NOVA NOTES

BI-MONTHLY JOURNAL OF THE HALIFAX CENTRE

1975
VOL 6
NO 3
MAY JUNE

THE ROYAL ASTRONOMICAL SOCIETY OF CANADA
252 COLLEGE ST. — TORONTO, ONTARIO
M5T 1R7

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NOVA NOTES are printed six times yearly (Jan., March, etc.) through the courtesy of the Nova Scotia Museum. Contributions on any aspect of astronomy are welcomed from non-members and members of the Halifax Centre. Closing date for contributions to the July issue will be June 7 and the issue will be ready for General Assembly 1975, so pick yours up there!

CONTRIBUTORS: R. Bishop, D. Brooks, D. Burleson M. Cunningham, D. Dupuy, P. Gredley(Vancouver Centre) P. Edwards, P. Reynolds, W. Zukaukas

UP COMING MEETINGS AND EVENTS:

MAY 23, 8:00 PM at the Nova Scotia Museum, Summer St. It has been some time since we have had someone tell us about telescope mirror grinding. This is especially for our newer members but those who have been with us some time may be prompted to start one as well. Perhaps we may even have enough interest to start a mirror grinding group--there are five in production in the centre at the moment ranging from $4\frac{1}{2}$ to $12\frac{1}{2}$". Bill Sheppard, Roy Bishop, and Foster Beveridge will each describe their experiences in various aspects of the grinding process. Order your blank now--you'll want to start it May 24.

JUNE ?? Orientation for GENERAL ASSEMBLY 1975

Minutes of the March Meeting

The March meeting of the Centre was held on Friday, March 21 at 8:00 PM in the Nova Scotia Museum.

Dr. Bishop opened the meeting with some general comments on current astronomical events including a summary of arrangements which have been made for the General Assembly 1975 to be held in Halifax this summer.

This was Members' Night and we were delighted that so many of our members brought along a selection of their favourite slides to show us. I have listed below the speakers and their topics; hopefully, I have not left anybody out! Walter Zukauskas performed ably throughout the evening as projectionist.

R.L. Bishop (the planets as seen by the Mariner and Pioneer spacecraft)

R.C. Brooks (viewing from Mount Kobau, B.C.)

P.E. Edwards (constellations as viewed from Bedford)

R.M. Cunningham (Copernicus stamp collection)

J.S. Hall (assorted deep-sky objects)

S. Williams (astronomy in Nature)

W.P. Zukauskas (meteorological topics)

This was certainly a highly successful meeting, and of a type that I hope will be repeated in the not-too-distant future.

Refreshments were served as usual.

P.H. Reynolds
Secretary

Minutes of the April Meeting

The April meeting of the Halifax Centre was held at the Nova Scotia Museum at 8:00 PM, April 25 and was attended by a large group.

The proceedings were opened by Dr. Bishop who made announcements concerning the General Assembly Registration packets and the Toronto Centre's Sky Brightness Program. He then introduced Reid Dexter who has to be one of the most entertaining weathermen around.

Mr. Dexter's well presented talk described how and why weather patterns are caused. Pressure gradients, which he likened to hill contours, are created by differential heating across a large area where terrain and land and water proximity cause the air to warm or cool at differing rates. The air then begins to move in the direction of decreasing pressure but the Coriolis force (resultant force of the Earth's rotation from west to east) increases as the wind velocity increases causing the wind velocity and direction to reach an equilibrium along the lines of equal pressure.

He then described how precipitation patterns can be predicted by considering the usual weather map and the verticle cross section of highs and lows. The professionals use wind directions at 18,000 ft. (height at which half the air mass is above and below) superimposed on the surface map to predict directions and velocities of pressure areas. Cold air moving south and warm air moving north have set up the jet stream encircling the globe in a wavy pattern with 4 to 6 lobes. This pattern may persist for months if large storms do not destroy the balances that exist , and as a result weather may not change for some time. He concluded with a few suggestions where astronomers should go for good clear steady skies--the Artic! An active question period followed.

Refreshments--no--cookies were served. Wonder who forgot to switch on the coffee pot? Sherman Williams then presented several excellent slides of the recent Venus-Jupiter conjunction. Incidently, more than 50 people phoned the Observatory at SMU that night from Sable Is. to Kentville. Finally the long range forecast for the summer looks good if the jet stream doesn't move.

Bk

Editor's Page

Hi! it's me again...along with Nebulous,"Hi..." as a guest editorialist, (Earl Cameron;eat your heart out!!).

Well,were are they all? I mean all those articles. Just 'cause I'm not there to brow beat you intc submitting articles doesn't mean Randall can't...brow beat! You know,word's out;your editor is a graduate of 'Sam Ervin's Brow Beating School'.

Let's remember that Nova Notes is the monthly bulletin OF the Halifax Centre and not the monthly bulletin For the Halifax Centre. It is all that YOU make it and nothing more.

On the notice board...

Things are really starting to happen fast in the mail rooms ('post office') of the General Assembly Committee. We are recieving mail on four fronts as it were; 1)general correspondance,2)paper sessions, 3)gereral attendance and 4)displays.

