

A. Vibert Douglas

University Lectures

Astronomy I  
1946-47

17.

Loc. 2303.9

Box 1



# Astronomy I.

1946-47

Lecture 1. Fri Oct 4.

(1907 Sept 26)

1962 Sept. 21

Baker.

Read: Other worlds...  
world of Copernicus

Seating & Text Book.  
Introduct: Astron. - oldest of the Sciences

a descriptive course - i.e. not a mathematical  
problem course

but not week end reading

Go & register in something else if you  
don't want to learn to think logically  
and reason from a justifiable premise  
to a legitimate ~~reasonable~~ conclusion.

Science (Oxford Dict): systematic and formulated  
knowledge, the pursuit of this, the principles  
regulating such pursuit

Natural or physical science: one dealing with  
material phenomena and based mainly on  
observation, experiment and induction.

Exact science: admitting of quantitative  
treatment.

Induction: inferring of a general law from  
particular instances.

Deduction: inference from the general to the particular.



# The measurable & the immeasurable

science.

philosophy, religion aspects of art & literature.

To express the inexpressible.

Measurement: pure numbers, & phys. dimensions: M L T  
vel.  $\frac{L}{T}$   
dens.  $\frac{M}{L^3}$

## The progress of knowledge due to various causes

1. practical necessities of life
2. man's natural curiosity.
3. " imagination
4. " faith. (seek + ye shall find, knock + it shall be opened)
5. " ability to reason + honest self criticism + scepticism.

- 1.
2. why? how? where? when?
- 3.

4. that there is order in the universe. "Trust in reason which rests ultimately on faith in the Divine Logos the self-revealing soul of the Universe" - Clement of Alexandria - Dean Inge  
"In the age of reason faith yet remains supreme, for reason is one of the articles of faith" - Assolomon.

5. critical judgment - ~~wholesome~~ <sup>wholesome scepticism</sup> - [Prove all things but hold fast that which is good]

3 without 5 leads to the magician, astrologer, alchemist - too often deceiving himself + frequently playing on the ignorance, fear, and superstition of his fellow men.



# Francis Bacon

## attributes of the man of science

" The desire to seek, patience to doubt,  
 fondness to meditate, slowness to  
 assert, readiness to reconsider,  
 carefulness to dispose and set in order,  
 a man that hates every kind of imposture "

L.2

## The Scientific Method

1. Observations & collection of facts & data  
     perhaps
2. Induction - tentative formulation of a  
     statement of relationships - a general  
     principle  
     Kepler "Bow down before facts  
     & let them speak to you"  
     J.J.T "a theory is a tool - not a creed".
3. Deduction :- of crucial tests  
     by observation, by experiment  
     [Example of Pasteur  
     Try to disprove your own  
     theory -  
     Be your own severest critic]
4. ~~Indefinite~~ Crucial experiments - & shows
5. Modification or amplification or fresh start  
     ad in function



## The universe around us. Cosmology

SLIDES

Homer 1100? - 900 BC?

Anaxamander 611 - 545 BC.

Egyptian Hermopolis

" Symbolic

Hindoo mythology

Hildegard of Bingen 1170 AD.

Astron prognostication 1546

16<sup>th</sup> Century woodcut

Scales Manipus in Universe. ✓

## Why is astronomy the oldest of the Sciences?

1. Time
  2. Direction
  3. Natural awe + curiosity.
- } 2 fundamental needs of mankind

### UNITS OF TIME

Day, month, year, divisions in their beginnings  
week - see p. 5.

year - with gnomon -  $365 \frac{1}{4}$  days.

Anomalistic year. 365.25964 dy.

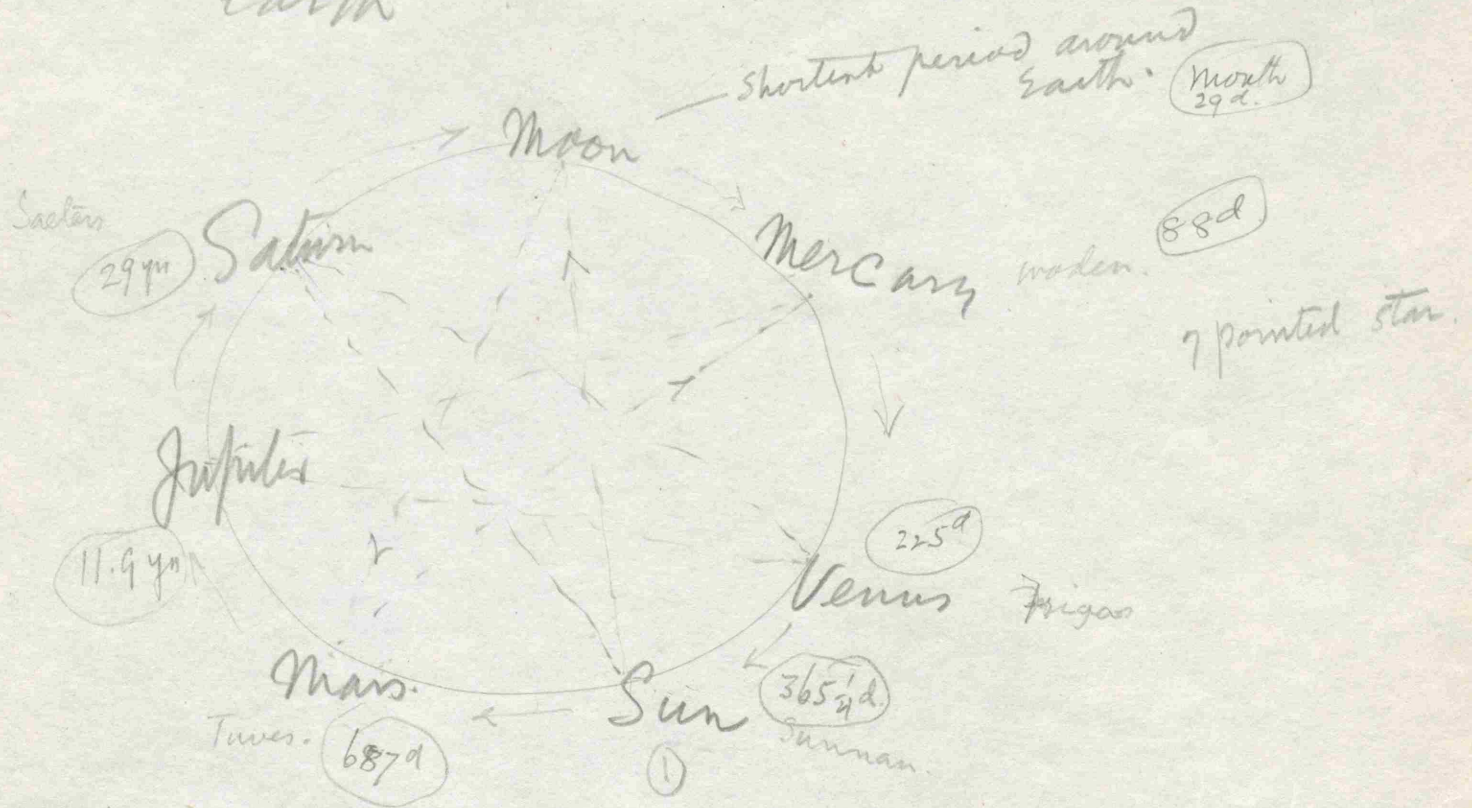
Sidereal year .25636 dy.

