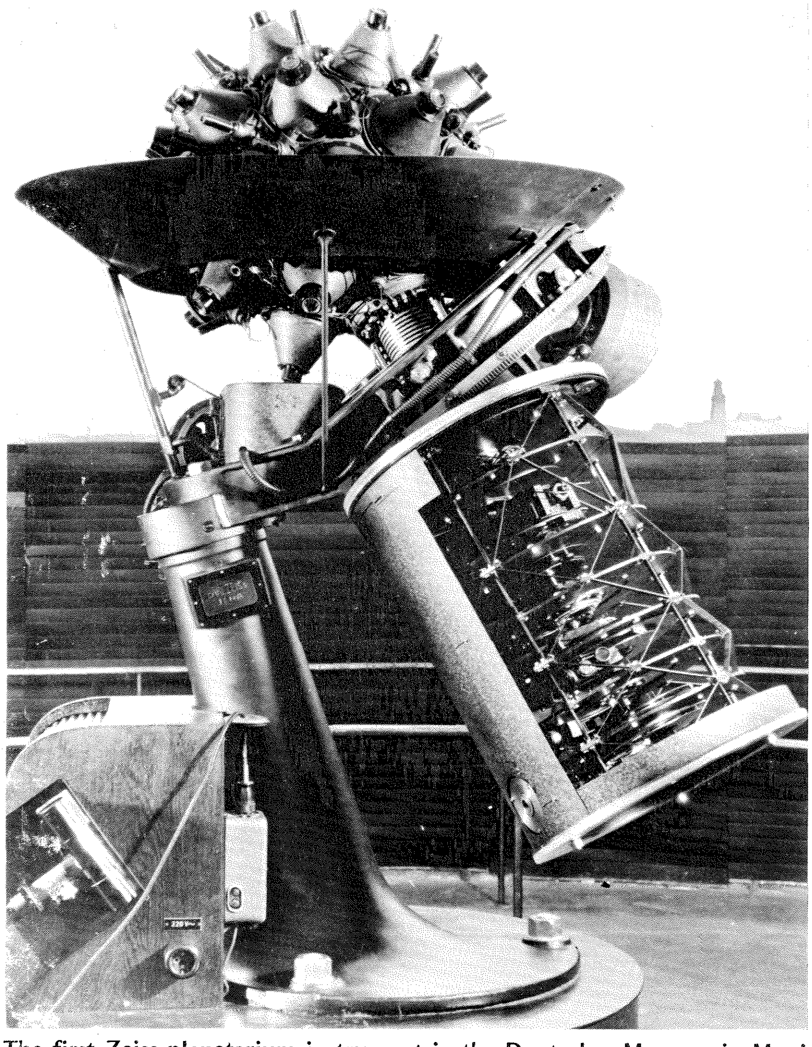
INTERNATIONAL SOCIETY OF PLANETARIUM EDUCATORS

the PLANETARIAN



The first Zeiss planetarium instrument in the Deutsches Museum in Munich, 1923.

The "Wonder of Jena" is Fifty this October

ISPE

Vol. 2, No. 3
September 21, 1973

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THE PLANETARIAN, Vol. 2, No. 3

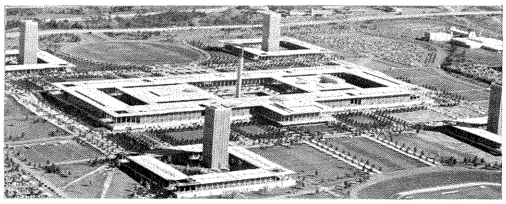
The cover illustration appears courtesy of the American Museum-Hayden Planetarium and Carl Zeiss, Inc. Shown is the original Zeiss Mk. I Projector installed at the Deutsches Museum in Munich, Germany – the "Wonder of Jena."

AN EDITORIAL

Those of us associated with ISPE are pleased to note this golden anniversary of the first official demonstration of the "Wonder of Jena" this October. These fifty years have seen the concept seized by Walther Bauersfeld and his co-workers at Carl Zeiss grow. It has reached solidly into the classroom, it has entertained many tens of millions, it has sometimes even served peculiar uses in Man's quest for knowledge, and ultimately it has established its own growing profession of planetarium educators. The latter man today's installation, which is often a sophisticated multi-media center, used for a variety of pedagogical purposes and equipped with a veritable arsenal of special projection devices and audio systems. The recent creation of ISPE is itself a credit to the "Wonder of Jena" which we salute in this issue.

We congratulate Carl Zeiss, Inc. on this golden anniversary of the projection planetarium. It can feel justly proud of its heritage and of its continuing interest and development of the concept.

Frank C. Jettner



thoughts from fcj

I want you to consider some *thoughts* from one of your hardest-working, but quietest ISPE members. One of the discussion items before your Council now in session was defined by its introducer as "the biggest problem facing ISPE at this time!" and is specifically the "poor" distribution of *THE PLANETARIAN.* While I can think of other problems that make this seem considerably overstated (general lack of money and creation of professional *esprit de corps* in the planetarium field for two), we certainly have had to deal with numerous complaints in this area. Many have stemmed from the awful deterioration of postal service, but there are other reasons as outlined in the edited letter below by Ronald N. Hartman.

Ron's letter is published not only to tell the other side of the story but to indicate to our readers the extent of the real work undertaken by a few ISPE members. In short the next time you feel like griping about something, please ask yourself first what you have done lately to contribute to the cause. Rich Calvird recently wrote that ISPE is like a large team with an enormous number of substitutes on the sidelines that need to get into the game. My *thought* is that the game of life is whatever you want to make it – further, the ISPE game is more fun on the field than on the bench.

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Norman Sperling, *Chairperson*
ISPE Publications Committee

Dear Norm:

Regarding your letter about the problems of late and missed issues of *THE PLANETARIAN,* we are aware of many of the initial problems which led to errors in data subsequently entered onto my mailing list. I hope most of these are now eliminated. I also believe Phyllis Pitluga is attempting to sort out any problems, errors, etc. she inherited with her position of Executive Secretary.

From practical experience I can suggest that some of the difficulties have resulted from the disorganized way the regional organizations have reported their members; i.e., now-and-then, here-and-there, and from one officer to another on a sheet or attached scrap with marginal scribbles such as, "Do you have him?," "This may be a duplicate, will you check?" "You may already have this name," etc. Very frustrating! Sometimes the same name is given with two addresses (home and office) leading to duplication. There have also been cases where the member was omitted altogether, and of course, only he is aware of the fact that he has paid his dues and assumes his name was forwarded to us.

Some people can not follow simple directions on the subscription blank or do not use common sense. I have received (by accident sometimes) letters regarding *THE PLANETARIAN* addressed to Mt. San Antonio College but *not* with my name or that of the MSAC Planetarium. These may get lost in our business office or library as not every employee here knows me or has heard of *THE PLANETARIAN* (although they are finding out!). Eventually, it may reach someone who knows me or connects *planetarian* with *planetarium* and asks if I know anything about it.

Take two other examples: No. 1., A complaint from a former employee of the Griffith Observatory who claimed he was not receiving his magazine. Checking, he had resigned, not given a new address, and apparently the publications were still going to the Griffith Observatory and not being forwarded although he denied this could happen! As soon as we got the new address, the problem ceased. No. 2., One of our own faculty members did not receive two issues. His name *was* on the mailing list. I showed him the label! Yet, he never got his *PLANETARIAN.* Lost in the mails? Apparently. No other explanation.

As to people getting issues late. It may *seem* that way. I get mine *weeks* after the general bulk mailing by Frank. I'm sure in many instances, some of the magazines do take forever to travel. As an analogy, I once received a Special Delivery package from Downie (which is about 25 miles away). It took two weeks to arrive.

Now, regarding solutions: I have sent Phyllis a list of affiliated organizations' individual membership lists. She will bring each up to date and send it to the organization to verify its correctness. As soon as I receive it back, I shall prepare seven individual lists, via the computer, and keep it up to date. A copy will be sent to Phyllis, Frank, you if you wish, and most important, the organization itself every quarter. If anyone sees errors, they can be found at once, *before* the mailing. A separate list will be prepared for subscribers with individual lists for expirations each quarter. This new procedure will evolve as quarters elapse and is being initiated as of September 1973.

I hope the above will answer your questions and those of any others concerned with the problems.

Sincerely,
Ronald N. Hartman
ISPE Circulation Director
Mt. San Antonio College
Walnut, CA

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As a footnote, one might ask why we don't send the journal to everyone by first class mail to alleviate the distribution problem. The answer rests in part on our postage bill for July: $15.04 bulk rate to send a shipment of 553 issues within the USA (actually figured at 8¢ per pound) vs. a proposed cost of $265.44 for their first class distribution. Considering that we're squeezing nickels to keep going, this expense was the first marked off. *Ideas anyone?*

Frank C. Jettner

LETTERS

ECLIPSE DAY – JUNE 30, 1973

Along with 1800 other hopeful eclipse chasers, I viewed the big show of June 30, 1973 from the decks of the Canberra off the coast of Mauretania. Eclipse Day minus one the big scramble for deck space was on. Have there ever been so many telescopes and cameras jammed together? On the upper decks it was possible to get around only by picking your way over and around people. Some determined souls even slept on deck to safeguard space and equipment.

Eclipse day didn't dawn – it was cloudy and as depressed as our spirits, but the ship remained idly drifting on station instead of steaming to a clear spot. Gradually, as the meteorologist had predicted, it cleared to reveal a silver sky and silver sea, the result of sands blown from the desert.

With the deepening of the partial stages, the horizon became less distinct, the sky and sea a shimmering dark silver. There was no display of twilight colors along the horizon – no salmon, saffron and purple of other eclipses. This wiped out my project to photograph color changes of the sky.

The light level dropped abruptly. The sky turned a midnight blue. No shadow bands flickered by, no chilling lunar shadow dropped over us. With a last blaze of white light, the sun hid behind the moon and the pearly luminescent corona shimmered into view.

Photographs will never do justice to the real thing. The long irregular streamers of the outer corona spread like a pale white veil. Ringing the moon was the bright inner corona. Venus blazed below the sun, but after a quick scan of the sky, I decided not to spend further time hunting for stars and planets and returned to the corona.

The sound of cameras clicking steadily was as an army of crickets. All around, amid directions issued to teams, people were calling, "Fantastic, Splendid, Oh, my God, Beautiful." A conservative estimate of the amount of film shot is that it would reach to Jupiter and back. Surprisingly, no one fell overboard in the excitement, although a lifeboat had been lowered with just such an eventuality in mind.

The shortest time in existence is the period between second and third contact, no matter what the clock ticks off. A bulge of white light swelled out of a deep lunar valley, creating the longest lasting diamond ring I've seen. Gradually the corona was banished, there was a last view of prominences and chromosphere, and the sun slid into view once more. There was a collective sigh and then applause! A thank you to the celestial powers, but there was no encore.

While the eclipse was the main event, there were extra bonuses provided by the cruise. The volcanic islands of the Canaries gave us a chance on Tenerife to drive into a caldera of 8 miles diameter. At its center it holds a younger cone rising over 12,000 feet. The startling formations in the caldera will probably reappear next winter in planetarium landscapes for extragalactic planets. The jumbled forms of lava, jagged peaks and shiny fields of striated brown and black obsidian form a perfect background for space shows.

(continued on page 135)

ANNOUNCEMENT

A pamphlet "Information For Contributors" to *The Planetarian* is available for distribution. For your free copy please write to:

Mr. John F. Christian
Division of Science & Math
Genesee Community College
1401 E. Court Street
Flint, Michigan 48503

1974 CHECKLIST OF PLANETARY CONJUNCTIONS

The following is a list of all conjunctions of the sun and naked-eye planets with each other and with first magnitude stars during 1974. The table should be useful in helping planetarium operators set their planet projectors and determine the short-run accuracy of their annual motion systems. For completeness, oppositions of planets with the sun, as well as equinoxes and solstices, are listed.

The table gives the date of conjunctions and oppositions in *celestial longitude* (not right ascension), and therefore, for conjunctions, corresponds to the time of closest approach, since the planets move in paths nearly parallel to the ecliptic. The time of these events is stated to the nearest tenth of a day, in Universal Time.

For each event the angular north-south separation in latitude of the objects at the time of conjunction is given, as well as the elongation, expressed as the angular distance east or west of the sun. If the objects are observable from earth on the date of the event their magnitudes are given; circumstances of visibility for latitudes near 40° north can be obtained from the 1974 *Graphic Time Table of the Heavens*[1]. Magnitude values enclosed in parentheses indicate that circumstances are unfavorable for observers in these latitudes. Magnitudes are omitted for events which are undoubtedly too close to the sun for observation.

The planetarium operator should be sure that precession motion is set to the present epoch. In 1974 the sun passes Regulus on August 23.0 UT. If the ecliptic is graduated with March 21.0 at the equinox, the star field should be precessed until Regulus is at the same longitude as the August 23.0 position of the ecliptic. As a check, the right ascension of Delta Orionis, the westernmost star of Orion's belt, should be $5^h 30^m.7$ in 1974.

An accurate method of setting planet projectors is to set each for the date of a solar conjunction. For each planet, the date of the first solar conjunction in 1974 is marked by an asterisk in the table. For details in this suggested procedure for setting planets, see the author's article "How Well Do Your Planets Move?" in *THE PLANETARIAN*, Volume 1, Number 3 (December 21, 1972), page 84.

Robert C. Victor
Michigan State University
East Lansing, Mich.

[1]Published annually by the Maryland Academy of Sciences, 119 S. Howard St., Baltimore, Md. 21201. Also appears annually in the January issue of *Sky and Telescope.*

1974 CHECKLIST OF PLANETARY CONJUNCTIONS

	DATE		EVENTS		ELONGATION	MAGNITUDES
1974	Jan	9.3*	Mercury	1°.9 S of sun (superior)	0°	
		19.7	Mercury	7°.9 S of Venus	E 7°	(-1.0, -3.4)
		23.9*	Venus	6°.7 N of sun (inferior)	0°	-3.2
		28.2	Mercury	0°.8 S of Jupiter	E 13°	-1.0, -1.5
	Feb	13.7*	Jupiter	0°.8 S of sun	0°	
		24.9	Mercury	3°.7 N of sun (inferior)	0°	
	Mar	4.2	Mercury	3°.6 N of Jupiter	W 14°	(+1.7, -1.5)
		16.2	Mars	7°.1 N of Aldebaran	E 74°	+1.2, +0.9
		21.0	Sun passes Vernal Equinox			
		21.7	Mercury	0°.1 S of Jupiter	W 28°	+0.5, -1.6
	Apr	14.6	Venus	1°.0 N of Jupiter	W 46°	-3.9, -1.7
		20.6	Mars	2°.3 N of Saturn	E 60°	+1.7, +0.3
	May	4.7	Mercury	0°.1 S of sun (superior)	0°	
		16.8	Mercury	7°.2 N of Aldebaran	E 14°	(-0.9, +0.9)
		28.4	Mars	5°.3 S of Pollux	E 46°	+1.9, +1.1
		31.3	Sun	5°.5 N of Aldebaran	0°	
	Jun	2.3	Mercury	2°.5 N of Saturn	E 23°	+0.5, +0.3
		21.8	Sun passes Summer Solstice			
		30.5*	Saturn	0°.6 S of sun	0°	
		30.8	Mercury	4°.4 S of sun (inferior)	0°	
	Jul	1.2	Mercury	3°.9 S of Saturn	W 1°	
		4.0	Venus	3°.9 N of Aldebaran	W 32°	-3.4, +0.9
		15.8	Sun	6°.7 S of Pollux	0°	
		24.6	Mercury	1°.3 S of Saturn	W 20°	+0.2, +0.3
		26.8	Mars	0°.6 N of Regulus	E 26°	(+2.0, +1.3)
		31.4	Venus	0°.2 N of Saturn	W 26°	-3.3, +0.3
	Aug	1.6	Mercury	6°.7 S of Pollux	W 16°	-0.8, +1.1
		9.1	Venus	6°.6 S of Pollux	W 23°	-3.3, +1.1
		17.4	Mercury	1°.8 N of sun (superior)	0°	
		20.1	Mercury	1°.3 N of Regulus	E 3°	
		23.0	Sun	0°.5 S of Regulus	0°	
	Sep	2.0	Mercury	0°.1 S of Mars	E 14°	(-0.5, +2.0)
		5.8	Jupiter at opposition	1.5° S of ecliptic	180°	-2.5
		8.0	Venus	0°.7 N of Regulus	W 15°	-3.4, +1.3
		22.5	Mercury	0°.2 N of Spica	E 24°	(+0.2, +1.0)
		23.4	Sun passes Autumnal Equinox			

DATE		EVENTS		ELONGATION	MAGNITUDES
Oct	14.5*	Mars	$0^\circ.5$ N of sun	0°	
	17.3	Sun	$2^\circ.1$ N of Spica	0°	
	18.6	Mars	$2^\circ.6$ N of Spica	W 1°	
	21.4	Venus	$3^\circ.3$ N of Spica	W 4°	
	24.6	Venus	$0^\circ.7$ N of Mars	W 3°	
	25.6	Mercury	$0^\circ.9$ S of sun (inferior)	0°	
	26.8	Mercury	$0^\circ.6$ S of Venus	W 3°	
	27.5	Mercury	$0^\circ.7$ S of Mars	W 4°	
Nov	6.6	Venus	$0^\circ.8$ N of sun (superior)	0°	
	25.2	Mercury	$1^\circ.0$ N of Mars	W 14°	-0.6, +1.8
	27.0	Venus	$4^\circ.6$ N of Antares	E 5°	
Dec.	2.0	Sun	$4^\circ.6$ N of Antares	0°	
	8.3	Mercury	$4^\circ.3$ N of Antares	W 6°	
	19.9	Mercury	$1^\circ.4$ S of sun (superior)	0°	
	22.2	Sun passes Winter Solstice			
	24.2	Mars	$4^\circ.4$ N of Antares	W 23°	+1.7, +0.9

MORE ON UNDERSTANDING SCIENCE

As I see it, Dr. Verschuur's letter in the June 21st, 1973 issue of *THE PLANETARIAN* accurately exposes current concerns in science, i.e., (1) we now have so much data accumulating so rapidly that no one can understand much less relate it to anything or anyone else, (2) ". . .because it's there" as a *raison d'etre* should perhaps be re-examined and replaced with a more leisurely, reflective approach to the problems of the earth and the universe, and (3) public understanding and approval of science is changing in a direction as yet undetermined.

Dr. Verschuur speaks of science in general; as I try to relate his thoughts to planetarium education in particular, I realize that I am falling into the narrow niche of my own profession and pushing myself right into the dilemma that he describes. In other words, as we thrust ourselves into more and more selective endeavors, it is more difficult to become involved with a general concern of where we are going.

We, as planetarians, must be as genuinely involved with these concerns as anyone else, and in fact, we have a unique opportunity to use the planetarium concept to develop badly needed lines of communication between the scientific community and the public. Astronomy, of course, is not all of science; however, the beginning of solutions to these concerns in *any* scientific area is an expansion of contact between secluded researchers and the world. Scientists in general, and astronomers in particular simply must re-think their relationship to the public.

Consider Isaac Asimov's article in Vol. 1, No. 1 of *THE PLANETARIAN* in which he insists that a "science writer" is badly needed to interpret for a scientific researcher exactly what it is he has accomplished. Planetarians are in an unequalled position to act as Mr. Asimov's "interpreter" between the astronomer and the public; the sooner that astronomers realize it, the sooner we can cooperate and go on with whatever it is that science is becoming, instead of diverting ourselves into more and more deadend alleys. There are indications that such interdependent realizations are beginning to occur as in George Reed's report in the June 21st, 1973 issue of *THE PLANETARIAN* that the American Astronomical Society, in a recent conference, in part concerned itself with its relationship to the planetarium community.

Lest it sound as if planetarians are saying "the sooner you get with us, the sooner things will happen," we should remember that the planetarium environment as a significantly effective educational tool is still statistically unresolved. It is just that we *all* need to get together to figure out where it is we are going.

At the recent SEPA conference in Miami, I met at least one astronomer whose purpose in attending was to find out how he could work with planetarians in his geographical area to explore sincerely common concerns of astronomy. Perhaps the beginnings of "getting together" are here and we simply need to encourage them. I believe, as Dr. Verschuur does, that mutual endeavors among the scientific community, educational community and the public are not only personally mind-expanding, but are absolutely inevitable in this soul-searching decade.

Jane Geoghegan
Richmond, Va.

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(914) 238-3945

CIAO! again ——

It is difficult to imagine that "our" business has been around for fifty years — COUNT EM {{ 50 }} Difficult to imagine because the signs (non-astro) now point to the real birth and growth of the "DOMED COMMUNICATIONS ENVIRONMENT" Let's assume that there are only 1000 existing working domes —— that makes an average growth rate of TWENTY per year — NOT BAD! (Especially since we know that most of these are recent) WHERE?? - then - is the combined knowledge from all this design, building, and teaching??? In OUR minds; and (here comes the pitch) in my files — and the experience of my associates. The role of an effective consultant is to store, sort, and combine the best of everything in order to help the client meet his objectives and goals. Planetarium pioneers might? be surprised, to see some of the unique applications of 'their' media — but probably not!! - because they were the men of vision that created "the dome" that is now used in so many different ways.

During the next 50 years let us all grow together

Donald M Lunetta

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A FIFTY YEAR ANNIVERSARY OF A TWO THOUSAND YEAR DREAM

by Mark R. Chartrand III, *American Museum-Hayden Planetarium*

The planetarium profession started just 50 years ago. At that time, progress in optics, instrumentation, and electricity made possible the realization of a two thousand year old idea – a perfect representation of the starry sky *inside a room.* With it came the possibility to have a celestial time machine, with time marked by the motions of the planets.

Twenty centuries ago, maps of the sky were placed on the outside of globes to illustrate the heavens for the purposes of art and of learning. Some actually moved, reproducing the diurnal motion. Archimedes is credited with the first device demonstrating planetary motions about 250 B.C. After he was killed by invading Romans, the device was taken to Rome as booty where it was seen and described by Cicero. Its fate remains a mystery. Later, Ptolemy's globe is alleged to have even demonstrated the precession of the equinoxes.

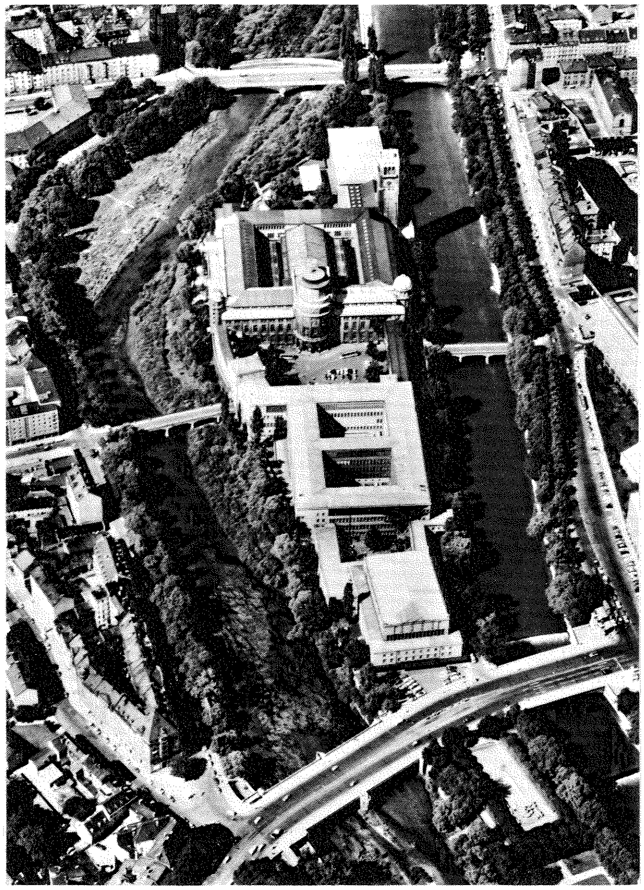


Figure 1. The Deutsches Museum in Munich, site of the first planetarium. Destroyed during World War II, it was completely rebuilt. The projector which replaced the original Zeiss Model I is today located on the 5th floor of the central tower. The River Isar runs along either side of the Museum, and downtown Munich is a kilometer off to the right.