Nebulous has been invited to a masquerade and he was wondering if any of you had a UFO costume that you would lend him. If so, please get in touch with him as soon as possible... He wanted to write this ad in poetry,but I realized the poor Editor had to proof read this stuff.

Keep those letters and cards comming, some of them are bound to reach us sometime!

Peter Rawards
The Vice-President!

P.S.

WOW! That title is even longer than my name!

(Ed. note) We're going to have to keep an eye on the V-P if he gets swell headed over a title--threaten to make him editor again next year perhaps!

ATLAS REVIEW--I

The revised and expanded Norton's Star Atlas, published in 1973, contains many improvements over the older edition. The entire book is easier to read due to the larger print and is more clearly organized with large stand-out headings and a new table of contents all of which make it easier to use at the telescope.

The planets, sun and moon are more thoroughly covered with 18 pages as compared with a meagre four pages in the old Norton's. There's even a short section on artificial satellites. The astronomical photography section also contains more detailed information on exposure times and techniques and types of film to use.

The moon map has been infinitely improved. The old Norton's contains only a small gray sketch while the new book has a large semi-colour, finely detailed drawing. There's also a map (earth based) of Mars with coordinates of major features. Diagrams are more abundantly used throughout the book and aid considerably in clarifying the definitions and descriptive notes on technical terms. The descriptive material has been corrected and updated to reflect the changing thoughts of astronomers since the 1959 edition. By the way, this most popular atlas was first published in 1910. Arthur P. Norton, the original author, died in 1955 and subsequent editions have been rewritten by J.G. Inglis but the 1973 (16th edition) was revised by G.E. Satterthwaite, Patrick Moore and R.G. Inglis.

Many more objects are listed for viewing--700 in all--and marked on some 15 charts which now show 9,000 stars. Curiously, the Orion Nebula has been omitted from the list of interesting objects for maps 5 and 6. This list also gives an incorrect position for M1, the Crab Nebula, and neglects to identify NGC 869 and NGC 884 as the double cluster (h and χ) in Persei. It is hoped that new printings will correct these oversights and errors.

All in all the new NORTON'S STAR ATLAS offers 64 more pages of interesting and useful tidbits. This is an excellent reference for the beginning astronomer or the inexperienced observer as well as the more avid nite-hawks among us.

Diane Brooks

Registration material for the General Assembly has been passed or mailed out to all members of the Halifax Centre. If you have been overlooked please call David Dupuy at 422-7331 ext 313, and he will ensure you get a packet. Please note the deadline for sending registration fees.

The Toronto Centre has set up a 'Sky Brightness Program' to monitor light polution around Canadian cities. This involves building a photometer, calibrating it, making measurements in different parts of the city then ploting contours. The measurements will then be compared for all cities. The booklet describing the photometer construction etc is available free from Robert Pike, 2515 Merrington Cres., Mississauga, ONT., L5K 2B8 or I can get you a copy for 60¢. Unfortunately it is too long to publish here in full although parts may appear if there is sufficient interest. It will be available for perusal at the May meeting.

The Planetarium of the Manitoba Museum of Man and Nature requires an Assistant Planetarium Director. Duties include planning, writing,recording and production of shows and general advisory activities. Experience on the staff of a planetarium in the above lines is a prime consideration in filling the position. Apply to Mr. B. F. Shinn, Planetarium of the Manitoba Museum of Man and Nature, 190 Rupert Ave., Winnipeg MAN. R3B 0N2

We are hoping to keep meetings going through the summer this year. As last year there will be an observing session and a repeat of the Messier contest will probably be part of the activities. Start dusting off your telescope and practice picking out M87 and M82. Then go from there. Last years contest I heard was difficult to judge because everyone was helping the other guy find the object. If you haven't had a telescope in the country lately don't miss this!

AMATEURS IN THE COMMUNITY

Local Elementary School teachers and youth group leaders are looking up these nights, and finding that they live beneath a sky full of lights they know nothing about. As part of a program to encourage awareness of the natural world, the Education Section of the N.S. Museum is promoting certain badges among Guide and Scout groups-- one of these is the "Astronomer's" badge. We supply learning materials like celestial globes, charts, and books, but with limited manpower (one person) we can't meet the requests for help. Remember how bewildering the stars were the first time you looked for constellation patterns? How you could never get the chart twisted quite right? Many girls and boys, ages 9-14, are just now beginning to struggle with the night sky. We as amateur stargazers can help in two ways:

1. Spend half-an-hour with 4 or 5 children to point out signposts in the sky, to help them get oriented.
2. Be a "tester"-- examine the child's astronomical knowledge by having him or her point out stars and star groups, describe the solar system, the seasons, etc.

No regular commitment is requested. Just let me know that you are willing to spend half-an-hour some evening of your choice, near your home, with a few of these future astronomers. To volunteer or if you would like more details, please contact;

Debra Burleson
Assistant Curator of Education
Education Section
Nova Scotia Museum (429-4610)

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NEW MEMBERS of the Halifax Centre:
Larry Bogan, Ralph Bosun, G.F. Burton, Larry Coldwell and David MacDonald

Some and only some of the most interesting articles which have been printed in other newsletters from centres across the country are reprinted here. Most often these will be articles telling of activities of other groups but occasionally it will be a particularly interesting article--as it is this month. If you would like to read some of those other interesting articles ask to borrow them from the editor.

