among the arts students, as testified by the *Astronomy and art* course, while their science sisters, on the contrary, show an exceptionally low interest in this type of courses. We can offer no explanation for this startling reversal of interest between the sexes for the interdisciplinary courses.

Table 2. Comparison of enrolment and pass rate between a pure science course and an interdisciplinary course, spring term 1992.

Courses	Enrolment		Pass rate		
	Total	Women	Men	Women	Mean
Sturcture of the universe					
Arts students	29	41%	29%	17%	24%
Science students	42	43%	54%	50%	52%
Astronomy and art					
Arts students	38	63%	36%	38%	37%
Science students	23	22%	28%	60%	35%

One would expect women between 30 and 50 to be too preoccupied with raising a family to have time off for intellectual pursuits. However, the proportion of women who study the interdisciplinary courses stays surprisingly constant with age - see Figure 3. There is a definite decline with age for women studying the pure science courses, which probably is a reflection of a change in women's attitude toward science over the last generations.

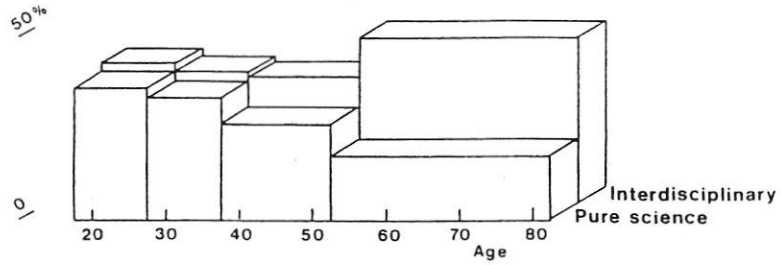

Figure 3. Proportion of female students with age for two types of courses.

The courses end with a written examination in monograph form. Although most of our students take the courses chiefly to raise their level of general knowledge for pure personal satisfaction and not as part of an undergraduate training program, about 41 per cent of them nevertheless choose to pass the test. The pass rate is nearly the same for both men and women when all courses are

taken together. No definite variation with age is noticeable, neither for men nor for women - see Figure 4.

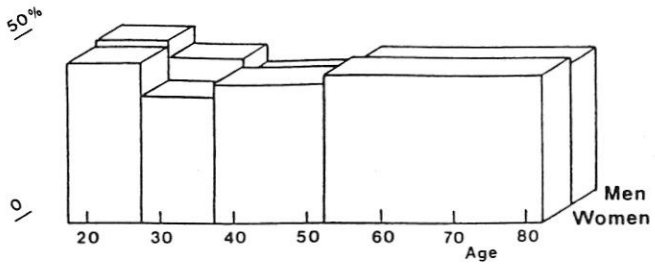

Figure 4. Pass rates for men and women with age.

It is also gratifying to note that both arts and science students in an interdisciplinary course like *Astronomy and art* are equally capable of passing the examination - see Table 2 and Figure 5. On the other hand, in a pure science course like *Structure of the universe*, it is quite understandable that science students should be more inclined to test their newly acquired knowledge than their arts friends, but the pass rate for female arts students in this course is unacceptably low at only 17 per cent.

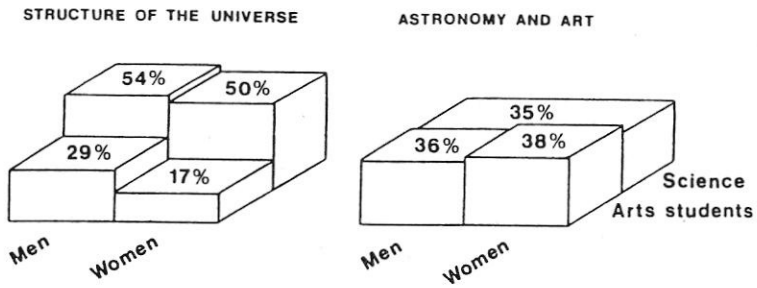

Figure 5. Comparison of pass rates between a pure science course and an interdisciplinary course, spring term 1992.