Tropical year .24220 dy.



Observations :- Star groups. (fixed)  
7 wanderers.

Constellations  
Ptolemaic order of "planets" from earth



If Saturn governed 1<sup>st</sup> hour of one day (Saturday)

Jup	"	2 <sup>nd</sup>	"	(Sunday)	Saxon Sunnan
Mars	"	3 <sup>rd</sup>	"	(Monday)	Monan
Sat	"	8 <sup>th</sup> , 15 <sup>th</sup> + 22 <sup>nd</sup>	hours.	(Tuesday)	Tues-
Jup	"	23 <sup>rd</sup>	hour -	(Wednesday)	Woden
Mars	"	24 <sup>th</sup>	hour.	(Thursday)	Thors
Sun	"	1 <sup>st</sup>	hour of next day	(Friday)	Frigas
Moon	"	"	" next day	(Saturday)	Sacton
Mars	"	"	"		
Mercury	"	"	"		
Jupiter	"	"	"		
Venus	"	"	"		
Saturn	"	"	"		

hence order of days speak.



6  
L. 3 Baker Ch. 1 & models.  
azimuth + alt. (9<sup>30</sup> pm. Gibbons mass)  
to p. 11.

L. 4. Cel. Eq. Horizon diagrams  
see p. 7 [10 questions]

Ecliptic diagram  
Ra + Dec.

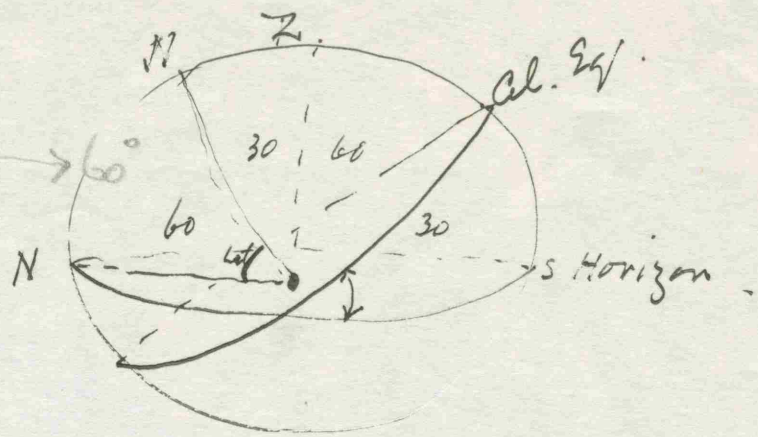
Last class on Thanksgiving Day Oct. 4

L. 5 Oct 16 Ecliptic Ra + Dec. model

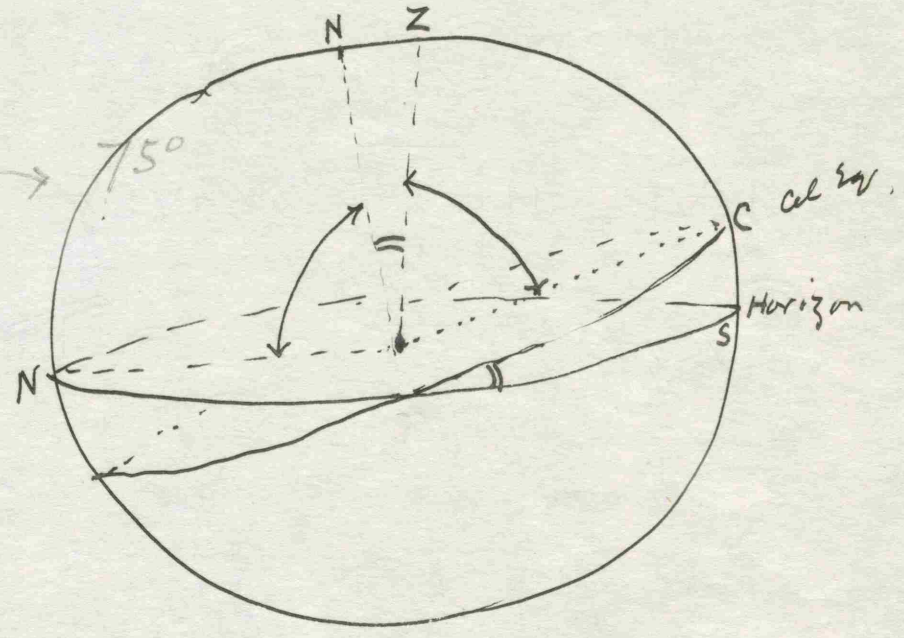
angle of incl. ecl. to horizon.  
Seasons, equinoxes



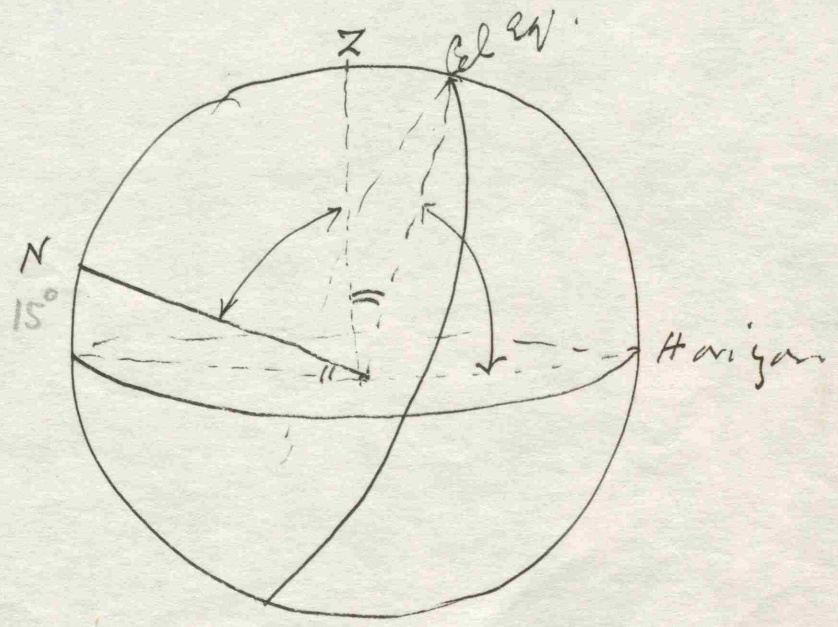
Diagram  
for lat 60



for lat 75°



Lat. 15°





L6-13. L13.<sup>12</sup> } Time + questions

L. 14 Nov. 4. Time from D's T. astro. Viewpl.  
+ clocks. D's a. in W. at war.  
began LIGHT :

L 15. Ch. 10 LIGHT

visib. to Phys Lab.