THE MOONS OF MARS

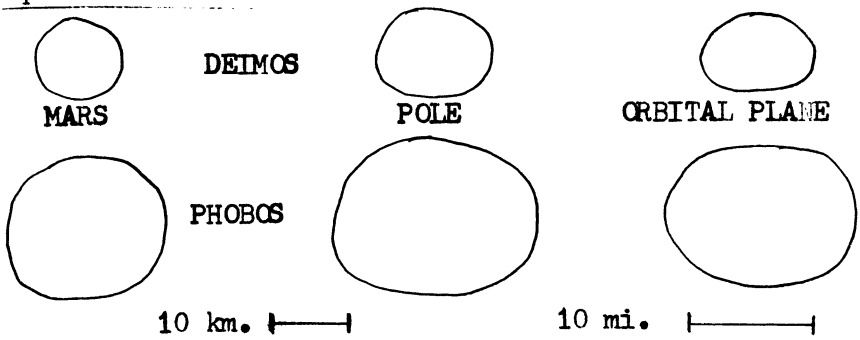
The planet Mars has two moons. They are called Phobos and Deimos. They are much smaller than the Earth's moon and are, in fact, so faint and close to Mars that they can only be seen in an amateur telescope with great difficulty. G.P. Kuiper, using the 82" telescope at McDonald Observatory, estimated their magnitudes to be 11.6 and 12.8 at the 1956 opposition of Mars. Until very recently, little was known about these moons. Then Mariner 9 went into orbit around Mars.

Mariner 9 took 32 high resolution television pictures of Phobos and 9 of Deimos. 27 of these pictures were used in preparing the map shown in Fig. 2. The pictures are shown, after computer processing to increase the contrast, in a paper in the October 1974 issue of ICARUS International Journal of Solar System Studies. This is number 2 of volume 23. There are nine authors, the first of whom is Joseph Veverka. Consequently, the paper is referred to as "Veverka et al". That article is called "A Mariner9 Atlas of the Moons of Mars". In this article I would like to review the contents of that paper for those of you who do not have access to a copy of ICARUS. (ed. note-- ICARUS can be found in the MacDonald Science Library at Dal)

Coverage of Phobos is much better than that of Deimos. Both Phobos and Deimos rotate on their axis in the same time as they revolve around Mars. Just like the Earth's moon, they always point the same face at Mars. Phobos revolves 6000km above the surface of Mars, Deimos is 20,100km above the surface of Mars. Mariner 9 varies

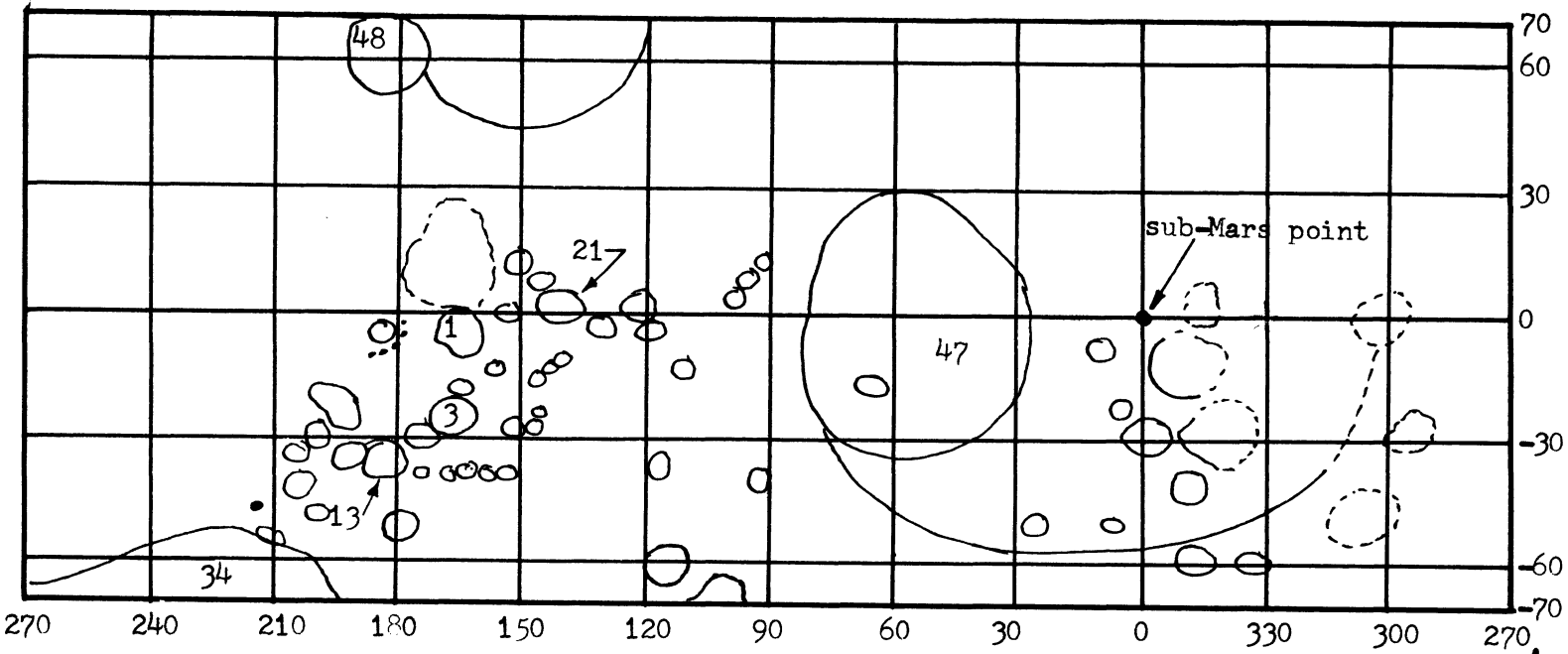
between 1650km and 12650km above the martian surface. Since Mariner is always between Deimos and Mars, it cannot see the "dark side" of Deimos, just as we cannot see the "dark side" of the moon. The photographs taken cover about 50% of Deimos and 80% of Phobos.