The next improvement came with the enlargement of the globes. The most famous, the Gottorp globe constructed in the middle 17*th* century (it took 20 years!), was about 4 meters in diameter, weighed over 3 tons, and could seat several persons inside on a circular bench. The stars were holes in the globe.

Other globes like the Gorroro sphere were built, one of the last being the Atwood globe in 1913 for the Museum of the Chicago Academy of Sciences. With a diameter of almost 5 meters the Atwood globe shows 692 stars, and a moveable light bulb represents the Sun. Apertures along the ecliptic, which can be uncovered as necessary, represent the planets.

With the coming of the Copernican idea (whose 500*th* birthday we also celebrated this year) and with advances in instrument-making, various models of the planetary system were constructed as teaching devices. These are called "orreries" in English, but they are also known as planetaria, which serves to confuse things. The orreries reached their culmination in the large ceiling orreries at Munich (since destroyed), Chapel Hill, and New York. Meanwhile, elaborate astronomical clocks were developed showing various sky events. Thus the stage was set for the entrance of the next advance.

The First Projection Planetarium

Generally considered as the first projection device for showing planetary motions is the Orbitoscope, invented about 1912 by Prof. E. Hindermann in Basel. This instrument is driven by springworks and has two planets revolving about a central Sun. A small light bulb on one of the planets projects shadows of the other two objects in the directions they would be seen from that planet, reproducing accurately the retrograde loops and speed changes. This ingenius device is useful for instruction, but of course had many shortcomings.

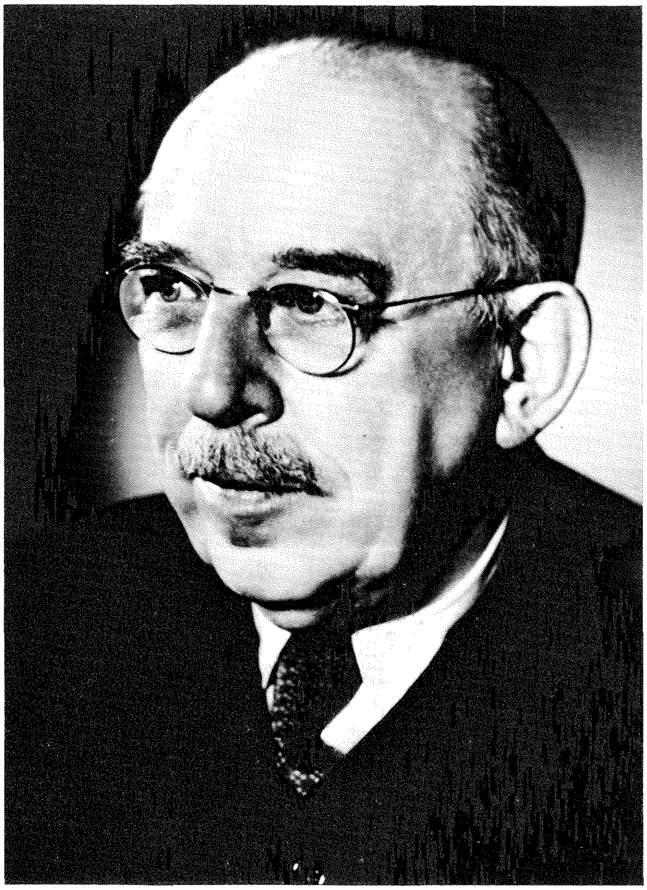


Figure 2. Walther Bauersfeld.

The Deutsches Museum and Carl Zeiss

The idea of realistically reproducing the sky in detail is due to astronomer (and then privy counselor) Max Wolf. He was involved with the Deutsches Museum, a then-new institution devoted to science and technology.

The museum was the brainchild of Oskar von Miller, an engineer interested in all aspects of science. He founded it in 1903 with the help of such other well-known scientists as von Siemens and Roentgen. 1906 saw the preliminary opening in temporary quarters. The museum eventually was given the beautiful island in the Isar River as its new home in Munich, but the opening planned for 1916 was postponed due to the war. The fully constructed museum finally opened in 1925.

In 1913, Wolf had suggested to von Miller the idea of a device for his museum which would reproduce not only the stars but also the planetary motions. von Miller approached the well-known optical firm of Carl Zeiss in Jena, and they agreed to look into the problem.

Carl Zeiss Company had begun in 1846, where that skilled instrument maker produced microscopes in his home workshop. Later collaboration with Ernst Abbé resulted in the first optical instruments produced from theory and plans, rather than from trial and error. Later still, Otto Schott, a glassmaker, introduced a process for producing good quality optical glass reliably, and the company established its reputation as a maker of high-quality optical goods.

The Idea

It was from this background that the planetarium sprang. About March 1919, Walther Bauersfeld, chief design engineer and later director of Carl Zeiss, hit upon the idea of projection of the celestial objects in a dark room. The original plan had been for some sort of globe similar to that of Gottorp. The new idea simplified things immensely. The mechanism could be on a small scale and easily controllable.

Five years of calculations and trials were needed to bring this idea to fruition. Five years, in which Bauersfeld and a large staff of scientists, engineers, and draftsmen considered the astronomical principles involved and the mechanical devices which would realize them. They rediscovered the work of Christian Huygens, who had used the mathematics

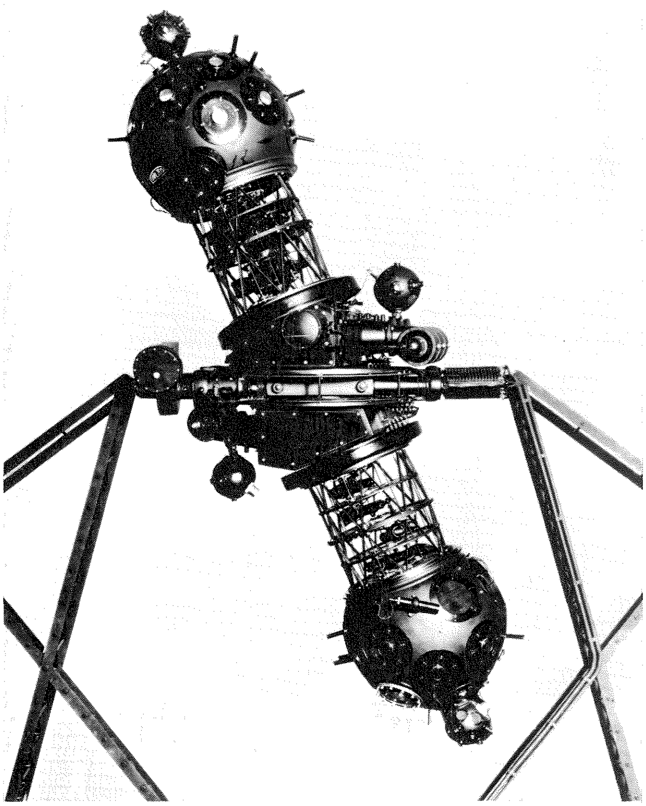


Figure 3. The Zeiss Model II planetarium as produced during the 1920's and 1930's.

Figure 4. The American Museum-Hayden Planetarium in New York City.

of continued fractions to construct his famous orrery in 1682. They constructed star plates of film with images of 4500 stars. They found ways of interconnecting the daily and annual motion drives so the planets would stay in proper relative positions. In short they *invented* the modern projection planetarium.

In August 1923, a 16 meter dome was set up on the roof of the factory in Jena, and the first Model I projector was installed. The "Wonder of Jena" had its first unofficial showings there. Then the instrument was taken down, shipped to the Deutsches Museum, and installed there in a 10 meter dome.

On October 21, 1923, Prof. Bauersfeld demonstrated the projector to a congress at the museum, the first *official* public showing. The professional and public reaction was enthusiastic.

After this debut, the instrument was again returned to Jena for finishing touches, finally being permanently installed in Munich in May 1925. It operated there until the beginning of World War II, when it was taken down and put in safe storage. Thus it survived the bombing which almost totally destroyed the museum in 1944-45. After the Deutsches Museum was rebuilt, the original Model I was re-installed on May 7, 1951. It has since been replaced with a Model IV, and the planet cage is in storage at the museum. The star projector has been loaned to the Max Planck Institüt, being used for research in bird navigation by the stars.

Spreading The Word

The planetarium so impressed many scientific and civic leaders in Germany that in the few years following the first Model I, several other cities ordered and received projectors. Dusseldorf installed a Model I, then replaced it with a Model II which Zeiss had developed in the meantime. (This planetarium had a 30 meter dome, one of the largest ever constructed, and totally destroyed in the war.) The Model II was the large dumbbell-shaped projector which everyone has since identified with Zeiss. 1927 saw the first planetarium outside Germany, a temporary installation in Vienna. The Rome planetarium opened in 1928 (now alas, a cinema!), and the Moscow planetarium in 1929. Except for Munich and Jena, all of these early installations had linen domes.

1930 witnessed five new planetaria, including ones in Stockholm, Milan, Hamburg, a new one for Vienna, and the first outside of Europe. In 1928, Max Adler, a Chicago philanthropist, heard of the "Wonder of Jena" and took his wife and an architect to Germany to see it. He was so impressed, he donated to his home city the first planetarium in the Americas. On May 12, 1930, the Adler Planetarium greeted its first visitors. Over 22 million have since seen its Sky Shows and exhibits.

Also attracted to the Zeiss planetarium about the same time were Samuel Fels of Philadelphia, Col. G.J. Griffith of Los Angeles, and Charles Hayden of New York. They all saw the machine in operation and were sufficiently impressed to give planetaria to their communities. The Fels

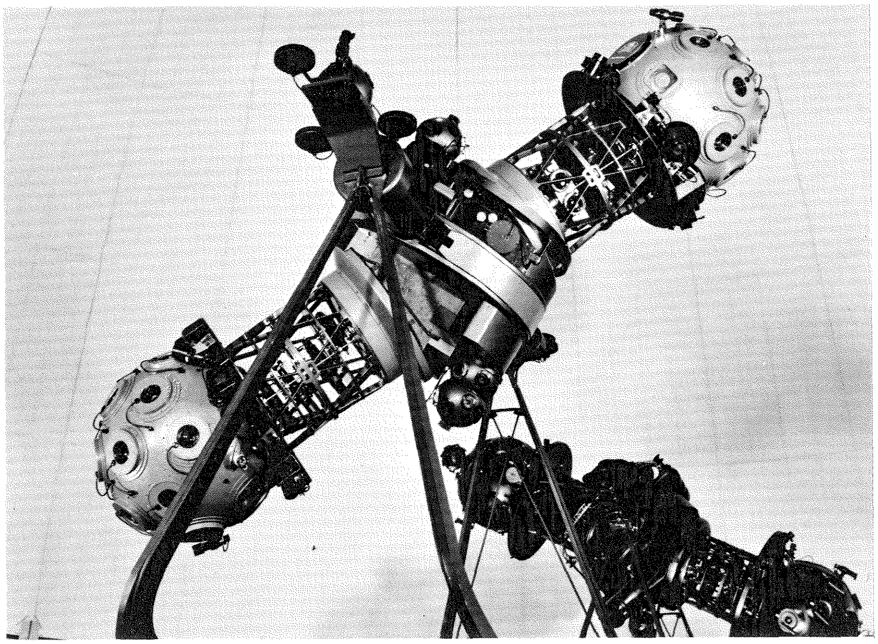


Figure 5. The Zeiss Model VI in the foreground is the most advanced built by Carl Zeiss, Inc. and is now available with automation. Behind it is a Model IV being rebuilt.

Planetarium became the second in the U.S., opening on Nov. 1, 1933, and 1935 saw the opening of the Griffith Planetarium on May 14 and the Hayden Planetarium on October 2. During these years, other instruments began to show the sky in Sweden, Belgium, and Holland. Except for the latter, all were Model II's.

The Orient got its first glimpses of a planetarium sky in Osaka in 1937 and Tokyo in 1938, the latter soon-to-be totally demolished in the war. 1939 marked the first instrument on an elevator, the Buhl Planetarium in Pittsburgh. During the 1930's, Carl Zeiss also designed and built many small projectors, used mainly for navigation instruction for pilots. (One may be seen in operation today at the Science Museum in London. It was captured at the end of the war.)

The 1930's also saw the first non-Zeiss planetarium, designed and built by the Korkosz brothers in Springfield, Massachusetts, and installed in the museum there. The device projects 9500 stars, but has no planet projectors. Later a similar device was built for the Charles Hayden Planetarium in Boston, endowed by the same person as the New York Planetarium. (The Korkosz projector in Boston has since been replaced by a Zeiss Model VI.)

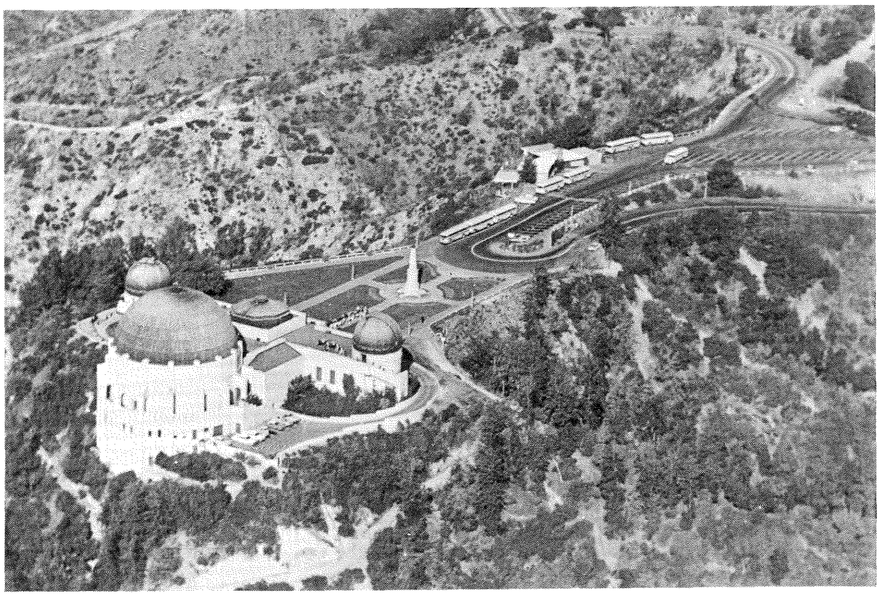


Figure 6. The Griffith Observatory and Planetarium, located in Griffith Park in Los Angeles, California.

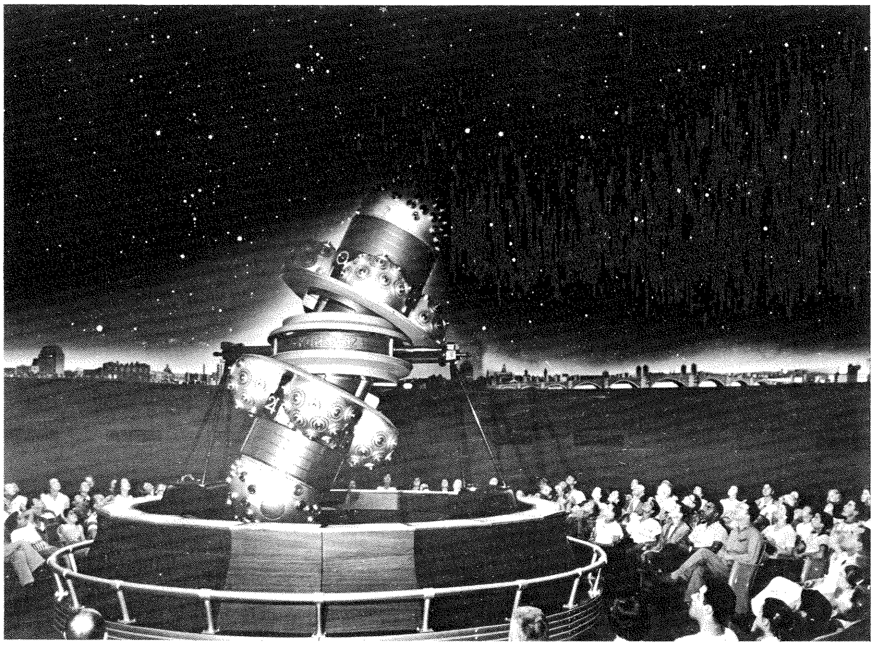


Figure 7. The unusual projector built by the Korkosz brothers for the Charles Hayden Planetarium in the Boston Museum of Science. This instrument has since been replaced with the Zeiss Model VI.

The War, and After

During World War II, Carl Zeiss produced few planetarium instruments. The only large installation, a Model II, was in Göteborg, Sweden in 1944. It was removed to the Morehead Planetarium in Chapel Hill, N.C. in 1949.

In 1945, Russian troops occupied Jena and took over the Carl Zeiss factory. Prior to the occupation however, Allied troops had evacuated about a hundred top company personnel to the American sector and resettled them in Heidenheim, near Stuttgart. The Jena facilities were dismantled by the Reds, but later the factory was reorganized. Today Carl Zeiss of Jena again produces optical equipment, including several sizes of planetarium projectors. Most of the post-war Jena instruments are inside the Iron Curtain countries. A few are found in some of the major Canadian planetaria.

The refugee personnel reorganized the now West German company and established a new factory in the beautiful small town of Oberkochen. They have since built up once again a vigorous production of high quality optical goods. The numerous advances made in recent years in planetarium technology have culminated in the Zeiss Model VI instrument now found in many major planetaria.

Immediately after the war neither Oberkochen nor Jena were capable of building a planetarium projector. Because of this, the California Academy of Sciences in San Francisco commissioned a comparable, one-of-a-kind projector for the Morrison Planetarium. After four years of design and construction, it was opened on November 6, 1952.

Everyman's Planetarium

In 1936, Armand Spitz, a Philadelphia newspaperman, took a part-time job as a lecturer at the Fels Planetarium and immediately saw the pedagogic possibilities of the planetarium. He also saw that it was impossible for a small school or museum to have one because of the great cost in money and space. He set out to build a projector which would give a reasonable reproduction of the sky but sell for a couple of orders of magnitude less than that of the large Zeiss. The result was the famous Spitz dodecahedron used in the Models A, A-1, and A-2. His invention has caused his colleagues of today to affectionately name Armand Spitz the "Henry Ford of the planetarium field." All were saddened by the news of his death on April 14, 1971.

The first Spitz projector was demonstrated to a meeting of astronomers at Harvard College Observatory in the late 1940's. The small projector was a great success, despite the lack of planetary motions and with a motor drive for diurnal motion only. In 1949, Spitz Laboratories was founded, first in an old factory building and then in an old theater. As the enterprise grew, they later moved to an old snuff factory in Yorklyn, Del. and are now located in a spacious new factory in Chadds Ford, Pa. The company has changed its corporate ownership several times in its brief history and is now Spitz Space Systems, Inc.

The Spitz Model A-1 improved on the Model A by having star images of different brightnesses. The control panel was modified and enlarged. Next came the A-2 and then the idea of a much larger projector with planet motions and

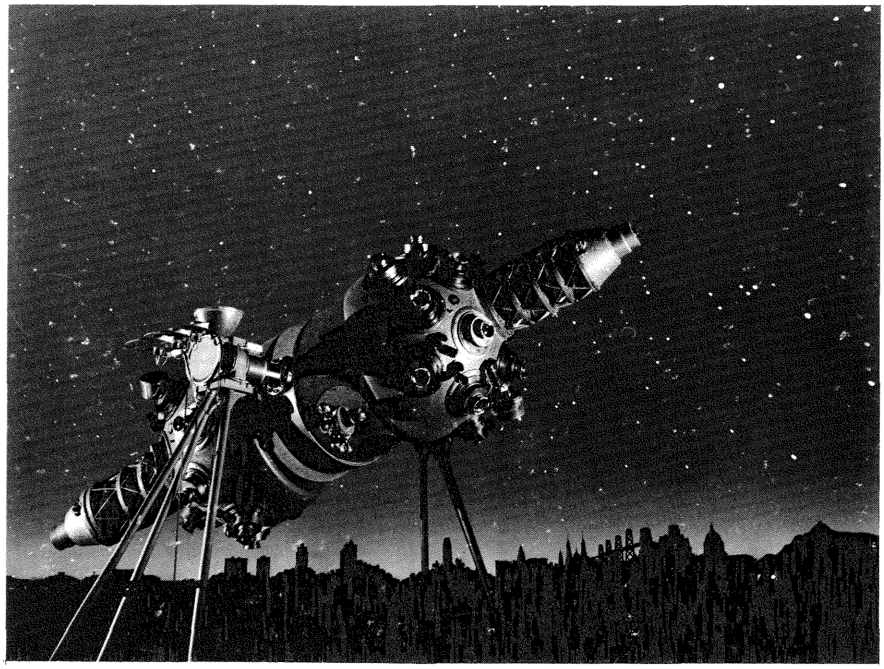


Figure 8. The Academy projector in the Morrison Planetarium in San Francisco's Golden Gate Park.

suspended by cables from the dome. The result during the 1950's was the Model B, of which only three were made, all still operating. The first was the Montevideo (Uruguay) Planetarium, which opened in February 1955, the first in South America. The others are at the Air Force Academy in Colorado Springs and the Longway Planetarium in Flint, Michigan. Spitz Laboratories concurrently produced one intermediate-sized Model C, now the planetarium at the Minneapolis Public Library.

During the 1960's, Spitz widely sold the Models A-3 and A-3-P with planet motions and spherical star projectors as well as the more advanced and larger Model STP (Space Transit Planetarium). Planetary motions for these instruments differed from the Zeiss concept in that they were derived from electrical analogs instead of gearworks. Still later has come the Spitz A-4 and A4A (now System 512), which may be completely automated. The company has pioneered in one-way planetarium seating and inclusion of azimuth rotation among other innovations. There are now some 700 Spitz projectors of varying sizes throughout the world. The latest and most sophisticated development is the Model STS (Space Transit Simulator), a departure from standard planetarium design both in the projector and the theater. Complete programming is possible with a built-in digital computer, and the system resides in a tilted hyper-hemispherical dome. The first STS was installed in early 1973 at the San Diego Hall of Science.

From Across the Pacific

Towards the late 1950's, Seizo Goto, a leading Japanese industrialist, used the expertise of his company in the field of telescopes to produce the first Goto planetarium. After trials in Japan, the first Goto in the United States filled the sky with stars in Bridgeport, CT on January 20, 1962. The Goto company was actually the first to produce a small projector which included planetary motions. Many Goto instruments have since been installed all over the world, a large number in the U.S. These planetariums are currently distributed in North America by Mitsubishi, Inc.