Although the pass rate is the same for both arts and science students in the *Astronomy and art* course, it is comforting to note that the arts students secure higher marks on a ten point graded scale - see Table 3. In this course there is no significant difference in the mean marks obtained by younger and older students or by men and women, but students who have already passed the test in one of the other courses achieve much better results than those who sit for their first examination. The low performance by science student beginners is probably the result of an underestimate of the amount of work needed to fulfil the requirements of a course which frequently is seen as undemanding by regular students of the natural sciences.

Table 3. Mean marks obtained in the written examination on April 11 1992 in the interdisciplinary course *Astronomy and art* for different categories of students. Figures within brackets denote the number of students that the mean marks refer to.

Students	Under 33	Over 33	Women	Men	Begin-ners	Experi-enced	Mean
Arts students	4.6 (6)	4.1 (6)	4.3 (6)	4.3 (6)	2.7 (6)	6.0 (6)	4.3
Science students	3.1 (6)	2.0 (2)	2.3 (3)	3.1 (5)	0.5 (3)	4.2 (5)	2.8
Mean	3.8	3.6	3.6	3.8	2.0	5.2	3.7

Finally, I would like to point out that it is vital for the teacher of these courses that the reading of published material in the many fields covered by the courses is supplemented by own research in allied fields, by direct personal contact with fellow workers in other departments and by participation in international congresses and seminars. In return, the teaching of these courses is an enormous joy. The broad range of topics dealt with casts new and revealing light on one's own subject from unusual angles of perspective. To follow the progress of people captivated by the delight of seeking new knowledge is tremendously stimulating.

Our conclusion is that university courses especially designed for the intellectually curious with no previous experience of higher education have a great potential for raising the cultural standards, both for personal fulfilment and for the advancement of the entire society.

A LEARNING EXPERIENCE OF ASTRONOMY FOR PRIMARY SCHOOLS: "PEDACITO DE CIELO" (*)

(*) "A TINY BIT OF SKY"

by Horacio Tignanelli & Florencia Enghel

Observatorio Astronómico; Paseo del Bosque s/n; (1900) La Plata; Prov. de Buenos Aires; Argentina

The teaching of Astronomy in primary schools has become an issue often neglected by teachers, who generally lack the minimum basic indispensable knowledge and the adequate didactic strategies to accomplish the subject. Here we report an innovative learning experience being put into practice in primary school settings, acting as a strong incentive of children's natural interest in Astronomy. We will particularly describe the didactic resources used in the experience, based on the firm belief that play stimulates the significant learning of Astronomy.

PEDACITO DE CIELO is a learning experience of Astronomy aimed at children six to twelve years old, developed and put into practice in primary schools settings by Horacio Tignanelli, an astronomer from La Plata National University, Buenos Aires, Argentina.

The purposes of PEDACITO DE CIELO are: a) recover and question the alternative conceptions about Astronomy that every child has got; b) provide the children with elements for an eventual scientific understanding of astronomical phenomena; c) encourage in children an attitude of permanently questioning their surrounding reality.

The contents of PEDACITO DE CIELO are centred on the understanding of the Solar System, which is based on the one of the Earth-Sun-Moon System in terms of three essential concepts: shape, size, and movement (as well as the multiple relationships established between them). Such contents are adapted in each case according to the ages and previous knowledge of the pupils taking part in it.

The children's alternative conceptions regarding the above mentioned contents have been thoroughly identified through different investigations, and they are used in the experience as a starting point from which to promote significant learning.

But PEDACITO DE CIELO's most particular feature is perhaps its didactic resources. Based as it is on the firm belief that play stimulates meaningful learning, the experience is shaped as a period of play in which intelligent thinking is favoured by making it possible to centre and decentre attributes of two different worlds, reality and fantasy.

Multiple resources turn the experience into a setting in which play and learning are inextricably linked, being the most outstanding: 1) a hopscotch game; 2) the use of dramatisations; 3) a puppet show. We will briefly explain the teaching potential of such resources as used in PEDACITO DE CIELO.

1) Hopscotch.

This game, that makes it possible to come and go between Earth and Sky, has been played in most cultures since the beginning of times, and constitutes in the experience the first proposal of approach to the notion of universality, which lies at the base of the understanding of how the physical phenomena of the Solar System work.

2) Dramatisations.

