A. Vibert Douglas

Manuscripts

Mss of published works

34.

Loc 2303.9

Box 1

Al-Biruni, Persian Scholar ~~973-1048~~
973 – 1048

Abu Raihan Muhammad bin Ahmad al-Biruni was born on September 4 one thousand years ago.

One of his scientific books written between 1018 and 1025 begins thus:

"In the name of God, most gracious, most merciful.

"Minds have a pressing need for expanding their domains of activities, and souls cannot be satisfied without spiritual contemplation. Hence it is my ambition to present what passes through my mind concerning the creation of an art, or the perfection of the projected shadow of knowledge; so that on beholding it the mind shall see the shadow most beautifully clothed and shall find in it the satisfaction which is inspired by the virtues of excellence

and permanence for all time." Further on in this book we read,

"This is why an observer should keep alert, constantly scrutinizing his work, promoting his self-criticism, moderating his self-admiration, and pursuing his researches without impatience or boredom."

Al-Biruni, perhaps the greatest scientist of his day and a productive scholar in many other fields was born of Persian parents in 973 in the territory of Khwarizm (now called Khiva), a region lying south of the Aral Sea, struggling to keep a measure of independence from the rulers of Central Asia. He early became a counsellor at the court of the princes of the House of Ma'mun ~~al-Ma'sal~~ but civil war compelled him to seek safety in 999 in Gurgan ~~by~~ with the ruling prince al-Ma'ali to whom he dedicated in the year 1000

his major work on the Chronology of Ancient Nations.

From 1010 To 1017 he lived again in Khwarizm but internal strife ~~dg~~ once more broke out and al-Ma'mun was murdered. Sultan Mahmud of Ghazna conquered the land thus extending his empire north westward. His court was a centre for poets and scholars. To join this learned group al-Biruni was brought To Ghazna as a hostage in 1018, and here ~~in Ghazna~~ in Afganistan he died in 1048, the generally accepted date, or 1050 according To Professor Jamil Ali of Lebanon.

Between 1018 and 1025 al-Biruni worked on his Determination of the Co-ordinates of Cities in which he explained the methods for finding latitudes and longitudes, The Qibla and the inclination of the ecliptic, with the plane and spherical

geometry involved. The Qibla was important to every Muslim, being the azimuth of Mecca towards which a devout followed of the Koran bowed in prayer daily. Longitudes are given relative to the meridian of Baghdad and the positions of a dozen cities east and west of Ghazna were determined and their distances, ~~from~~ cross checked. ~~Eratosthenes~~ Ptolemy, Hipparchus, and other Greek sources as well as Arab astronomers are quoted, and his own determinations for inclination of the ecliptic defined as half the arc between the two solstices. The final value, at Ghazna, is given as 23° 35' but this earlier solstice observations at ~~Khwarizm~~ Khwarizm had given 23° 35' 50". Observations of lunar eclipses and one partial solar eclipse are recorded.

Accompanying Sultan Mahmud on many expeditions into India as his counsellor and court astrologer

gave al-Biruni opportunity to observe the customs of the Hindus and to study their astronomy, astrology, language, philosophy religion and literature as well as the history and geography of the country. In 1030 he began his greatest treatise on astronomy the Mas'udic Canon dedicated To Sultan Mas'ud of Ghazna, an encyclopaedia of astronomical sciences. In it he wrote "I do not scorn to accept truth from whatever source I can find it". The Ministry of Education, Government of India, had this great compendium translated and published in 1954 with the comment "No other scholar before or after him has combined the study of all that was available in his times from Indian, Greek and Muslim sources and at the same time left behind him so many original contributions on numerous spheres

of learning." Al-Biruni was familiar with Persian, Sanskrit, Turkish, Hebrew and Syriac, and wrote all his treatises in Arabic. He could not read Greek or Latin but devoured the Arabic translations of their scientific and philosophical works. Among Muslim writings he found speculations about the motions of the earth relative to the sun, admitting his inability to prove or disprove this, but he discussed*. He believed the universe could not be eternal, giving as evidence the terrestrial changes in rock and land surface due to natural forces like wind, water and fire.

His massive book on India written about 1032 has placed him among the greatest Indologists. It ranges over geography, climate, customs, laws, religion, literature and philosophy. He believed geography

* with approval the diurnal rotation of the earth which made possible determinations of longitude from records of time of solstices as reported by astronomers from Alexandria to Ghazna.

was an essential background for an historian. He propounded the daring theory that the valley of the Indus was once a sea bottom. ~~Although~~ He was a Muslim of the most liberal and tolerant kind, far removed from the bloodthirsty ~~sects of Islam.~~ ~~Muslim sects~~. His deep appreciation of Hindu philosophy, when stripped of vulgar imagery, led to a critical but sympathetic appraisal of the similarities and the contrasts with the Koran and with the richest Greek philosophy.

But al-Biruni's genius lay most creatively in mathematics and astronomy. Among his writings are Indian arithmetic and the books Mathematics, Trigonometry applied in Astronomy, On Transits. He invented a new type of astrolabe. He discussed ratio and proportion,

extraction of cube roots, chords and tangents, heights and distances, time, days and nights, the phases of the moon, twilight, eclipses, comets, meteorites, measurement of the radius of the earth by dip of the horizon, the equator, projective geometry of spheres on planes, spherical astronomy used for ascensions of signs of the ecliptic and ~~of astrology~~ in great detail astrology as practised ~~by~~ in Persia, Greece and India. He did not belive in alchemy condemning it vigorously as intentional deceit ~~of~~ in contrast ~~to~~ with chemistry and mineralogy.

→ * Insert

Al-Biruni's interest extended also to medicine and brought him into correspondance with another somewhat older Islamic scholar, Avicenna. He compiled a Materia Medica from Islamic and Indian sources and practice. He is credited with the earliest known diagram illustrating Caesarian section.

* When staying at Nandana in India he calculated the height of a nearby mountain and from its summit observed the dip of the horizon as 34' of arc. From these figures he deduced the radius of the earth as ~~12,803,33~~ 7 Cubits! 1 Cubit is variously given as 18 inches, 1 or 2 2 inches, the former being the earth's radius as 3,602 miles, the latter as 4,402 miles; nearly approaching the true value.

In the Al-Biruni Commemorative Volume produced by the Iran Society in Calcutta in 1951 the Iranian ambassador To India, M. Nowry Espandiary, wrote " The Sheikh's disinterested pursuit of Truth, his relentlessness as a perturbed spirit, his breadth of mind, his versatility of genius, his vision, his unbounded love for human culture are and will remain for ever as beacon lights for the caravan of ~~mankind~~ misguided humanity .... We must shed off narrow mindedness and all the fissiparous tendencies against which the great master waged a relentless war all through his life".

Al-Biruni deserves to be remembered and honoured by all who cherish the scholarly pursuit of knowledge.

A.W.D.
10/3/73

Sent to Ottawa
5/4/73

Al-Biruni — 973 - 1048

In this one thousandth year since the birth of the Persian scholar al-Biruni it is fitting ~~for us~~ to recall some of his contributions to science and in a wide field of scholarship. Born in the region south of the Aral Sea (now USSR) in a period of civil war and foreign conquest, he lived the latter half of his life a hostage in the court of successive Sultans of Ghazna. Here and on journeys into India with the Sultan he determined latitudes and longitudes of cities and the Qibla or azimuth of Mecca, so important in Muslim worship. He measured the dip of the horizon and thus the radius of the earth, and also the inclination of the ecliptic.

His writings covered the known knowledge

of Mathematics, astronomy, medicine, mineralogy, history of ancient nations; and the geography, literature, language, religion and philosophy of India.

Al Biruni 973 – 1048

Arab scholar & scientist. Learned & outstanding intellectual of age. 4 Sept 973. Persian parents b. Kwarizm (Khiva) Central Asia.
Wrote Arabic, Knew Turkish Sanskrit Persian Hebrew & Syriac. Wide range of studies Astron, math, chronology, physics med & history. Corresponded with Ibn Sina (Avicenna.

After 1017 went to India & studied its culture – Later lived in Afganistan until death 1048. in Ghazni (Central court of Sultans Mahmud & Masud.

In religion a Shi'ite, leaning towards agnosticism

Works include "Chronology of Ancient Nations", "Elements of Astrology" "The Mas'udi Canon", a major work on astronomy dedicated to Sultan Mas'ud of Ghazni, ~~and~~ "History of India" and a Materia medica.

In Astron he discussed & approved the Earths rotation on its Axis & made accurate determinations of Lat & Long.

In Physics he explained natural Springs by laws of hydrodynamics & found Sp. Gr. of 18 precious stones & metals

Canadian school library association. Moccasin telegraph. Ottawa
MC GIC v.[8, 1967- v.9, 1968]-

Canadian society of exploration geophysicists. Journal. Calgary, Alta.
MC SC v.7, 1971-

Canadian travel research notes. (Canadian government travel bureau) Ottawa
MC BU no.10, 1971-

Canadian tribune. Toronto
TP BL 1972-

Canadian tuberculosis and respiratory disease association. Bulletin. Ottawa
ET RI current issues

Canadian university service overseas. Bulletin. Ottawa
MC SS v.[6, 1968]-
TP BL v.[4, 1965- v.6, 1968]; no.2, 1971-

Car life. Newport Beach, Calif.
TP P current 3 months
TP RN current issues

In geography ~~he postulated~~ propounded the daring theory that the valley of Indus had once been a lake basin.

Ency. Brit.