Somewhat later, the Minolta Company of Japan, known for high-quality cameras and optics, made some tentative entries into the field in the mid-1960's. The first major planetarium was at DeAnza College in California. By the late 1960's, Minolta had decided to officially enter the planetarium business, and they now produce a line of projectors of all sizes. These are distributed in North America by Viewlex, Inc. of Holbrook, N.Y. The latter firm also manufactures their own lines of small, automated planetariums.

Later

Since World War II and particularly since the flight of Sputnik I, the number of planetaria has grown tremendously. With this growth the projection systems have become more sophisticated in operation and accurate in their

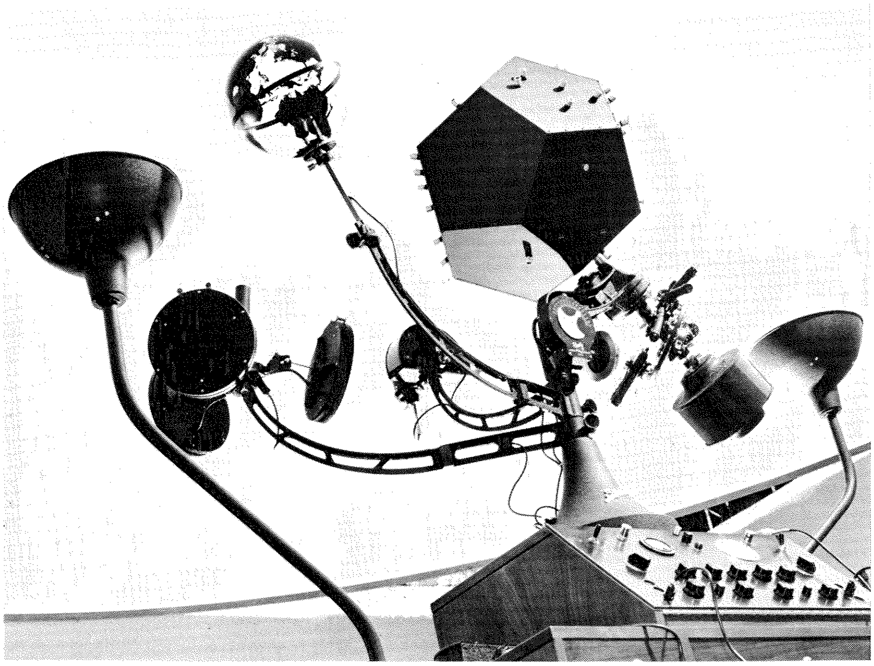


Figure 9. The Spitz Model A-1 planetarium with its famous dodecahedron. The planet projectors, seen on the right hand side of the star projector, were set individually by hand.

portrayal of the heavens. Many projectors now have provision for automation of the entire program.

Many school systems and colleges now use a planetarium in their astronomy courses. While the small planetaria find their primary use as teaching devices, the planetaria in museums serve the function of informing an interested audience of the wonders and discoveries of astronomy, from the simple identification of constellations to elaborate, sophisticated multi-media shows demonstrating and explaining concepts which were not even around when Bauersfeld first proudly demonstrated his "Wonder of Jena"; e.g., quasars, pulsars, and black holes. (Actually black holes were "invented" about 1913, but no one thought of talking about them in a planetarium!) Modern planetaria have been used for the performance of science fiction plays, musical events, and multi-media shows with light, sound, and live performers.

The planetarium, both as a fine instrument and as an institution, has come a long way since 1923 when astronomer Elis Strömgren wrote:

> "Never before was an instrument created which is so instructive as this; never before one so bewitching; and never before did an instrument speak so directly to the beholder. The machine itself is precious and aristocratic. . .The planetarium is school, theater, and cinema in one – a classroom under the eternal dome of the sky."

And it is still true today. *(End)*

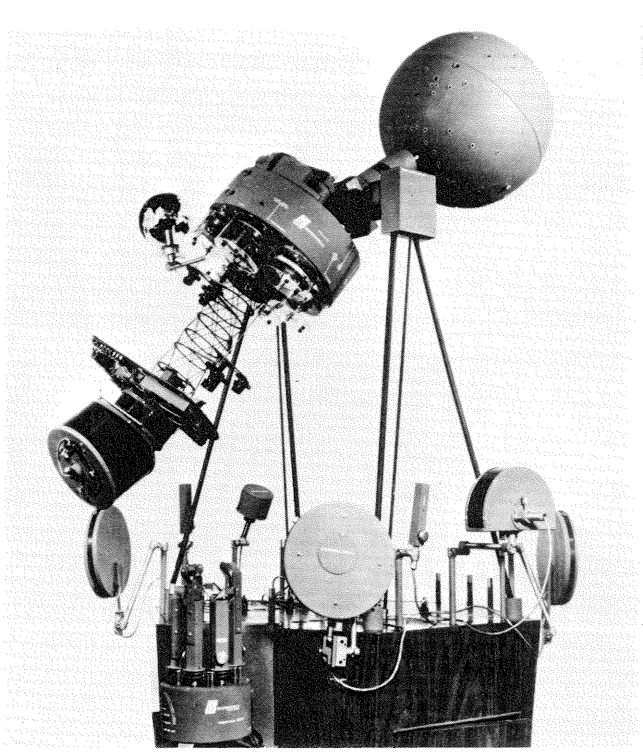


Figure 10. The Spitz Model A-3-P, undoubtedly the most abundant planetarium instrument in existence. Hundreds were sold to schools, colleges, and museums during the "boom" period of the mid-1960's.

The Technical Side

Conducted by O. Richard Norton
Flandrau Planetarium
Department of Astronomy
University of Arizona, Tucson

* * * * * * * * * * * * * *

For years, planetariums have struggled to eliminate the background around an object of interest on a transparency. The realistic nature of a planetarium sky demands that anything projected onto it must be just as realistic in appearance to maintain the illusion. Any transparency showing a bright background around the subject of the transparency immediately introduces scattered light that is essentially undesirable "light" noise that destroys the illusion of the evening sky so painfully attained by the planetarium manufacturer. In this and the winter issue of the Journal, your editor will discuss some effective methods of eliminating the unwanted background.

For our purposes, we will divide the subject into two categories each representing a different problem with the same results desired. They are:

a) Eliminating the background around objects with well-defined edges.

b) Eliminating the background around objects with ill-defined edges. The former will be treated first.

Most production departments are aware of the old methods of masking film by using Kodak red or black Opaque compound. This material was developed years ago primarily for correcting defects (pinholes, scratches, etc.) in high contrast ortho negatives used for line work. Applying it heavily on the non-emulsion side of a film effectively acts to block unwanted light from being transmitted through the film. Although this material is relatively easy to apply to a 3-1/4" x 4" format transparency, the almost universal use by planetaria of 35 mm format increases the difficulty of applying this material with the necessary accuracy. Although it can be applied around the horizon of a landscape scene with relative ease, the limitations immediately become apparent when trying to mask a spacecraft or radio telescope with complex tubing and antennae as part of their superstructures. Thus, a new method was needed to accomplish "zero background" on a small scale and with high accuracy.

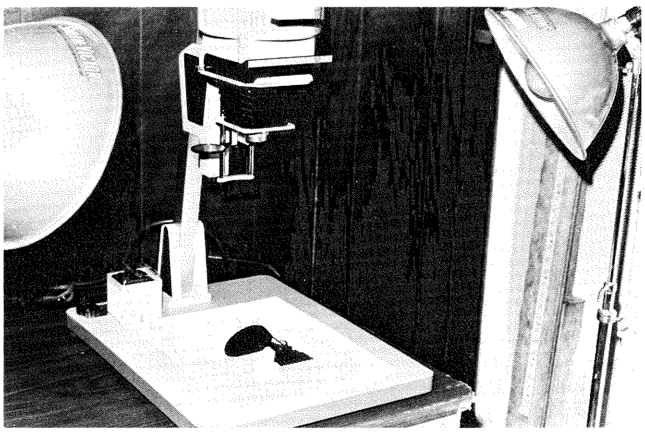


Figure 1. An enlarger is used to project an image of the original scene. The artist outlines the object in the scene and fills in the object, producing a silhouette which is then photographed using the enlarger as a camera.

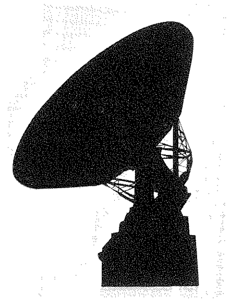


Figure 2. This is the mask resulting from the enlarger photograph of the original silhouette artwork.

In recent years the use of Kodak Kodalith film, an extreme high contrast ortho line copy film with zero transparency in the blacks and almost 100% transparency in the whites, has been used in the planetarium as masking material to overlay the original transparency. The above characteristics of this film make it highly ideal for this purpose. The primary problem in its use, however, is to find a method that produces a photographic kodalith mask that exactly fits the original transparency. It is obvious that, to successfully work with fine detail, the original transparency must be enlarged, the artwork for the mask made from the enlarged transparency, and then photo-reduced to the exact size needed to produce a perfect fit over the original transparency. Although numerous methods using slide projectors and camera combinations have been published, the only really accurate method must use the same optics and identical projector/camera geometry. To maintain these restrictive criteria, a photographic enlarger is used both as a projector as well as a camera. First, the original 35 mm transparency is placed *in between glass* to prevent buckling of the film. It is then projected by the enlarger onto the enlarger easel. A 50 mm focal length lens is suggested since this lens should produce an enlargement sufficient in size-brightness for critical tracing work by the artist. A white cardboard mat is taped securely to the easel upon which the artist carefully outlines the details of the subject.

To produce a sufficiently bright projected image, it may be necessary to substitute the normally modest light source of the enlarger with a higher wattage source. In this event, it may be necessary to place a heat filter between the source and enlarger condensers to protect the optics and transparency.

After the pencil trace has been made, the outline is carefully retraced in place with a fine pen using black drafting ink and then filled in to complete the mask. Care must be taken to use a good quality white cardboard upon which a fine ink line can be accurately drawn. Moreover, the material must be of sufficient thickness to prevent shrinkage and warpage when the ink is applied. Ordinary drafting paper is not applicable to this method.

The next step is to photograph the mask. The enlarger is now used as the camera (Figure 1). The original transparency is carefully removed and replaced by a piece of 35 mm Kodalith film. It is important here to be careful that the subject (film) to image distance be maintained to keep the scale constant. Two #2 photofloods are arranged on either side of the enlarger easel and about 4' away from the subject. The enlarger lens is set at F/11 and the floods are turned on for 1 second. The exposed film is developed using the Kodalith A & B developers. The result is a mask that exactly fits the original transparency (Figure 2).

There are obvious advantages of using the enlarger as both projector and camera. Optically, the projector and camera are identical, only used in reverse. Thus, any optical aberrations introduced by the enlarger optics are automatically corrected when photographing since the same lens has been used to pass incident light in both directions. The projector to screen and camera to object distance are identical thus eliminating the difficulty of obtaining an exact 1:1 scale. This is especially troublesome when using a separate projector and camera.

If an enlarger is not available, a slide projector of good optical quality can be substituted. In this case, the transparency is glass mounted and projected onto an appropriate surface taking care that the optical axis of projector is perpendicular to the projecting surface. After the artwork is completed, the Kodalith film is mounted in the same glass mount and placed in the projector. The projector is then used in reverse as a camera. One problem may arise due to possible deficiencies of the projection lens. Usually a standard projection lens is inferior in quality to a good enlarger lens. Changing the F/ratio of the enlarger from fully open to F/11 seldom changes the image quality to any important extent. This may not be true for a standard projection lens. To eliminate this problem, one should reduce the effective aperture of the lens by introducing a stop of appropriate diameter to give the lens a value of between F/8 and F/11. If a 300 to 500 watt projector is used, there should still be sufficient light available to project a good image. The same stop should be used for photographing the mask.

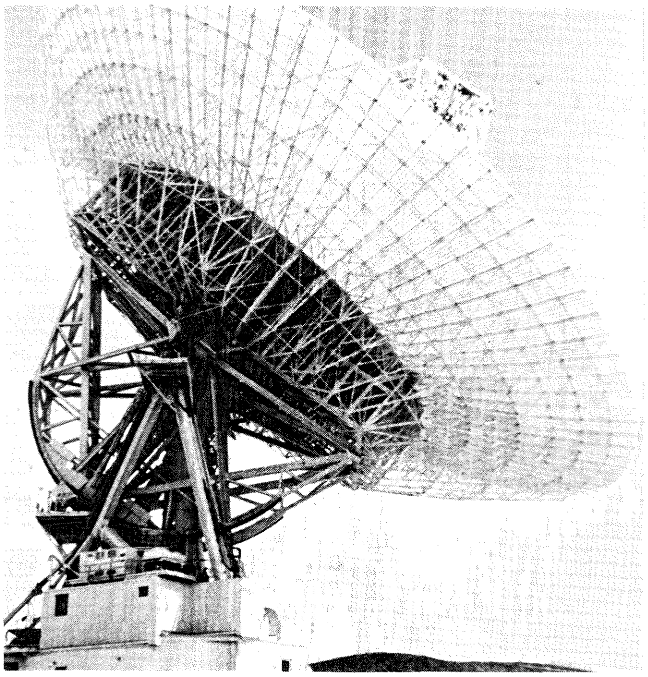
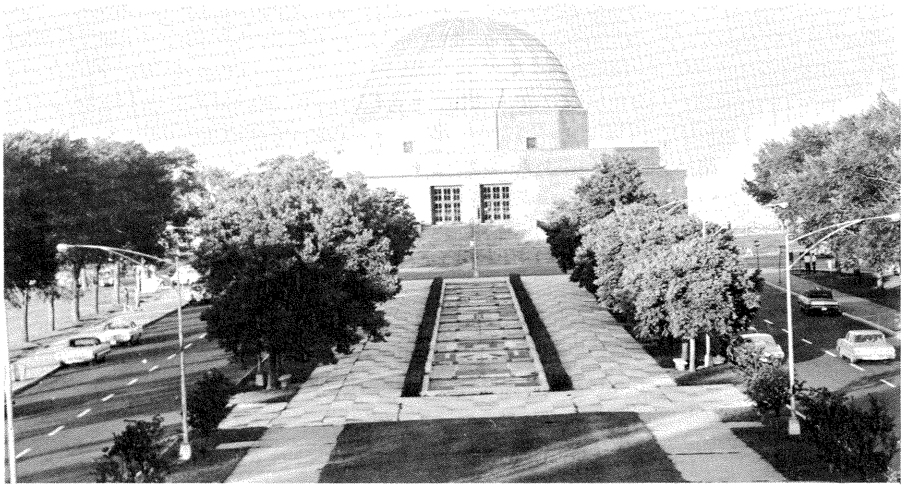


Figure 3A. This is the original scene of the radio telescope to be masked.

Figure 3B. This is the scene after the mask has been applied. Note that the dipole and some structure has been purposefully eliminated.

Planetariums On Parade



THE ADLER PLANETARIUM

Chicago, Illinois

The Adler Planetarium before the construction of the Astro-Science Center. The entrance to the new underground building is near the far side of the terrazzo garden, which has now been removed.

When Max Adler retired in 1928 from his position as a senior officer of Sears, Roebuck and Co., he decided to do something for the city in which he had lived most of his life and where he had made his fortune. He had heard of a spectacular new device in Germany that could create a near-perfect reproduction of the night sky on the ceiling of a domed room. With his wife and architect Ernest A. Grunsfeld, Jr., Mr. Adler visited several planetarium installations that were already functioning in Germany. The scouting Chicagoans concluded that the magnificent panorama displayed by the Zeiss planetarium projector was not only thrilling, but instructive. Further, Max Adler believed that if people understood more about the vast universe of which they were but a tiny part, the humility thus engendered would influence them eventually to forego force and to feel their interdependency with each other. He forthwith decided that Chicago was to have the first planetarium installation in North or South America.

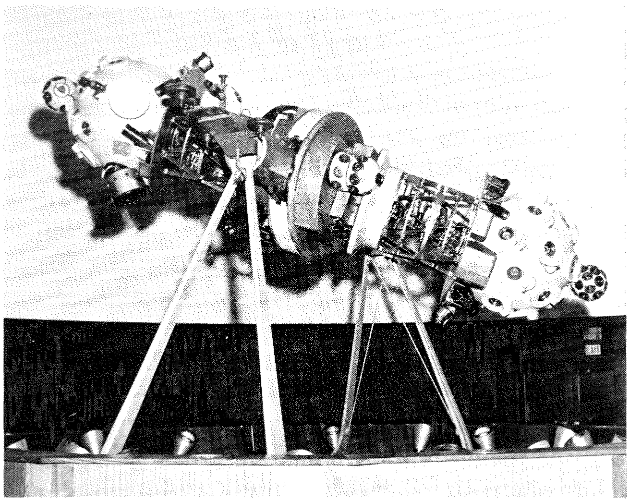
The distinctive Grunsfeld-designed Adler Planetarium on the Chicago lakefront opened its doors on May 12, 1930. It was an unencumbered gift to the people of Chicago to be operated by the South Park Commissioners (later the Chicago Park District). From the outset it was tremendously successful; several million people attended Sky Shows during the first few years, including over a million and a half visitors during the Century of Progress Exposition of 1933-34.

More than forty years have passed since the first Sky Show was presented; more than 22,000,000 visitors have attended the dramatic programs or have viewed the collections of astronomical instruments representing over 500 years of science and technology. But these same forty years have also seen unprecedented change in the science of astronomy. The Ianelli planet mural in the main entrance foyer depicts only eight of the nine planets: Pluto was discovered shortly after the opening of the new institution and inadvertently symbolized the quickening pace with which astronomy advances. Subsequently, nearly every aspect of astronomy has been restudied. The distance scale of the universe, the nature of stars, the dynamics of galaxies, and the physical characteristics of the solar system are only a few examples.

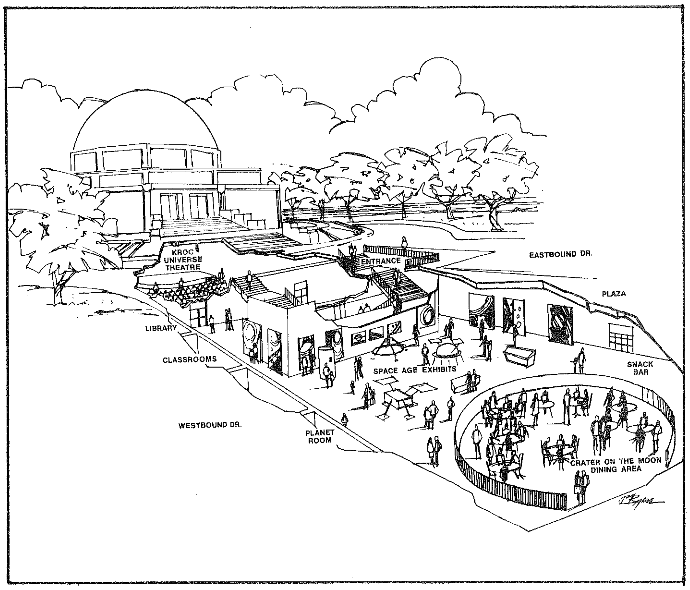
In 1967, Mayor Richard J. Daley appointed a committee chaired by Hale Nelson to review the status of the Planetarium and to make recommendations for the future. Its report in early 1968 recommended the creation of a Board of Trustees to more fully represent the community and to share responsibility for the management of the institution with the Commissioners of the Chicago Park District; the strengthening of the professional staff and consequent amplification of educational, research, and popular programs; the installation of a new planetarium projector in the Sky Theatre; and the construction of a new building that would adequately fulfill the needs of generations to come.

In the spring of 1973, just five years later, the Astro-Science Center was dedicated. This new facility has been built entirely underground, in order not to impair the aesthetic characteristics of the area. It more than doubles the floor space of the original building. It includes the unique Kroc Universe Theatre, a vast space-age exhibition arcade, a children's cafeteria, a Crater on the Moon dining area, classrooms, a reading and reference center, and office and support space.

Joseph M. Chamberlain
Director, The Adler Planetarium



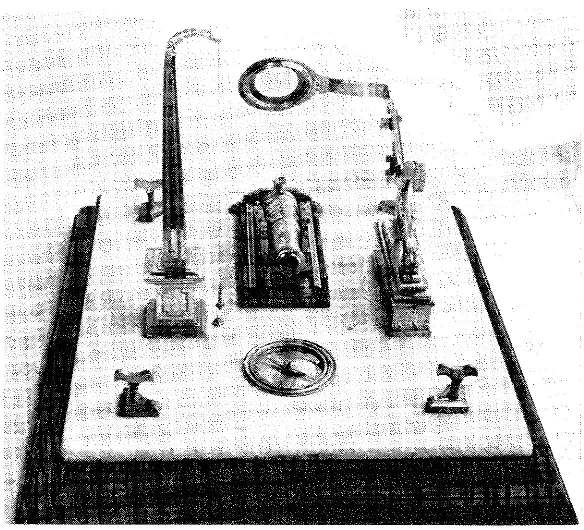
The Zeiss Mark VI planetarium projector.



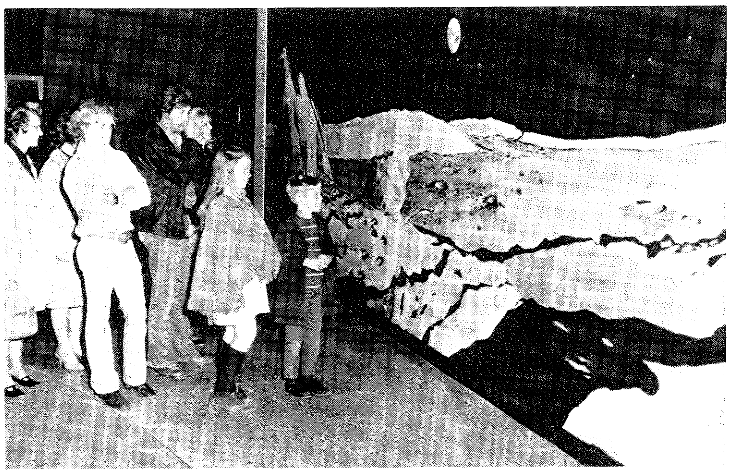
A schematic view of the new underground wing.

"The popular conception of the universe is too meager; the planets and the stars are too far removed from general knowledge. In our reflections, we dwell too little upon the concept that the world and all human endeavor within it are governed by established order and too infrequently upon the truth that under the heavens everything is interrelated, even as each of us to the other."

MAX ADLER
May 12, 1930



This cannon sundial (French, circa 1700) is from the Mensing Collection. The burning glass, when set to the correct date, fires the cannon at noon.



Visitors viewing the lunar mural at the Adler Planetarium. The Crater On The Moon dining area is just to the left.