Dramatisations, to represent, for example, the planetary movements, are used in PEDACITO DE CIELO with a double purpose: not only do they allow the protagonists the chance to experience and therefore structure internally the notions of rotation and revolving as real movements, but they also give the remaining pupils another chance (added to the one that the puppet show provides, as we will soon explain) to observe and describe the apparent movements of the stars as perceived from the Earth.

3) The puppet show.

By means of the puppet show, in which "a tiny bit of sky" is set in motion to resemble the real one, PEDACITO DE CIELO gives the pupils the chance to put into practice and train observation, an essential skill for the study of Astronomy.

However, providing such an opportunity to observe is not the only purpose of the puppet show in the experience. In PEDACITO DE CIELO, the dramatic conflict (which in the traditional structure of the puppet show sets up with the presence of three characters) transforms itself into a cognitive conflict.

Character I has got an alternative conception with regard to a certain astronomical phenomenon. Such alternative

conception corresponds to one of the identified as the most common among the children of the age in question.

Character II brings with him the astronomical explanation of such astronomical phenomenon.

"Character III" comes out of the conflict between the alternative conception sustained by character I and the scientific explanation stated by character II: the cognitive conflict has set up in the situation, and both puppets and children participate in it.

It is now when PEDACITO DE CIELO puts the "sky" of the puppet show in action, reproducing the astronomical phenomena in question, and characters I and II share with the children their search for answers to their questions by means of observation.

The atmosphere of enjoyment and fun that sets up in the situation promotes a kind of learning of strong affective significance, which is therefore more stable.

PEDACITO DE CIELO was designed and first put into practice early in 1993, and since then we have been carrying out an educational study of it in order to contribute with elements to a better teaching of Astronomy in the initial level. Issues such as the evaluation of the efficacy of the didactic strategies used and the development of alternative didactic resources to be used by school teachers, among others, are currently under way.

Buenos Aires, february 1994.

TEACHING ASTRONOMY THROUGH SECONDARY LEVEL CURRICULLA.

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ASTRONOMY is the oldest science. It is the science which was initiated and gradually evolved with the increasing demand of the need of ever growing human civilization on Earth. The gradual accumulation of knowledge about the physical universe to the human society is comparable with the learning process of a child. A growing child acquires information and experiences about the material world around it with the passage of time. In a similar way, the entire human society discovers and invents various truths and phenomena relating to the physical universe. In fact, from the standpoint of physical behaviour and need, there is no difference between a new-born baby from a primitive man. As the time passes on, both take a curious look into the mysterious world around them for adaptation with with their environment. Here we notice that every baby is blessed with protective and guiding parents and the human society. But for our growing human family itself, the acquired wisedom and experiences are the agencies of protection and guidance.

If we now trace the history of early civilization of the human society when man just emerged to conquer the adverse forces of nature by sheer possession of intelligence, he first learnt to combat with hunger and desease. In the process of learning the technique of getting regular supply of food, that is, the science of Agriculture, man had to know the phenomena of Astronomy. Subsequently, in course of time, with the increasing quantum of need and urge for knowing his wider environment man came to know many more aspects of Astronomy.

So, it is an important responsibility of School-Level Curriculum to enlighten the young students about the very wonderful world in which they will have to live in. Their natural instinct to know about the grandeur of the spherical dome overhead must be reared for their further understanding of physical universe.

The curriculum of the Secondary School students includes mainly the rudimentary studies on the Solar System, in general, and on the Earth in paticular. The brief descriptions on the planets and satellites are distributed among the text books of physical science and geography from Class VI to Class X.

There are quite a few difficulties in teaching Astronomical topics, whatever may be included in the curricula:

FIRST, most of the Schools, whether it is residential or not, give lessons during the day time when the only observable celestial object is the Sun. Thus the schooling time is unfavourable for giving guidance for the observation of night sky.

SECOND, unlike other science subjects these topics cannot be easily taught with practical demonstration inside the Class room.

THIRD, there is dearth of well trained teachers for teaching topics on Astronomy.

FOURTH, the most disappointing aspect of teaching Astronomical topics in the Secondary Level in West Bengal, India, particularly, is that there is no scope of taking higher education with Astronomy. Only a very few students who take Mathematics as their Hounours subject in undergraduate course, have chance to learn only some positional Astronomy.