U. of T. Library al Biruni 973-1048

1. India Circa 1030 Eng Edn London 1888
religion, phil, lit, geog, chron, astron customs laws & astrology

2. Book of Instruction in the elements of the art of astrology, written in Ghaznah 1029 AD reproduced from Brit Mus. MS. Or. 8349. Trans & notes by R Ramsay Wright London 1934.
LArab B6198 b.

3. The Chronology of Ancient Nations - Eng. version of Arabic text. or "Vestiges of the Past" collected & reduced by al Biruni in 1000 AD - Tr & notes by C Edouard Sachau London 1879

4. Chronologie orientalischer Völker C. E Sachau Leipzig, 1923

5. On Transits by Abū al-Rayḥān Muḥammad ibn Aḥmad al-Bīrūnī - Trans & commentary by E S Kennedy, Beirut 1959.

Central bank of Kenya. Economic and financial review. Nairobi, Kenya
MC BU v.[3, 1970]-

Central mortgage and housing. Toronto apartment vacancy survey. Toronto
MC CHM 1971-

Centre de recherche en civilisation canadienne-française. Bulletin. (University of Ottawa) Ottawa
MC GIC v.1, 1970-

Church music. (Church music association) London
MC ML v.[3, 1970]-

Cipher. (Canadian institute of quantity surveyors) Toronto
MC SC v.[2, 1971]-

Civic, the public works magazine. Toronto
NY W v.24, 1972-

Co-ed. New York
NY W v.16, 1970-

Coming events. (Art gallery of Ontario) Toronto
TP CH current year

6. U of T catalogue in Sci dept. queries 478.
Determination of co-ordinates of positions for the correction of distances between cities.
trans. by Jamil Ali. Beirut 1967.

7. Mineralogy - Edited by F. Krekow

8. astronomy - an encyclopaedia of astronomical sciences.
QB 41 B57 Manager of Pub. Govt of India 1954

9. variation of 2.

10. mathematics

11. Trigonometry applied in astronomy
Hanover 1927

12. al-Biruni commemoration volume.
Calcutta 1951
QC 143 B517 Iran Society

Ambassador for Iran to India M. Nowry Esfandiary wrote "The Sheikh's disinterested pursuit of Truth, his restlessness as a perturbed spirit, his breadth of mind, his versality of genius, his vision, his unbounded love for human Culture are + will remain for ever as beacon lights for the caravan of misguided humanity. - We must shed off narrow mindedness and all the fissiparous tendencies against which the great master waged a relentless war all through his life."

Arthur Upham Pope (New York) "al B as a Thinker"
observation + experiment; importance of geography as foundation for a historian;

Asphalt. (Asphalt institute) College Park, Md.
MC SC v.[23, 1971]-

Banco do Brasil. Boletim trimestral. Brazilia
MC BU v.[3, 1968- v.4, 1969]-

Bibliography of Asian studies. (Association of Asian studies)
N.p.
MC HI 1969-
Supercedes Journal of Asian studies bibliography

Bits & pieces. Fairfield, N.J.
MC CHM v.100, 1971-

Boat builder. N. p.
NY W 1969; 1972-

Boston Spa, Eng. National lending library for science & technology.
NLL review. London, England
MC GIC v.[1, 1971]-

British Columbia government news. (Dept. of trade and industry, British Columbia) Victoria, B.C.
NY W v.20, 1972-

12. cont'd

B. M A Kazim, Muslim Univ, Aligarh.

His creative genius lay most in math & astron
Invented a new type of astrolabe
Wrote on Indian arith - extraction of cube root, ratio proportion, chords & tangents, calc of heights & distances time, days & nights, moon & its phases, twilight eclipses, & comets, meteorites - horoscopes, Indian astrology, measurement of earth by dip of horizon, projective geometry of bodies and spheres on planes.
Spherical trig. used for ascensions of signs of the ecliptic
Lat & long rel. To equator & to meridian of Baghdad. for Ghazna from observations in 1018, 19, 20. Then used Ghazna as his prime meridian for Indian Towns E & W.

also Obliquity of ecliptic 23°35' Ref 8

Ref 8 - AcB "Idrisi seems to accept truth from whatever source I can find it"
"No other scholar before or after him has combined the study of all that was available in his times from Indian, Greek & Muslim sources & at the same time left behind him as many original contributions of his own on numerous spheres of learning.
His great work al-Qanūn dedicated to Sultan Mas'ud c. 1035 or later.

Interested in Muslim Theory of motion of earth. but stated his inability to prove it or disprove it.
Believed Universe could not be considered eternal
Evidences of change from rocks & natural forces like Water & fire. see p. xxx for Continents of Am

Acadiensis. (Dept. of history, University of New Brunswick) Fredericton, N.B.
MC HI v.1, 1971-

Aerospace historian. (Air force historical foundation) Manhattan, Kan.
MC HI v.[18, 1971]-

Alaska journal. Anchorage, Alaska
NY W v.2, 1972-

Alphabet. London, Ont.
NY W no.1, 1960-
Absorbed Waterloo review

Alternatives. (Trent university) Peterborough, Ont.
MC CHM v.1, 1971-
ET RI v.[1, 1972]-

Antiques journal. Dubuque, Iowa
TP DP v.[27, 1972]-

Aphra. New York
NY YW v.3, 1971-

Asia research bulletin. Singapore
MC HI v.1, 1971-

962

Enc. Americana Feb 10

Al-Biruni 973 – after 1050

brilliant scholar in a brilliant epoch of Muslim literary philosophical & scientific advances

b. in Khwarizm, a region S. of Aral Sea

made major contributions to astronomy, math. astrol. meteorology medicine mineralogy etc. Geog, antiquities & culture of India

Colliers Ency – no ref

Ency-Am.

Avicenna 980–1037

The most illustrious philosopher, scientist & med. writer of medieval Islam. (Ibn Sina)

His book Shifa – a comprehensive acc. of ancient knowledge – Aristotle, Euclid, Ptolemy + his mystical & metaphysical ideas

His med. book Canons was influential to 17th C.

Alberuni's India
Edited Sachau 1962.

Abu Rahan
Alberuni } b. 973 in the independent
kingdom of Khwarizm (the province) South of Aral Sea,
what is now Khiva in ~~what is now~~ South Central
USSR.

He Persian King Mahmud, whose court at
Ghazna attracted poets & other literary figures
from far and near, was a warrior as well
as patron of the arts. He conquered Khwarizm
in 1017 and took his leading scholar Alberuni
as a hostage. Thus it transpired that ~~the~~
~~leading astronomer and astrologer of the~~
~~time accompanied Mahmud~~ he lived in
exile in Persia & eastward in Afganistan
and India until his death in Afganistan
in 1048. Mahmud never showed any
special regard for his learned hostage but
his younger son ~~Sultan~~ Masud who succeeded
him became patron to Alberuni. Thus in
the preface to his great book on India
Alberuni pays the minimum of decent
respect for the deceased ruler, but his
greatest work ~~dedicated to~~ Canon Masudicus

contains a dedication of oriental extravagance
in honour of Sultan Masud who was
in reality an ineffectual monarch not
unaddicted to drunkeness.

1018 - 1025

$(\frac{11}{83}$ of $360)$ = arc betw

The two solstices

23°.8

½ arc = obliquity of ecl. or 23° 48'

at B called maximum

dec. of ecliptic

To Ptolemy 23°.51

Al B's [illegible] 23° 35'

23.333

23 + one third and

one quarter

of a degree

333
25
23°.583
60
35.98

p. 77 p. 1 p. 182

23° 35'

25 1/3°
15 1/4°
35' 1/4°

360°

78 6

The National Gall

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47 ; 42 , 10°
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on Thursday, 1 March

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Baghdad
Jayhun
Jurjaniya
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Khwarizm
Balkh
Bukhara
Shiraz
Zarang
Ghazna
Bust
Sijistan
Raqqa
alexandria

Al Biruni 973–1048

Mss for JRAS
Al-Biruni, Persian Scholar
973-1048
completed 10/3/73.

OSLER LIBRARY

McINTYRE MEDICAL SCIENCES BUILDING

3655 Drummond Street
McGILL UNIVERSITY, MONTREAL 109, CANADA

February 14, 1973

Mr. A. Vibert Douglas
127 King Street West
Kingston, Ontario

Dear Mr. Douglas:

Thank you for your letter of January 26. Please excuse the delay in answering it. Have you checked with the National Library in Ottawa for other copies of De Revolutionibus in Canada? The Union Catalogue there should remove any doubt from your mind.

I shall be glad to tell you of the Al-Biruni material in our Library. Unfortunately, it is very little, as you can see from the following list:

Bibl. Osl. 5637.
Arnold, (sir T[homas] W[alker]) 1864-
The Caesarian Section in an Arabic MS. dated 707 A.H. ...
1a. 8°. Camb., (1922).
With an illustration, said to be the earliest picture of the operation. From a MS. of Al-Bērūnī's 'Al-Āthār al-Bāqiyah', A.D. 1307-8, in the Edinburgh Univ. Library.
Repr. fr. volume of Oriental Studies presented to Prof. E. G. Browne, Feb. 1922. Bd. with no. 86.

WZ 290 A3375b 1934
Albiruni (973-1048)
The book of instruction in the elements of the art of astrology, by Abu'l-Rayhān Muhammad ibn Ahmad al-Birūnī; written in Ghazna, 1029 A.D., reprod. from Brit. Mus. MS. Or 8349; the translation facing the text by R. R. Wright. London, Luzac, 1934.
[3] xviiip.; 333 [3]ℓ. facs. 23cm.

Added title-page in Arabic. Pages of Arabic text unnumbered.