SERVICES OF NASA TO ASTRONOMY EDUCATION

by Myrl H. Ahrendt, *Educational Programs Division, Office of Public Affairs, National Aeronautics and Space Administration*

The Space Act that established the National Aeronautics and Space Administration (NASA) stated that the first responsibility of NASA was the "expansion of human knowledge of phenomena in the atmosphere and space." To give NASA a mandate to expand our knowledge of phenomena in space is very close to saying that one of NASA's primary purposes is to expand our knowledge of all aspects of astronomy. NASA does, indeed, through in-house activity and research contracts, conduct a very broad and intensive program of research in astronomy. Unlike the *Apollo* flights, this program receives little publicity in the news media, except when NASA undertakes unusual activities such as the recent flights of *Galileo*, the Convair 990 stationed at Ames Research Center, which carried scientists and 10,000 pounds of instruments on a trip outside 99 percent of the earth's atmospheric water vapor, to make studies of Mars.

Although NASA's primary function is research and development, not education, it is logical to assume that, with its broad mandate to explore space, NASA should engage in some activities related to astronomy education. A survey of NASA programs and publications does reveal a considerable amount of such activity.

The most basic function of the NASA program is to acquire knowledge. Finding ways to present this knowledge in school programs is the responsibility of the teacher, the curriculum specialist, and the textbook writer. Thus NASA's activity in astronomy education has basically been to provide individual pieces of information that the interested teacher can use. Specifically, it is not consistent with the objectives of NASA's Educational Programs Division to support the preparation of sequential courses in astronomy. Despite this restriction, NASA's contributions to astronomy education are significant.

The primary emphasis in this paper is on astronomy education at the non-collegiate level, but NASA does also have publications and programs of value to astronomy students on the undergraduate and graduate levels.

One restricting difficulty in organizing material on the non-collegiate level is the content of the school curriculum itself. Students get little pieces of information about astronomy in courses on general science, earth and space science, physical science, and the like. They are taught a little about Earth-Moon-Sun relationships, the probable history and composition of the earth, the solar system, and gravity, and are given some simple information on orbits and a few ideas about stars, galaxies, and the nature of the Universe. Sequential courses in astronomy on the high-school level seem to be rare.

In many cases, the student's only introduction to observational astronomy and the groupings and motions of stars and planets is obtained through visits to a planetarium. The planetarium directors and lecturers constitute a visible, active group. It is undoubtedly because of the enthusiasm of the leaders of this group that a number of NASA educational efforts have been directed specifically toward planetarium education. The first publication for planetarium directors was *The Planetarium,* An Elementary School Teaching Resource. This publication shows how the Bridgeport Planetarium in Bridgeport, Connecticut, was used not only to teach elementary astronomical concepts, but also to help the teacher to use the planetarium visit to develop information and concepts on physical science, mathematics, earth science, the solar system, and the Moon. The book suggested various ways in which planetarium directors and teachers might work together.

An outgrowth of the preparation of this publication was NASA's Educational Programs Division's survey of permanent planetarium installations in the United States. This, the first comprehensive survey ever taken, became the nucleus from which the ISPE list of planetariums, Special Report #1, developed. The survey, made via questionnaire, collected information on facilities, programs, attendance, institutional affiliations, and the like. Co-operation was excellent; we received reports from 97 to 98 percent of the permanent installations. However, a policy decision, made after the report had been prepared for press, ruled out publication at NASA expense but urged publication by an interested nonprofit agency. Many agencies were contacted, but no publication money was made available. Although the report was never published, and is too far out of date to be published now, it has served a useful purpose with a number of groups.

A third result of the contacts with the planetarium field

Mr. Ahrendt's paper first appeared in *Annals of the New York Academy of Sciences,* Vol. 198, 1972 and appears courtesy of that body. This paper was presented during the historic Minnaert Memorial Conference on Education in and History of Modern Astronomy, New York City, 1971.

has been NASA's establishment of a mailing list of planetariums. Those who have requested placement on the list receive copies of, or announcements about, new NASA educational publications as they appear.

Most of the informational-educational publications of the NASA Educational Programs Division are oriented toward technology, hardware, missions, history, future directions, scientific findings, benefits or spin-offs, international co-operation, information about NASA field installations, and the like. Many of these publications, however, have also contained the same type of elementary astronomical material as is found in school programs: information about the solar system, the interplanetary medium, gravity, orbits, studies of the Sun by the Orbiting Solar Observatory, exploration of the Moon, findings of the *Mariner* flybys past Mars and Venus, and so forth. These publications have been useful in school programs in which some astronomy is taught.

A few years ago the NASA Educational Programs Division began the preparation, through university contractors, of a series of curriculum-enrichment booklets, under the general title *Space Resources for Teachers.* They provide information on various aspects of space, which the teacher may use to supplement his regular courses. Books have been produced on the industrial arts, biology, chemistry, and space science. This last volume is highly cosmological in nature. Perhaps the content of *Space Science* can best be described by listing the titles of the six chapters: "Measurement, Distance, and Size in Astronomy"; "Atoms, Spectra, and Stars"; "Atomic Nuclei and Stars"; "The Solar System"; "The Origin and Evolution of Life"; and "Motion, Rockets, and Gravity." This book, which emphasizes an understanding of the cosmos, has been used at grade levels ranging from junior high school through junior college.

A curriculum supplement in mathematics went to press in 1971. Astronomy-related mathematics problems included were astronomical measurements, motions of the planets, gravity, and orbit theory.

NASA's *Aerospace Bibliography* can also be a valuable source of materials. Under the heading of Astronomy, it lists references to publications under the following headings: General information; Astronomical Tools; The Planets, Sun, and Solar System; The Moon; and The Stars, Comets, and Meteors.

Two series of educational publications of a slightly more advanced nature, one series recently completed and one now in production, will contain information that could definitely be useful in astronomy education. The completed series, *America in Space, The First Decade,* contains volumes entitled *Space Physics and Astronomy* and *Exploring the Moon and Planets.* The second series, *Space in the Seventies,* contains volumes entitled *Earth Orbital Science, Planetary Exploration,* and *Satellites at Work.* These booklets describe the new, more sophisticated satellites for space astronomy, such as the Small Astronomy Satellite, Orbiting Astronomical Observatory, Radio Astronomy Explorer, High-Energy Astronomical Observatory, and Orbiting Solar Observatory. These satellites will be searching the celestial sphere for ultraviolet, radio, x-ray, gamma-ray, and cosmic-ray sources of energy. Some scientists think that satellites such as these may lead to new knowledge about the physical laws that control the cosmos. It would seem that any serious search for new knowledge in astronomy would require acquaintance with these programs. All the publications listed above are sold by the United State Government Printing Office. The brochure *NASA Educational Publications,* which lists these and other titles, can be obtained from the NASA Center that serves the area or from the Educational Programs Division, Code FE, NASA headquarters.

NASA films have been widely used at several educational levels. Many planetarium lecturers have expressed their appreciation of them. These films, like the publications mentioned above, deal with a broad range of topics, but some of them are strongly oriented toward astronomy. There are a number of films on the *Mariner* flybys of Venus and Mars, which describe both the missions and their findings. Other films are concerned with the Orbiting Solar Observatory, planetary exploration and satellite research in the seventies, the Orbiting Astronomical Observatory, the work of the modern astrophysicist, the universe, and historical theories of the nature of the solar system. These films, and a few filmstrips, are listed in the brochure *NASA Film List.* A list of technical films, *Selected Professional and Technical Films,* is also available. These technical films deal primarily with restricted technical and professional areas; only a few are closely related to astronomy. Copies of either of these lists can be obtained by writing to the Planning and Media Development Division, Code FAM, NASA Headquarters. Films or filmstrips are available for purchase, or may be borrowed for the cost of return postage and insurance. Instructions for obtaining the films are given in the lists mentioned above.

NASA maintains a large bank of pictures and transparencies. A sample of these is listed in a catalogue entitled *Space Photography.* Most of the many photographs listed are available either in black and white 8 x 10 glossy prints or 4 x 5 inch color transparencies. Information media may borrow photographs without charge. Non-information media may purchase them from a photographic contractor for a laboratory service charge. To obtain the catalogue and instructions for ordering, or to request information about other photographs not indexed, write to Audio-Visual Branch, Public Information Division, Code FP, NASA Headquarters.

At the most advanced academic level, in the upper years of high school or in college, the NASA Special Publications series is another source of information on many topics in astronomy. These publications could be of use both to the astronomy educator and the practicing astronomer. The Special Publications are compilations of some of the thousands of highly technical reports filed in NASA's data bank of technical information. This information is pulled together by experienced writers to produce comprehensive and sequential reports on many scientific and technical subjects. The following topics in astronomy are among those included in the wide list of titles: several summaries of information gathered through flybys of Mars and Venus, and reports on the surface features and atmospheres of Mars and Venus, the atmosphere of Jupiter, plans for long-range programs in space astronomy, the structure and orbits of comets, optical telescope technology, extraterrestrial life and its detection, techniques of high-energy astrophysics, achievements in space astronomy, and the like. The Special Publications are sold by the United States Government Printing Office and the Technical Information Service.

Some researchers or teachers may wish to consult the actual technical reports from which the information for the Special Publications is obtains. These are indexed in two series of reports, *STAR* (Scientific and Technical Aerospace Abstracts) and *IAA* (International Aerospace Abstracts). The *NASA Thesaurus* gives the proper identifications for the main topics and subcategories. One can subscribe to *STAR* and *IAA* and purchase the Thesaurus. NASA's new computerized information storage system, however, makes it possible to obtain the same listings of reports by remote console (NASA/Recon). Remote consoles have been installed in all NASA field centers. If a remote console is not available, one may ask that a literature search be made with NASA/Recon by the NASA Scientific and Technical Information Facility at College Park, Maryland. Major universities and NASA contractors may have searches made without charge. The range of topics covered by the reports is far too great to be listed here. Some reports that are identified through *STAR* and *IAA* or through searches by NASA/Recon may be available in the requester's library. If not, they can be purchased either from the United States Government Printing Office, or the National Technical Information Service. Those who desire catalogs of our Special Publications, or further information about how to obtain the technical reports, should write to the Scientific and Technical Information Office, Code KS, NASA Headquarters.

There would be a serious gap if I did not report the support of education and research in astronomy funded by the Supporting Research and Technology program of NASA's Office of Space Sciences and Applications. A policy directive on university programs states in part: "University activities supported by NASA shall be relevant to NASA's mission and compatible with the interests, activities, and capabilities of the university. These activities... shall provide, to the maximum extent practicable, for participation by younger faculty members and graduate students as well as senior investigators in ways that strengthen and enhance the universities' traditional teaching and research mission." This statement means that a university research program in astronomy automatically includes a considerable amount of astronomy education.

During the fiscal year ending June 30, 1970 this program gave slightly more than $20 million to astronomy programs, through 146 grants and contracts to 55 universities in 26 states. Involved in these programs were some 750 graduate students and 550 full- and part-time faculty members. It is anticipated that the program will be continued at a nearly comparable level during the years immediately ahead. Any-

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one desiring further information about this program may write to the Physics and Astronomy Programs Division, Code SG, NASA Headquarters.

Although the writer has attempted to make this paper comprehensive and complete, it is very unlikely that he has succeeded. The NASA program is so broad in scope and so multifaceted in nature that a really complete report is probably not possible. This report has centered on activities administered at NASA headquarters. A survey of activities at various NASA Centers would probably yield information on many other NASA contributions to astronomy education. The astronomy educator should not be discouraged by the fact that there is no single office to which he can write to obtain information about all aids from NASA. It may be appropriate to suggest that requests be sent to any of the sources listed should be as specific and precise as possible, and that they should be followed up with as much persistence as necessary. The determined seeker for help may find much that is useful in the rich storehouses of information that exist in NASA.

In listing sources of further information, the writer has merely given the name of the office involved and its Headquarters code. It is suggested that a more complete form of address to any of these sources might be as follows: name of office, code designation, National Aeronautics and Space Administration, Washington, D.C. 20546. *(End)*

ANNOUNCING:

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1960 – May, 1972

by Prof. George Reed, *West Chester State College, Pa.*

If you are *not* a member of ISPE, you may obtain these comprehensive reports by ordering from Frank C. Jettner, *ISPE Executive Editor;* SUNYA, ES 314; Albany, N.Y. 12222. Members receive one copy free.

Having attended the SEPA conference in Miami in June, I can only echo Frank Jettner's comment that Jack Horkheimer created a FANTASTIC experience for each of us. Being with other planetarians exclusively for several days also allowed me to make some surprising observations about the *biological* nature of the planetarian, an aspect of his personality heretofore unreported in any journal. I have not completed my investigation, but preliminary data indicates that planetarians:

a) are dark-adapted for 24 hours of each day.

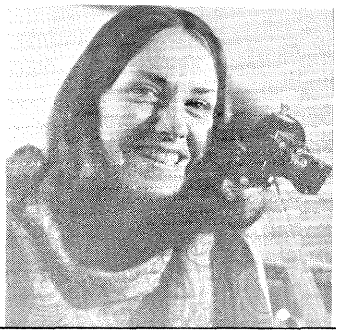
b) have biological clocks which are set so that their active period begins at evening twilight and ends with morning twilight. As a point of fact, their closest living relative, the Night-Blooming Cereus, audibly pops open each day as dusk approaches, and

c) can definitely be described as a social species.

Jane's Corner

BY

Jane P. Geoghegan



Send your "happenings" to Jane Geoghegan, 4100 W. Grace St., Richmond, Va. 23230

Confirming data is badly needed; perhaps similar future gatherings will produce significant findings to be reported at a later date.

Overhead:

James Hooks of Lumberton, N.C. as he addressed a group of fellow planetarians: "Unaccustomed as I am to speaking to adults in the light. . ."

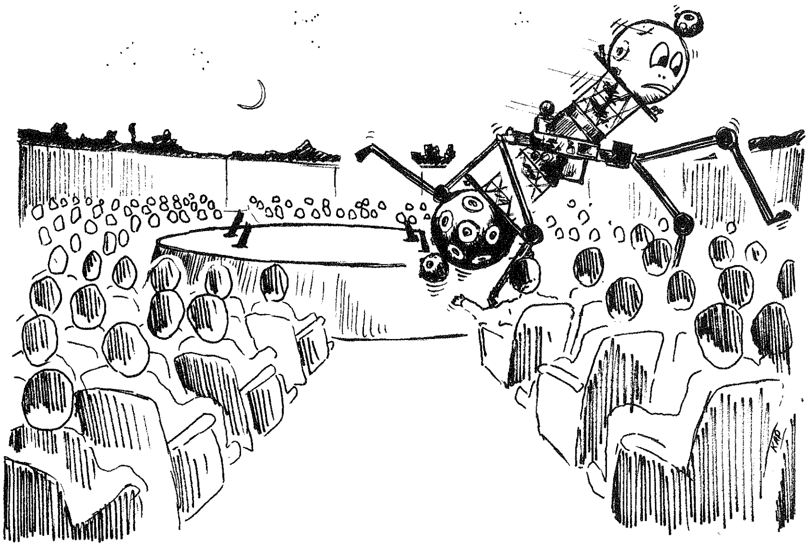
Planetarian Jules Cohn of Falls Church, Va. High School asked:

"Does anyone remember the names of the stars which circle the North Star, Polaris?" An enlightened 5th grader replied: "O, I remember them. They're called the circumcised stars!"

LET'S SHARE OUR GOODIES. . .

EDITOR: Jane also wrote in, "How about a request in the next issue for us to receive original black-and-white artwork from everyone, to be reproduced for the purpose of anyone of our readers being able to copy it? You know, cartoons or titles that would appeal and be useful to all of us in our shows. I will be glad to act as a clearinghouse and select the most appropriate ones. That's sort of what I have in mind when I pick out the *Conchy* cartoons from James Childress for example. Most planetariums, even the smaller ones, make their own slides, and we could really help each other out."

Enough said? Let's get on the ball! Let this friendly soul hear from you.



The Ultimate Planetarium Motion

Kenneth A. Patterson, *Morrison Planetarium, San Francisco*

Co-Editors: Frank C. Jettner and Von Del Chamberlain. This series was originally conceived as a first-year, graduate level textbook in planetarium education, written by the leading specialists in the field. Installments will appear in each issue of THE PLANETARIAN until completion. It is suggested each installment be removed from the centerfold, punched, and stored in a looseleaf binder for future reference. ISPE and the Co-Editors regret they cannot furnish special binders for this purpose. Questions regarding the text matter may be directed to either Co-Editor or the chapter author.

Editor's Note: Because 1973 marks the 50th anniversary of the projection planetarium, Charles F. Hagar, Director of the Planetarium Institute, San Francisco State University has given us permission to print a chapter from his forthcoming book: "Planetarium: Window to the Universe." Professor Hagar writes: "I appreciate this opportunity of sharing this article about the historical development of the planetarium with the readers of *THE PLANETARIAN*, and hope that it will give them as much pleasure in reading it as I had in writing it. I also wish to express my thanks to Dr. Henry C. King for reading the manuscript and offering critical comments. The planetarium community looks forward to the publication of Dr. King's definitive work on the history of the planetarium which will be far more encompassing than this brief chapter."

THE HISTORY OF THE PLANETARIUM

by Charles F. Hagar, *Planetarium Institute, San Francisco State University*

This year marks the 500th anniversary of the birth of Nicholaus Copernicus and the 50th anniversary of the inauguration of the projection planetarium. These two events are linked by centuries of man's attempts to make models of the planetary system and representations of the starry night. More specifically, the projection planetarium, invented by Walther Bauersfeld of Carl Zeiss, Germany, and unveiled for the first time in August 1923, incorporated into its design a planet mechanism based upon the heliocentric system. Professor Bauersfeld went beyond the pure Copernican system, however, for he offset the circular planet drive disks to account for the eccentricity of the planetary orbits. He also invented a mechanism which closely approximated the elliptical motions of the two naked eye planets which had the most eccentric orbits: Mercury and Mars.

In this chapter we honor the invention of the projection planetarium by Walther Bauersfeld and trace the development and history of the planetarium concept from early celestial globes through hollow star spheres, various planetarium mechanisms and "orreries," and finally culminating in Bauersfeld's "Wonder of Jena" unveiled in 1923 on the rooftop of the Carl Zeiss factory.

from the book: PLANETARIUM: Window to the Universe,
Copyright 1973, Carl Zeiss, Inc., Oberkochen

We shall also trace the continued development of the projection planetarium by the Carl Zeiss Company to the present. Because of limited space, detailed technical aspects of recent planetarium designs, including those of other than Zeiss manufacture, will *not* be explored. These aspects, including recent design philosophies and planetarium use form the subject of a subsequent chapter.

The history of astronomy is filled with the stories of men who have broken through the boundaries of mind and space to explore territory beyond the confines of earth. The names of Copernicus, Galilei, Kepler, Newton, Herschel, and others are emblazoned on the marquee of the astronomical stage, not to mention the astronomers of more recent times.

Paralleling the theories of the universe dreamt by these men has been a retinue of models which have served as visual and educational aids. Such models are of two main categories:

1. Celestial globes which depict stars and constellations as seen from different latitudes.
2. Mechanical models to represent the motions of the sun, moon and planets.

From time to time, attempts have been made to combine these two categories into one. As we outline the development of these teaching and descriptive models through the centuries, we shall see that they become fully integrated finally in the invention of the *projection planetarium* by Walther Bauersfeld at Zeiss in 1919.

MODELS OF THE NIGHT SKY

Farnese Atlas (National Museum of Naples)
(Fig. 1)

Probably the best preserved celestial globe of antiquity is incorporated into a statue called the Farnese Atlas *(Atlante Farnesiano)* now at the National Museum of Naples. The statue is of marble and shows a kneeling figure of Atlas holding a celestial globe. The statue is 6.1 ft. (1.86 m) in height and the supported globe is 25.6 in. (65 mm) in diameter.*(1)*

The statue of Atlas is dated 73 B.C. at the time of Julius Caesar and was kept for a long time in the Pallazzo Farnese, Rome, hence the name of the statue. The globe itself may date from about 300 B.C. considering the relation of the position of the constellation figures to the globe's vernal equinox. The globe shows 42 constellations in *bas* relief. Five of the northern constellations are missing, however, including Ursa Major and Ursa Minor, although probably originally present.