L 16 Nov. 8 Reflecting telescope

tree cont. 5h.

L 17 " 11 Refracting "

He + Ne

nd abstr. lines

18 13 Spectra

19 15 cd standard

20 18 Doppler

21 20 moon motions

22 22 moon - tides

23 25 eclipses (+ T. de ref. from RDS)

24 27 solar systems. (names + 29<sup>th</sup> for 1947 Handbook)

25 29 stationary pts

26 Dec 4 } quick contrbs  
+ cosmological speculations

27 6 Planets. James

28 9 gravitation + Relativity

29 11 Planets. Jap + Saturn (Read Galileo 1610 Jan 7-11)

30 13

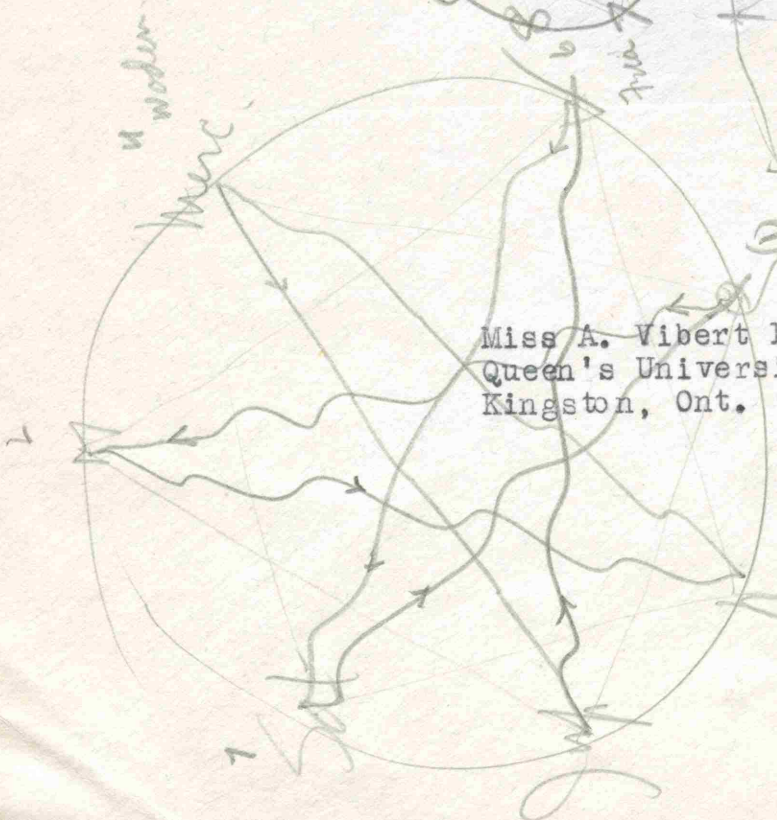
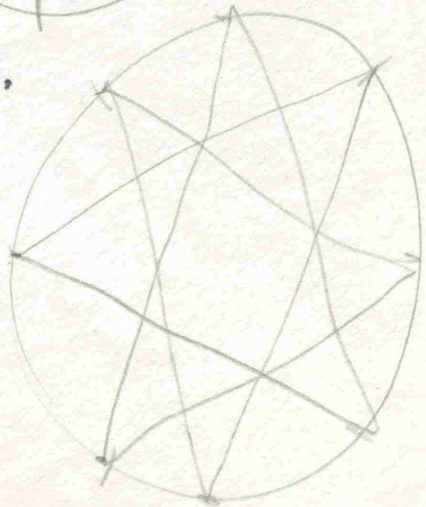
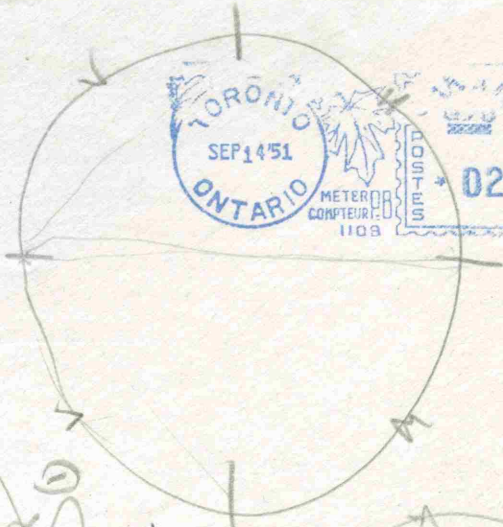
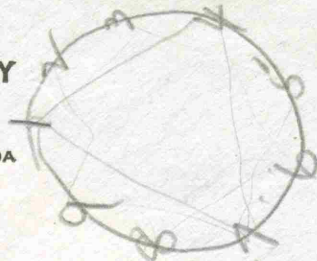