Phobos and Deimos are not round. They are too small for gravity to have pulled them into a spherical shape. They are quite irregular but are nearly triaxial ellipsoids. This is just a shape that looks elliptical whichever direction you look at it from, but is a different sized ellipse from different directions. In Fig.1 I have shown pictures of Phobos and Deimos as seen from three directions, to show how big they are. These pictures are on a scale of 1km/1mm. The moons are shown as seen from Mars, from above the pole, and from the orbital plane of the moon.



Neither Phobos or Deimos is nearly as smooth as the three view drawings suggest. Unfortunately a photograph cannot be properly reproduced in NOVA (NOTES). Therefore you are urged to look at the photographs in the journal if you can. For example, The crater Stickney looks like a big bite taken out of Phobos.

As well as showing all the pictures of the moons of Mars, Veverka et al shows a map that was drawn using the photographs. This map of Phobos has been reproduced in Fig.2. Kepler Ridge is believed to be a crack in Phobos caused by the tremendous impact that created Stickney crater. All the other features shown on the map are craters. Another paper in the same issue of ICARUS shows how this map was produced from the photographs. Dashed lines on the map show features that are thought to be there but



MARINER 9 MAP OF PHOBOS

are not shown well enough on the photographs to be certain. The I.A.U. Subcommittee on Phobos-Deimos nomenclature, whose chairman is Carl Sagan, and one of the authors of Veverka et al., has approved two crater names on Deimos. They are Swift and Voltaire. The subcommittee also approved several crater names for Phobos:

map no.	crater name	map no.	crater name
1	Todd	34	Hall
3	Sharpless	47	Stickney
13	D'arrest	48	Roche
21	Wendell		

Peter Gredley
(from NOVA, Vancouver Centre)

Peter and I shared an office when we worked as summer assistants in Victoria some time ago, and the last time I saw him he was working on a PhD at Western Ontario so I was interested see ing his name again. Editor

GENERAL ASSEMBLY 1975

HALIFAX

June 27,28,29

Speakers	Banquet
Paper Sessions	Buffet
Displays	Sherry Party
Observing	Peggy's Cove
Bluenose II Tour	
Haligonian Tour	

Reserve this weekend and help us extend a warm welcome to our guests coming from St. John's to Vancouver

THE ALL-PURPOSE HALLEY

Edmond Halley was one of those rare creatures who could make commendable progress in almost any field of science. In fact, so remarkable were his scientific achievements, both in astronomy as well as in other fields, that he was widely hailed as one of THE outstanding scientists of his day. (Astronomers were evidently held in higher esteem by governments in those days; Galileo and his lifelong government pension for his development of the telescope for military purposes comes to mind also.)

First, a quick look at Halley's astronomical prowess, which was impressive to say the least. His love of astronomy began early, as seen from the preface of his Catalogue of the Southern Stars: ". . . from my tenderest youth I gave myself over to the consideration of Astronomy . . ."[1] In 1673, at the age of seventeen, he began to study at Queen's College, Oxford, and he pursued astronomy with even more zest. A few years later, he described this period with: "My study was so intense that I read through and found out in a short time every hidden fact in that Science (astronomy) that is unknown to the general public."

Halley's earliest interest was in observations of the planets, presumably since there was still some controversy about planetary motions. When he was eighteen, Halley wrote to the Astronomer Royal, John Flamsteed, to communicate the results of his observations. His competence was reflected in "I can confide to one minute (of arc) without error by means of the telescopicall sights and skrew for the subdivision of my Quadrant . . ." Indeed, Halley's observations were accurate enough that he soon wrote to Flamsteed that he had found errors in Tycho's famous catalogue!

Halley's first paper was published in 1675 (age 20), and was "a brilliant mathematical feat" in the area of planetary orbits. He left Oxford to spend a year and

[1]This and other quotes from Edmond Halley, by C. Ronan.

and a half on the island of St. Helena, compiling observations with a 24 foot telescope for his mammoth work entitled A Catalogue of the Southern Stars (the full title has 103 words!). His recognition of the need for such a catalogue, and his perserverence in obtaining the observations are astounding. He wrote: "I did not go to bed when I could see the Sky was in a state to permit study." How many graduate (let alone undergraduate) students do you know with that kind of determination?