Figure 1

This globe may be one of the original – and famous – **Aratus globes.** Eudoxus of Cnidos, a contemporary of Plato and Aristotle, is believed to have brought out of Egypt about 370 B.C. some celestial globes which showed the constellation figures. Whether Eudoxus actually made the globes himself or simply designed them, is not known. In any event, a Greek poet named Aratus (*ca.* 270 B.C.) wrote a poem called "Phenomena" which was based upon Eudoxus' description of the constellations. This poem was translated into Latin by Cicero and was widely distributed and became very popular. There were a number of celestial globes manufactured to illustrate and to clarify this poem. They became known as *Aratus Globes.* These globes had depicted upon them figures of the major constellations as well as the celestial poles, equator, ecliptic, solsticial circles, circumpolar circles, and colures.*(2)*

Ptolemy's Celestial Globe *(ca.* **A.D. 150)**
(Fig. 2)

Although none of Ptolemy's celestial globes are extant, as far as known, we do know that he must have constructed at least one, perhaps more. He gives detailed directions in the *Almagest* on their proper construction. A paraphrase of Ptolemy's instructions follows:

"The sphere should be dark in color so that it might resemble the night and not the day. . .it should have movable rings of hard and well polished material. . .The starting point (in marking the stars) should be the dog star Sirius. . .The position of the other fixed stars, as they follow in the list, can be determined by making the globe turn upon the poles of the zodiac (ecliptic), thus bringing the graduated circle to the proper point of each (star). . ."*(3)*

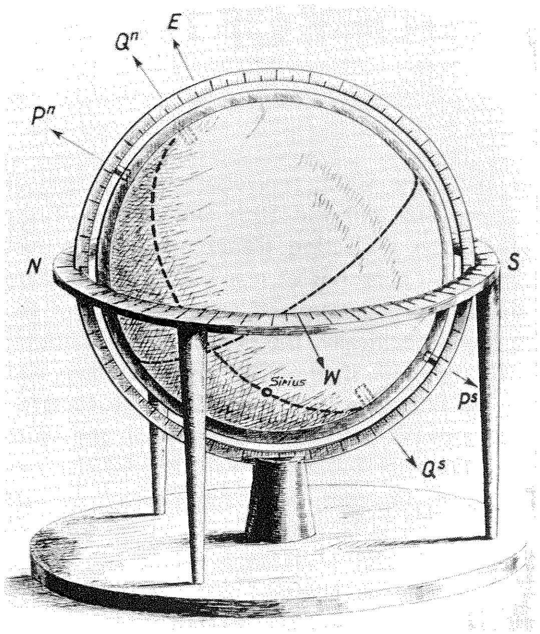


Figure 2

Stevenson states that Ibn Alnabdi, "a clever mechanic," mentions two globes in the public library of Kahira in 1043: "one of the globes. . .was made of brass by Ptolemy himself."*(4)*

Persian Celestial Globe (A.D. 1362/63) (Museum of the History of Science, Oxford)
(Fig. 3)

The astronomy of the Greeks was of much interest to the Arabs, particularly the *Almagest* of Ptolemy, which they studied carefully. Indeed their imprint upon this work

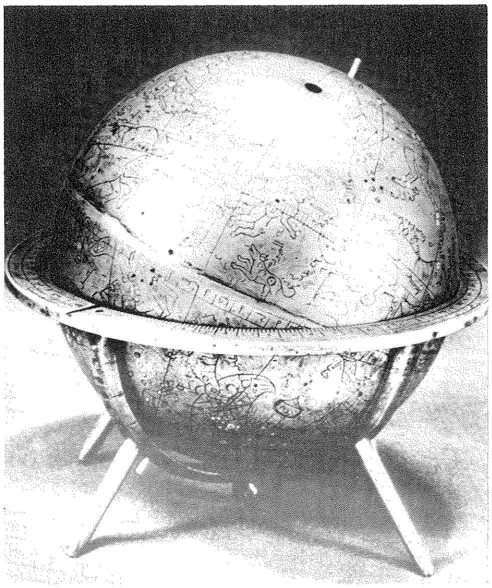


Figure 3

is evidenced by the Arabic name commonly used for it, *Almagest*, meaning *the majestic.* The majority of the brighter stars were also named by the Arabs, and their names betray the Arabic influence (e.g., Altair, Algol, Aldebaran, etc.), the prefix *al* meaning *the.*

The production of celestial globes was part of Arabian and Persian astronomy. According to Stevenson, the earliest Arabic globe dates from A.D. 1080. Less than a dozen globes constructed prior to 1600 are known to exist. One of these, a Persian globe, is at the Museum of the History of Science, Oxford (Fig. 3). The globe is made of brass and is 6.4 in (16.2 cm) in diameter. The first magnitude stars are represented by inlaid silver disks. The stars of lesser apparent brightness are represented by small dots and circles of different sizes. Constellation figures are also depicted. The celestial equator and ecliptic are divided with sufficient care that one can fix the epoch of the globe by the relation of the stars to the vernal equinox. The globe was made by Ja'far b. 'Umar b. Dawlatshah al-Kirmam.(5)

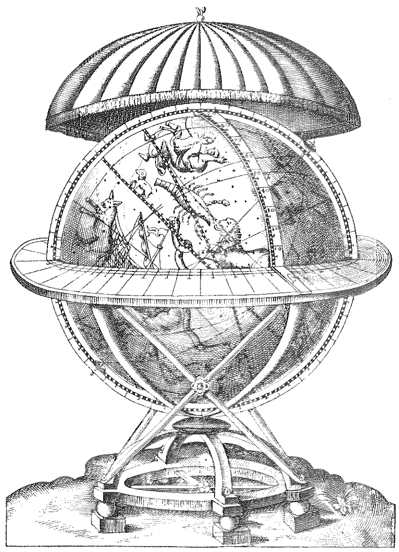
Celestial Globe of Tycho Brahe *(ca.* 1584)
(Fig. 4)

This splendid celestial globe was destroyed by a fire in a castle in Copenhagen in 1728. It was approximately six feet in diameter and had an interior structure of wood. The surface was sheathed in brass by Tycho himself after he was satisfied of its sphericity. According to Tycho's writings, he had the wood innerstructure – "...with many intersecting circles and special supports..." – made in Augsburg in 1570. After transporting it to Denmark – "...not without much difficulty" – he covered it with brass and carefully engraved the circles, dividing them into degrees *and minutes* of arc! All the naked-eye stars were carefully added for correct magnitude and position to the epoch 1600. "...there passed nearly twenty-five years from the first work on this globe until it was finished."(6)

The horizon circle had painted on it in gold the following inscription:

"In the year of Christ...(1584), Frederick II reigning in Denmark, this globe like unto a celestial machine, in which are fixed the stars of the eighth sphere as set down on his globe each exactly in its place, also the wandering stars as they appear among these, Tycho Brahe, to all on earth who desire to understand this matter, shows the heavens by this mechanical device which he perfected for his sons, for himself and for posterity."(7)

Figure 4



The Gottorp Globe (1654-1664, rebuilt 1748-52)
(Lomonosov Museum, Leningrad)
(Fig. 5A – 5B)

A disadvantage of the early celestial globes was that they showed the sky in reverse – *i.e.,* the observer was supposed to imagine himself *outside* the celestial sphere and looking in. One of the earliest attempts to depict the sky view correctly and to show the stars as bright points against the dark sky was the Gottorp Globe. This hollow globe, about 10 ft. (3.1 m) in diameter, was designed by Adam Olearius (Oelschlager) court mathematician and librarian to Duke Frederick of Holstein-Gottorp. It was constructed to Olearius' specifications by Andreas Busch of Limberg during the period 1654 to 1664 at the Duke's castle.

The globe, made of copper, resembled from the outside a large globe of the earth with the various continents and oceans painted on the exterior (it is not known if this was the original exterior design). It was mounted at an angle of 54°.5 to the horizontal. A door in the Indian Ocean per-

Figure 5a

mitted as many as ten people to crawl inside and to sit on a circular bench with a backrest along the horizon line. The interior was painted with stars and constellation figures for the epoch A.D. 1700 and was originally illuminated by two oil lamps. As the operator turned a small handle, the entire globe would slowly rotate, causing the gilded stars and constellation figures to pursue their diurnal courses.

Czar Peter the Great received the Gottorp Globe as a gift in 1715 and then turned it over to the Academy of Sciences in St. Petersburg *(Leningrad).* The globe was badly damaged by fire in 1747 with only the skeleton remaining. It was completely rebuilt and modernized in 1748-52 in the workshop of the Petersburg Academy of Sciences and is now on display at the Lomonosov Museum, Leningrad.(8)

Subsequent to the Gottorp Globe there have been several hollow globes that would accommodate spectators. One was constructed by Erhard Weigel, professor of mathematics at the University of Jena from 1654 to 1699. The Weigel globe was about 11 ft. in diameter and fabricated of iron sheeting. A small model of the earth was placed at the center of the sphere above the observing platform. Weigel must have been somewhat of a showman for Coronelli states that there were working models of Aetna and Vesuvius on the earth globe. "They give out steam, flames, and pleasant odours, which please the spectators."(9)

King describes a larger globe designed by Roger Long,

Figure 5b

professor of astronomy at Cambridge. Set up at Pembroke College in 1758, Long called it the **"Uranium,"** and with it hoped to popularize astronomy. Similar to the Gottorp Globe, it was 18 ft. in diameter and could accommodate up to 30 persons. The stars were represented by small holes of various diameters punched in the sphere to depict the different magnitudes. The entire sphere could be rotated about the polar axis to exhibit diurnal motion.

Despite Long's enthusiasm and best of intentions, his **"Uranium"** never received the popular attendance he had envisioned. He even paid an attendant to keep it in running condition, but it finally fell into disrepair and was sold for scrap in 1874.*(10)*

The Atwood Celestial Globe (1912-13, remodeled 1959) (Museum of the Chicago Academy of Sciences (Fig. 6)

The largest hollow star globe still in operation today is the Atwood Globe designed by Wallace W. Atwood, former President of Clark University and director of the Science Museum. The globe was constructed and presented to the Chicago Academy of Sciences by La Verne W. Noyes, president of the Board of Trustees ". . .in order to broaden and to promote the educational and scientific work of the Academy."*(11)*

The globe, 15 ft. (4.57 m) in diameter, is made of 1/64-in (0.4 mm) galvanized sheet iron. Because of light construction techniques the globe weighs only 500 lbs. (227 kg). The sphere is mounted at a 42° angle, the latitude of Chicago. It is supported mainly by a 2.5 in. (6.35 cm) diameter tubular ring around the equator of the globe, which rests on electrically driven rollers.

The sphere is perforated with 692 holes of various diameters depicting stars down to the fourth magnitude, including selected stars of the fifth. The stars are illuminated by light falling on the exterior of the sphere. The sun is represented by an electric lamp which is moved along the ecliptic. The ever-changing phases of the moon are represented by a series of disks cut to the different phases and coated with luminous paint. Four planets: Venus, Mars,

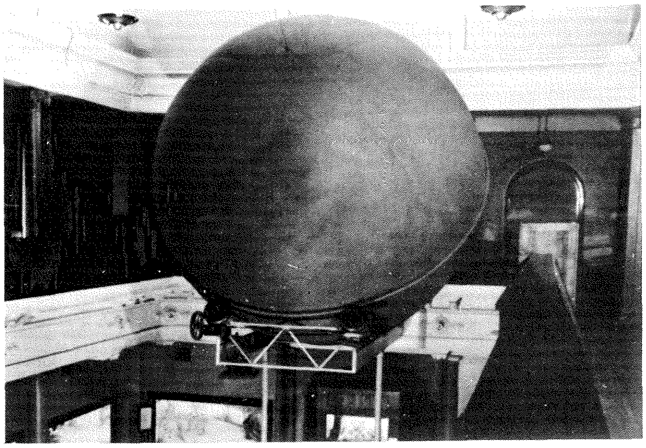


Figure 6

Jupiter, and Saturn, are represented by small openings which may be uncovered around the globe in the zodiacal belt. The southern circumpolar area has been cut away, and an observing platform has been inserted at that place from which one may watch the sky.

In 1959 W. J. Beecher, Director of the Academy, undertook a complete renovation of the Atwood Globe and its museum setting. The exterior was painted to represent a geo-physical globe. The star perforations were re-drilled for correct magnitude and fitted with color filters for the brighter stars. Ultra violet lamps now illuminate the sun, moon, and planets inside. As a final touch of realism, the Chicago skyline has been added to the globe's interior horizon together with dimmer-controlled illumination to simulate descending night. There is seating for 17 spectators, and the globe has been demonstrated up to 13 times a day. With these improvements and additions, the name of the Atwood Celestial Sphere has been changed to the Globe **Planetarium.***(12)*

(EDITOR: All references for Prof. Hagar's chapter will be included in its third and last installment, scheduled for the March 1974 issue.)

"MUSIC" – A Call For Papers

Our readers will recall that Chapter 2 in this series is entitled "The Use of Music in the Planetarium." In the last issue we called for short papers in this subject area. In roughly 1000 words or less, please tell about your philosophy of musical selection, helpful hints, pieces used for specific purposes, etc. Papers submitted by February 1, 1974 will be grouped and published in the Spring issue of *THE PLANETARIAN.*

THE CONSTRUCTION OF A PLANETARIUM RADIO SKY

by Warren Young, *Youngstown State University*

Since the end of the second World War x-ray, ultraviolet, infrared, and radio studies have become major fields of astronomy, but most planetariums can only show the universe as it appears in visible light. Ideally planetarium projectors should also project x-ray, ultraviolet, infrared and radio skies. At the Youngstown State University Planetarium we have just completed constructing a radio sky and an x-ray sky projector.

The planetarium radio sky shows the sky as it would appear if our eyes were sensitive to radio waves instead of light. The appearance of the radio sky will be quite different at different frequencies. Since it is easiest to build a projector which projects the sky at a single radio frequency, we built a 250 megahertz radio sky. Later we hope to add other frequencies to the projector.

250 megahertz was chosen because John Kraus gives data in his book *Radio Astronomy* which can be conveniently used to build a projector for this frequency. The radio contour map on page 296 of Kraus' book was converted into shades of black and white painted on a transparent plastic globe. The radio sky panorama on page 297 was used to check the shading on the plastic globe. Light from a lamp at the center of the globe shines on the dome to produce the planetarium radio sky.

A flutter ball purchased from the Marlin Toy Company, Horicon, Wisconsin, for two dollars, was used as the plastic sphere. A higher quality sphere can be obtained from Farquhar Transparent Globes, Philadelphia, Pennsylvania. The sphere was cut into two hemispheres and the radio brightness contours and the locations of the discrete radio sources were plotted on each hemisphere. This was done by developing a spherical coordinate system for the plastic hemispheres. A thin strip of paper whose length was the same as the globe's circumference was graduated into 24

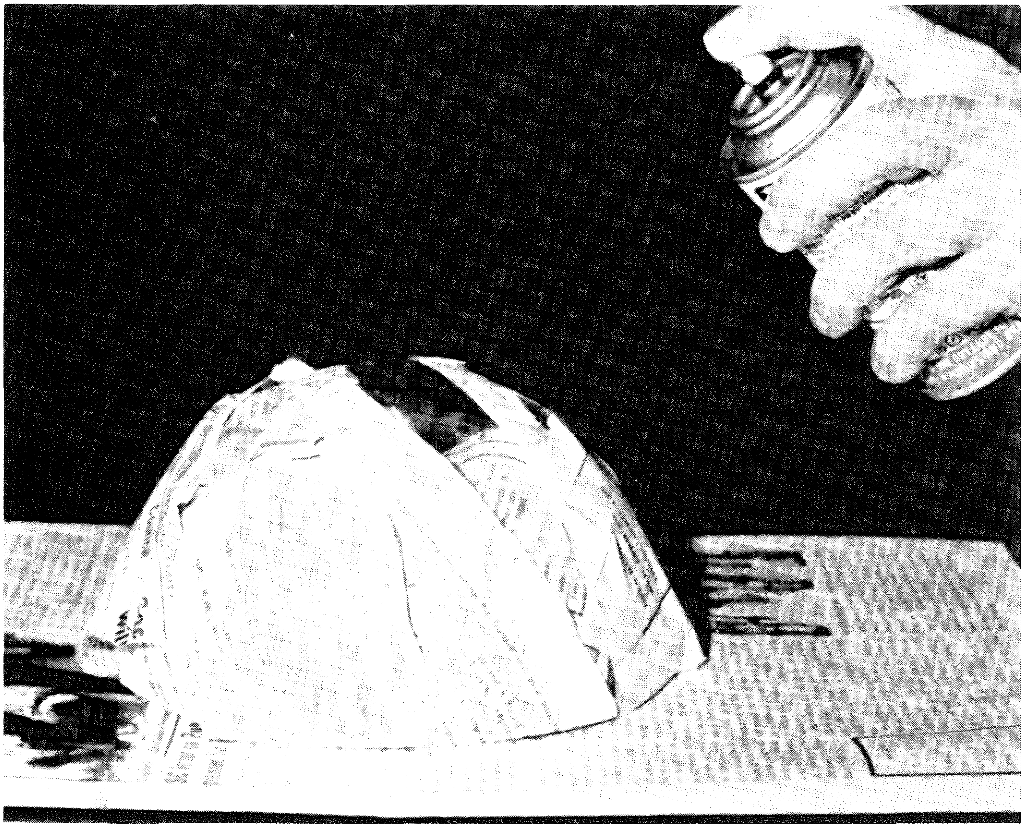


Figure 1. The plastic hemispheres of the Radio Sky Projector were painted using black spray paint.

equal parts. This was then taped onto the equator of the hemisphere to become the right ascension coordinate. A pin was stuck into the pole and a string which reached to the equator was tied to it. The string was calibrated in 10 degree intervals to serve as a measure of the declination. This made the plotting of the radio contour lines and discrete radio sources fairly easy. The lines and points were marked on the inside of the globe with a marking pencil.

The outside of the hemisphere was then painted according to the density of the radio radiation from the region to represent the diffuse radio radiation. This was a major problem since most of the paints tried either were too opaque or produced streaks. We finally used spray paint. All but a small area of the hemisphere was masked off and the area was sprayed until the proper transparency was reached. This process was then repeated, area by area, until both the hemispheres were completed. Since this technique is very time-consuming, we hope to develop a better one before we construct our second radio sky projector.

The discrete radio sources are projected by pinhole projection by drilling holes of the appropriate size in the hemisphere to produce images that are of the proper brightness. Then the marks on the inside of the hemisphere were removed.

The radio sky sphere was mounted by replacing the geocentric earth globe on our Spitz A3-P projector. The lamp on the geocentric earth projector then becomes the light for the planetarium radio sky and the liquid level light cutoff provides the horizon for the radio sky. To make the projector more flexible it was motorized and remounted. The motor provides daily motion of the radio sky.

It was remounted by bolting it to the horizontal latitude axis of the planetarium projector as seen in figure 2. Since it is pointing south, the shadow of the star sphere is in the north near the pole where there aren't any strong radio sources. Since the Youngstown Planetarium has unidirection seating, the audience is facing away from this shadow. This remounting makes it necessary to alter the wiring of the geocentric earth projector slightly. The wires leading to the old position were pulled through a hole drilled in the cover of the horizontal latitude axis and attached to the projector in its new location.

A simpler way to build a radio sky projector is to only make one hemisphere and mount it on the Spitz Spherical Overlay Projector or a homemade equivalent. This approach has the disadvantage of limiting the projector's use to one particular latitude and time of day.

We used this second approach in constructing our planetarium x-ray sky because the x-ray observations from the recently launched orbiting Astronomical Observatory, Copernicus, will rapidly make the projector out of date.

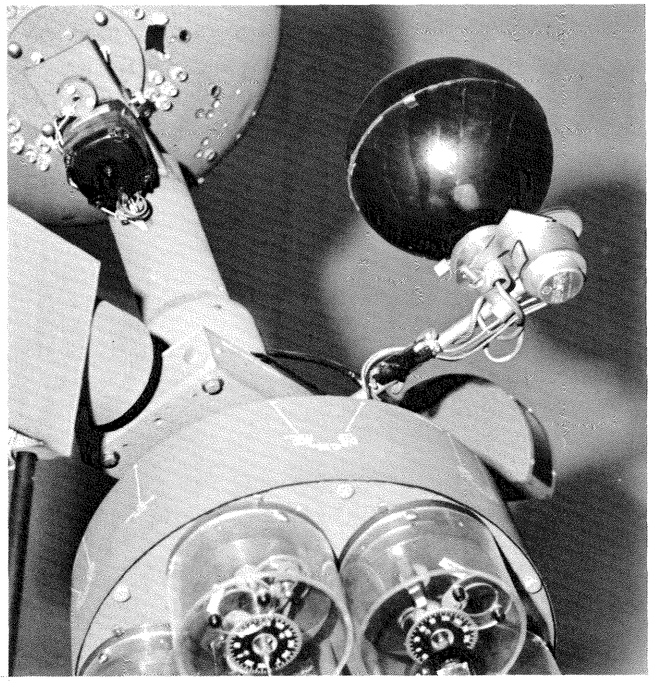


Figure 2. The Radio Sky Projector mounted on the horizontal latitude axis.

The x-ray sources and their positions were taken from an article in Scientific American July 1972 by Schnopper and Delvaille. Since we were only plotting discrete sources, the plastic hemisphere was painted black and then holes of the appropriate size were drilled in the hemisphere to produce images of the proper brightness.

We find that the planetarium x-ray and radio skies are very useful in discussing these types of astronomy with both the general public and the students in our university astronomy classes. "A radio picture is worth a thousand words." *(End)*

REGIONAL ASSOCIATION

NEWSBEAT

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SEPA, Robert J. Hitt, Chesapeake Planetarium, 300 Cedar Rd., Chesapeake, VA 23320.

SWAP, John L. Cotton, Jr., 3717 Purdue, Dallas, Texas 75225.

International Editor, Vacant.

PAC AT EDMONTON. . .

By the time this issue reaches you, **John Hault**, Chairman of PAC '73 and our Canadian colleagues will have already concluded their big one for the year and from the looks of the pre-conference info it should have been a good get-together. With professionals like **Sig, Wieser, Donald D. Davis** and **David Rodger** around, the affair could have been nothing but lively and stimulating. From what little contact this editor has had with our Canadian counterparts, I can say I'm really sorry I had to miss the events.

David A. Rodger, Director of the MacMillan Planetarium in Vancouver reports a very good year and word from various wandering planetarians back him up. The MacMillan's approach to public programming appears quite sophisticated both script-wise and technically speaking. . . and the public goes for it. Rodger's staff did three shows this year that deserve special mention: "ON ANY CLEAR NIGHT," "THROUGH THE JUPITER VEIL," and "COSMIC DANCE." "COSMIC DANCE" deals with a theme that is becoming more and more popular with today's demanding audiences; namely, a philosophical and "almost mystical evaluation of matter, energy, time and space." And keeping in tune with the need for media-enriched presentations, generous use of original film and music can be found in the Vancouver productions. Perhaps someone can persuade David to pass around the title song "ON ANY CLEAR NIGHT," composed and sung by **Roberta Meilleur.**

IT LOOKS LIKE IT'S GOING TO WORK OUT. . .

As you may recall in our last issue, the procedure for getting your items in *NEWSBEAT* was altered, hopefully for everyone's benefit. To wit: Mail your *local news* directly to me at the below address instead of to your regional editor. However, continue to send your *articles and papers* to your own regional editor. This new method should keep the news a little more current.

Jack Horkheimer, Assoc. Ed.
THE PLANETARIAN
Miami Museum of Science
3280 South Miami Ave.
Miami, Florida 33129

REGARDING EXHIBITS. . .

The Special Libraries Association provisional division of Physics Astronomy Math Librarians is undertaking a survey of observatory and other astronomy libraries to determine sources of astronomy exhibit materials. These items can be anything usable for bulletin boards, tables, cases, or whole traveling exhibits. If you would like to participate in this survey and receive the compiled results, please write to:

Mrs. Sara June McDavid, Librarian
Fernbank Science Center
156 Heaton Park Dr. N.E.
Atlanta, Georgia 30307

PPA AT SAN DIEGO...

Tom Tsung of California State University at San Diego hosted the annual spring meeting of PPA on May 11, and **Mike Sullivan** of the San Diego Ruben H. Fleet Space Theater acted as host on May 12. Friday's session at CSUSD included the following presentations:

1. **Art Young** of CSUSD challenged our introductory astronomy presentation approaches in his talk "Introductory Astronomy – A 20th Century Blunder," and encouraged us to deal with the woods, not the trees. He put forth the idea that science progresses from paradigm to paradigm and sees the world based on the presently held paradigm.
2. **Bob Dixon** of Riverside City College spoke on the role we should play in astronomy education in his talk "Bridging the Gap." He raised such questions as "Should technology be the interpreter of science?"
3. **Dale Etheridge** reflected some thoughts on the effectiveness of planetarium education and suggested we need to examine our effectiveness with the planetarium facility.
4. **Cy Denny** of Boller and Chivens spoke on the Burke-Baker facility in Houston. He gave us splendid insight into the technical problems and thinking that surrounded the project.
5. A panel discussion made up of **Mike Bennett** representing Spitz Space Systems, **Jim Nakashita** of Minolta Corporation, **Cy Denny** of Boller & Chivens, **Kingsley Wightman** of Chabot Science Center and **Tom Johnson** of Celestron Pacific, discussed a variety of concerns in which the makers of equipment in our field are involved.

Saturday was Fleet Space Theater Day. We were given a complete tour of the facility, viewed the current breathtaking and overwhelming program, viewed the exhibits, and were treated to a panel discussion on techniques, approaches and problems. **Roger Tilten, Mike Sullivan, Jim Crooks, Zoltan Rosmair** and **John Mulligan** participated in the discussion. Roger Tilten is the producer-director of the movie "Garden Isle" shown through the Omnimax system. Zoltan Rosmair is the composer of the musical score for "Garden Isle" and Jim Crooks is long time Space Theater main technical engineer. Mike Sullivan and John Mulligan are two officers of the Fleet Space Theater whom we will all come to know much better as their fame spreads far and wide.

(Reported by Tom Gates)

GRAND RAPIDS TO HOST GLPA...