**E. T. LYNCH & COMPANY**

DOMINION BANK BUILDING  
68 YONGE STREET

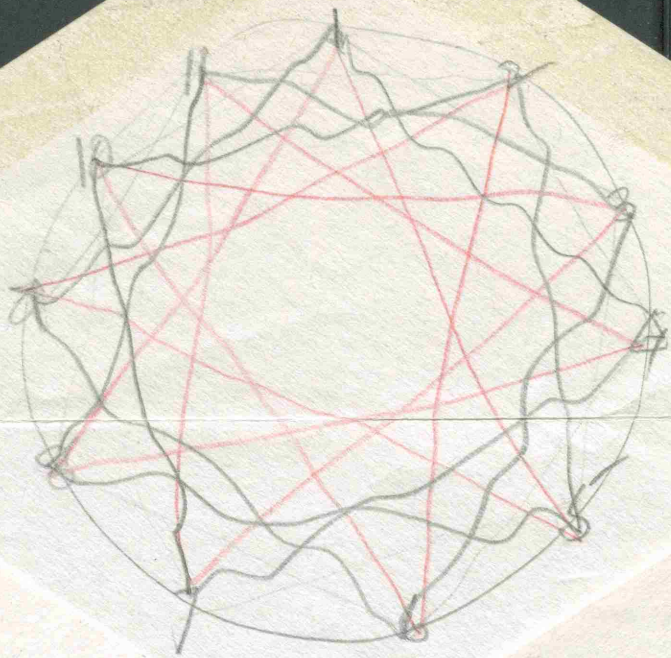
TORONTO

CANADA

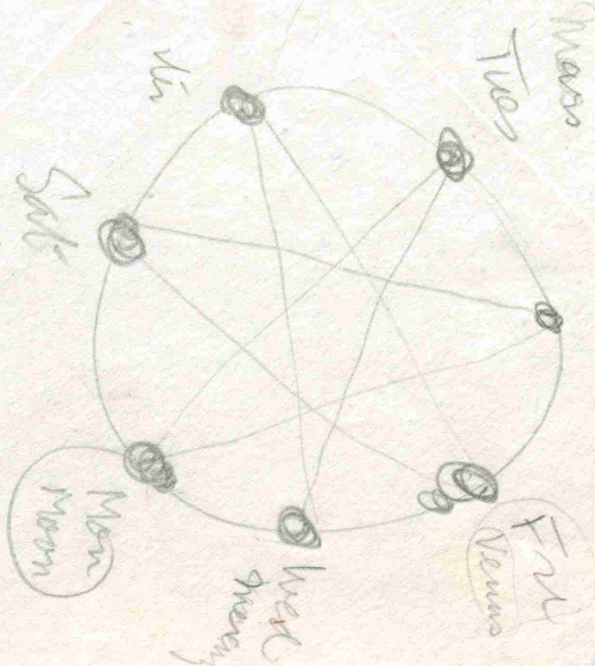


Miss A. Vibert Douglas,  
Queen's University,  
Kingston, Ont.





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SUN  
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B



1940 July 3.

1941  
1959

Lecture 1.

# Astronomy

1. Text Book & Star Chart.
  2. Exercises & Essays. corrected up to those received by June 14<sup>21</sup>. Others as time permits.
- Questions: Mondays ~~2-3~~<sup>4-5</sup> or by appointment.

## Lectures

1. Introductory lecture as historical approach
2. Solar System <sup>Read H. G. Wells.</sup> - coords. Kepler's Laws. Newton Law of Grav.
3. Spectroscopy - Kirchhoff's Laws - Doppler Law.
4. Constellations - etc.

3

Astron must anc. sci. Why? Time & Divin.  
Babylonians & Chaldeans.

1941  
Dec 8th 5  
July 11 5  
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11

1943 Slides  
4-10  
23  
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27  
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29  
30  
31

End of  
lecture 1.  
1941.

End  
lecture  
1943

1. Flamsteed Diagram
2. "Zodiac Ptolemy"
3. Babylonian Stone 1200 BC.
4. Anaximander 600 BC.
5. Homer map. b. 1100 - 900 BC.
6. Hindu
7. Egypt. symbols
8. " section of world.
9. " Denderah Papyrus.
10. Chinese
11. Ptolemy 135 AD Almagest.
12. Hildegard of Bingen.
13. Astron Prof. 1546 woodcut
- 14.

Center of empty space.  
S Pole 2700 BC



- 15. Copernicus d. 1543  
Solar System
- 16. Galileo d. 1642
- 17. Tomto Lessi's picture at Arcetri 1890
- 18. Galileo's Tel. 1610.
- 19. Dec. 8th Pleiades . 7 stars
- 20. Maestlin 1579. 11 stars .
- 21. Galileo 1610 36 "
- 22. Hertzprung 2616 "
- 23. Tycho Brahe d. 1601.
- 24. J. Kepler d. 1630-  
3 Laws.
- 25. Newton 1642 - 1727
- 26. " Tel. 1672
- 27. Hevelius of Danzig .
- 28. DAD 72"  
The Age of Telescopes  
& Modern Astronomy & ap.
- 29. The Galaxy.
- 30. M 31 .

Tycho's records have "the fragrance of ammonia."

Solone



Additional Lecture notes 1941. 1943, 1944

Lecture 1  
Introduction

Why study Astronomy?

Some universal characteristics of mankind, one is his insatiable curiosity

In all ages, in all lands, he looks out upon his world and asks How? When? where? WHY?

Curiosity about his environment, curiosity about himself.

The former leads to SCIENCE

the latter " " PHILOSOPHY and RELIGION.

ASTRON. oldest of sciences. why?

- (1) The most challenging mystery - because so remote & so stuffy.
- (2) The <sup>drive of</sup> practical necessity in TIME & Chronology and in direction.

of wandering.





Research Notes to be made by Astronomy Class 1944 Q.S.S. 26.

1. Summarize Solar Phenomena & Geomagnetism

Nature April 15, 1944 p. 452-454

Consulting Text Books to get the necessary background and definitions.

29. Eddin Nature Dec 25, 1943

p. 754

Too hard

2. Life and work of Sir Isaac Newton.

Skeleton of a 15 min address with following notes full enough to deliver it when called upon

3. Summarize Energy production in stars

Hans Bethe American Scientist Oct. 1942

4. List the most essential facts about the following For Aug 10

Essay 25%

①

1945  
9/23

- Hepparchus
- Ptolemy of Alexandria
- Copernicus
- Giordano Bruno
- Galileo

Age of Earth + Sun.

Stellar Motions

Applications of Doppler principle in astronomy

Chemistry of the Stars

Method of astronomy to Physics.

The Influence of Astronomical Knowledge + Observation in Literature

Interstellar Gases.

The Calendars of the Past Pres. & Future.

The Mythology of the Constellations.

Astronomy of the Bible  
Energy Prod. in Stars

- ② Brahe
- Kepler
- Newton
- Halley
- The Herschels

- ③ Huggins
- The Struves
- Lord Kelvin

- ④ Eddington
- Shapley
- Henry Norris Russell
- W. S. Adams E. Hubble.

- ⑤ Einstein
- de Sitter
- Lemaître
- Bethe

1946  
Cop. Galileo  
T. Brahe  
Kepler  
Newton

for July 17

Read Sir R. Ball. p. 127  
Bacon - p. 127  
Al Biruni

Ptolemy of Alexandria p. 121  
Herbert Spencer. p. 153.

1940 July 4.

# Lecture 2.

Complete Lecture 1.

Slides 24 - 30.

Keplers 3 laws.

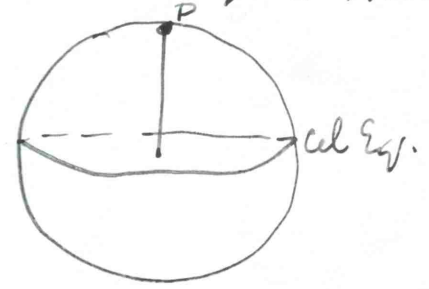
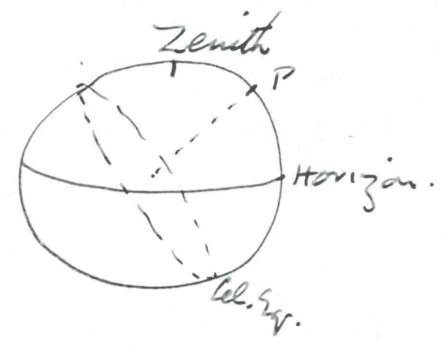
Newton's Law of Gravitation.