That Halley is famous for his work on comets is known by most. But probably the most valuable contribution to astronomy was the realization that the transits of Venus could in principle, yield a value for the astronomical unit. He had observed a transit of Mercury while on St. Helena ("...obtained .. the very moment in which Mercury, entering the Sun's limb, seemed to touch it internally ... without an error of one single second ..."), and this led to the development of the method (1716) and his encouragement that younger astronomers would not fail to take advantage of the upcoming transits. Although the eventual results were disappointingly inaccurate, it is fair to say that the observations were valuable and that the incredible effort involved in getting around the world in those days would never have taken place, had Halley not realized the importance of the method.

Well, what else did Halley do? Incidently, you should impose corrective measures on anyone who pronounces Halley to rhyme with Bailey! Legal papers of that day were written phonetically as 'Hawley' or as 'Hall-ey'. Probably his most far-reaching but little-known efforts were in his influence in the publication of Newton's Principia. Newton first became known to Halley after the Royal Society asked Newton to build for them one of his newly-developed reflecting telescopes. Some controversy about Newton's theory of light then arose, and Newton became even more reticent about defending his new theories, even though his brilliant mathematical reputation was well established.

Halley eventually went to Newton for help in the proof of the gravitational inverse square law (which Newton quickly came up with), and the two men became good friends. In fact, Halley quickly appreciated the breadth of the theory he and Newton discussed. Eventually Halley persuaded Newton to organize and publish his theory with geometrical proofs (Newton's fluxions were virtually unknown as yet and would not have been considered as adequate proof). Halley acted as a go-between, with the reluctant Newton on one side and the Royal Society on the other. With his intense desire to see Newton's work published, Halley agreed to oversee all of the printing details, undertake the correction of proofs, and even pay all publication costs! Newton came to have great confidence in his friend, and wrote to Halley: "...I am very sensible of ye great trouble you are in at this business, & ye great care you take about it." In the preface, Newton wrote: "In the publication of this work the most accurate and universally learned Mr. Edmund Halley not only assisted me in correcting the errors of the presses and preparing the geometrical figures, but it was through his solicitations that it came to be published ..."

Finally, a look at Halley's non-astronomical endeavors. One of his larger forays was in the area of deep sea diving. In 1691 Halley published four papers relating the results of his experiments in this subject. In short, Halley suggested a cylindrical container, open only at the bottom, so that when lowered into the water the trapped air would slowly be compressed and keep the water out. One could wear this contrivance while walking around on the sea floor. To overcome the problem of the air compressing so much that water would rise too high, Halley suggested sending down "barrels" of compressed air, which would be transfered to the diving bell. It worked! But the procedure of introducing more air had to be repeated for every 15 feet of new depth--slow business, indeed. Later models weighed up to 1 3/4 tons to ensure that they did not float, and some refinements appeared, e.g. a bench inside the bell "...for the men below to sitt on when

they should be cold and whereon a man might sitt with all his clouths at any depth drie." A valve in the top of the diving bell let out the "...hot and effete air unfitt for further respiration."

Most of Halley's non-astronomical persuits had to do with the sea--not surprising in view of England's facility with the oceans and the lucrative contracts with the Admiralty. Halley made numerous experiments with magnets, compasses, and the earth's magnetic field. At one point, he concluded that the earth had four magnetic poles, which would explain the secular variation of the magnetic poles on the earth; he thought that two of the poles might be imbedded in the inner, slowly rotating core. Halley first proposed lines of equal magnetic variation, which became known as Halleyan lines. He also wrote many papers on the workings of barometers and the Trade Winds. He dipped into an analysis of the composition of seawater, and the behavior of sea mussels and cuttlefish. Not surprisingly, all of this and his love of travel led to his commission as captain of one of His Majesty's ships.

Unfortunately, his crew disliked working under a non-seaman, and they mutinied. After arresting his first mate, Halley successfully "...brought the Shipp well home from near the banks of Newfound Land, without the least assistance from him," and arrived home "... having buried no man during the whole Voiage and Shippe being in very good condition." The redoubtable Mr. Hawley went on to command two more voyages, mapping magnetic variation in the Atlantic from latitudes of +60° to -59°!

David L. Dupuy

(Reprinted from Casseopeia)

Why not give a paper yourself at the Assembly? Papers are generally 10 minutes in duration. Submit an abstract to David Dupuy at SMU not latter than JUNE 1

1906 and 1982

What do 1906 and 1982 have in common? You don't know? Not much really except 1906 was the year of the great earthquake in San Francisco and 1982 is the year that Drs. John Gribbon and Stephen Plagemann are predicting a possible repeat. This is one of the possible consequences of the grand allignment of the planets which is to occur in 1982 and which was studied by the two as graduate students at Cambridge beginning in the 60's. The former is now one of the physical sciences editors at NATURE and the latter is with NASA at Goddard Space Flight Centre. The result of their efforts is a book entitled "THE JUPITER EFFECT" which has been receiving considerable attention lately especially in the press.