The annual convention of GLPA will be held Oct. 25 through 27 in Grand Rapids, Michigan. Hosting will be the Roger B. Chaffee Planetarium of the Grand Rapids Public Museum with cooperation from the Godwin Heights School Planetarium. Thursday afternoon will include workshops in slide preparation, specialized photography, script preparation and musical programming. The executive committee will meet in the evening while members tour the Chaffee Planetarium and Veen Observatory. Friday morning will be spent on papers from members, committee meetings and a planetarium show. The luncheon speaker will hopefully be a NASA personality who will discuss either the aftermath of Project Apollo or the Mariner 9 mission to Mars. Technical (gadget) sessions will be conducted in the afternoon. The evening banquet will feature the annual Armand Spitz lecture which will be delivered by **Dr. George M. Pitluga.**

After a Saturday morning business meeting, a highlight of the convention will be an education session conducted by **Lawrence Sabbath**, GLPA Education Committee Chairman. The closing session will be devoted to the subject of specialized photography and reports on the African solar eclipse.

Open to all interested planetarium people, further information may be obtained from Convention Chairman **David L. DeBruyn**, Chief Curator Chaffee Planetarium, 233 Washington, S.E., Grand Rapids, Michigan 49502. Headquarters will be the Hospitality Motor Inn, I96 and Cascade Road, Grand Rapids.

JULIUS STAHL, WHERE WERE YOU?...

Jane Geohegan, Editor of *Jane's Corner* elsewhere in this journal and director of Thomas Jefferson Planetarium in Richmond, Va., has a penchant for traveling. Being a devoted SEPA member, she agreed to meet another fellow SEPAer **Julius Stahl** of Fernbank at Stonehenge at the summer solstice. (If you drop Jane a postcard, she'll meet you anywhere, anytime just so she can try out some of her new jokes on you). The Druids showed up, the Hippies showed up, Jane showed up. . .Julius didn't. If you see Julius, and you will at the ISPE meeting in Atlanta, ask him to give you his version of the Chinese interpretation of Lepus the Hare. My guess is Julius failed to make his appearance because if he told Jane the story she'd print it. (After trying to learn the Druid ritual dance, Jane was subsequently heard from in Hawaii. Wonder what kind of salaries they pay in Richmond?).

(Far right: Small boy, paid by Jane, asking large Druid, "Are you Julius?")

GREAT PLAINS PLANETARIUM ASSOCIATION...

During the 1973 National Convention of the Astronomical League, held at Creighton University, Omaha, Nebraska, a quorum of planetariums within the region of Nebraska, Kansas, Missouri, Arkansas, and part of western Iowa established the Great Plains Planetarium Association. A constitution and set of by-laws was modified and approved. These by-laws were written by a committee appointed at a planetarium educators' conference held at Missouri Western State College, St. Joseph, Missouri, in the spring of 1973. The constitution and by-laws are being submitted to ISPE for approval and acceptance to allow GPPA to affiliate with ISPE. *(Editor: This matter is currently on the agenda of the ISPE Council now meeting by correspondence. Results of voting were not available as this issue goes to press.)*

A meeting of GPPA, to be hosted by Joe Olivarez and his staff at the Hutchinson Planetarium, Hutchinson, Kansas, will be held October 27, 1973. An election of officers and appointments to committees will be effected during this first association meeting. GPPA and ISPE dues will be collected at this meeting. The business sessions will be held in the morning and talks and demonstrations about aspects of planetarium operation taking up the rest of the day.

There are some 48 planetariums in operation and 6 additional in the planning stages within this new association, and this first meeting will allow regional planetarium people to get to know each other, fostering the kind of interaction we hope GPPA will provide.

(by Russell C. Maag, *St. Joseph, Mo.)*

ROCKY MOUNTAIN PLANETARIUM ASSOCIATION MEETING...

On September 28, 1973, Rocky Mountain Planetarium Association members met in Pueblo, Colorado, at Centennial High School to examine the Viewlex planetarium recently installed. Chuck Percival, Planetarium Director, and Sam Genova, Science Specialist, greeted 25 visitors from throughout Colorado and parts of Nebraska. The members discussed ideas and possibilities for the automated tape system used in the new facility.

After a business meeting discussing challenges for the year, the group listened to Dr. G.L. Verschuur, Director of the Fiske Planetarium of the University of Colorado. He spoke about his discoveries on the possibility of "Other Civilizations" based on his work in radio astronomy. Dr. Verschuur related some of his ideas and theories about "Mysterium," Pulsars, and L.G.M. (little green men). According to Dr. Verschuur, the ability to communicate across our galaxy is now technologically a possibility – by picking up radio signals. He suggested (humorously) to look for these civilizations at a common place where men have always gathered – at the waterhole! That is, between the H (21 cm.) and OH (18 cm.), which, of course, gives us H_2O (water). Observations have been made at these various radio wavelengths to explore our galaxy for other civilizations.

Mark Peterson, Director of Denver's Gates Planetarium, gave a slide presentation on the June 30th African solar eclipse. Brilliantly clear photographs and an informative discussion highlighted his experience of this outstanding astronomical event.

A tour and demonstration of the planetarium facility accented the afternoon program. Terry Schmitt of Tersch Enterprises concluded with some of his slides and experiences from a cruise during the June 30th total eclipse.

(by Terry DiIorio, *Colorado Springs, Colo.)*

THE SPIDER THAT ATE SKYLAB, LORD NELSON'S BEDPAN AND JANE FONDA, A LA BUFF...

Less than a quarter of a mile from the Key Biscayne White House, an intimate island retreat lies lazily on the sun drenched, palm scattered shore of the Atlantic. Looking more like a remote Tahitian sanctuary for artists than part of a modern metropolis, the Silver Sands Hotel opened its doors and arms to six dozen SEPA refugees: May 30, 31, June 1, 2, 3; 1973. It will never be the same.

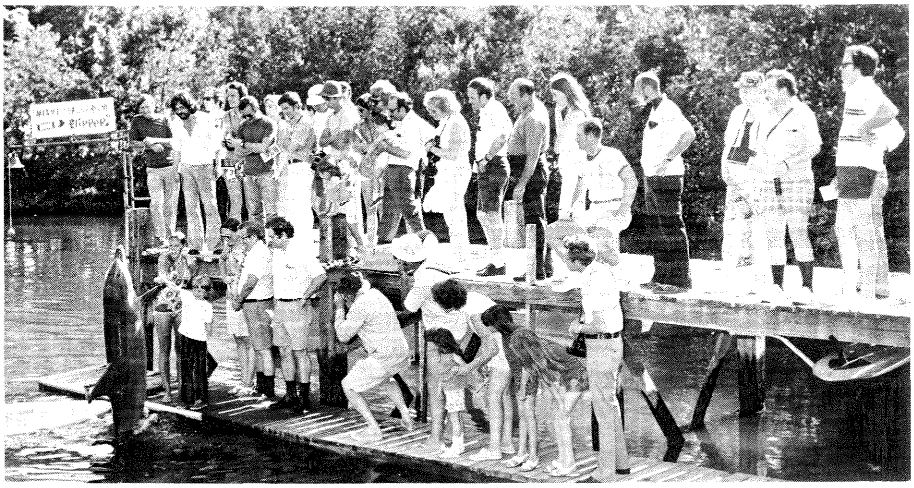
Realizing that planetarium people are not traditionally among the highest salaried in the land, and knowing that some would have to use vacation funds for such a distant excursion, it was decided that this conference would be handled differently than any before.

INNER-OUTER SPACE, subtitled A Sensate Journey into Other Realities, a planned 'happening', designed to immerse the participant intellectually and emotionally in the arts and sciences both pertinent and relative to the profession, four intensive days modeled in the classic retreat manner of Ignatius of Loyola, even MADE money.

Wednesday evening found members at the Gables by the Sea home of Mr. and Mrs. Donald Kahn. Champagne, caviar and a whole house that became a light show. Later, an executive meeting and pool party till 2:00 A.M. Thursday morning saw a cavalcade across Biscayne Bay to the hosting Miami Museum of Science.

In the planetarium a septuagenarian mis-adventureful Buck Rogers saws off the end of his aging side-kick's cane to plug up the air leak in the zero gravity toilet while a member of the audience tries to rescue her (side-kick Wilma) by use of the STP remote control when she loses her footing while on an EVA to reverse the engines. After a 320 pound lovely in a bikini zooms over the audience to the strains of '2001', members leave for lunch. Stuffed artichoke hearts, canelloni and wine in the hippie/artist colony of Coconut Grove. . .then a tour of the National Hurricane Center. Swimming pool and cocktail party followed by an evening sponsored by Celestron Pacific and the Museum's Interplanetary Sisterhood of Bacchus. The setting: Italian Renaissance; lavish Villa Vizcaya Palace and Gardens, rented for the night. A buffet in the pallatzo, lighted fountains, moonlight walks, thirty five Spanish guitarists and a series of special skits by the new comedy group, The Intensive Care Unit. Teaching a coconut how to talk, seduction in the park and, bringing down the house, the *real* story behind Skylab: two high school teachers (PE and Industrial Arts) as last minute astronauts as Cape Kennedy goes on strike. The discovery of exotic plants on Skylab (a high school experiment) found things higher than anticipated by NASA; the effects of zero gravity on a spider that could

SEPA planetarians meet a star... Flipper. (*Photo courtesy of Wometco Miami Seaquarium*)



only be duplicated in a Japanese sci-fi flick. Then guest speaker Frank Jettner talking on Superheterodyne Spectroscopic Stellar Measurement, highlights of which were the sudden appearance of a wild raccoon on the podium and an avid photographer intent on getting good pictures of him (the raccoon). Mr. Jettner ended his dissertation by mashing to a pulp, in magnified view of all, some tropical insect that inadvertently appeared on the overhead projector; a somewhat colorful if not gory finale.

Immediately following, a talk by writer/producer Dick Weiner and a showing of his national TV Special 'The Devil's Triangle.' Then at Midnight, sponsored by The Interplanetary Brotherhood of Non-Disciplined Rationale and Sensation, an uncut viewing of Jane Fonda's 'Barbarella', complete with a free-fall strip-tease on a flight to Alpha Centauri. At 4:00 A.M. at least fifteen members could still be found floating in the pool under a pitch black star-filled sky.

Friday morning sleep-in nevertheless dawned with over two dozen members standing on their heads meditating in Suite 3, being instructed on how to cope with the rest of the conference by Zen Yoga Master Lee Langstroth. BMBM followed. *B*loody *M*ary *B*reakfast *M*orning in the sand and then the annual business meeting outdoors under the thatched roof of the Chiki hut: attire specified. . .swimming suits or shorts. New officers were elected and in keeping with the spiritual kinship of the events, an updated recording of 'Desiderata' was played for all. "You are a fluke of the Universe, you have no right to be here, and whether or not you know it the whole Universe is laughing behind your back."

A private Mensanity concert at Lumonics Studio of Sight and Sound took up the afternoon. Unique in all the world, Lumonics can best be described as a 'live' last sequence in '2001'. Upon leaving this visual-aural bombast, one delegate commented, "I don't know what's happening to me, but I THINK I'm going crazy."

At 5:00 P.M., a combination swim suit cocktail party slide lecture on Atlantis proved somewhat of a first. Internationally famous Dr. J. Manson Valentine, upon discovering a martini in the place of the usual speaker's water glass, beamed at his audience seated on the floor fifty feet away from the Atlantic. "I'll say *one* thing for you. You're certainly not stuffy." (Dr. Valentine, incidentally, is an underwater authority on the Bahamas and the civilizations of the Yucatan.)

Then off to the Jamaica Inn for a glimpse at their orchid jungle, model ship collection, curios (Lord Nelson's bedpan) and dinner for 110 guests accompanied by Robert Little's famous Gemini Twins lecture. Following: a late performance of "CHILD OF THE UNIVERSE" and swimming.

Saturday morning in the planetarium heard a couple of papers delivered and saw several effects displayed during the workshop period. Then a planetarium showing of "LONG JOURNEY OF A YOUNG GOD" starring Leonard Nimoy. As one of the program's themes is Man's inhumanity to Man, it was most gratifying to see that the delegates politely ignored the missile display set up on the Museum grounds specifically for SEPA.

The rest of the day was left to 'inner space', water. Two marine biologists led a group on a deep sea dig. Then a special VIP tour of the Miami Seaquarium. Although President Nixon was unable to attend the meetings, nevertheless, the group, as promised, had the opportunity to shake hands with an international figure. . .Flipper. Later, onto the water itself, on a Spitz sponsored three-hour moonlight cruise aboard the Island Queen. Featured on board were dinner and a slide lecture by Charles Lacombe, Director of Maya Studies, on the 'Ancient Maya Lunar Calendar.' As Jettner by a raccoon, so too was Lacombe upstaged by a drawbridge. Mentalist games were played, resulting in the finding that all women aboard were psychic and were awarded prizes. Jane Geohegan was awarded a watch for two years of service to the organization and due to an excess of nautical motion, her acceptance speech is being transcribed in *National Lampoon.*

The newly elected officers for SEPA, 1973-1974 are:

President. . .John Burgess of FernBank Science Center, Atlanta, Ga.

Vice President. . .Paul Campbell of the Hardin Planetarium, Bowling Green, Ky.

Sec.-Treas. . .James Summers of Fernbank Science Center, Atlanta, Ga.

Newsletter Editor. . .Robert Hitt of the Chesapeake Planetarium, Chesapeake Va.

(Respectfully submitted, B.B. Rebonzo)

SWAP IS SWAPPING. . .

Excuse the bad pun, but that's what's happening in the Southwest. **John L. Cotton** has been spending the summer putting together a show exchange index for fellow SWAP members and **Rich Calvird** of El Paso recently supplied two tapes and scripts for it. If the system catches on, maybe our Southwestern brothers will be the first with a 30 hour work week. Everyone knows how many man hours it takes to put a show together. Additionally, **Don Garland** has edited a shorter version of **Tom Gates** and **Don McDonalds'** "JUPITER PIONEERS" which will be supplied to SWAP members for the simple price of a role of blank tape. Might not be a bad idea to join SWAP. I'm sending in my check tomorrow.

A COMMON COMPLAINT OF JET-SETTERS. . .

"Where do you go after you've been everywhere?" Fly ARCHIVE ONE. . .if you're in the Rochester area. From the reviews, one of the best trips going is at the Strasenburgh onboard the imagination of **Terry Dickinson**, Assistant Director of the planetarium and author of the currently featured "ARCHIVE PROJECT." Teamed up with the original electronic score of **Tim Clark** (staff composer and an Eastman graduate), **John Paris'** tech crew, **Vic Costanzo's** art direction, the objective is the Black Hole at the center of the Galaxy in search of a passage to another Universe.

Incidentally, Vic Costanzo's fine work appears both on the cover and scattered throughout the September issue of the new magazine *ASTRONOMY.* Mr. Dickinson has also joined the *ASTRONOMY* staff and his current article on quasars is quite lively. (If you want to 'steal' a good rendering of what a quasar might look like, Costanzo's interpretation accompanying the text makes it. Sorry, Vic, but we've all got to survive in this business.)

ARCHAEOASTRONOMY AND THE PLANETARIUM

by Jonathon E. Reyman, *Department of Sociology-Anthropology, Illinois State University*

Introduction

Anthropology is an eclectic discipline, and archaeology is the most eclectic subfield within anthropology. An archaeological site is a sort of skeleton, the remains of an organism from which the flesh appears to be gone leaving intact only the hard internal structure. This is not to say that the archaeologist, like the scavenger, must be content to pick the bones. As many have argued and demonstrated, there is a good deal of "meat" left which we *can* salvage, if we have the right conceptual and technical tools (see, e.g., Taylor 1948; Willey and Phillips 1958; Binford 1962, 1964, 1965; Longacre 1964; and Hill 1970).

It is in the search for and the employment of these tools that the archaeologist, who is *really* an anthropological *technician* (Taylor 1948:43), of necessity must become highly eclectic. The data which one seeks are dispersed through space, time, and a variety of mediums and so are not readily discernible; thus botanists, physicists, zoologists, and chemists, among others, are often called upon to help recover and interpret data in order to aid the archaeologist in putting the *people* who constructed and occupied the site back into it. Let me cite several examples. The dirt which contains the "usual" artifacts such as potsherds, projectile points, and grinding stones also contains pollen and seeds. These last two indicate which plants were utilized at the site and possibly the time of year during which the site was occupied. From a roof beam we can learn not only the genus and species of the tree, but also the year in which it was cut (through dendrochronology which was discovered and developed by the physicist, A.E. Douglass), perhaps how it was felled, and something about the climate during its lifetime and the occupation period of the site. Animal bones indicate the kinds of fauna which were exploited and perhaps the time of year in which the site was utilized; markings on the bones may suggest the techniques used for butchering, and the distribution of the bones may provide data regarding the statuses and spatial distributions of groups of people who lived at the site. Similarly, the architecture gives us insight into the engineering techniques and skills and the degree of planning and social control exercised by the culture, as well as its exploitation of the surrounding area in terms of materials utilized in the construction. Furthermore, the orientation of walls and/or other architectural or cultural features, if they are found to have been astronomically aligned, provide information about the culture's hypothesized interrelationship with the heavens.

Archaeoastronomy

Hawkins (1963, 1968:45) coined the term "astro-archaeology" to describe the merger of astronomy and archaeology for the purpose of studying and explaining the function of certain prehistoric structures, in this case Stonehenge. More recently the term "archaeoastronomy" has been substituted with increasing frequency because, after all, we are engaged in the study of ancient astronomical practices.

The field of archaeoastronomy, however, is not a recent development. Stonehenge has long attracted attention; as early as 1740, William Stukeley observed and published that, in effect, the basic orientation of the site was to the summer solstice sunrise. In the New World, the first Spanish *conquistadores* who arrived in Mexico made detailed records of their observations of Aztec and Postclassic Maya astronomical practices, particularly in relation to specialized buildings (see, e.g., Pollock 1936; Tozzer 1941; Burland 1950, 1954; Dibble and Anderson 1953; and Durán 1964; c.f. Ricketson 1925, 1928; Marquina 1964; Dow 1967; Aveni and Linsley 1972). Until World War II, almost every ethnographer who worked among the Southwestern Pueblos studies and commented upon the Indian astronomical practices and associated socio-ceremonial complexes (see, e.g., Stevenson 1904; Bunzel 1932; Benedict 1935; Stephen 1936; and Parsons 1939; also Lange 1959; Titiev 1960; and Ellis and Hammack 1968). Several researchers have been and currently are engaged in investigating certain prehistoric sites to determine the extent to which modern practices and ceremonies represent a continuation of the Southwestern prehistoric contexts. These preliminary studies have been promising (Reyman 1970, 1971). As a result, new, long-term studies are being initiated in order for us to understand better both the nature and extent of the Anasazi and Hohokam commitments to astronomical observations and the incorporation of these observations into buildings and features at their respective sites.

Archaeoastronomical studies must be based, as much as possible, on sound ethnographic data. Fortunately, as I indicated above, the Mexican and Southwestern ethnographic and ethnohistoric sources, among others, are literally crammed with materials relating to native astronomical

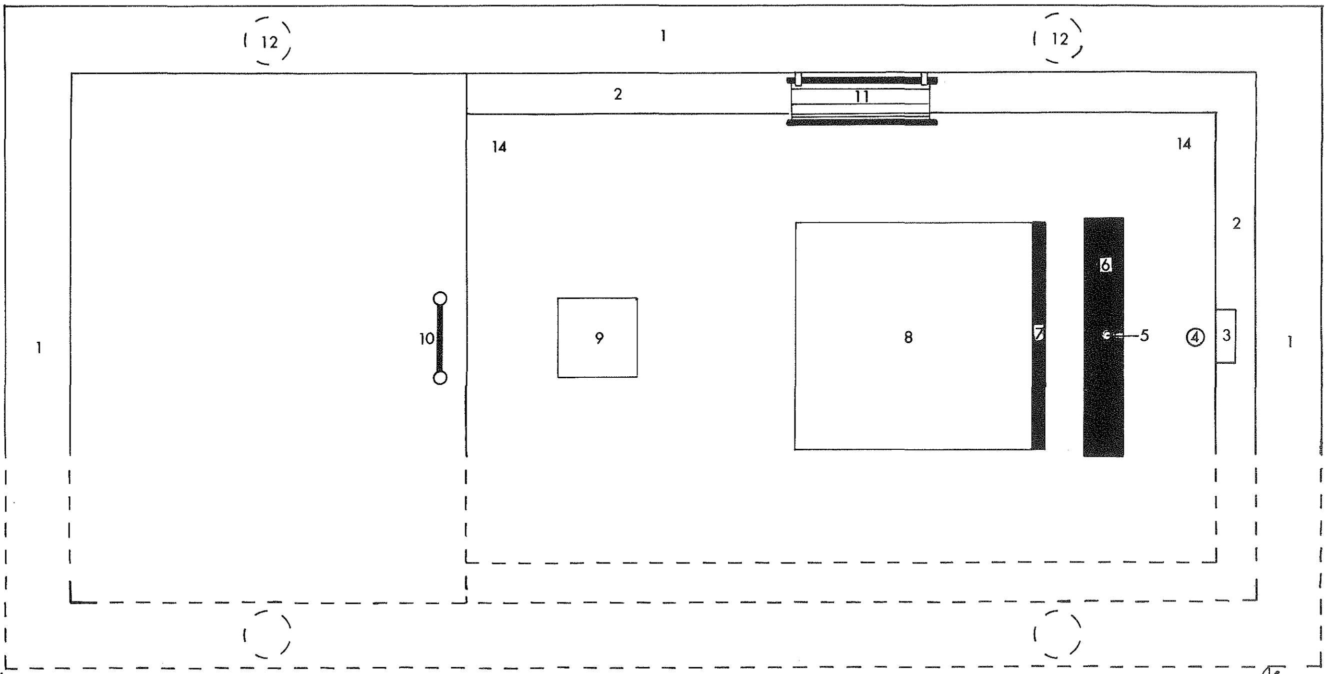


Fig. I: Schematic overhead view of modern Hopi kiva.

Key

—— Features present in kiva & planetarium mock-up

– – – Features present in kiva but <u>not</u> mock-up

1 Outer wall
2 Bench
3 Katchina niche
4 Kiva jar
5 Sipapu opening
6 Sipapu plank
7 Altar screen
8 Altar
9 Firepit
10 Ladder
11 Loom & weaving
 a Underground loom attachments
12 Roof supports
 a Roof beams
 b Cross-beams
13 Wall design (Orion)
 a The Pleiades
 b Cloud-rain-lightning
14 Raised floor

(See Stephen 1936 for details of screen & altar designs)

practices. Thus they are a rich source for the formulation of archaeoastronomical hypotheses which can then be tested in the field. These same resources contain various types of ethnographic accounts which can provide the bases for exciting, new planetarium programs.

The Planetarium

I do *not* mean that planetariums have not presented interesting programs on Indian sky-lore. At the 1972 GLPA meeting, Stephen Berr gave a talk on this very topic and presented examples of his planetarium programs which incorporate a considerable amount of Indian mythology. During the past year, The American Museum of Natural History-Hayden Planetarium presented a two-month long show on North American Indian astronomy; it probably will stage another in 1973. Other planetariums, including the one at Illinois State University, have also presented such programs. Nevertheless, many of these have not really tapped the available resources, and now, given the results of our recent archaeoastronomical studies, coupled with ethnographic and ethnohistoric data, we are in a strong position to aid planetariums in presenting what should be innovative and exciting programs.