## Solar System

omitted Read Ch. 1. 2. H.G. Wells: Short (Hist. of World).

- Slides 1. 5 orbits to man.
- 2. 5. " " Kep.
- 3. Rel. dimensions, Sun planets.
- 4. Eclipse diagram
- 5. J.H.J. cigar.
- 6. Precession show model.  
5. polar sky - date Babylonian Astr.
- 7. Vernal Equinox in Taurus. (small slides)
- 8. Precession circle near  $\alpha$  Drae 2170 BC.  
 $\alpha$  Polaris 2000 AD.  
 $\alpha$  Lyral 14000 AD.

Coord:



1943  
Lecture 2.  
Keplers  
(H.G. Wells)

1943  
Lecture 3  
Newton (H. Einstein)  
(Solar Syst Models)  
Precession (Stonehenge)  
Pyramids

1943 L. 4  
Motion of Earth System

L. 5  
Light Radiation  
Wavelength + Amplitude

L. 6. Atomic models re  
Spectra - abs + em.  
H - He +

1943 Handr. Kepler

1943 L. 7  
slides Spectra  
Chromosphere + Sunspots  
Comet 9p.  
Planets

L. 8  
galaxy  
E-M radiation chart  
Baker p. 298-301

L. 9  
Phys. Biol.  
Spectra  
Sunlight + Air Temp

1943 L. 10  
Air Temp  
Doppler  
6 cases

L. 11  
Constellations  
- Par. Stars  
Baker ch. VII  
||

L. 12  
Zodiac  
mes. app. abs.  
L. 13  
Spectra  
Sunlight + Air Temp



1940 July 5

Lecture 3

Newton  
2. Read H.G. Wells.

1941 slides not shown lecture 2  
Newton's part of gravitation  
Precession Model  
Coord. system models  
Read H.G. Wells  
Give out notes & prints

1. Co-ord. Systems

3. Spectroscopy

B. p. 266.

Pr. line sp.  
Cont. sp.  
Abs.

Lecture 4  
Atomic Structure

July 6

- Slides
1.  $\Delta$
  2. Runners
  3. } Elements' lines
  4. }
  6. Solar
  7. line matching
  8. Secchi types
  9. Planets
  10. Solar Chromosphere
  11. Comet sp.
  12. " "
  13. Doppler. p Ori
  14. " Mizar
  15. Saturn
- Sun's Rotation p. 268 Baker

1941 Lecture Chap. VII  
July 5 Spectroscopy -  
Doppler shift  
Sun  
Chromosphere slide  
Rotation same

Read also 7. in Baker

Lecture 5

July 8

- (1) Scattering of Shorter W's. Spectrum  
Blue sky  
Sunset colors
- (2) Doppler Velocity: 1843  
B. p. 269

Lecture 6  
Electromagnetic  
Radiation  
Range  
Visible  
Infrared  
Ultraviolet

Extra Hours

Questions Planets, Solar Motion  
Ecliptic, Molecular Spectra

1941  
Lecture 7  
July 10

||x  
proper motion  
Spencer  
begin magnitude

Lecture 8 July 11  
Physics Lab.  
courtesy H.W. Huggins  
+ atomic structure

# Lecture 6. July 9.

Baker 1.21 - 24. - constellations  
Read.  
8.7, 11-13. Motions  
8, 10.

Parallax. Distances.  
8.1, 4)

# Lecture 7. July 10

Define parsec. p. 307  
light year.

$$\text{Dist} = \frac{1}{p} \text{ in psec.} = \frac{3.258}{p} \text{ l. y.}$$

1st problem  
of Aug 21  
+ Planet

Nearest stars p. 308  
8.5

Solar ||x The Astr. Unit. 8".803  
93 x 10<sup>6</sup> mi.

4.19 and 8.12

Eros dist ∴ Solar Dist. by Keplers 3<sup>rd</sup> Law.

Spec. determination

7 methods giving mean value 8".803 ± 0.001  
see RSD p. 187.

1943  
New Ras 1942 Feb.  
J. Rasc. Nov. 1942  
Eros  
93,005,000 ± 9000 mi  
8".790 ± 0".001  
2848 plates 1930 Oct to 1931 June  
24 observatories  
14 countries.

- SLIDES .
1. 25 nearest
  2. " "
  3. Eros.
  4. Dipper p. in 200000 yrs. +
  5. human hair
  6. spec. types sequence.



# Lecture 8

July 11.

1941 July 11  
with luminosity  
in Phys. Lab.

Spec. Types. 8 14 15 17 18 19 20 21.

Henry Draper Classification p. 321

July 14 →

Magnitudes 8 . 22 23, 25, 27, 31, 32

Hipparchus

Ptolemy

John Herschel.

W. Weber 1834  
(Fechner)  
1859.

ru Baker. 325-

→ Pogson. 1856.

$$m_1 - m_2 = c \log \frac{L_2}{L_1}$$

$$\therefore 5 = \frac{c \log 100}{c \times 2} \therefore c = 0.4 \therefore \log \frac{L_2}{L_1} = 0.4(m_1 - m_2)$$

$$[c = 2.5 \text{ or } \frac{1}{0.4} = \frac{1}{\log(2.512)}]$$

$$\frac{L_2}{L_1} = 2.512 \text{ if mag diff is } 1.0.$$

$$\therefore 1 \text{ mag diff} = 2.512 \times \text{luminosity}$$

$$\text{If } m_1 - m_2 = 1 \quad \frac{L_2}{L_1} = 2.512.$$

Abs. Mag. 10 psc. or // x 0.1

$$M = m + 5 + 5 \log p.$$

$$[ M = m + 7.57 - 5 \log \text{dist. in ly.} ]$$

Lecture 9.  
July 12.

$$\log \frac{L_2}{L_1} = 0.4 \{ m_1 - m_2 \}$$

$$M = m + 5 + 5 \log p.$$

Examples - 1. If Sirius has  $m = -1.6$ .  
How much brighter is it than a 6.0 star?