In 1982 all 9 planets will be lined up on the same side of the sun (this happens every 179 yrs.) and this the authors suggest will trigger, if it doesn't happen before, a series of earthquakes along the major fault areas around the earth including the famous San Andreas Fault in the Los Angeles-San Francisco corridor. First some quick calculations. Determine the mass of each of the planets in earth units (Earth=1) and the mean distance from the Earth to each planet at opposition in AU's. Determine the quantity M/d^2 for each. You will recognize this as part of the Universal Gravitation Law and alone means little. However, if one now calculates the balance of forces from the planets closer and those further from the sun than the Earth the net resultant is 8.6, the direction being towards Jupiter. Well is this sufficient difference to cause the effects they predict? I am certain it is not! If one now calculates M/d^2 for the moon the result is 1864 so 8.6 is only 0.0046 and quite insignificant. Therefore we must look further to see what forces are at work to cause such effects on the Earth.

Gribbin and Plagemann quote recent findings from solar and planetary astronomy, geophysics and meteorology to support their claims. Many of you will remember the spectacular solar flare and aurora of August 1972. It has been determined that the Earth's rotation slowed by 1/1000 of a second as a direct result of the interaction of the Earth's magnetic field and the increased solar wind. Evidence from the solar activity in the 1950's

indicates increased numbers of earthquakes in the geologically unstable areas. These little bits of information alone prove little but they also note that if one correlates the dates of major quakes in the 50 mi. radius of San Francisco since 1836 then one finds they all occured within two years of maximum solar activity.

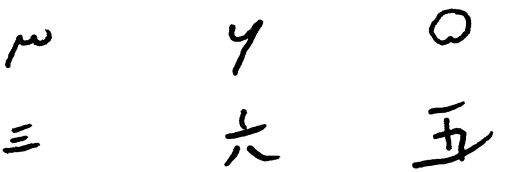
The planetary allignment in 1982 will have the following effects according to the two authors. The line-up will cause greatly increased solar activity on the sun which will be near solar maximum (actually I believe this is not the case since we are just now beginning a new cycle and 1982 will only be 7 yrs into this cycle). These huge sunspots and solar flares will, like all solar activity on such scales, affect the upper atmosphere creating aurora, creating havic with radio communications and according to them the most important--creating massive disruptions in global weather patterns. This latter effect will be most pronounced by sharply altering wind directions in the upper atmosphere and as a result of the wind shifts, rainfall and temperature patterns. Some have postulated that similar mechanisms may have caused the severe drought through Africa and parts of India in recent years. But more important than rainfall and temperature changes will be the effect of the friction exerted by atmospheric circulation on the earth's crust. This they say will be sufficient to trigger earthquakes because of the alteration in the braking exerted on the crust. Areas under severe geological strain will, when applied the necessary kick, relieve the strain--"there will be many earthquakes, large and small" say Gribbin and Plagemann. Certainly these predictions will be controversial among scientists but personally I'll not be wearing my hard hat to bed waiting for the results of the apocalypse.

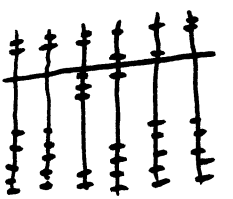
R.C. Brooks

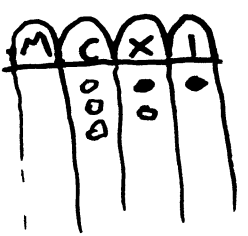
GENERAL ASSEMBLY 1975 rates a Special Issue of NOVA NOTES--the more articles the better so why not get the quill out and scribble down a contribution now!
Closing date--JUNE 7

HAVE YOU READ ?

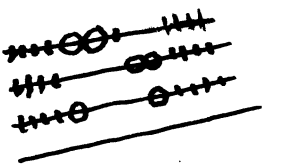
Number words and number symbols- A cultural history of Numbers by Kark Meninger Published by M.I.T. press Now I have never before put in a book in this series but this is one exception because this is such an enjoyable book for anyone who may be amused by mathematics. Why twelve? Did Fibonacci count with his fingers? How to youcalculate pi to several significant figures if you have only Roman numerals for numbers?







TGE



CCCLXV

All the same number

RMC

(365)

HAVE YOU READ?

SCIENCE Jan 24th p 244

This deals with the atmospheres on planets and shows how unique the situation on Earth is.

SCIENTIFIC AMERICAN Feb p 30

Imagine the primordial disc that became the Solar System. Now the clue to the condensation of the solid objects we know is found in the asteroids. The type C1 chondrites seem to have many of the answers to the state of affairs at the time of condensation. So do rush out and find another meteorite.

SCIENTIFIC AMERICAN Feb p 42

The first photograph of a star other than our sun. The disc of Betelgeuse is shown with some detail admittedly after much computer enhancement but there is the disc. Now may I put in a plug for the pronunciation of this beautiful red star in Orion. I have it on the authority of the late Ruth Northcott long time at the D.D.O. and secretary of the Observer's Handbook that it is pronounced Beetle Juice !!

SCIENTIFIC AMERICAN March p 24

You just won't believe this, it is just too fantastic and please can we have an X-ray telescope. This article is just too delicious and will last all summer!