Consider the following account from Zuni:

The man who went to the Sun was made Pekwin. The Sun told him, "When you get home you will be Pekwin and I will be your father. Make meal offerings to me. Come to the edge of the town every morning and pray to me. Every evening go to the shrine at Matsaka and pray. At the end of the year when I come to the south, watch

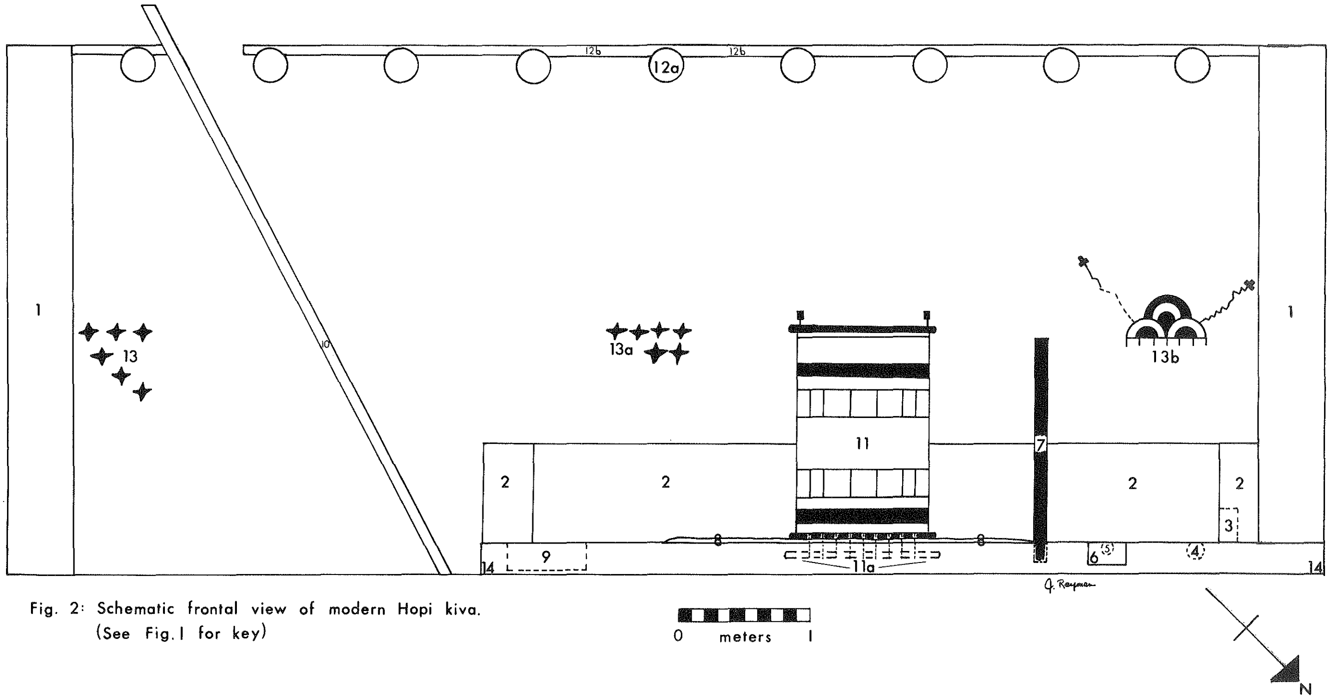


Fig. 2: Schematic frontal view of modern Hopi kiva. (See Fig. I for key)

me closely; and in the middle of the year in the same month, when I reach the furthest point on the right hand, watch me closely." "All right," He came home and learned for three years, and he was made Pekwin. The first year at the last month of the year he watched the Sun closely, but his calculations (for winter solstice) were early by thirteen days. Next year he was early by twenty days. He studied again. The next year his calculations were two days late. In eight years he was able to time the turning of the sun exactly. The people made prayersticks and held ceremonies in the winter and in the summer, at just the time of the turning of the sun (Benedict 1935:Vol. 2:66-67).

This entire sequence can be staged with a minimum of personnel and the use of even modest projection equipment; appropriate Zuni music, which is becoming increasingly available, and some good artwork, including a mural or greatly enlarged photograph of the pueblo, will further enhance the program. The point here, of course, is that the Indians (and other peoples) not only watch the sky, but they also *use it* for very practical purposes, such as the adjustment of the agricultural cycle to avoid late spring and early fall frosts which might damage or kill the crops; the observation and interpretation of celestial phenomena, particularly the determination of the solstices, was (and probably still is) essential to Puebloan survival (see Parsons in Stephen 1936:xxxix; Stephen 1936:389-390; Simmons 1942:231; and Lange 1959:322). The following is perhaps the best account of the reasoning behind the solstice observations and ceremonials.

Even if the June solstice is unnoticed, it is customary to hold important calendrical rites on or about December 21.

The main reason for this difference in attitude and behavior seems to stem from the fact that whenever it reaches either of its solstice points the sun at first makes so little daily progress in the opposite direction that it appears to rise in the same spot or, in a manner of speaking, to hesitate or to stand still for three or four days. When this "hesitation" takes place on June 21, there is little to fear, for vegetation is plentiful, crops are growing, and the weather is balmy. But it is quite another matter when the sun passes at its southern terminal and appears reluctant to move northward, in the direction of spring and summer. Such a threatened stoppage would, indeed, be a calamity. It might result in perpetual winter, no fodder for animals, and no crops for man. That is why strenuous efforts are sometimes made to get the sun to turn from its southern to its northern path; and that is also why winter solstice observances so commonly take the form of new-fire rites, or else include a number of symbols expressive of man's desire for increased light and heat (Titiev 1960:297-298).

To return to the discussion of possible planetarium programs, one might take and carefully research the contents of a major Puebloan ethnographic source such as Stephen's (1936), *Hopi Journal.* One then selects a series of accounts describing the events which take place in a kiva (a subterranean or semi-subterranean ceremonial chamber) during a ceremonial period such as the Winter Solstice or the Plumed

Serpent Ceremony. These events are combined into a program and presented as follows: An inexpensive papier-maché-over wire mock-up of a kiva is constructed on the floor of the auditorium (see Figs. 1 and 2). The program begins with the projected sky set at just before daybreak. Several people, costumed as Hopi men, are seen sleeping in the kiva; they awaken, observe and record the point of sunrise, and then go about their ceremonial chores in accordance with the movement of the sun during the day. This sequence culminates with the setting of the sun, and the auditorium is then dimmed; now, using the planetarium, the stars begin to emerge as night falls. During the course of the night, the Indians observe the positions and movements of various stars and constellations, adjusting their activities to these motions. The program concludes with the end of the ceremony, an event which coincides with the rising of Venus as Morning Star or, where ethnographically appropriate, the heliacal rising of the Pleiades. Again, the proper music, artwork, slides of the actual Hopi area, and either voice-over narration for explanation or explanation by the "actors" themselves will add significantly to the total presentation. Audience participation can be enlisted by selecting people to play a drum or to act as sky-watchers for observing the first appearance of Orion or some other important constellation or star. The aid of the theater department might be solicited, especially since interdisciplinary projects seem to have a better chance of being funded, should additional financing be necessary.

One program which has worked well at Chaco Canyon National Park (New Mexico) involves a lecture on Puebloan astronomy using the sky (in this case the planetarium) as the "blackboard." Thereafter follows a demonstration of how the Indians aligned a wall or building using three sticks and sighting over them to a rising or setting star. Alternatively, one can paint a mural of the Hopi horizon, or use an enlarged photograph (see Stephen 1936 or Forde 1963:227 for maps of this feature), and with this as a backdrop, back project the movement of the sun during the course of the year (see Fig. 3). Again, using three sticks, the audience can see how the Indians aligned walls or other cultural features (shrines) to the solstice points. The audience can also participate directly by helping to align the sticks and by erecting the wall using papier-maché "stone" blocks. This program has been well received at Chaco Canyon by both adult and child audiences; we believe that it has greatly increased non-Indian appreciation and understanding of and respect for Puebloan astronomical skills and what these skills have meant in terms of Puebloan adaptation and survival. It should be noted that Acoma and Oraibi have been occupied continuously since about A.D. 1000.

An interesting beginning for this sort of program has been suggested by Von Del Chamberlain (personal communication) of the Abrams Planetarium at Michigan State University. Let us assume that the site with which we are concerned is about 900 years old. First, the planetarium projects the sky on the ceiling. Next, the narrator points to a star that is approximately 900 light years away and says:

> Nine hundred years ago, when the light which we now see coming from that star was first leaving it, this site was occupied by a tribe of Southwestern Pueblo Indians. We shall now take you back in time over those nine hundred years to when the Indians began to construct the building which you see before you. We are going back in time so that we can learn how and understand why the Pueblo Indians used the stars to aid them in planning and erecting certain buildings in the places where they lived.

Finally, with older audiences (high school and up), one might simply present a planetarium and slide lecture on archaeoastronomy and/or current Puebloan (or other Indian) astronomy. Ruins are interesting in themselves, and when slides or ruins are combined with Indian mythology and a planetarium show, the result is a visually exciting educational program. I believe that this was somewhat demonstrated at the GLPA meeting in Youngstown.

Such programs, of course, require a considerable amount of research and planning. Chamberlain (1972, 1972a) has provided a good outline for program preparation. I have only briefly sketched a *very few* possibilities. The references which I have included provide a basic reading list on Puebloan astronomy, and I have also included a few Mexi-

Fig. 3: Composite drawing of western horizon, First Mesa, Hopi (see Stephen 1936).

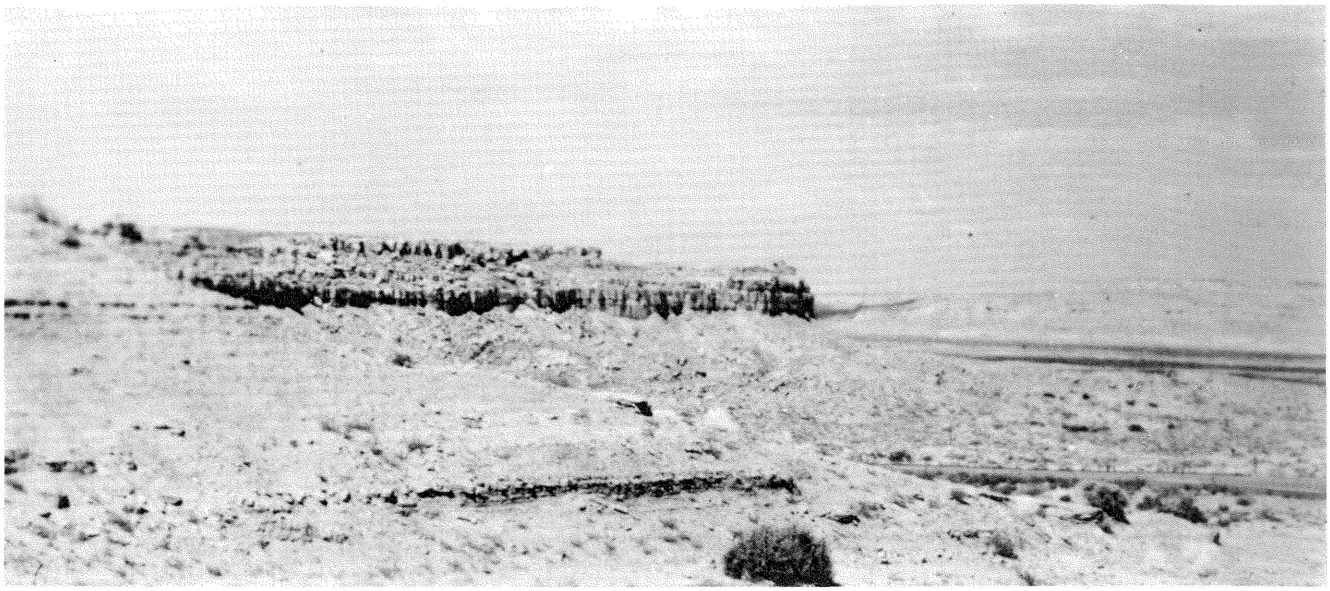


Plate 1: A portion of the eastern horizon as seen from the base of Hopi Second Mesa, northeastern Arizona.

can sources. Other materials, including slides and music, are more or less readily available, the former from the National Parks and the latter from large, urban record stores. Further assistance can probably be obtained from various museums and university anthropology departments. In certain locales, particularly in the Southwest, informed anthropologists may be available for direct consultation and/or lecturing, *per se,* in the program. There seems to be an increasing number of planetarium personnel interested in this topic, and so it may be feasible to exchange programs or even people on a short-term basis. Obviously, archaeoastronomical programs need not be limited to the New World; excellent astronomical materials exist for Egypt, China, and Britain, to name but three such areas. It must be noted, however, that the last situation is a controversial one, to say the least. The data are ambiguous, and scholars are in considerable disagreement over the interpretation of them (cf. Hawkins 1963; Hawkins and White 1965; Atkinson 1966; Hoyle 1966, 1966a; Newham 1966; Hawkes 1967; and Hawkins, Atkinson, Thom, et al. 1967).

So far this discussion has centered on how archaeoastronomical studies can provide material for planetarium programs. However, the relationship between archaeoastronomy and the planetarium is a reciprocal one and should be more fully exploited.

It is my understanding that at least several of the better planetariums are accurate enough in their projection to permit direct experimentation. If so, then it should be possible for anthropologists to formulate hypotheses regarding Indian astronomical practices with the express idea of doing the preliminary testing and evaluation of these hypotheses *in the planetarium.* Thus we shall be able to refine our research programs *before* engaging in the costly and very time consuming process of actual fieldwork. For example, using one of these planetariums, one can construct a scale model of a kiva hatchway, and then precess the sky back to the period when the kiva was constructed. Looking through the hatchway from below, one can assess the amount of clearance needed around the kiva opening in order for those inside to observe Orion, the Pleiades, or other ethnographically important constellations as they moved about the sky (Stephen 1936:*passim;* Parsons 1939:*passim*). Thus one should be able to determine which of the kivas at large sites such as Pueblo Bonito (with its high outer walls) could have been used for these sorts of observations and which were positionally ill-suited for making them. I realize that (all) planetariums are not precise in their projections back through time because the machines do not incorporate the proper motions of the stars. For preliminary testing purposes, however, they should be accurate enough to enable us to make a basic assessment of the hypotheses. As noted above, this represents a large potential savings in time and money.

Summary and Conclusions

I have tried to present an overall or general picture of archaeoastronomy, what it is, and the contributions that it can made to our anthropological knowledge; the interrelationships between archaeoastronomy and the planetarium have also been discussed, although this has necessarily been

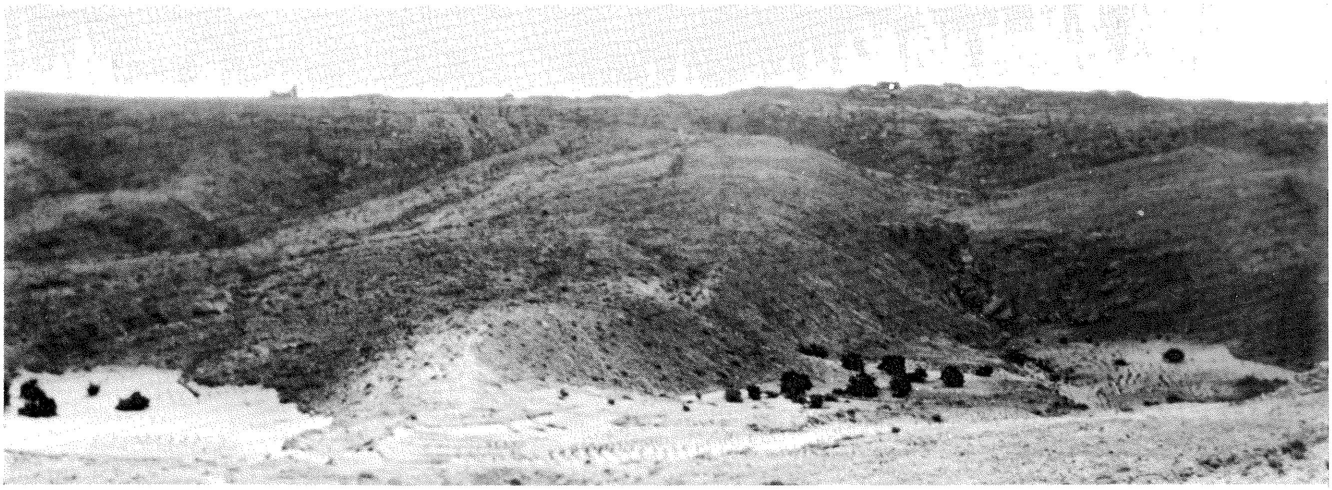


Plate 2: The Hopi village of Old Oraibi, Third Mesa, northeastern Arizona (looking west). The large ruin on the far left is the shell of Voth's church which was built in the late 19th century as part of an attempt to convert the Hopi to Christianity; it was destroyed shortly after Voth left the pueblo. Note the maize and other agricultural fields at the base of the mesa (lower part of photograph).

a brief treatment. Nevertheless, enough material has been provided to indicate that both science, *per se*, and education can and will benefit from a closer working relationship between anthropologists and planetarium educators. Toward this end I have tried to provide a working bibliography of Southwestern ethnographic and ethnohistoric materials.

An interchange between archaeoastronomy and the planetarium has already begun on a small scale. More needs to be done, however, and the sooner this begins, the sooner we shall reap the benefits of this joint venture.

REFERENCES CITED

Atkinson, R.J.C.
1966 Moonshine of Stonehenge. *Antiquity* 40:212-216.

Aveni, Anthony F. and Robert M. Linsley
1972 Mound J. Monte Albán: possible astronomical orientation. *American Antiquity* 37:528-531.

Benedict, Ruth
1935 Zuni mythology. *Columbia University Contributions to Anthropology* 21.

Binford, Lewis R.
1962 Archaeology as anthropology. *American Antiquity* 28:217-225.
1964 A consideration of archaeological research design. *American Antiquity* 29:425-441.
1965 Archaeological systematics and the study of culture process. *American Antiquity* 31:203-210.

Bunzel, Ruth
1932 Introduction to Zuni ceremonialism. *Bureau of American Ethnology, Annual Report* 47:467-544.

Burland, Cottie A.
1950 *The four directions of time: an account of page one of Codex Fejervary Mayer.* Museum of Navaho Ceremonial Art, Santa Fe.
1954 Some notes on ancient Mexican stellar beliefs. *New World Antiquity* 2:1-4.

Chamberlain, Von Del
1972 Planetarium programming for the general public. *The Planetarian* 1:15-18.
1972a Planetarium programming for the general public. *The Planetarian* 2:47-50.

Dibble, Charles E. and Arthur J. O. Anderson
1953 Florentine Codex: general history of the things of New Spain, by Fray Bernardino de Sahagun. Book 7 – The sun, moon, stars and the binding of the years. *Monographs of the School of American Research and the Museum of New Mexico, Monograph* 14, Part 8.

Dow, James W.
1967 Astronomical orientations at Teotihuacán, a case study in astro-archaeology. *American Antiquity* 32:326-334.

Durán, Fray Diego
1964 *The Aztecs: the history of the Indies of New Spain,* translated by Doris Heyden and Fernando Horcasitas. Orion Press, New York.

Ellis, Florence Hawley and Laurens Hammack
1968 The inner sanctum of Feather Cave, a Mogollon sun and earth shrine linking Mexico and the Southwest. *American Antiquity* 33:25-44.

Hawkes, Jacquetta
1967 God in the machine. *Antiquity* 41:174-180.

Hawkins, Gerald
1963 Stonehenge decoded. *Nature* 200:306-308.
1968 Astro-archaeology. In *Vistas in astronomy,* edited by Arthur Beer, pp. 45-88, Pergamon Press, Oxford.

Hawkins, Gerald, R.J.C. Atkinson, A. Thom, C.A. Newham, D.H. Sadler, and R.A. Newall
1967 Hoyle on Stonehenge: some comments. *Antiquity* 41:91-98.

Hawkins, Gerald and John B. White
1965 *Stonehenge decoded.* Doubleday and Company, New York.

Hill, James N.
1970 Prehistoric social organization in the American Southwest: theory and method. In *Reconstructing prehistoric Pueblo societies,* edited by William Longacre, pp. 11-58, University of New Mexico Press, Albuquerque.

Hoyle, Fred
1966 Stonehenge — an eclipse predictor. *Nature* 211:454-456.
1966a Speculations of Stonehenge. *Antiquity* 40:262-276.

Lange, Charles H.
1959 *Cochiti: a New Mexico pueblo past and present.* University of Texas Press, Austin.

Longacre, William A.
1965 Archaeology as anthropology: a case study. *Science* 144:1454-1455.

Marquina, Ignacio
1964 Architectura prehispanica (Second edition). *Instituto Nacional de Antropologia y Historia, Memorial.*

Newham, C.A.
1966 Stonehenge — a neolithic "observatory." *Nature* 211:456-458.

Parsons, Elsie Clews
1939 *Pueblo Indian religion.* University of Chicago Press, Chicago.

Pollock, H.E.D.
1936 Round structures in aboriginal Middle America. *Carnegie Institution of Washington, Publication* 471.

Reyman, Jonathan E.
1970 Southwestern Pueblo conservatism: a new look at an old "myth". Paper presented to the 1970 meeting of The Society for American Archaeology, Mexico City.
1971 Astro-archaeology in the Anasazi area. Paper presented to the 1971 meeting of The Society for American Archaeology, Norman.

Ricketson, Oliver G., Jr.
1925 Report on the repair of The Caracol. *Carnegie Institution of Washington, Yearbook* 24:265-267.
1928 Astronomical observatories in the Maya area. *The Geographical Review* 18:215-225.

Stephen, Alexander M.
1936 Hopi journal, edited by Elsie Clews Parsons. *Columbia University Contributions to Anthropology* 23.

Stevenson, Matilda Coxe
1904 The Zuni Indians: their mythology, esoteric fraternities, and ceremonies. *Bureau of American Ethnology, Annual Report* 23.

Stukeley, William
1740 *Stonehenge, a temple restored to the British Druids.*

Taylor, Walter W.
1948 A study of archeology. *American Anthropological Association, Memoir* 69.

Titiev, Mischa
1960 A fresh approach to the problem of magic and religion. *Southwestern Journal of Anthropology* 16:292-298.

Tozzer, Alfred M.
1941 Landa's relación de los cosas de Yucatan. *Peabody Museum of Archaeology and Ethnology, Papers,* Vol. 18.

Willey, Gordon R. and Philip Phillips
1958 *Methods and theory in American archaeology.* University of Chicago Press, Chicago.

Of Stars and Domes

by Mark R. Chartrand III, *Amer. Mus.-Hayden Planetarium*

You will be talking about comets for the next few months. That is pretty well certain with the imminent appearance of the current Comet of the Century. To prepare for this predictable desire for information on comets, here is a summary about them. We can hope with the extensive observations planned by NASA and observatories all over the world, much more will be known about comets by this time next year.

On the average, there are about three new comets discovered each year having periods longer than 100 years, about one with a shorter period, and about 2½ predicted comets recovered. There may be about two visible in any one year. There are about two dozen periodic comets, having been observed on at least three passes.

Periodic comets have the following average orbital parameters: period, 7 years; semi-major axis, 3.6 a.u.; perihelion distance, 1.3 a.u.; eccentricity, 0.56 (the lowest is 0.135); and inclination, 15°. Nearly all periodic comets are in direct orbits. The major exception is Halley's. Comets with periods longer than 100 years have an average perihelion distance of 1.0 a.u., and the orbits are oriented randomly.