$$\log \frac{L_2}{L_1} = 0.4 \{ 6 - (-1.6) \} = 0.4 (7.6) = 3.04$$

$$\therefore \frac{L_2}{L_1} = 1096 \text{ times brighter.}$$

2. How much brighter is Sun than full moon?

$$\log \frac{L_2}{L_1} = 0.4 \{ -12.6 - (-26.7) \} = 0.4 (14.1) = 5.64$$

$$\therefore \frac{L_2}{L_1} = 436500$$

3. Abs. mag. of Sirius  $m = -1.6$   $p = 0''.373$

$$M = -1.6 + 5 + 5 \log 0.373.$$

$$= 3.4 + 5 (7.5717)$$

$$= 3.4 - 5 + 28.5 = 6.25 - 5 = +1.25 \text{ or } +1.3$$

4. Dist of Sirius  $p = 0''.373$ .

$$\frac{1}{p} = 2.681 \text{ parsec.} = 3.258 \times 2.681 \text{ l.y.} = 8.7 \text{ l.y.}$$

5. Dist. of Rigel.  $m = 0.34$   $\left[ \begin{array}{l} \text{7 mid.} \\ p = 0''.006 \end{array} \right] M = -5.8$

$$M = 5m + 5 + 5 \log p.$$

$$-5.8 = 0.34 + 5 + 5 \log p.$$

$$-11.24 = 5 \log p.$$

$$-2.25 = \log p = 3.75 \therefore p = 0.00562 \therefore \text{dist} = \frac{3.258}{0.006} = 543 \text{ l.y.}$$



Lecture 9  
cont'd.

Range of Electromagnetic Radiation

Laws of Radiation  
7.37  
38  
39

Black body rad<sup>n</sup>.

Planck's diagram  $E_\lambda = f(\lambda T) = \frac{c_1 \lambda^{-5}}{e^{c_2/\lambda T} - 1}$

Stefan's Law.  $E = a T^4$   
 $= 5.70 \times 10^{-8} T^4$

Wien's Law  $T \lambda_{max} = \text{const} = 0.289$

Lecture 10  
July 15

NB → Diameters by Radiation Laws.

10 4, 7, 8

Stellar Interferometers

Lecture 11  
July 16

Betelgeuse

& Antares system

Sirius "

see special notes  
of data.

and demonstration of spectra in  
Physics Lab. Courtesy of Dr. H.W. Harkness

# Lecture 12

July 17.

Variables  $\underline{8.35, 36}$

(1) Eclipsing  $\underline{9.27, 29}$

(2) Cepheids  $\delta$  Cephei  $\underline{8.37-41}$   
*of Aquilae cluster variables*

(3) Long period  $\underline{8.42-43(44)}$   
*Mira*

(4) Irregular  $\underline{8.47}$

(5) Novae  $\underline{8.48-51(52)}$   
*p. 352. Nova Aquilae 1918.*

# Lecture 13

July 18.

1941 Lect. 12  
July 17.  
Novae  
Hugan Motions  
Ch. IX.  
Solar  
+ radioactive relation  
L. 13 July 18  
Finish Oct + 15 P.  
Begin Main Clusters

# Lecture 14

July 19

Finish Novae

Binary refs.  $\underline{9.11, 17, 21, 25, 26}$

Eclipsing  $\underline{9.27, 29}$

Spec. Binaries  $\underline{9.21}$

1941  
L. 14 July 21.  
Binary Stars.  
L. 15 July 22  
massive Read Alt.  
White dwarfs. Resol.  
Eclipsing Binaries  
Algol.

# Lecture 15

July 22

→ Masses from Binary Relation  $\underline{9.19}$   
P. 373

→ Range  $10^{32} - 10^{35}$  gms. Read Stars + atoms  $\underline{p. 24}$  Radiation Pres.  
Mass - Luminosity Relation  $\underline{p. 24}$  mass relation

1941  
July 23.  
L. 16.  $\epsilon$  Aurigae. + Algol  
+ Ch. 10  
200 Fath.

1924 March

as Edington

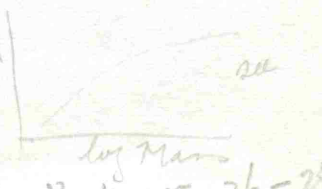
$\underline{10.13}$

# Lecture 16

July 23

Also may vs log Mass

Interior of Star Read Stars + atoms  $\underline{p. 11-12, 14-15, 26-28}$





Lecture 17.  
July 24

Mass Luminosity Relation - <sup>proper gas</sup> ~~Levin~~ for white dwarfs.  
Hertzsprung Russell diagram.

Spread in abs. mag increasing  
with Spec. Type A → M.

Spec. // x  
Baker p 411  
10 24, 25;

Hertzsprung - Kohlschütter  
Adams, Joy, Kimmel, Harber, Young  
Abetti, and, Lindblad etc.

L. 17.  
July 24  
Ch. X.  
Sources of stellar spectra.

Lecture 18.  
July 25

Table of Spec. // x criteria + workers.

Read Stars + Atmos bk -  
Sprint of research -  
" " seeking. p 53.

Star Clusters. 11. 1, 2, 4, 5, 7 M. 13.

+ Group // x method.

Slides } Open cl.  
          } Galact. cl.

✓ Perseus, Van der Linden

✓ Pleiades

✓ Besiege - open  
Distance // x diagram

✓ Glob.

✓ Distinction

✓ M 13

✓ M 13

Colheid relation

L. 18  
July 25  
Test +  
read abs. mag of stars. p 11-12.  
+ CHP Si Si<sup>+</sup> Si<sup>++</sup> Si<sup>+++</sup>

L. 19.  
July 26  
14-15  
26-28  
Mass Luminosity - Law  
+ Spec Maps

Lecture 19  
July 26

- (1) arrows above - as good
- (2) Distance of Gal. cl. see notes 1934 (Group // x)
- (3) " " Glob. cl. Alph + statistical method
- (4) Milky Way content.

Lecture 20  
July 29.

L. 20 July 29  
Gal + stars clusters  
+ slides  
+ Shapiro notes

Nebulae 11 11 12-19.

Diffuse  
Reflection  
Planetary Nebulae  
Nebularium

Bowen 11 19

see Baker's spectrum p-

0++ for both green lines

L. 21 July 30  
Lecture 21  
July 30.

Interstellar gases. 10 30-32

see notes.

Ca<sup>+</sup>

Na.

Ti<sup>+</sup>

Ca

K

} T Dunham.

[Coronium problem  
see Telescope  
1941 June.

Fe ionized 9-13  
Ni " 15  
Ca highly ionized.  
Eddington of Uppsala.

L. 22 July 31  
French film Nebulae.  
see p. 11, 20. Crab neb.  
+ Hercules M 31.  
+ his man.

Eddington p for interstellar space  $10^{-24}$   
1 atom per cc

air STP  $10^{19}$  atoms per cc.

Lecture 22  
July 31.

Rotation of Galaxy.