B
745
N264i
1964

Nasr, Seyyd Hossein
An introduction to Islamic cosmological doctrines; conceptions of nature and methods used for its study by the Ikhwān al-Safā, Al-Bīrūnī, and Ibn Sīnā. Cambridge, Belknap, 1964.
xxi, 312p.

The first item is the only Bibliotheca Osleriana item dealing with Al-Biruni. I have copied it for you, exactly as it appears in the Bibliotheca.

Could I ask you for the full reference of "the Eng. trans. of Osler's Al Biruni"? I have not been able to establish any connexion between Osler and Al Biruni, apart from that small item in his catalogue, cited above.

Sincerely,

M. Fransiszyn

M. Fransiszyn
MSS. and Reference Librarian

R 10/31/73

MF:ra

AL-BIRUNI, PERSIAN SCHOLAR

973 - 1048

Abu Raihan Muhammad bin Ahmad al-Biruni was born on September 4, one thousand years ago.

One of his scientific books written between 1018 and 1025 begins thus:

> "In the name of God, most gracious, most merciful. Minds have a pressing need for expanding their domains of activities, and souls cannot be satisfied without spiritual contemplation. Hence it is my ambition to present what passes through my mind concerning the creation of an art, or the perfection of the projected shadow of knowledge; so that on beholding it, the mind shall see the shadow most beautifully clothed and shall find in it the satisfaction which is inspired by its virtues of excellence and permanence for all time."

His attitude toward scholarly investigation is stated thus:

~~Further on in this book, we read:~~

> "~~This is why~~ ... an observer should keep alert, constantly scrutinizing his work, promoting his self-criticism, moderating his self-admiration, and pursuing his researches without impatience or boredom."

Al-Biruni, perhaps the greatest scientist of his day and a productive scholar in many other fields, was born of Persian parents in 973, in the territory of Khwarizm (now called Khiva), a region lying south of the Aral Sea, struggling to keep a measure of independence from the rulers of Central Asia. He early became a counsellor at the court of the princes of the House of Ma'mun, but civil war compelled him to seek safety in 999 in Gurgan with the ruling prince al-Ma'ali to whom he dedicated in the year 1000 ~~his~~ a major work on the Chronology of Ancient Nations.

From 1010 to 1017, he lived again in Khwarizm, but internal strife once more broke out and al-Ma'mun was murdered. Sultan Mahmud of Ghazna conquered the land, thus extending his empire north-westward. His court was a centre for poets and scholars. To join this learned group, al-Biruni was brought to Ghazna as a hostage in 1018, and here in Afganistan, he died in 1048, the generally accepted date, or 1050, according to Professor Jamil Ali of Lebanon.

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speculations about the motion of the earth relative to the sun, admitting his inability to prove or disprove this, but he discussed with approval the diurnal rotation of the earth which made possible determinations of longitude from records of time of solstices as reported by astronomers from Alexandria to Ghazna. He believed the universe could not be eternal, giving as evidence the terrestrial changes in rock and land surface due to natural forces like wind, water and fire.

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Al-Biruni deserves to be remembered and honoured by all who cherish the scholarly pursuit of knowledge. and the spirit of tolerance and sympathetic understanding of peoples of other cultures than our own.

A.W.D.
March, 1973.
/jp

To Editor.
Please
20/3/73

ROYAL ASTRONOMICAL SOCIETY OF CANADA

1973 General Assembly
Saturday, May 26, 9:00 a.m.

SESSION FOR PAPERS

1. Colour Astrophotography on a Small Budget
   G.R. Winder, Niagara Falls Centre

2. The Coelostat of the Dow Planetarium
   Jacques A. Dumas, Centre d'Astronomie, Montreal

3. Al-Biruni — 973-1048
   A. Vibert Douglas, Kingston Centre

4. Astronomy's Neglected Child: the Long-Focus Refractor
   Richard Berry, Toronto Centre

5. The 20.5-inch Buchroeder Catadioptric Telescope of the Montreal Centre, R.A.S.C.
   John Allcock, Montreal Centre

6. Astronomy at the Summer Camp at Port au Saumon, P.Q.
   Roger Gagnon, Centre d'Astronomie, Montreal

7. Activities at North Mountain Observatory
   F.P. Lossing, Ottawa Centre

8. Highlights of Astronomy Club Day
   Andreas Gada, Toronto Centre

9. An Orrery in Use in Canada Since 1835
   Rolland Noël de Tilly, Centre d'Astronomie, Montreal

10. Mars, the Old View and the New Concept, a Contrast
    Peter M. Millman, Ottawa Centre

11. An Easy Graph for the Figure of a Telescope Mirror
    Peter Andreae, London Centre

12. Observations of Sunspot Motions and Related Phenomena, 1972
    Rob Pike, Toronto Centre

13. Construction of a Ritchey-Chretien Telescope
    Henry Coïa, Centre d'Astronomie, Montreal

14. The Ottawa River Solar Observatory
    V. Gaizauskas, Ottawa Centre

* * * * * * * * * *

Al-Biruni May 1973

For Colliers Encyclopedia
1959

Arthur Stanley Eddington, O.M., F.R.S.

Arthur Stanley Eddington, O.M., F.R.S., English astronomer, born December 28, 1882. He was the son of Quaker parents; his father, Headmaster of Stramongate School in Kendal, died in 1884.

Educated at Brynmelyn School, Weston-Super-Mare, Owen's College, Manchester, and Trinity College, Cambridge, Eddington became Senior Wrangler in 1904 and was appointed Chief Assistant at the Royal Observatory, Greenwich, in 1906. His practical work included longitude determinations at Malta and an eclipse expedition to Brazil. Theoretical work on stellar motions and star-drifts soon placed him among the ablest astronomers.

Already a Fellow of Trinity and a Smith's Prize winner, he was appointed Plumian Professor of Astronomy at Cambridge in 1914. He discovered the fundamental role of radiation pressure in stellar equilibrium. Pioneer researches on the internal constitution of the stars and the pulsation theory of cepheid variables followed, and he formulated the mass-luminosity relation. He early realized that the sources of stellar energy must be subatomic. Simultaneously with Rosseland he recognized that hydrogen is overwhelmingly the chief constituent of the universe.

Reading Einstein's paper on general relativity, Eddington understood its intrinsic importance and became the first and most distinguished exponent of relativity in the English language and the first to confirm from eclipse observations the gravitational deflection of light (1919). He strove to develop a fundamental theory linking relativity and quantum theory within the framework of the expanding universe. He deduced from these relationships all the cosmic and atomic constants of nature. This provocative attempt at a great synthesis remained incomplete at his death.

Eddington was a brilliant expositor of scientific ideas. He participated in scientific gatherings on five continents. He was awarded five gold medals, and the great honour of the Order of Merit. He was a profound mystic in the Quaker tradition and this intuitive approach to truth guided also his approach to scientific problems. He died on November 22, 1944, in Cambridge, England.

Knighthood was conferred on him (1930) (1938)

Chief publications: Stellar Movements and the Structure of the Universe (1914), Report on Relativity Theory of Gravitation (1918), Space, Time and Gravitation (1920), Mathematical Theory of Relativity (1923), The Internal Constitution of the Stars (1926), Stars and Atoms (1927), The Nature of the Physical World (1928), Science and the Unseen World (1929), The Expanding Universe (1933), New Pathways of Science (1935), Relativity Theory of Protons and Electrons (1936), The Philosophy of Physical Science (1939), Fundamental Theory (posthumous, 1946).

A.V.D

Biography
Arthur S— E—
by A. V. D—
nelson 1936

From Euclid to Eddington
by Sir E. Whittaker
CUP 1942

Eddington F T
by N B Slater
CUP 1957

Mildred Douglas
1959 Oct. 6
Sent to Collins. Oct 7

Astronomy and the Orphic Hymns

A remarkably interesting piece of scholarly research has been done by Dr Constantin S. Chassapis, astronomer at the Penteli astronomical Station in Athens. A copy of this paper has been sent to me by the author and I feel sure that readers of The Journal will find, ~~as I did~~, that many of our ideas of the historical development of astronomy will need to be revised in the light of Dr Chassapis's findings.

First as to the date of the Orphic Hymns. Internal evidence of an astronomical nature places the hymns between 1841 BC and 1366 BC. Evidence for the later date is based on a line which states that the winter and summer seasons were of equal duration. In this year of 1968, from Spring equinox to autumn equinox is $186^{d}\ 10^{h}$ and from autumn equinox to

spring equinox will be 179 d. 14 h., thus a difference of 6 d 20 h. This is, of course, due to the part precession of the earth's orbit, the summer solstice now coming within eleven days of aphelion, when the earth is travelling most slowly in its elliptic orbit. About 1366 BC the summer solstice would have occurred when the earth was at one end of the minor axis of its orbit, thus causing the symmetrical division of the seasons referred to in hymn 33 line 21. A line in hymn 26 refers to the spring equinox in Taurus and in hymn 13 the summer solstice is stated to be in Leo; these positions indicate a limiting date of 1841. Hence the hymns belong to the period between these two dates. The author suggests the 17th century BC when the spring equinoxial point had not yet reached the faint stars of Aries and the

two seasons differed by only about 6 hours.

Dr ~~Chap~~ Chassapis interprets lines in hymn 33 as evidence that "the Greeks in orphic times had conceived the heliocentric idea, and it was from them that it was later borrowed by Pythagoreans and Aristarchus.... Indeed they were aware of the sphericity and rotation of the earth..." The word employed means 'globe' and they divided it into Torrid, temporate and frigid zones. The hymn suggests, however, that the earth was the centre of the celestial sphere which turned on an axis coincident with the axis of the earth. ~~and with~~ From hymn 7 it is deduced that the four seasons are due to the movement of the earth around the sun, the Sun exerting the controlling influence.