Murray Cunningham

Editor's filler

MERCURY Jan/Feb p 2

A good and reasonably simple review of the problem of the missing mass in the universe. The present measured value is about 1.5×10^{-31} gm cm^{-3} but if this could be raised to 5×10^{-30} gm cm^{-3} then the question of an open (steady state or one shot big bang) or closed (oscillating) universe could be answered. The missing mass may be in the form of background X-rays.

TELESCOPE RAMBLINGS

This spring, as last, I am enjoying following Pluto in its slow retrograde loop near the border between Virgo and Coma Berenices. On a black night Pluto is fairly easy to see with the 200 mm Newtonian at Maktomkus Observatory; however, without the finder chart from the February issue of Sky & Telescope, Pluto would be indistinguishable from a thousand other feeble points of light in the same region of the sky.

I shall present a calculation concerning the plutoshine which produced a weak but definite signal in my visual cortex. I found the results quite interesting and hope that anyone who ventures to read further will not be disappointed.

As is well known, for the human visual system equal intervals of brightness correspond to equal ratios of luminous energy; i.e. its response is logarithmic. Also, by definition, a brightness difference of 5 magnitudes ($\Delta m = 5$) corresponds to a luminosity ratio (L) of 100. Hence:

$$L = 10^{\frac{\Delta m}{2.5}}$$

The "solar constant", the electromagnetic flux from our Sun at Earth's location, is about 1.4 kW/m^2 (about one hotplate per backside at the beach!). The portion reflected by Pluto to Earth, the "plutonian constant" (pc), can be calculated with the equation above. The apparent magnitudes of Sun and Pluto are -26.5 and 13.8, respectively, so:

$$pc = 1.4 \times 10^{-\frac{13.8 + 26.5}{2.5}}$$

$$= 1.06 \times 10^{-16} \ kW/m^2$$

Assuming that Pluto has a uniform reflectivity (i.e. little or no wavelength dependence), this radiation will have the same spectrum as the Sun. Hence, although its peak lies near the middle of the visible spectrum, significant fractions of the energy lie in the ultraviolet and infrared regions. Also, due to the feeble signal, even the red portion will be invisible. (This is because only the rod cells of the retina are sensitive at low levels of illumination, and these cells are not sensitive to red light.) Thus perhaps only one photon in three has the proper energy to activate the retina. (A better estimate would involve an integration of the solar spectrum as modified by both the reflectivity curve of Pluto and the response curve of the rod cells. I do not have the necessary data, but an efficiency of 1 in 3 seems not unreasonable.) Thus:

$$\text{Effective pc} \cong 0.3 \times 10^{-16} \text{ kW/m}^2$$

Multiplying this by 0.75 of the area of the telescope mirror gives the power (P) entering my eye. (The "0.75" is to allow for a light loss of about 25% due to the diagonal shadow and two reflections in the telescope):

$$\begin{aligned} P &= 0.3 \times 10^{-16} \times 0.75 \times \pi (0.1)^2 \\ &= 7 \times 10^{-19} \text{ kW} \\ &= 7 \times 10^{-16} \text{ J/s} \end{aligned}$$

The energy of a photon of light of λ = 500. nm (about the optimum λ for rod vision) is:

$$E = h\nu = h\frac{c}{\lambda} = 6.6 \times 10^{-34} \times \frac{3 \times 10^8}{500. \times 10^{-9}}$$

$$= 4.0 \times 10^{-19} \text{ J/photon}$$

Thus the number of photons entering the cornea of my eye per second is:

$$\frac{P}{E} = \frac{7 \times 10^{-16} \text{ J/s}}{4 \times 10^{-19} \text{ J/ph.}} = 1800 \text{ photons/s}$$

Of these, most are scattered and/or absorbed before they encounter a rhodopsin molecule in a rod cell. Measured values for the quantum efficiency of the human visual system fall within about a factor of 2 of a figure of 3% (ref: Jor. Op. Soc. Am. 64, 1706, 1974). i.e. About one out of every thirty photons arriving at the cornea is able to reach and trigger a rod cell in the retina.

Thus about 1800/30 = 60 photons per second are providing the dim, luminous twinkle in my consciousness which I call Pluto.

Roy L. Bishop

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STEADY STATE ASTRONOMY

Changing ideas in astronomy:

FROM: Zeitschrift fuer Astrophysik, April 1954
In 1952 Morgan, Sharpless and Osterbrock of Yerkes Observatory discovered the position and orientations of two spiral arms in the solar neighborhood of the galaxy. W.Becker and J.Stock of the Bassel Univ. and Warner and Swasey Observatories resp. have confirmed these results by studying 14 open clusters while the previous authors had used early type stars in emission regions. Three colour photometric observations were made for more than 800 stars in the clusters and by correcting for interstellar absorption the authors have been able to determine the distances to the clusters. A polar diagram with the sun at the centre clearly indicates the concentration of clusters to two nearly parallel sequences—the sun belonging to one and the other 2,000pcs distant. The new results indicate that our arm stretches at least 5,000pcs. The 1952 observations were the first confirmation of spiral arm structure in our galaxy but it was well known from observations of external galaxies that open clusters lie along the spiral arms which fact has been used in the present paper by Becker and Stock.