- ✓ 1. Read from stars From Atoms to Stars.
- ✓ 2. Other galaxies. M. 31. Spirals.
- ✓ 3. Is our galaxy a spiral  
& is it in rotation.
- ✓ 4. Evidence from stars radial velocities  
" " Interstellar Ca clouds. rad. vel.
- 5. Island galaxy or island "universe" ? Def<sup>n</sup>
- 6. Read J.H.J.
- ✓ 7. Data from astro note book on Centre + Rotation. p. 9, 23.



# Lecture 23

Aug. 1. \*

## Spiral Galaxies.

Baker Entire Chap. XII.

L23. Aug 1.

slides  
vels  
exp. universe

⊗ read notes. 1936.

# Lecture 24

Aug. 2. ⊗

- [\* Slides ] \* Lord Rosse 1845 - first drawing
- \* Scheiner 1899 " spectra
- \* Hubble & Stephens
- \* Humason.

L. 24 Aug 4  
① clusters of sp galaxies  
② age of earth

⊗ Go through Baker paragraph  
by paragraph.

- \* Spectra Recessional velocities
- \* Lemaitre Expanding Universe.

# Lecture 25

Aug. 5.

Theories of Stellar Evolution 10 35-38

Maintenance of Stellar Radiation 10 39-42

L. 25 Aug 5:  
① Complete age of universe  
② Luminosity  
③ The calendar

Age of Universe . 1. Geological methods 3 10<sup>8</sup>.  
2. JH Jeans Astron 10<sup>12</sup>.  
3. Lemaitre 10<sup>10</sup> - 911.

Read 1. JH Jeans Eos. 10 420 10<sup>9</sup>. p. 54-55.

- 2. " Univ. around us p 342-3. Pterodactyls birds etc.
- 3. + WB Yeats " All things fall and are built again  
and the spirits of them who build are gay "

Lecture 26  
Aug 6.

The Calendar . 2, 37, 38, 39.

see notes . Julian  
Gregorian  
proposed World Calendar .

" 13-month - "

Slides of sunspots & prominences.

L 26. Aug. 6  
① Finish  
② Slides old wooden  
eclipses, Corona. & prominences  
& Corona Spectra.

Lecture 27  
Aug 7-8-9-12-13-14. Review quiz.

Lecture 32

Last Lecture No 33  
Aug. 15

Questions on 5<sup>th</sup> Astronomers .  
Greeks - modern times .

Halley - Comets .  
notes on Life . (1937 Jan)

Newton Life + Achievements .

Quotations & comments .  
Voltaire's tribute .  
see Gr. Br. Astr. Notes .



1944

- L. 1. July 4 - Handbook PRASC. - Notes p. 20 Solaris, Calendar - Essay Topics - Solar Syst model.
- L. 2. 7 wanderers - alchemy - astrology - Superstition Read 5 excerpts p 26. Kepler Newton + H. G. Wells
- L. 3. Newton & precession
- L. 4. atoms, electrons, spectra + el. mag. table & etc.
- L. 5. July 11 \* 2.5. + test
- 6 " 12 Demonstration in Physics Lab.
- 7 " 13. Spectra, comets, Corona, Zeeman Henry Draper.
- 8 " 14. Draper, Doppler, P.M. Red Vel + Space Vel.
- 9. 15 Stellar maps - m + M
- 10 18 Variable stars (Gaposchkin classification) L. p. Mira, Cepheids.
- 11 19 novae + super novae (Chambers neutron core)
- 12 20 Solar Motion, star streams, rotation of Galaxy.
- 13 21 Binaries - Castor, Sirius
- 14 24 } 1/2 Amigos - Algol Rotation of stars
- 15 25 } Ch. X. ASD m-L 1944 Law. Columns & Heat Index
- 16 26 } Ch X stellar diams - Longy: CHP Si+ ++ +++
- 17 27 Read according to star status.
- 18 28. Star clusters, globulars our galaxy. Hubble's model. (Review of Constellations)
- 19 31 Milky Way - C. Galaxy.
- 20 Aug 1 Planetary Nebulae
- 21 2 Interstellar gases
- 22 3 Ch. XII. Read J. H. Jeans Nature July 8, 1924 p. 41-42. - The Galactic System
- 23 4 M 31 + c.
- 24 7 Red Shift; Lemaitre exp. Univ. Edd. recession speed + Hubbles
- 25 8 Summary of Cosmological data.
- 26 9 " " Stellar & earth motions + Doppler effect. [14 items]
- 27. 10 " " Chem. of Stars.
- 28 11 Review Typical data (mimeographed sheets)
- 29 14 " " + Age of Universe.
- 30 15 " Age - Calendars, Energy.
- 31 15 pm " Energy - astron of Bible (Enoch) + in Lit.
- 32 16. " Interstellar space, Doppler. General reading books -

Overhead

Lecture in St John's College, Cambridge 1923.

Astron. Royal for Scotland

Program of Modern Science - Physics + Astronomy  
is Towards the Light -

This is true metaphorically & literally.

Motto of R.A.S.

" Quicquid nitet notandum "

Whatever Shines is to be noted.



1945'

1. July 3. Astron. notes p. 2a, (1) Observ. eye tel. & sp. (2) Spectroanalysis. Non math but formulae + logical approach.  
Generous credit up to 5% if it raises standard of final otherwise neglect.  
5 groups great astronomers - notes on each + quiz ev. Fin. am. (see p 2.6) - Eclipse July 9

- 2 4 Models. Constellations
- 3 5 Precession. etc
- 4 6 Test - Biographies Group 1

- 5 July 9. Electro magnetic radiations. Ch. 7.  
Corona. Eddin.
- 6 10 Spectra - Energy distrib. Temps
- 7 11 Distances  $\parallel$   $\alpha$  U. (cross 1942) stellar  $\parallel$  nearest stars
- 8 12 Pm + radial vel. Doubles
- 9 13 Biographies Group 2
- 10 16 Stellar spectra. + magnitudes app.
- 11 17 Physics lab. Spectra.
- 12 18 Chem. of universe. - Abs mag
- 13 19. Variable stars. Aph. LP. Eury. Novae.
- 14 20. Fused Novae Supernovae - Biographies Herschels, Huggin, Le V. + JCA. Stars
- 15 23. Kelvin & abs zero. Ch. Stellar motions, solar, Galaxy Rotation, Clusters  
MNRAS 1944  
No 2. Vol 104
- 16 24. Binary stars - Mizan, Coates, Sirius, Alzol, 2 Aurigae
- 17 25. Chap. X Stellar diam.
- 18 26 " " masses + M-L relation. Read ast. 5 + a selected passages esp. re M-L.
- 19 27 " " general run over latter part + stellar energy - C cycle of Bethe.
- 20 30 Chap XI Galactic system. open + glob clusters.
- 21 31 " " "
- 22 Aug 1. " Diffuse neb. + F & Ross Atlas.
- 23 " 2 " Nebulae + Bowen + Planetary + Galactic structure
- 24 " 3. } Ed. ~~Wright~~ Shapley H & Russell W & Adams. + Books
- 25 " 6 } Russell + Adams + Review. Begin Ch XII
- 26 7 Ch XII Galaxies.
- 27 8 " " + Einstein + de S. + Lemaitre + philos of spacetime.
- 28 9. Review + data on Stellar Planetary systems
- 29 10. " Questions
- 30 13 " " Telescopes. Spectrograph (diagram from M & X. p 496)
- 31 14 am. " Parallax determinations
- 32 pm " Interstellar space
- 33 15 " Stellar diam + move + nebulae + constellations + ENERGY