The following conclusions are ~~also~~ also drawn from the hymns by Dr Chassapis in his 88 page paper:

The Orphics ~~the sh~~ distinguished between the stars and the seven planets. They used the names in use today, which, it is claimed, are therefore of Orphic origin.

They introduced the Zodiac, naming its 12 constellations and some others. These names are deemed to be of Orphic origin.

They determined and named the ecliptic, using the same word employed by Archimedes centuries later.

They developed astrology, Oinopides being an astrologer-astronomer.

They knew that the diffused light, as well as that of dawn and twilight, were due to the atmosphere.

They introduced the idea of the ether as filling the space beyond the atmosphere.

They accepted the presence of mountains on the moon.

They used a lunar calendar, ~~measuring~~ the month ~~from full moon to full moon~~ being the interval between two full moons.

They accepted that all phenomena were governed by universal law, which regulates all of the sky and earth and secures the stability of the existance of the earth.

From the ~~[illegible]~~ Lithika it appears that they were familiar with lenses.

~~Two conclusions are drawn by Dr Chassapis~~

The summary of this ~~interesting~~ remarkable paper concludes thus:

(a) the existing views of the history of Astronomy, concerning the so-called priority of the Assyro-Babylonians ~~against~~ over the Greeks for many of the above ideas, must be revised.

(b) the views of Prehistory, according to which the pre-Greeks and the Aegians were not Greek tribes, must be revised. ~~Because~~ The dating of the Orphic Hymns through astronomical methods proves that these, regardless of the time of their gathering

and registration during the 6th century B.C. were formulated much earlier and were communicated ~~much earlier~~ from generation to generation by the initiated of Orphism. These hymns were the genuine product of the Greeks who lived in the country in the depths of the 2nd millenium B.C. They cultivated the observation of the sky, and laid the foundations of the basic astronomical truths.

I am happy to express my gratitude to Dr C.S. Chassapis for this paper and I hope it may call forth valuable comment from other scholars who are competent in these two fields — early Greek literature and astronomy.

1968 June 5

Historical Significance of Five Conjunctions, 1226-27

History records no more spectacular and ruthless conqueror than the great Mongol emperor Jenghiz Khan. He lived from 1162 to 1227, succeeding to the Mongol throne at the age of thirteen. His great qualities of leadership soon manifested themselves as he gradually consolidated the several Mongol tribes and raided farther and farther east and south into China, twice overrunning most of the Chinese states.

Turning his face westward he sent emissaries far inland along the ancient trade route, but they were killed and his wrath was kindled. In 1219 began the great epic of his western conquests and merciless revenge, of looting, massacre and terrorism. West of Samarkand, Bokhara and Merv fell to his sword. The northern part of India was ravaged. Pushing around the Caspian Sea in 1222 he conquered Georgia in the Caucasus. The next year he returned to central China.

In 1226 he ~~returned to~~ invaded west China in a campaign of savage brutality and decimation. But that autumn brought into the western sky at sunset a rare juxtaposition of the five planets and five planetary conjunctions occurred in just over two months. The emperor's astrologer, Yelin Chut'sai, read a dire warning in these events — heaven was displeased at the terrible massacre at Tangut. Jenghiz Khan was smitten with foreboding, called a halt to the campaign and ordered his armies homeward. He reached Kansuh on the river Si-Kiang where he became ill and died in August 1227.

Two questions arise: (1) What were the celestial phenomena which led to the abrupt ending of this chapter of history? (2) What were the astrological reasons for interpreting these phenomena as unpropitious?

The answer to the first question was found by plotting the solar and planetary longitudes, as given in the Tables of W. D. Stahlman and O. Gingerich (1963) for 10-day intervals over the period 1226 November 12

to 1227 January 31. The graphs are shown in Fig. 1. and indicate the presence of the five known planets in the south western sky at sunset during November and more than half of December 1226. Mercury then drew closer to the Sun and after conjunction with it, passed into the morning sky at the end of the year. Five interplanetary conjunctions are seen to have occurred between November 20 and January 28, three of these involving the planet Mars, traditionally associated with war. The zodiacal background for this spectacular procession of the planets is successively Capricornus, Aquarius and Pisces. About December 12 the five planets were almost equally spaced along or close to the ecliptic in order eastward from the western horizon Mercury, Venus, Saturn, Jupiter, Mars, an array which would not occur again in many hundreds of years.

The first of the five conjunctions involved Mars and Saturn with Mars moving eastward more rapidly than Saturn and passing it about November 20 when Jupiter was some 5° further east. The second conjunction occurred when Mars came into alignment with Jupiter at the end of November. The third involved Venus and Saturn about December 18 with Venus moving rapidly eastward. By December 27 the fourth conjunction took place when Venus passed Jupiter. The fifth occurred a month later about January 28 when Venus overtook Mars. By that date Saturn had already passed the Sun into the pre-dawn sky and Jupiter was to follow suit in early February. Thus in just over two months five interplanetary conjunctions and three solar-planetary conjunctions had occurred.

The answer to the second question is less accurately ascertainable. An astrophysicist attempting to trace out a path amid the mysteries of astrology is like a wanderer in treacherous boggy country, finding few firm

footholds and somewhat bewildered by the swirling mists of influences and counter-influences. The sources of the astrological arguments which follow are Al Biruni's Elements and an Indian astrologer, T. N. K. Gopalaswami, to whom the author is deeply indebted.

Al Biruni explains how each Sign of the Zodiac is divided into three faces with one of the five planets or Sun or Moon being Lord over each face. Persians, Greeks and Hindus agreed that Mars is Lord of the first face of the first Sign, Aries. ~~The~~ Sun, Venus, Mercury, Moon, Saturn, Jupiter being successively Lord of the succeeding faces, with repetition in this order throughout the Zodiac. The Hindu system made the Lord of the first face dominant over the Lords of the second and third faces; the Persians gave to each Lord his full authority. Since Mars is not Lord over any face of Capricornus or Aquarius or Pisces in which the five conjunctions occurred, it follows that the influence of Mars could not be paramount at any of these times and hence the conjunctions could not be considered propitious according to the Persian and Greek systems. Since Mars was not Lord of the first face of any one of these Signs, the conjunctions could not be favourable according to the Hindu system. Whichever system the Mongol astrologers used the result is the same — all five conjunctions unpropitious for Jenghiz Khan's campaign.

T. N. K. Gopalaswami is a follower of the school of thought of a leading authority on modern Hindu astrology, Prof. B. V. Raman of Bangalore. The discussion which follows is based on his interpretations. The ~~date~~ day of Jenghiz Khan's birth in the year 1162 is unknown, but

since many historians rank him second to none among the great conquerors mankind has known, there appears to be a strong probability that he was born under the favourable influence of Mars. This would occur when the Sun is in Aries (April 21 - May 21) or in Scorpius (November 21 - December 21) since in both these constellations Mars is said to be in his own House. In the moveable Zodiac system of Hindu astrology, Sayana system, the traditional significance attached to the Signs remain attached to the corresponding constellation thus shifting the Sign in accordance with the precessional movement of the Spring Equinox, which in 1226 was in the first third of the constellation of Pisces.

The first conjunction, Mars and Saturn, occurred far on in Capricornus when these planets were very nearly entering Aquarius and therefore not totally unaffected by influences from the latter where Venus dominates and is always antagonistic to Mars. The Sun is Lord of the third face of Capricornus, where the conjunction occurred, and Jupiter is the dominant influence in the first face. True Mars is Lord of the second face but Saturn is in his own House and can neutralize the influence of Mars. Hence for two reasons this was not a favourable omen.

The second conjunction, Mars and Jupiter, took place in the first face of Aquarius where Venus is Lord. Between Venus and Mars permanent enmity exists. Neither Mars nor Jupiter holds a Lordship in this Sign, so Venus dominates. This is again unfavourable to the making of war.

The third conjunction, Venus and Saturn, was

in Capricornus nearing Aquarius and therefore, as in the first conjunction, it was decidedly unpropitious. Quite apart from ~~Mars this~~ the above argument, this conjunction could ~~only~~ be propitious for persons born under Capricornus and ~~Aquila~~ Aquarius. That his astrologer did not interpret it in this way is an argument against Jenghiz Khan having been born between January 21 and March 21.

The fourth conjunction, Venus and Jupiter, occurred in Aquarius where Venus is Lord of the first face and Saturn is in his own House. Both are unfriendly to Mars. The conjunction is an omen of great uncertainty and following so closely on the three unfavourable ones it might well have caused his advisers to ~~warn~~ urge Jenghiz Khan to abandon his campaign and his lust for conquest and bloodshed — especially as they could undoubtedly foresee that Venus would overtake Mars at a Time not five weeks distant when the portents would be exceedingly ominous, if not calamitous.

This fifth conjunction, Venus and Mars, about January 25, 1227, took place in the Sign of Pisces. Here Venus is exalted and for a person born under the beneficent influence of Mars — as presumably Jenghiz Khan was — this conjunction would be a portent of dire misfortune, ~~if not~~ even perhaps death. Saturn is dominant as Lord of the first face, in which face the conjunction occurred; and as the planets had just moved out of Aquarius a carry-over influence antagonistic to Mars would be exerted by the dominant Venus.

Some or all of these arguments and perhaps other arguments unknown to the writer carried so much weight in Asia in 1226 that one of the world's greatest conquerors in the flush of victory brought his campaign to a sudden termination, commanding his armies to retreat to their Mongolian homeland. Had he any foreboding that he, the great Jenghiz Khan, would not live to reach his home? One chapter of history had come to an end.