Even in the background of such dismal picture, the learning process of Astronomy is stealthily progressing on. Whenever a debate, quiz or lecture compition is organised, on any topics of Astronomy, by Educational Institutions, Birla Industrial & Technological Museum or local Science Clubs, the school students take part with remarkable

enthusiasim. In Calcutta alone a great zeal is noticed among the participants when Indian Astronomical Society (IAS) or Birla Institute of Astronomy and Planetarium Sciences invite applications for taking part in their part-time courses. The Winter School on Basic Astrophysics is one such courses of six weeks duration, organised by the I A S. It is annually held in the premisses of the University Colleges of Science, Calcutta University. The author as one of the lecturers of the said School has noticed that the perticipants of different ages ranging from 20 to 70 years hail from various walks of life, such as , post graduate students, School, College and University teachers and even retired technical and administrative personalities. These people could not satisfy their urge for the knowledge of Astronomy through their formal education. The number of applicants in such courses are so large that often severe restrictions in number have to be imposed.

In view of such popularilty of the subject, as also, the necessity for more extensive exercise on the subject in India, a good number of Schools, if not all, could be selected as the site of learning basic Astronomy and Astrophysics. If there is an arrangement for imparting twenty theoritical lectures of one hour each along with some ten nights of observational activities, even with the naked eyes, every year for the students of Class of IX, then the course of study of Astronomy may take a great impetus. For the alurement of both the teacher and the taught, some kind of appreciation may be offered. Such appreciation may not be always in the form of money, but in the form of literatures on the subject itself.

As the subject like Astronomy is not in the Curricula at the Higher Secondary and Under Graduate Pass course level of all the Universities of West Bengal, the the teachers who are mainly a product of these institutions , may not be well acquainted with the subject and may not have the skill of observational techniques. So, in view of the pausity of well trained teachers, a group of resource persons can be entrusted to go to the Schools

for demonstration with the equipments like slide projectors , small telescopes or binoculors and star maps. These Schools may be initially selected one from each District, and gradually the number of such Schools may be increased. The resource persons can deliver a few lectures on the upto date concept of the Solar System and the Universe. The Copies of these lectures may serve as the resource material of the local teachers who in their turn can convey these astronomical information to their students. For this purpose, there should be a central learned body or institution in each state. This central body may seclect a pool of resource persons who may be the University, College or School Teachers, even if, they are retired.

Now, I intend to discuss, how a Secondary level student can learn a few ideas on basic Astronomy through their curricula. Before the attainment of Calls IX standard, a student has to know something about the Solar System, its constituents, their motions and physical aspects. The relatively extensive study is made only on the Earth, -its shape, size, atmosphere and motion round the Sun. They also become acquainted with the name of a few constellations, for example, the Big Dipper (Saptarshi mandal),the Orion (Kalpurusha) and the Cassiopeia ().

The students may be introduced to both the theoritical and observational aspects of Astronomy. In their theoritical curricula, they may be taught how the Solar System with its constituents evolved and how these constituent bodies were spaced. The students may be asked to prepare a table describing the physical and orbital elements of the planetary system. Thus by making table and charts a student can learn more about the celestial bodies easily.

Besides a few constellations, the students may also recognise the Andromeda which is the only galaxy beyond the Milkyway galaxy visible with the naked eye. They may learn to read the star maps and locate different constellations, zodiacs and some bright stars with the help of it.Being experienced in such a manner, they will be able to report the location of any outstanding

incidents if they observe to happen in the cosmos.

In fine, if the astronomical data and names are used in other allied subjects, such as physics and mathematics, then an attitude towards the subject may grow in them. As for example, in solving problems on sphere the data of the planetary spheres could be supplied for calculations of densities, volumes or masses. These data on being repeatedly used leave an impression in the memory of the students for future use.

So, it is the high time to look into the affair of teaching Astronomical topics in the Secondary School level of our country. A vast country like our own with various kinds of geographical advantages, can contribute more in the effort of exploration for the knowledge of Astronomy than what it is now doing. Now it shuold be the concern to the authorities responsible for imperting education to explore all the avenues for effective teaching of Astronomical topics in the Secondary level.