# 33 LECTURES, ASTRONOMY 1947

Summer

1947 July 6.

Names  
Hours: extra lecture hours Fri 2-3 +  
Obs: Sun pm after singing Jupiter  
Mizar - Alcor  
Handbook R.A.S.C.

May - June Outlines -  
Intro to Baker, expand.  
Ch. 1.

July 4

Constellations know posn of. Ursa Maj. + min (Mizar - Alcor)  
Models. Cassiopeia (Polaris)

Precession

SLIDES Bab. Bootes (Arcturus)  
Assyria Les. (Regulus)  
Ninoo Virgo (Spica)  
9K. Cygnus (Deneb)  
Hildegard. Lyra (Vega)  
17 and 10607 Telescopes.

Hercules  
Corona  
Aquila (Altair)  
Ophiuchus  
Sagittarius  
Scorpio (Antares)

July 7

p. 107. Spectrum, v p. 351-5  
Doppler Pr.

Phys. Lab. Spectra.  
Filters - Solar Spect.  
Laws + Relativity  
Planets.

Ch. X. 9 pages/lecture  
Solar atmosphere + sunspot + slides  
Ch. XI - Corona  
Ch. XI Read. HGW + d (trac. bse)  
stellar flux - Near star. ~~PTF~~

Cop.  
Gal.  
Newby  
Keller  
Herchel

Speed Vel. + P.M.  
Speedia. + mag.  
abs mag.

Variable stars

Gamma + Delta novae  
Planetary neb. + c.  
Binaries Alpha Gem, Alpha Cent, Alpha Lyr.  
Sirius B. - Spec. Binaries + M-L law.

7 E. Aur. + Algol (Ecl. Binaries) Rotation of Stars

Interferometer

Ch. 14. Read 3rd. Stars + atoms + Bethe C-cycle.

July 30. Ch. 15. Nebulae  
31. Interstellar lines + atoms + molecules

over



Lecture	Date	Topic
26	1947 Aug 1	Gal. Clusters
27	"	Gal. Clusters
28	Aug 4	Milky way - Rot. of Galaxy
29	5	Other planets Ext. Galaxies
30	6	Spirals + Red Shift + Recession
31	7	
32	8	
33	"	Review

Solar System      Scale  
 members  
 origin  
 place in galaxy  
 Sun position of

Stars      distrib.  
 no.  
 mass  
 Chemistry  
 spectra  
 methods  
 Spectra



# The Influence of Astronomy

Eight lectures .

1. In Babylonia and Egypt.
2. In Hebrew ~~and Arab~~ writings
3. In Greece

1937 Feb 14-

scanners  
x life  
above

Science  
Literature and Philosophy .

Extension Lectures

for  
1937 Autumn

Eight lectures

As - Astrology -  
... & Enoch ...  
...  
... on Philosophy  
...  
... Stellar  
... Planets  
... mirror etc  
... The Dypt  
... An Introduction



# Notes on Buddhism

by T W Rhys Davids

(75a)

1937 Feb 14

Gautama 600 B.C. - the Buddha.

Salvation not by rules & penance & self mortification  
but by love & self control.

The noble 8-fold path

1. Right belief
2. " feeling
3. " speech
4. " actions
5. " means of livelihood
6. " Endeavour
7. " memory
8. " meditation

Four Noble truths. Suffering or sorrow coexists with consciousness of individuality & a separate existence.

The cause of suffering is the lust for life.

The cessation of sorrow only with conquest of lust for life.

The path to cessation of sorrow is the 8-fold path above.

Man in the Moon - Hare in the Moon - Legend

In the Jataka legends <sup>(500 tales legends & parables)</sup> the future Buddha is a holy hare who resolves to give his body as food for a hungry man. The god Sakra to test him comes in the form of a Brahman & says - The hare offers himself & jumps into the fire, but the fire does not burn him & Sakra says O wise hare let your virtue be known through all time. He then splits open a mountain & taking the saps of the mountain, he draws a picture of the hare on the disc of the moon. Hence from Hare in the Moon to spirit of hare being Gautama the Buddha to Man in the Moon.

[ Jataka legends probably handed down by word of mouth like the Vedas for centuries, possibly written down 400 to 200 B.C. Translation & Commentary on them 500 AD in Ceylon ]



# The Influence of Astronomy

## Eight lectures

1. In Babylonia and Egypt.
2. In Hebrew ~~thought~~ writings
3. In Greece
4. In Dante's Paradiso
5. In the Renaissance of Science
6. In the Renaissance of Literature and Philosophy
7. In the modern world
8. The Cosmic Point of View.

1. Constellations - Eclipses - Lunar - Solar Cycle - Nebulae + Kivvina - Pyramids - Astrology -
2. Astronomy in Literature - 2-fold approach - (1) Bible - Job - Nebuchadnezzar + the astrologers. Book of Enoch - ideas amplified. Man in Moon - Enoch + Buddha.
3. Inheritance from Babylonia - Greek astronomy - speculation + achievement - Infl. on Philosophy - The Prime Mover -
4. Place of Dante in Time. Astronomy of his day - Ptolemaic Universe - Quotations
5. Copernicus, Bruno, Galileo, Kepler, Newton, Herschel - early observatories.
6. Impact on thought - Milton - Shelley - Kant <sup>Leibniz</sup> + Pascal + Spinoza. Pope (date?) Shakespeare (date?)
7. Since 1800 - Great observations - greater + greater accuracy of measurement - Stellar distances, velocities, chemistry - popular imagination stimulated by planetaria - newspaper propaganda + publicity re new theories - Relativity, 200-inch mirror etc. Popular books - Edd. + Jeans.
8. The Universe as we think of it today - The far vision in Time + Space - Dark Spenses - The Dyson Gen. Smith - A.C. Redden + perspectives. The Cosmic ~~setting~~ setting - Reason Dean Inge, as a philosopher.