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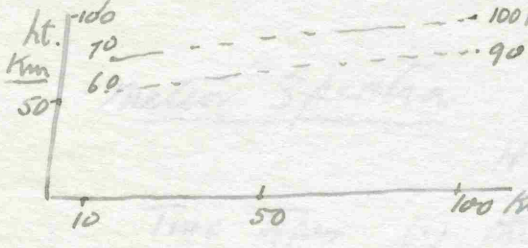
Albert Langtad
1968 June 10

Meteor Notes.

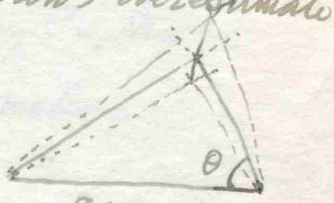
from Lecture to R.A.S.C. by P.M. Millman.
1937 April 22.

Great Leonid Shower - Humboldt - 1799.
Recurred Nov. 13 1833
" 1866.

Height: Harvard observers in Arizona
22 mi. base. 3500 obsns for alt.
faster meteors become luminous at greater heights.



Observations tend towards overestimate of height since errors to alt. angle give greater error if too large.
Error ± 50.



Density of atmosphere increases 10 times for drop of 25-km. at height of 100 km.
No large H atmosphere at 50 to 130 km.

H vel > 41 km/sec. or 26 mi/sec. Sun's gravitation field cannot hold particle.
∴ escape from Solar System.
Conversely ∴ a cosmic or interstellar origin.

To estimate time of passage of meteor across grid system of Sky Chart, a conical motion of a mirror is used. star background gives ellipses for each star image + swift meteor gives → whereas slow meteor produces a track

for v. bright meteors.
photographic method with occulting shutter is pos - ie rotating sector 25 breaks/sec.
for faint meteors the above visual method gives for
mag 8m - 120 km/sec.
4m - 75 km/sec. } both obviously interstellar in origin.

Meteor Notes.

a few v. br. meteors are interstellar.
possibly all non-shower meteors are interstellar.

Shower meteors - radiant or apex.
periodic.
related to Comet orbits

av. vel. of bright meteors. -5^m 14 km/sec.

Meteor Spectra. 40 now made.
H & K lines, Fe, Mg, Mn, Cr, Na.
Two types (1) the H & K visible . . . Y meteors.
(2) no H & K. . . . . Z " .
always Fe lines. of low excitation.
corresponding to furnace 1800°
If meteor has series of bursts & more quiescent time the lines of higher excitation come only in latter part of path.
H & K lines only when above Heaviside layer.

Average mass $\frac{1}{10}$ to $\frac{1}{100}$ gm. for -5^m.
If brightness > moon it is prob. a meteorite. vel. massive.

Motion of luminous train indicates hurricane velocities in upper atmosphere.

Meteoric dust chiefly Ni. Fe.
Age (Öpik) < 3000 x 10^6 yrs. (like earths crust)

Cosmic Drift from Pleiades & Hyades RA 50 Dec +20 towards Scorpio. vel. 5 km/sec. Statistical result. Great obscuring clouds in these two regions.

1975 Dec 8

Regiomontanus
1436 - 1476

The year 1976 marks the 500th anniversary of the assassination in Rome of Johann Müller, who was perhaps the most advanced mathematician of his age. Some searching has revealed no evidence of motive; was it ~~perhaps~~ just one of those dastardly senseless acts of violence of which we are becoming all too familiar in our own day?

He was born in Königsburg on June 6 1436. At the age of 11 he was admitted to Leipsig University and in 1452 he journeyed to Vienna to study under Georg Purbeck whom he assisted in his work on Ptolemaic astronomy. Realizing that his knowledge of Greek was inadequate he went in 1462 to ~~Rome~~ Italy to pursue his studies of Greek under the tutelage of Cardinal Bessarion, delving deeply into the original text of the Almagest. Assuming at first the name Johann de Monteregio, he later adopted the latin form Regiomontanus under which name all his published work appeared.

In 1463 he completed the Epitome left incomplete at the death of Purbeck two years previously. This was published in Venice, but only in 1496. After five years in Italy, he went

To Vienna and thence to Buda where he collated Greek manuscripts at the invitation of the King of Hungary

Regiomontanus finally settled down in Nürnberg in 1471 to teach and pursue his own researches in astronomy and mathematics. One of his pupils was Bernhard Walther who became his patron. Together they constructed an astronomical observatory, furnishing it with greatly improved instruments which are described in the Scripta. This book, however, remained unpublished until 1544.* In 1472 a spectacular comet appeared and extensive observations were made of this. In the same year he set up a printing press in Walther's house and produced Purbach's planetary theory as well as some popular calendars. Two years later he published ephemerides for 1474-1506. This book contained also his method of using lunar distances for the determination of longitude at sea. The principle involved was far from new and is essentially valid but neither then nor throughout the succeeding two centuries were the practical results satisfactory for the simple reason that no accurate lunar tables existed. To remedy just this and other navigational problems the Royal Observatory at Greenwich was established by Royal Charter in 1675. The first Astronomer

* His manual dexterity was not only evident in his instruments, for when The Emperor Maximillian I visited Nürnberg he was requested to construct a large mechanical eagle to be mounted over the gate to the city.

Royal, Dr James Flamstead, made the accurate determination of lunar positions over an extensive period his prime concern.

A mathematical treatise, De Triangulus, was completed in 1464. This has been described as the "earliest modern exposition of plane and spherical trigonometry". In this he introduced the use of tangents and invented the term "sinus". ~~The~~ This book was not published until 1533 in Nürnberg. He was one of the first mathematicians in Europe to discuss the algebra of Diophantus. These studies resulted in the publication in 1475 of the Tabulae directionum.

Regiomontanus was summoned to Rome in 1472 to assist in the difficult task of calendar reform. On a subsequent visit to Rome in 1476 his tragic death just one month past his fortieth birthday robbed the world of scholarship of an able scientist at the peak of his intellectual productivity.

A VIBERT DOUGLAS
Kingston.

METEORS

By A. Vibert Douglas

22/10/75

Enc Brit Vol 15 P980

Regiomontanus
Johann Müller 1436 - 76
500 anniversary of death 1976

b. Königsberg June 6 1436
most advanced mathematician of his age
called himself Johann de Monteregio later
the Latin Regiomontanus
1452 To Vienna to study with Georg Purbach (1423-61)
assisting him with work on Ptolemaic astron.
1462 to Italy to study Greek & original Almagest text
1463 completed Purbach's Epitome - pub Venice '96
1468 in Vienna & thence to Buda; invitation by
King of Hungary to collate Greek ~~texts~~ MSS.
1471. settled in (Nuremburg) Nürnberg
With Bernhard Walther, his pupil and
patron, constructed an astronomical Obsy.
Made improved types of instruments described
in his Scripta (pub. only in 1544)
(No) →
1472. extensive observations of great comet, prob. Halley
" erected printing press in Walther's house; popular
calendars + Purbach's planetary theory -

1474 published ephemerides for 1474 – 1506 and
This contained his method of lunar distances
for determination of longitude at sea.
His gt. mechanical ability indicated in
his instruments + a mechanical eagle for Nürnberg
gate to welcome Emp. Maximilian I
1464 his mathematical treatise De Triangulis
(pub in Nürnberg 1533) the "earliest modern
exposition of plane + spherical ~~Trigonometry~~ Trigonometry"
He was one of the first in Europe to discuss
the algebra of Diophantus publishing in
1475 his Tabulae directionum
1472 Pope Sextus IV summoned him to Rome
to assist in calendar reform.
1476 July 6 on a subsequent visit to Rome
he was assassinated.

Probably Halley's had appeared about 1444 or 45
it came in 1066 and 1531

1c 1066 · 1141 · 1217 1293 1369 1445 1531

Larousse 9.
P. 92

Regiomontanus
Admitted to University of Leipsig at age 11.
Studied Greek 'auprès' de Cardinal Beosarion
In his treatise on trig he introduced
the use of tangent and invented the term "sinus"
(sine??)

Observatory 19/1/76

Sept. 1975

Tercentenary of the R.G.O.

A. Vibert Douglas

The Tercentenary of the Royal Observatory Greenwich was celebrated by holding an International Historical Symposium at the National Maritime Museum at the foot of the Observatory hill from July 14 – 18, 1975. This was the 4th Joint IAU/IUHPS Symposium on the History of Astronomy. The theme of the Symposium was "The

Origins, Achievements, and Influence of the Royal Greenwich Observatory, 1675-1975."

The published list of participants in the Symposium included 107 names, late registrations brought the number to about 140, with a wide spread of nationalities: South Africa, Japan, India, USSR, Poland, Czechoslovakia, Hungary, East and West Germany, Switzerland,

Denmark, France, Portugal U.S.A., Canada with five representatives, and of course a large number from the United Kingdom. As at all such meetings the informal social events are of special value. The "Meridian Party" was a reception by the Trustees and Director of the National Maritime Museum in the "Queens House", the central section of the Museum which was built as a summer palace for ~~William IV's Queen~~ Queen Charlotte wife of Charles I. On the

fourth evening most of us went in to London to the spacious rooms in Carleton Terrace as guests of the President of the Royal Society and the President of the R.A.S. The next day we went by bus to visit the Royal Observatory at Herstmonceux with its Isaac Newton telescope and six smaller domes, its library and lovely gardens where a garden party was held following the unveiling

by Princess Anne of a bust of the first Astronomer Royal, Rev. John Flamsteed and a large sundial. The "Transit Dinner" in the Trafalgar Tavern in Greenwich concluded the programme except for a Commemoration Service in Westminster Abbey on Sunday July 20 at the invitation of the Dean and Chapter. Just before Evensong Sir Richard Woolley laid a wreath on the flagstone over the grave of King Charles II, founder of the Royal Observatory in 1675.