FROM: Physical Review Letters, April 1965
Neutron stars are the result of natural evolution of stars which have totally exhausted nuclear fuels at the end of its evolution. These collapsed stars would be about 10 miles in diameter, be as massive as the sun and would have a central temperature of 10^9 degrees k. X-ray radiation would be the only energy measurable assuming that the star does not cool too rapidly. This is the problem that Cal Tech astronomers J.N. Bahcall and R.A. Wolf have investigated. Their calculations indicate that depending on the manner in which energy is carried from the neutron star, the cooling rate may be 100 to 10^6 times faster than previously believed. If the latter figure is accepted then the X-rays would be emitted only for a matter of weeks after the collapse and the previos calculations that the radiation would continue for thousands of years are grossly incorrect. Fast cooling rates they say are inconsistant with the hypothesis that the Crab Nebula contains a neutron star.

A SPECIAL PULSAR

> "We wish to report the detection of an unusual pulsar discovered during the course of a systematic survey for new pulsars .... The object has a pulsation period of about 59 ms -- shorter than that of any other known pulsar except the one in the Crab Nebula -- and periodic changes in the observed pulsation rate indicate that the pulsar is a member of a binary system with an eccentric orbit of 0.3230 day period. Thus for the first time it is possible to observe the gravitational interactions of a pulsar and another massive object, and additional observations should make it possible to determine the masses of the two objects unambiguously."

With these words, R. A. Hulse and J. H. Taylor, both of Univ. of Massachusetts, introduce the object now known as PSR 1913+16, and remind us once again that binary star astronomy is a most exciting business.

Is it possible to derive the mass of this object? Hulse and Taylor have detected velocity variations for the pulsar component only. The classical theory tells us that unless both members of the binary are recorded the masses cannot be found. At best, the mass-function is all we can find, and this involves the masses of both components and the orbital inclination. Hulse & Taylor expressed hope that the other member would be a pulsar and be detectable, thus giving the masses of each. Of course, it would be exciting just having a double pulsar around.

A number of follow-up articles have emphasised different features of the system, much

attention being given to the unseen companion. Apparently, the system suffers apsidal motion, but not as much as might be expected if the companion were a normal star experiencing severe tidal distortion. Thus it seems that the companion is a"compact object" also -- a white dwarf, neutron star or possibly a black hole. If the companion were a normal star, it might be loosing mass to the pulsar, and appear as an X-ray source. No corresponding source has been detected. The binary may consist of two exotic stars.

Because of the intense gravitational fields, tests to distinguish between various theories of gravitation are possible. D. M. Eardley, in an article of March 1, points out two tests of gravity theory that can employ PSR 1913+16. He shows that the Brans-Dicke theory allows gravitational radiation in the dipole mode whereas the Einstein theory does not. This extra channel for energy loss -- a potentially efficient one -- should produce an observable lengthening of the orbital period if it is operative.

Esposito & Harrison, also of Univ. of Massachusetts, have shown that even though only one component has been observed, it is possible to derive the masses of both components. Thus the first direct measure of a pulsars mass is near at hand, as well as the first mass for a ???-object.

The pulsar is about 15,000 light years distant, and visible light arriving here would have been dimmed by about 10 magnitudes by the interstellar material. Thus optical studies are not too promising. Anyway, if you wish to see where it is behind something else, look at Northernmost Aquila, RA = 19^h13^m, DEC = $+16^\circ00'$ (1950).

OBSERVING REMINDERS

Fri. 16 May-- Most favorable elongation of Mercury for the year. 22° eastern elongation means it will appear in the western sky at sunset and will be 19° above the horizon at that time. Should be visible 5 days before and after this date in binos. Magnitude will be 0.6.

Thur.22 May-- Never seen Uranus! Well on this date it will be 3° N of Moon late in the afternoon. At opposition it is visible with the naked eye (forget it in Halifax though) and on this date it will be about 6th mag. and apparent diameter of 3.8" of arc.

Sun. 25 May-- Try and find Neptune less than 1° N of moon and the same situation occurs on Sat 21 June. Magnitude is 7.7 and angular dia. is only 2.5" but will be discernable in a small telescope.

Sat. 21 June--Summer solstice at 20^h 27^m AST

Fri. 27 June--General Assembly 1975 begins. Make sure you reserve this weekend!

Grazing Occultation-- the last one of the year for our area. You'll have to go about 30 miles N of Halifax to reach the northern limit of the grazing of 84 B.Cnc, a 6.4 mag. star. The number of favorable occultations for May 16 to June 30 is not large however all will disappear or reappear at the dark limb of the moon. Refer to the Observer's Handbook p. 59-60 for details.

No meteor showers are to be seen in this period.

Has anyone been keeping an eye on the number of sunspots? We must be very close to an increase in activity as cycle 21 should begin this year.

Beta Persei (Algol) might make a good object for investigation this time around. This eclipsing binary has a period of 68.8^h and eclipse lasts 5 or 6 hours during which time it drops from Mag 2.2 to 3.5 and back to 2.2. Again refer to Obs. Hdbk. or Sky & Tel. for the details.

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