Astronomer M.F. Baldet estimates that there have been 1738 comet sightings from 2315 B.C. up to July of 1963, and several dozens since then. Of the historical sightings, at least 132 are thought to be not really comets, but novae, etc.

Of the well-observed comets, 55 have eccentricities less than 0.96, which corresponds to a period of about 200 years. There are 119 with e between 0.96 and 1.0, and 292 with e estimated to be 1.0, that is, in parabolic orbits. About 68 comets have been calculated to have an e between 1.0 and 1.004, with none having e greater than the latter figure. The seeming preponderance of parabolic orbits is due to several factors. First is the very, very small difference between an elliptical orbit and a parabolic one for comets with periods longer than a hundred years or so. Another is the short duration of observations of many comets which does not allow a more precise figure to be calculated from the data. And a third, practical reason is the relative simplicity of calculating the parameters of a parabolic orbit compared with an elliptical orbit. At present, Comet Kohoutek (ko-HOW-tek) is assumed to have a parabolic orbit until more observations show otherwise. This will be possible in late September after the comet comes out from behind the Sun.

FOLLOWING COMET KOHOUTEK

The parameters of the orbit of the comet have appeared elsewhere (e.g., *Sky and Telescope*) so we won't repeat them here. Nevertheless, based on the preliminary data, Dr. K. L. Franklin of the Hayden Planetarium has calculated some times of orbit crossings and other important points in the orbit which might be of interest:

1973 Oct. 26: crosses the orbit of Mars, inbound.
Nov. 26: crosses orbit of Earth.
Dec. 8: crosses orbit of Venus.
Dec. 19: crosses orbit of Mercury.
Dec. 27: at ascending node.
Dec. 28: perihelion, 21 million kilometers.
1974 Jan. 4: crosses orbit of Mercury, outbound.
Jan. 7: seen about 1° from Venus.
Jan. 10: crosses orbit of Venus.
Feb. 4: crosses orbit of Earth about 5 million kilometers north of the plane.
Feb. 21: at descending node.
Mar. 4: crosses orbit of Mars.

THE COMET ITSELF

The most striking part of a comet is the tail. It usually begins to form at about 1.7 a.u. from the Sun, and its exact size, length, and brightness cannot be predicted. The part of the tail visible to the unaided eye may range from 10 to 160 million kilometers, and contain a total mass of around 10^{14} grams.

The nucleus of a comet is between 1 and 100 kilometers across as determined from photometric observations. It is hoped that observations of Comet Kohoutek will improve our knowledge of nuclear sizes. The mass there is between 10^{14} and 10^{20} grams, with 10^{18} grams being typical. The albedo is about 1/10.

Surrounding the nucleus, and with it comprising the head of the comet, is the coma, several thousands of kilometers in size, and composed of gases and dust. The average density is about 10^{-21} grams per cm^3, not much denser than some of the dense interstellar clouds. The average dust grain is believed to be about 0.4 microns in diameter.

Acting on the comet, and particularly on the tail, are a number of forces. These include radiation pressure from the Sun, corpuscular radiation pressure (the solar wind), magnetic fields, explosions in the nucleus, and braking due to interplanetary plasma. The force of repulsion on the tail may reach 100 to 1000 times the gravitational force of attraction to the Sun.

Radio Astronomy Notes

Conducted by G. L. Verschuur

In 1960 radio astronomers had only catalogued a few hundred extra-galactic radio sources. Now we have over 10,000 catalogued. How much more do we know about various objects in intergalactic space that emit strong radio signals? Let me briefly review what we have learned, in particular during the 10 years since the discovery of quasars.

There are apparently two groups of extra-galactic objects that emit strong radio signals – radio galaxies and quasars. As far as the radio observations of these are concerned, the astronomer can find no systematic differences between the two groups. It is only the addition of optical information on the large redshifts of the quasars that leads us to group them apart from the lower redshift radio galaxies.

Both groups show similar spatial structure. These are sometimes extended, often double, centers of radio emission surrounding a visible radio galaxy. Some quasars show extended structure as well. Quasars always have a very bright, very small nucleus emitting radio energy. These may be less than 0.001" in diameter. Many radio galaxies have similar very small nuclei.

Both groups show variability in their radio emission on a time scale of days to years, indicating the occurrence of explosive events of some sort. Often the apparent double nature of the extended emission regions (minutes of arc across) are mimicked by similar structure on a much smaller scale (seconds of arc across) in the nuclei indicating a succession of explosive events perhaps; the extended components being remnants of old explosions, the small components being remnants of recent explosions.

Both groups show evidence for changes in their structure from month to month even, changes which have led to interpretations involving expansions at speeds greater than that of light in the sources. These phenomena can be explained in other ways but we don't yet know for certain what is occurring.

The big problem is the difference between the groups which is implied by the large redshift of the quasars. If the redshift is interpreted as it is for galaxies the quasars must be very much further away. This means that the energies they are emitting must be very much greater for us to see them at all. For example, the energy differences implied by the time variations of some of the quasars is equivalent to turning a giant radio source like Cygnus A on within one year.

No theory as to the origin of such enormous quantities of energy is yet universally accepted. Not only does one need to postulate the generation of enormous quantities of energy but this energy, somehow, has to be converted into radio signals, which we observe here on Earth. Also, why do double radio sources maintain their double structure at all? Is there something in intergalactic space confining the radiating particles to a relatively small volume of space (although 100 kpc across for some sources)? New evidence on tails emanating from some radio galaxies suggests that these galaxies are moving through a sea of intergalactic matter inside clusters of galaxies.

Is it possible that the redshift of quasars is not a measure of their distance? Yes, but it is unlikely. A recent observation by two scientists at the NRAO threw some light on this question. The quasar 3C 286 has a redshift of 0.849. Drs. M.S. Roberts and R.L. Brown searched for possible absorption of the radio signals from this quasar by intervening neutral hydrogen clouds. These should absorb at a frequency of 1420 MHz when they are in our galaxy. They found absorption at 839 MHz indicating the existence of a cloud of neutral hydrogen gas at a redshift of 0.69 in the direction of 3C 286. They inferred that an intervening galaxy was responsible, suggesting that the quasar must be beyond this galaxy – therefore most of its redshift is due to the great distance of the quasar in the expanding universe. The intervening galaxy has never been seen photographically, but will be searched for when 3C 286 becomes a night time object again.

ANNOUNCEMENT

Reprints of the two star charts and the zodiacal figures chart provided in the article THE ECLIPTIC AND COORDINATE SYSTEMS by John Soroka *(THE PLANETARIAN,* Vol. 2, No. 2, 1973) can be obtained for classroom use from the ISPE Executive Editor. Each figure is printed on high quality bond stock, taken directly from the original 8½ x 11" offset mechanical.

Cost is 2¢ per sheet + 25¢ per order up to 100 sheets (any mixture of the three figures) or 1½¢ per sheet for orders over 100 sheets. Order from:

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ASTRONOMY EDUCATION RESOURCES

conducted by George Reed, *West Chester State College (PA)*

The Astronomy in Project Physics

Introduction

Project Physics is one of the two major, secondary school, curriculum projects that has included a significant amount of astronomy in its finished product. Project Physics is an introductory one year, high school, physics course that attempts to develop an understanding of the relationship between "pure physics," the other sciences such as astronomy, and the humanities. The course follows a philosophical and historical trend to present a sequence of physical concepts concerned with the production of a successful scientific theory and model within a humanistic and social context. Project Physics is based upon Harvard Project Physics, a national curriculum improvement project that was first funded in 1964. The course was developed by scientists, historians and educators under the direction of such notables as Gerald Holton and Fletcher Watson.

Student Text

Unit Two of the "student guide" is concerned with "Motion in the Heavens." Chapter 5, "Where is the Earth? – The Greeks' Answers," reviews the major observations which any theory had to explain. The underlying assumptions of the Greek model and the mechanisms used to "save the phenomena" are inspected. An effort is made to explain the philosophical thought that created the Greek model. Chapter 6, "Does the Earth Move? – The Works of Copernicus and Tycho," emphasizes the need for precise observations and the philosophical implications of the Copernican model. Tycho's compromise system is also presented for evaluation. Chapter 7, "A New Universe Appears – The Work of Kepler and Galileo," discusses the relationship between science and freedom. This discussion goes beyond the Galileo trial right up to the burning of Einstein's works because of his Jewish heritage. Chapter 8, "The Unity of Earth and Sky – The Work of Newton," discusses the assumptions behind the Newtonian model and the proofs offered for that model.

The text or student guide functions to develop the main concepts of the unit and to establish logical relationships among the concepts. This is successfully accomplished with the use of numerous pictures and diagrams. Questions and problems are in evidence both within each chapter and at the end of each chapter. The answers are given at the end of the unit. Extensive use is also made of related quotations from such figures as Dante and Milton. The text will provide enjoyable and informative reading even to those familiar with the history of astronomy.

Student Reader

The student reader is an outstanding collection of articles of different types by authors of both the present and the past. The articles run the gamut from historical manuscripts to science fiction. The authors range in time from Galileo and Copernicus to Isaac Asimov and Arthur Clark. The student reader is highly recommended for anyone with an interest in astronomy.

Laboratory Exercises

The laboratory exercises and materials for Unit Two of Project Physics are uncomplicated, inexpensive, historically significant and conceptually challenging to students. The exercises and materials are specifically designed to complement and reinforce the text materials that deal with the historic problem of the motions of the planets. The exercises can be adapted to any astronomy program and at a large range of levels. The possible uses of these laboratory materials with the planetarium will be obvious. The laboratory exercises are outlined below:

E14, "Naked Eye Astronomy" – The purpose of this exercise is to familiarize the student with the continually changing appearance of the sky. Long term observations of the sun, moon, planets and stars are suggested.

E15, "Eratosthenes' Method of Determining the Size of the Earth" – An astrolabe ($3.95) is used to measure the altitude of a selected star when it is on the meridian at two different earth positions, 200 miles apart on the same line of longitude. The circumference of the earth is determined by use of a ratio treatment of the data. The two observations are arranged by correspondence between two schools separated by the required distance.

E16, "The Height of Piton, A Mountain on the Moon" – Using a Lick Observatory photograph of Piton when it is near the terminator ($3.00/set of 2 different moon halves), the height of the "slab-like pinnacle in an otherwise flat area" is determined using a similar triangle technique. The exercise is a demonstration of the use of indirect measurement in Astronomy.

E17, "The Shape of the Earth's Orbit" – A filmstrip of the sun ($3.45), taken from U.S. Naval Observatory photographs, is used to measure the relative diameter of the sun at different times of the year. Relative distances are calculated from the relative diameters and the positions of the earth are plotted. The points are connected with a smooth curve to obtain the shape of the earth's orbit.

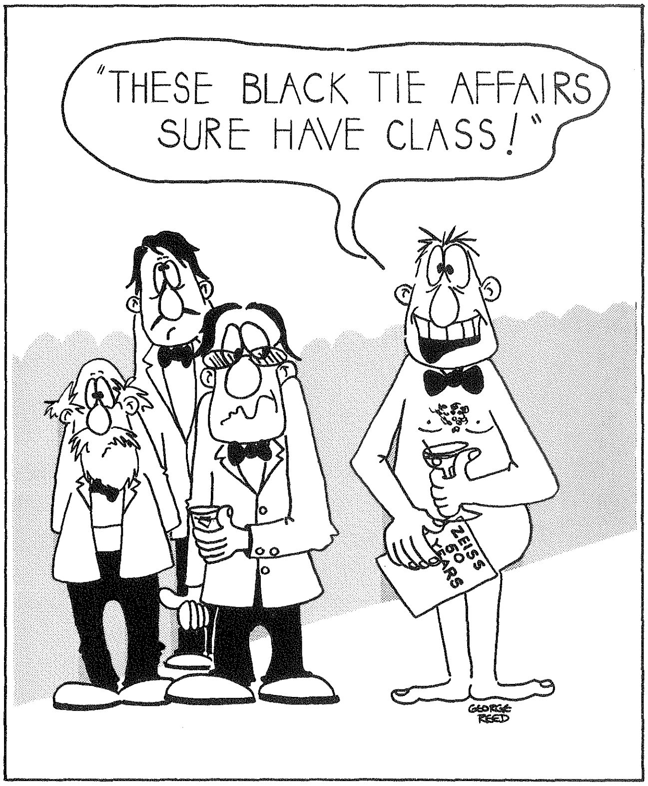
E18, "Using Lenses to Make a Telescope" – An assortment of tubes and lenses ($12.35) are used to examine the properties of single lenses and to form a ten power or thirty power astronomical telescope.

E19, "Kepler's Method of Determining the Orbit of Mars" – Unretouched photographs of Mars, in booklet form ($8.25/set of 16 books), and coordinate overlays ($8.25/set) are used to determine the ecliptic longitude and latitude of Mars for eight pairs of observations separated by 687 days (sidereal period of Mars). The two lines, for each pair of observations, drawn from the earth to Mars are used to determine eight positions on the orbit of Mars. The eight positions are plotted and joined by a smooth curve to provide the orbit of Mars.

The geocentric longitudes of Mars are transferred to heliocentric longitudes and plotted to obtain the inclination of the orbit of Mars.

E20, "The Orbit of Mercury" – The orbit of the earth from E17 and a table of ten eastern and western elongation dates and angles are used to determine the direction of lines that are tangent to the orbit of Mercury. The shortest lines between the tangent lines and the sun are used to determine ten orbital positions. A smooth curve is drawn through the determined positions to obtain the orbit of Mercury.

The materials needed for the above laboratory exercises, as well as excellent, related super 8 color film loops and transparencies, may be obtained from Holt, Rinehart and Winston, Inc., 383 Madison Avenue, New York, N.Y. 10017.



LETTERS — *Eclipse Day (continued)*

We had a day ashore at Dakar, Senegal. Bus trips took us to native markets and out into the countryside. The land is desperately dry, with stony hard soil. It lies under a terrible drought. I saw nothing being cultivated. Unless food is quickly distributed to these people, they will perish.

A Senegalese dance troop performed aboard ship. Both men and women were draped with costumes only about their hips. During the show a small girl about 4 years old came to stand beside me where she could see better. She was a fragile china doll, yellow hair tied with a ribbon, long dress and white patent shoes. She watched intently awhile, then turned excitedly and pointed, "Look at them, look at them — they have no shoes on."

July 5th several of us were standing along the port rail photographing the sun's trail across the sea just before sunset. The sun abruptly swung about 110° along the horizon towards the stern. Well, not really. The ship smoothly altered course in response to a medical distress call from an American merchant vessel. Shortly before 2:00 a.m. the ships met and in half an hour the patient was transferred across the dark sea via our accident boat to our sick bay.

Not the least bonus of the eclipse trip was the pleasure of seeing friends from the four other totals I've observed and renewing friendships with astronomy club members from several states I've called home. Planetarium types were out in full force. Safe to say half the planetariums in the United States will be running an eclipse show shortly.

We were a wacky bunch in the opinion of the officers. Why else would we turn the dance halls and lounges into classrooms for two weeks, lug telescopes to the observation deck for hours of glorious stargazing, fish for Sargasso weed, tape slides to the wind screens and invade the radio room for satellite weather reports? We were the despair of the social director as we enjoyed ourselves examining each others' equipment instead of playing deck tennis. As the radio officer said, "We'll be bloody glad to get our ship back from this bloody bunch." Where will I be when other eclipses roll around? Hopefully, right on the central line. Each eclipse is unique. If you've seen one, you haven't seen them all. Make your plans now for 1974.

Dorothy E. Beetle
Norwood, Ohio

Contact!

by Tom Gates

The temperature of solar flares is estimated at around 100 million degrees ABS. How is it possible for this temperature to sustain itself over the life of the solar flares while the surrounding is at a low temperature of only a few thousand degrees ABS?

Thomas Tsung
Dept. of Physics and Astronomy
Grossmont College, El Cajon, CA

The temperature of solar flares is indeed very much higher than that of their surroundings. This in fact is why they only last a brief period of time. The energy loss in flares is almost completely determined by radiation losses and by the loss of the energetic particles through the cooler surrounding medium. The only factor which helps insulate the flares to a certain degree is the magnetic field, but the energy of the flare is indeed very rapidly dissipated to the surroundings. However, so much energy is released, that this normally takes several minutes, and in the case of a great flare even hours.

Harold Zirin
Big Bear Solar Observatory
California Institute of Technology
Pasadena, CA

Editor's Comment:

A number of planetarium directors have requested information on the availability and supplier of the program "The Jupiter Pioneers." When first made available about a year ago, it was in such demand that a large waiting list formed. That waiting list has now been serviced and copies are in stock now. Write to:

Educational Programs Office
NASA Ames Research Center
Moffett Field, CA 94035

Also, the Space Science Center, De Anza and Foothill Colleges, 12345 El Monte Rd., Los Altos Hills, CA 94022, is forming a planetarium program archives in the archives section of the complex. Already some 100 programs from various planetariums, mostly Minolta, Foothill, and Morrison, are on file, although Don Davis of the Manitoba Planetarium, and Mike Schwitters of the Air Force Academy Planetarium have contributed generously also.

Eventually we hope to have enough material to send scripts or outlines for almost any subject. Dale Etheridge has further suggested keeping tapes and graphics which are submitted. We will place into the archives any material you send, so please contribute. Also you may request materials on a given subject.

You will be charged only for the cost of materials and labor for scripts and outlines. If your cost has a limit of expense, state that limit. In such a case we will send you the better materials available in that category.

CONTACT! is our Question-Answer column. There are no holds barred on questions or requests for help, providing they are related to the legitimate purposes of this journal, and the Editor will send a researched reply to every letter sent him even though space may prohibit its being used in the column. So CONTACT: Mr. Thomas Gates, Space Science Center, 12345 El Monte Rd., Los Altos Hills, Calif. 94022.

AZP (a'·ze'·pe'), noun, acronym for Automatic Zoom Projection. 1. More properly a system for planetarium slide projection, hence AZP System. 2. Consisting of a collection of devices, a) to project slides, b) to zoom their images, c) to do so with automatic compensation for light level vs. image size. 3. A unique system designed especially to dramatize modern planetarium presentations.

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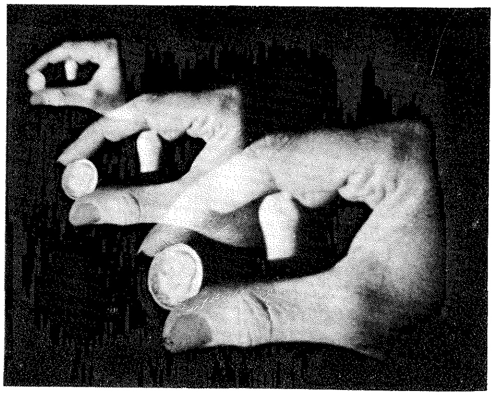

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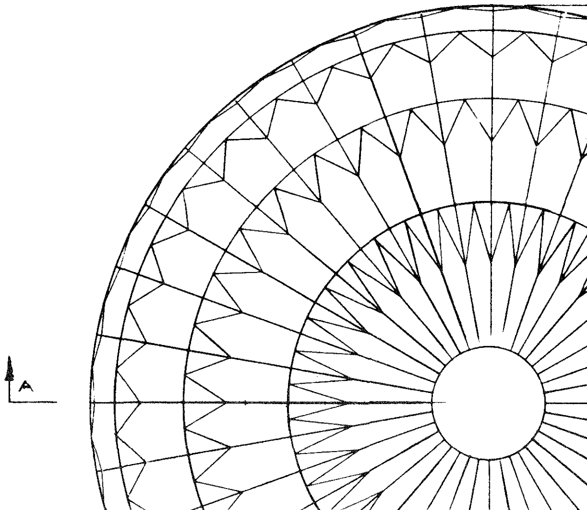

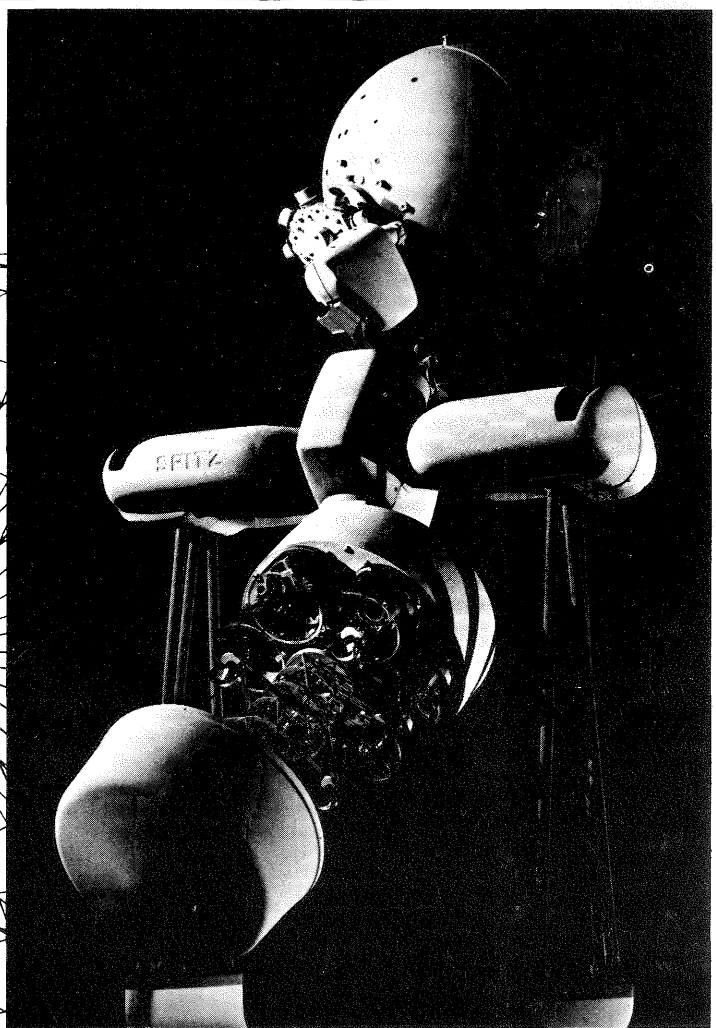

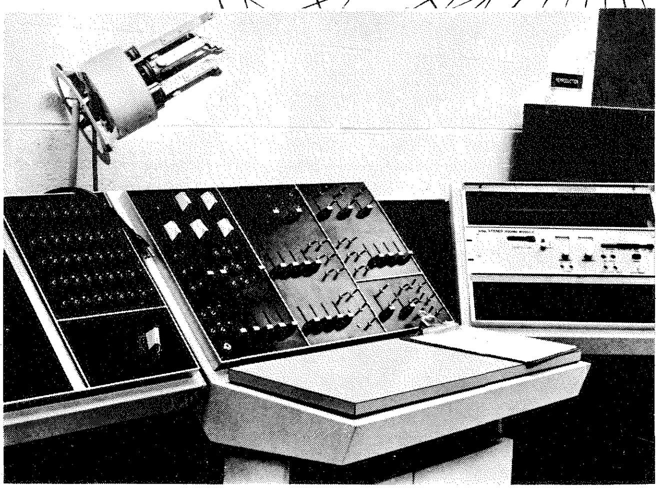

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