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To mark this Tercentenary a special 80 page illustrated booklet was ably compiled and written by Professor

W. H. McCrea, F.R.S. This is a beautiful and valuable record of events of astronomical importance through the terms of 11 astronomers Royal 1675-1971 and 2 Directors 1971-75. The Director-designate is Dr F. Graham Smith who takes over from Dr Alan Hunter in 1976. This book is issued by Her Majesty's Stationary Office at £1 net. In it we read that after Flamsteed had set up his great clocks, his equatorial

sextant and his ~~his~~ 7ft mural arc, he was visited by Peter the Great in 1698; that the first Nautical ~~Pu~~ Almanac was published in 1766 under the directorship of Maskelyne for the year 1767; that in 1818 the Admiralty took control of the RGO and this control lasted until 1965 when it was handed over to the National Research Council; that since 1822 the RGO has had charge of the Navy chronometers; that in 1884 the Greenwich meridian was chosen to be

the Prime Meridian for the whole earth; that in 1880 GMT became legal time in Great Britain; that the transfer of all instruments from Greenwich to Herstmonceux was completed by 1958.

The opening paper at the first session was an invited discourse given by Prof. Owen Gingerich of the Smithsonian Astrophysical Observatory, appropriately illustrated, a formidable task ably accomplished. The assigned topic was The Development of

Astronomical Theory and Practice from the 17th to the 20th Centuries. Subsequent papers covered a wide range: the founding of the Royal Observatory; the problems of navigation and quest for reliable chronometers; lunar tables; the observations and calculations of the early Astronomers Royal, Flamsteed, Halley, Bradley; early European observatories; the Paris Observatory planned in 1667 and established in 1671; Newtonian astronomy; the

Nautical Almanac; instruments and their uses at RGO 1675-1775; the Airy Era; Greenwich Time and the Prime Meridian; western astronomy in India; Greenwich instruments and the aberration of light; refraction, Twilight and the height of the atmosphere; positional astronomy from Bradley to Bessel; the RGO in the mainstream of science - (i) gravitation (ii) measurement, keeping and distribution of time (iii) principles of observation and theory of errors (iv) geophysics and planetary

science arising from astronomical observations (v) structure of the universe using optical astronomy directly and in cooperation with radio, infrared, X-ray, gamma ray and cosmic ray astronomy.

I conclude this report with one lengthy quotation from Alan Chapman's paper. "By the mid-eighteenth century, the Greenwich observations had become acknowledged as an international standard of accuracy, which had been achieved through the successful

application of the telescopic sight, micrometer and improved methods of graduating circles to astronomical measurement by the instrument makers of London. Indeed, the early Royal Observatory was fortunate to flourish at a time when the works of such craftsman as Sharp and Bird could be put to maximum effect by observers ~~of~~ of the

calibre of Hamsteed and Bradley. Resulting from these developments, the observations of Bradley showed an improvement of ten-fold upon those of Hamsteed, and sixty-fold upon those of Tycho."

Particular mention must be made of the warm courtesy and kind helpfulness of Commander D. W. Waters, Deputy Director of the National

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Maritime Museum and
of Commander H. D. Howse
Head of the Astronomy Dept.
of the Museum. Their
contribution to the success
of this gathering merits
~~his~~ sincerest thanks.

To Jan Halliday
J Rase.
Sept 18/75

1975 SPER 18

Tercentenary of the R.G.O.

A. VIBERT DOUGLAS

The Tercentenary of the Royal Observatory Greenwich was celebrated by holding an International Historical Symposium at the National Maritime Museum at the foot of the Observatory hill from July 14 - 18, 1975. This was the 4th Joint IAU/IUHPS Symposium on the History of Astronomy. The theme of the symposium was "The Origins, Achievements, and Influence of the Royal Greenwich Observatory, 1675-1975".

The published list of participants in the Symposium included 107 names, late registrations brought the number to about 140, with a wide spread of nationalities: South Africa, Japan, India, USSR, Poland, Czechoslovakia, Hungary, East and West Germany, Switzerland, Denmark, France, Portugal, U.S.A., Canada with five representatives, and of course, a large number from the United Kingdom. As at all such meetings the informal social events are of special value. The "Meridian Party" was a reception by the Trustees and Director of the National Maritime Museum in the "Queen's House", the central section of the Museum which was built as a summer palace for Queen Charlotte, wife of Charles I. On the fourth evening, most of us went in to London to the spacious rooms in Carleton Terrace as guests of the President of the Royal Society and the President of the R.A.S. The next day we went by bus to visit the Royal Observatory at Herstmonceux with its Isaac Newton telescope and six smaller domes, its library and lovely gardens where a garden party was held following the unveiling by Princess Anne of a bust of the first Astronomer Royal, Rev. John Flamstead and a large sundial. The "Transit Dinner" in the Trafalgar Tavern in Greenwich concluded the programme except for a Commemoration Service in Westminster Abbey on Sunday July 20 at the invitation of the Dean

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of Commander H.D. Howse, Head of the Astronomy Dept. of the Museum. Their contribution to the Success of this gathering merits sincerest thanks.

THINKING IN CENTURIES.

"Few men and fewer women can think in centuries". These words were spoken to me a few weeks before the Armistice in 1918, spoken quietly and thoughtfully by Sir Aukland Geddes - afterwards Lord Geddes - my Chief, in the War Office and later in the Ministry of National Service, in London during the First World War.

Aukland Geddes was a remarkable man. He was Professor of Anatomy at McGill when the First Great War began; he became a realistic and determined soldier, and then when a serious accident relegated him to the War Office, he evinced a rare clarity of insight into the problems of harnessing British man power and he became an outstandingly competent organizer and administrator. In the early 1920's he served as British Ambassador to Washington and later became the active far-sighted Chairman of the Rio Tinto Mining Company. This is the man who deprecated the average person's myopic vision. Many of the complexities and perplexities of our own lives, as well as many of the tensions and tragic situations in the world are due to short-sightedness. Even our statesmen have rarely had far vision, the ability to think in centuries.

May I interject here, because I feel so strongly on this matter, that Canada's failure to recognize the great awakening nation of China is an example of failure to think in centuries. Here is potentially the greatest nation on earth, 700 million people awakening to the possibilities of the modern age, throwing off the centuries of overlord tyranny and indifference to mass education. Schools, technical institutes and universities, railroads and power plants and industry springing up throughout the length and breadth of this vast country. Canada maintains an ambassador in the U.S.S.R., why not in China with its greatness and influence potentially exceeding even the U.S.S.R. in the present century! Let us at the very least have the realism and the courtesy to recognize them for what they are — the great and potentially greater and greater nation which is China.

I believe that every educator should feel some responsibility for seeing that the boys and girls of today become citizens who can see farther than do most of our generation. We want them to be men and women some at least of whom will think in centuries.

How can we develop in young people the habit of taking the long view?

I think one of the most important ways is by replacing a child's idea of a static body of knowledge that has to be learned, by the exciting dynamic view of knowledge which can be likened to a great river whose origins are mere trickles in a far distant past, growing in volume as little and great tributaries flow into it from many lands in every age, growing and growing with the years and still growing under our very eyes. Let us try to give our students this living, dynamic conception of knowledge and hold before them the privilege of joyously and receptively immersing themselves in this river. Awaken their imaginations to the possibility that after university training

they may themselves become searchers after knowledge and with hard work, honesty of purpose, and the luck of the Gods, they may perchance make their own contribution to this great flowing river. I remind you of these words of Einstein who knew whereof he spoke: "He who discovers a line of thought which permits us to penetrate even a little deeper into the eternal mystery of Nature is greatly privileged. He who, in addition, is encouraged by recognition, sympathy and help from the best minds of his time, experiences more happiness than anyone can realize."

I mentioned a moment ago that in your teaching you point the way to the universities. Encourage your students in their early school years to think of the university as a desirable goal, and as a possible goal, the gateway to a richer and more interesting life. My thoughts go back through the centuries to the great B.C. era of Athens when Plato gathered those who would learn of him in the shade of a tree by the road to Daphni; when Socrates discoursed on the highest values with thoughtful men and fools down by the Piraeus; when Aristotle established his ~~Academy~~ Lyceum hard by the steep northern slopes of the Acropolis. Two summers ago I invested some of my savings in going to Greece where I saw these very places and tried to catch something of the restless spirit of those centuries, the eager quest for truth in philosophic realms of thought; for beauty in sculpture and in architecture; for understanding of the phenomena of land and sea and air, and of the universe of sun, moon, planets and stars.

My thoughts come down ten centuries to Cordoba which I visited in 1927, standing in awe and reverence in the Mihrab of the ancient Moorish mosque where prayers were offered to the one true God 11 centuries ago. Cordoba was then the greatest seat of learning in Europe. It was the Mecca of the west to which students made their way from all parts of Europe - and this was two centuries before William of Normandy sailed across the English Channel.

Going now in thought to Bologna I remind you that in the year 1088 this oldest of the still existing universities of Europe was founded as a school of jurisprudence, afterwards adding medicine and natural philosophy. So rapidly did its fame spread across Europe that in the 12th century it had more students than has Queen's University at the present time. And not only did they develop powerful student self-government, but they did on occasion call the tune to which the professors had to dance or make good their escape from the city. I recall three statues in Bologna: one of a famous professor, Galvani, whose name is known to every student of electricity; one of Dante to the left of the entrance to the University Auditorium, a student there in 1287; and on the right of the entrance Copernicus of Poland with the inscription "glorious son of this University."

Soon after the founding of Bologna, universities began to spring up over Europe - the University of Paris, Oxford, Cambridge in 1281. The 14th - 18th centuries saw universities in almost every country of the west. In the city of Lima Peru the Spanish conquerors established the University of San Martin in 1551. In Russia the University of Moscow dates from 1755. The old university lies in the heart of the city near the Kremlin, but the huge new sky-scraper university was constructed between 1949-53 on the Lenin Hill on the bank of the Moscow river at the south extension of this great city. The central block is academic, 30 storeys high with a spacious entrance lobby, marble halls and stairways approaching the large Auditorium; numerous class-rooms, offices, reading rooms, and museums at the top. To east and west of the central building are

sixteen storey wings and beyond these, nine storey wings providing accommodation in single or double rooms with lounges and cafeterias for 6000 students. These wings terminate in two deep towers which accommodate 400 professors and their families in 3 and 4 room apartments. In this great building the International Astronomical Congress was held last summer where I was privileged to be one of about 20 Canadians, and one of some 600 astronomers from 34 countries. Moscow is a wonderful city to visit, and the spirit at the University is very alive with pride in their achievements since the war, and confidence in their plans for the future. But were you to ask me if I would like to be a student there or a member of Faculty my answer would be an emphatic No. No one of ~~us~~ who values the freedom of speech and thought of our Canadian schools and universities would willingly exchange this freedom for the constraint within the U.S.S.R. where Marx-Lenin doctrines as interpreted by the current party rulers must be taught and learned and must not be questioned; where never a whisper of criticism of their rulers is safely made. If you have read Pasternak's Dr. Zhivago, you may recall these words: "the great misfortune is when belief in the value of personal opinion is lost," and elsewhere "merely to have personal opinions is to draw suspicion upon oneself." As educators it behooves us to be alive To and oppose any attempt on the part of church or state, institution or individual to contain our right to hold and express personal opinions.

But let us return to my simile of the river of knowledge. As educators we all want to encourage our young people to expand their vision beyond a narrow bigotted nationalism, and to avoid intolerance. We know that ignorance breeds intolerance, and intolerance breeds hatred, and hatred breeds strife, and war in the present age is the ultimate in human folly and self-destruction. Let us therefore begin at the foundation and be certain that our students are not ignorant of the immense debt that we all owe to the great thinkers, inventors, artists of many lands throughout many centuries. This is a game you can play in five minutes in your class-room and with almost any subject of your choosing - you can skim down the river as in a speed boat, through the centuries, drawing attention to this tributary from this country and to that tributary from another country, each and every one augmenting the volume and grandure of the river of knowledge in the particular subject you have selected.

Take electricity, for example: you have static electricity described by the Greeks, you have Galvani and Volta of Italy, Ampère of France, Oersted of Denmark, Ohm, ~~and~~ Gauss and Helmholtz of Germany, Faraday of England, James Clerk Maxwell and Lord Kelvin of Scotland, Franklin and Henry and Edison in the United States, Steinmetz born in Lorentz in the Netherlands. I leave you to augment that list of ten nationalities.

Take my own subject astronomy: we can name Hipparchus of Greece, and Ptolemy of Alexandria, Naburianu and Kidinnu of Persia, Copernicus of Poland, Tycho Brahe of Denmark, Kepler of Germany, Galileo of Italy, Sir Isaac Newton in England, Le Verrier in France, Struve in Russia, Hamilton in Ireland, Saha and Chandrasekhar in India, Hale and W.S. Adams in the U.S.A., Plaskett in Canada, Rosseland in Norway, Edlen in Sweden; Kaptegn, de Sitter and Oort in the Netherlands, Lemaître in Belgium, Mills in Australia. I have now mentioned men in twenty countries ~~and~~ whose ~~their~~ contributions to astronomy, both theoretical and observational, span 22 centuries.

Think of the fun you can have with the great lawmakers from Moses and Hamurabi and Solon down the centuries; with poets from Homer and the Hebrew author of Job, and Omar Khayyam and Dante as a start; with artists and musicians, or with the makers of medical science. I am convinced that teachers and parents cannot begin too early to direct

Thomas Young (1773-1829)

Two hundred years ago, in June 1773, Thomas Young was born in Somerset. The ~~eighteenth century~~ period can boast of no more brilliant and versatile scholar. He completed the residence requirements for (although he ~~failed~~) his M.D degree in Cambridge in 1808, but he had began his medical studies in 1792 and in 1793 while in a student at St Bartholomew's Hospital in London he had read a paper before the Royal Society on ~~the accommodation~~ the accommodation of the eye. This led to his F.R.S. in 1794 at the age of twenty one. His was the first treatise on astigmatism, its measurement and nature. He proposed the three-colour theory of human vision in his Bakerian Lecture in 1801.

From his early youth, Young was interested in languages, mastering the classics and the Oriental languages, Hebrew,

Persian and Syriac. His interest in art and architecture led him into the archaeological field in Egypt. No key was known to the hieratic inscriptions, but in 1799 the Rosetta Stone had been discovered on which was inscribed the Memphis decree in three languages: Greek, demotic and hieratic Egyptian. Young studied these and ~~took~~ inscriptions at Karnak and succeeded in making the first bridge ~~between~~ to the interpretation of the hieroglyphics symbols.

But for astronomers, Young's fame rests not on these remarkable achievements, but on his pioneer work in physics. Young's Modulus is known to every student but more important is his path-finding work in optics. His was the first conceiving wave theory of light bringing him at once into a ~~period~~ of criticism and speculation between its announcement in Philosophical Transactions of the

Royal Society in 1801 and his published lectures on optics in 1807 and Fresnel's impressive support of the wave theory in 1818.

No astronomer is unaware of the application of interference phenomena by 20th century astronomers both in the optical and the radio ranges, applications which have ~~lead by~~ led to results ~~dates~~ of inestimable value. Thomas Young ~~he~~ was the first to enunciate the principle of interference and to explain the colour of thin plates. In this paper to the Royal Society in 1802, ~~In this paper~~ he suggested ~~stated~~, that ~~his experiments~~ ~~suggested~~ the velocity of light is less in a dense medium than it is in a vacuum, and that there is a loss of half a wave length on reflection at the interface between two media of different densities.

Quiquid nitet notandum is the

motto of the Royal Astronomical Society. "Whatever shines is to be noted." It is fitting that astronomers ~~honour~~ pay their tribute to the memory of this great pioneer in the study of light on the two hundredth anniversary of his birth.

A. Vibert Douglas.
1973 Dec 5

Footnote: A fine tribute to Dr Thomas Young has been paid by John Herival, Head of the Department of History and Philosophy of Science at Queen's University, Belfast, in a paper in Endeavour Vol. XXXII, No 115, 1973.

To Jack Locke
6/2/73
for J. Rose?
Proofs 9/5/73

Sent to
Mr. Miller
June 23 '24

Time.

"Time rolls his ceaseless course" — a Faust may call to the passing moment, "Stay, thou art fair", but the fleeting moment will not stay. Time waits for no man. Time will submit to no universally accepted definition. The future merges into the Past and the ever-advancing instant of transition we call the Present. Whence comes it and whither does it go? ~~Is it cyclical,~~ Is it infinite? Or is it finite, with a meaning to the oft-repeated phrase "when Time shall be no more". Is it perhaps cyclical? The finite mind of man becomes lost in the mystery of this most common yet most elusive of ~~the~~ fundamental notions. ~~of mankind~~.

Very different is the measurement of Time. It is a straightforward and understandable process. The succession of daylight and night time give us first natural and universal unit of time called the day. The succession of winter, ~~and~~ spring, ~~time~~ summer, and autumn with their seasonal changes made apparent ~~by~~ in the behaviour of all Nature provides the second unit of time namely the year, during which time the earth makes one ~~complete~~ circuit of its orbit around the sun. Now if the earth travelled around the sun in a circular orbit with constant speed and if the earth's axis were fixed perpendicular to the plane of this orbit ~~it is obvious~~ and the diurnal rotation of the earth about this axis were constant, it is obvious that every day would be exactly the same length and equally divided into two periods of light and darkness.

Furthermore there would be no seasonal changes and the year would be one long monotonous unvarying passage of time, marked only by the gradual change in the position of the sun relative to the distant background of the "fixed" stars.

But the earth's orbit about the sun is not a circle. It is an ellipse and therefore, by the laws of dynamics discovered by Kepler and partially explained by Newton, the speed of the earth varies along this orbit being greater when the earth is nearest to the sun in ~~our~~ northern winter season and least when the earth is furthest from the sun in our summer ~~time~~. The ancient Hebrews measured their day from sunset to sunset. If the earth were fixed at one stationary point in its orbit the time from one sunset to the next succeeding sunset would be exactly the time of one complete rotation of the earth on its axis. But actually during the time between one sunset and the completion of one rotation of the earth, the earth has moved along its orbit round the sun and therefore it has to turn just a little further on its axis to experience the phenomenon of sunset. Thus the day is just a shade longer than the exact period of rotation and as the speed of the earth in its orbit is greatest in winter, the day (not the period of day light) is longer than the day in summer, January 1st being about 17 sec. longer than July 1st and the average January day being about 15 sec. longer than the average July day.

On the other hand everyone knows that ~~the~~ the winter day has fewer hours of daylight ~~and longer nights~~ than the summer day and this is due to the same cause as produces ~~the~~ seasons namely that the earth's axis is not perpendicular to the plane of its orbit but inclined about 23 degrees and pointing at the present time in the general direction of the brightest star of the constellation called by the ancients the Little Bear. We usually refer to it in common speech as the Pole Star. When the earth is in that part of its elliptic orbit nearest to the sun the South pole is inclined toward the sun and the southern hemisphere has its summer, while for us in the northern hemisphere the hours of ~~daylight nights~~ exceed ~~the~~ in number ~~the~~ the hours of daylight and on December 21 or thereabouts we have the day of minimum daylight commonly called "the shortest day". This same day, by dwellers south of the equator, is called "the longest day" of the year because ~~they have~~ for them the period from sunrise to sunset is the longest.

The ancient custom of dividing the period from sunrise to sunset into twelve equal parts and the night into another twelve equal parts, irrespective of the season, was continued in Europe until the fourteenth Century when mechanical clocks began to

be developed. Obviously no mechanical clock will keep ~~the~~ The time indicated by a sundial with its changing length of day (day and night) ~~and changing relative proportions of daylight and darkness throughout the year~~ and unequal hours, and so instead of this "apparent Solar time" the civilized world have agreed to divide time into equal units called the mean solar day to begin at midnight and be subdivided into twenty four hours of equal length. Thus a standardized clock or chronometer keeps mean solar time and the number of minutes or seconds to be added to or subtracted from this in order to obtain sundial or apparent solar time is called the "equation of time" and is tabulated for each day of the year in all Nautical Almanacs. Four times in each year, once in April, ~~once~~ in June, in September and in December mean time agrees with apparent time. at other times the two are different and this difference may ~~reach as it~~ becomes as much as 16 minutes in November, for example.

No mention has yet been made of Sidereal Time and of Standard Time. The former is of purely astronomical interest being measured in terms of sidereal days, the time in which any given star appears to make one revolution around the earth, this time being about four minutes less than the solar day or time in which the sun appears to move once around the earth. Thus the year contains 366 1/4 sidereal days equivalent to 365 1/4 mean solar days. Incidentally it may here

be remarked that this extra 1/4 day necessitates the additional day every fourth ~~year~~ or ~~a~~ leap year.

Standard Time is quite another question. It is evident that the sun rises and sets a little later for each place on the surface of the earth as you go westward, and so purely as a matter of convenience it is agreed that all places within ~~a~~ certain defined boundaries, usually lines of longitude, shall set their clocks together, a change of one hour being made on crossing these arbitrary boundaries. Thus in Canada we have six belts of standard time agreed upon in 1883 as follows: Atlantic Time (60th meridian west of Greenwich and therefore 4 hours behind Greenwich time); Eastern Time (75th meridian, 5 hours behind Greenwich); Central Time (90th meridian); Mountain Time (105th Meridian); Pacific Time (120th meridian); Yukon Time (135th meridian, 9 hours slower than Greenwich).

From all that has been written above, it is clear that Time is measured in terms of the motion ~~of~~ or the apparent motion of the sun and stars. In these celestial bodies the almost infinitesimally small atoms are in a state of incessant external and internal motion throwing out into space each its distinctive quanta ~~radiations~~ of energy, ~~which~~ radiations great and small, which journeying onward through interstellar

and interplanetary space arrive perchance upon the earth and tell us of the existance of the stars from which they came and of their motions and our own. As a certain poet has put it very beautifully, ~~we upon the earth~~ the astronomer has caught . . . .

"The deep pulsations of the world,
Aeonian music measuring out
The steps of Time."

Time

To Montreal Star
Dec 1926

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1 Orig
1 cc

542-7007
Dr. Douglas
127 King West

Georges Lemaître

On June 20, 1966 Georges Lemaître passed away, and for many of us who were privileged to know him, especially those of us who remember vividly the great years in astrophysics and cosmology of the 1920s and 1930s, his passing leaves a sad blank.

I first met him at The Astronomical Luncheon arranged by D.T.C. A chant for the 38 astronomers of seven nationalities attending the British Association Meetings in Toronto in 1924. Our next meeting was in the Summer of 1925 at Yerkes Observatory where I was a volunteer research assistant from May to mid September and Lemaître came for a brief stay as The holder of a travelling fellowship. He had completed a year of research in Cambridge under Sir Arthur Eddington and as I had left Cambridge only a few months before he arrived there in 1924, we had much in common in reminiscing about the Cambridge of Rutherford and Eddington, the towering giants of those unforgetable years.

Georges Lemaître was born in Charleroi, Belgium on July 17, 1894. He fought as a poilu during the first great war, then entered the Jesuit University of Louvain and specialized in applied mathematics; taking also theological studies which led to the clerical rank of abbé in 1922. After his post-graduate years at Cambridge University and at M.I.T. where he obtained his Ph.D. he received an appointment as Professor of astrophysics at Louvain eventually becoming Professor of applied mathematics and being elevated to the clerical rank of Canon and Officer of Mopsignieur. For forty years of university life his talents were devoted to research and teaching.

In 1927, independently of earlier, little-known work by Friedmann, Lemaître developed his theory of the expanding universe and published it in Brussels

This paper made no stir in the scientific world until he sent a reprint in 1930 to Eddington who at once recognized the stroke of genius behind it. The Einstein world was not stable, it must expand or contract and Lemaître had worked out the geometry of a world whose radius of curvature was a function of time; ~~the spectroscopic evidence of the recession of the galaxies pointed to expansion~~, at the May meeting of the Royal Astronomical Society, Eddington reported Lemaître's results and proceeded to discuss the expanding universe as an intermediate stage between the Einstein and the de Sitter worlds, identifying the spectroscopically determined recession of the galaxies with this expansion and welcoming it as an indication of world curvature. He then departed from Lemaître's "primeval atom", for which he expressed an aesthetic dislike, to calculate the mass of the universe and its radius at the Einstein world stage from which he believed the expansion had started. Thus overnight the name and fame of Lemaître became known to the world, and his "fireworks theory" — his own expression — captured popular imagination.

During that decade, Lemaître twice visited Mount

(3)

Wilson each time passing through Montreal and gladly giving a lecture on the latest developments in cosmology to members of the Montreal Centre of the Royal Astronomical Society of Canada and the McGill Physical Society. I recall how friendly and genial he was at a small dinner in our home where a few friends had gathered to meet him informally. *

After the holocaust of the second world war, Lemaître I saw in Zurich at the 1948 General Assembly of the I.A.U. His grief over Eddington's death late in 1944 at only 62 years of age was very evident, and he told me of his deep feeling that there was something very worth while behind the provocative ideas of Eddington's unfinished, mystifying Fundamental Theory. He was himself trying to unravel some of its mathematical obscurities.

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Base of five found out

Dec 14. 1966

Typing cost $1.50

Georges Lemaître

On June 20, 1966 Georges Lemaître passed away, and for many of us who were privileged to know him, especially those of us who remember vividly the great years in astrophysics and cosmology of the 1920's and 1930's, his passing leaves a sad blank.

I first met him at the Astronomical Luncheon arranged by Dr. C.A. Chant for the 38 astronomers of seven nationalities attending the British Association Meetings in Toronto in 1924. Our next meeting was in the summer of 1925 at Yerkes Observatory where I was a volunteer research assistant from May to mid-September and Lemaître came for a brief stay as the holder of a travelling fellowship. He had completed a year of research in Cambridge under Sir Arthur Eddington and as I had left Cambridge only a few months before he arrived there in 1924, we had much in common in reminiscing about the Cambridge of Rutherford and Eddington, the towering giants of those unforgetable years.

Georges Lemaître was born in Charleroi, Belgium on July 17, 1894. He fought as a poilu during the first great war, then entered the Jesuit University of Louvain and specialized in applied mathematics, taking also theological studies which led to the clerical rank of Abbé in 1922. After his post-graduate years at Cambridge University and at M.I.T. where he obtained his Ph.D. he received an appointment as Professor of Astrophysics at Louvain eventually becoming Professor of Applied Mathematics and being elevated to the clerical rank of Canon and later a

Monsaigneur. For forty years of University life his talents were devoted to research and teaching.

In 1927, independently of earlier, little-known work by Friedmann, Lemaître developed his theory of the expanding universe and published it in Brussels. This paper made no stir in the scientific world remaining practically unknown until he sent a reprint in 1930 to Eddington who at once recognized the stroke of genius behind it. The Einstein world was not stable, it must expand or contract and Lemaître had worked out the geometry of a world whose radius of curvature was a function of time. At the May meeting of the Royal Astronomical Society, Eddington reported Lemaître's results and proceeded to discuss the expanding universe as an intermediate stage between the Einstein and the de Sitter world, identifying the spectroscopically determined recession of the galaxies with this expansion and welcoming it as an indication of world curvature. He then departed from Lemaître's "primeval atom", for which he expressed an aesthetic dislike, to calculate the mass of the universe and its radius at the Einstein world stage from which he believed the expansion had started. Thus overnight the name and fame of Lemaître became known to the world, and his "fireworks theory" —his own expression—captured popular imagination.

During that decade, Lemaître twice visited Mount Wilson each time passing through Montreal and gladly giving a lecture on the latest developments in cosmology, to members of the

Montreal Centre of the Royal Astronomical Society of Canada and the McGill Physical Society. I recall how friendly and genial he was at a small dinner in our home where a few friends had gathered to meet him informally.

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Note to The Editor JRASC.

Was Lemaître an Honorary Member of RASC??
If so please add to the last para. this sentence:

Members of the Royal Astr-Soc-Can—are proud to have numbered him amongst the Honorary Members of the Society.

A.V.D.
Dec 14, 1966