A. Vibert Douglas Lectures and Speeches 1930s (ii)

Light
atoms
&
stars

Westminster Park Ch.
1934 Feb - 4 -

Introduction

Motto of R.A.S. Quicquid nitet notandum
Whatever shines is to be noted.

Light. direct or reflected

Planets + Satellites
Suns

Light :- In the beginning / darkness was upon the face / + God said Let Lux — / No

Babylonians + Egyptians - observ only
Arabs - Alhazen 1100
Dutch Snellius 1610
Eng. Newton 1710
German Fraunhofer 1817
" Kirchhoff 1857
Eng Huggins -

Wave theory
Quantum theory

SLIDE

Conclusion

Harmony - laws
Realm of physical world.
" " spirit + mind + individual will.

SLIDES

1. hv runners
2. Jan sky. N.
3. Urs. Maj. ± 200 000 yrs.
4. Feb. sky S.
5. Size of Betelgeuse diagram.
6. March sky S.
7. Taurus extra prod.
8. Maestlin 11 stars 1579.
9. Galileo. 1610. 33 stars.
10. Pleiades. Hertzsprung 1929. 26-6.
11. Orion.
12. " 30' × 150'.
13. " Neb. 24" tel.
14. " " 60" tel. Behold the throne of chaos & this dark par. spread
15. " Horsehead.
16. Cygnus N. am. neb.
17. " albatross neb. wisps of glowing gas.
18. Here - cluster.
19. Milky Way 15.
20. " " 30.

21-27 Spirals

28. Diagram of Balance.
29. M-31.
30. M 101.

5 Telescopes

The Eclipse of the Sun

or

The Sun & the Eclipse

1. Business & Professional
   Womens Club
   Windsor Hotel 1932 Oct 19.

2. News Association Am. Pres. Ch.
   1932 Nov. 21.

The Eclipse of the Sun.

1. Introd^{n} Vic B.C. & B & P.W. Club Convention
& Plaskett's tribute to them.
Story of tourist in Vic B.C. home.

2. Cosmical spirit views the Universe.

M. 31
M 31
Coma Ber.
M 33 △ "distance inexpressible by numbers that have name" Milton.
M 81
M 101
Our Galaxy 10^{10} stars. Milky Way 15
3 n.e. stars
Milky Way 41 - Aquilae - altair 9 ses.
Giant Dwarf Sequence.
Our Sun & tidal disruption
Solar Syst. Planet dimensions
orbits
orbits.
Earth Sun
Shadows - & 1932 path.
Map. N. Am.
" Arctic to Atlantic
Partial eclipses (Crawford)
Partial "
Nineveh 763 B.C. Amos.
Talk about Chaldeans 4000 B.C.
& Saros. 18 yrs.
& Kidinu 54 yrs. 1 mth.
& modern prediction - Newton
to date.
Sky for star objects. April.
Sun & spots
Moon - edge
Butlers pantry - heads & prominence
Sunspots
Woolley Elephant.
Catania prominences 2
Cat " 1931 Aug. 6. Yerkes 290 000 miles
H " 76 exposures in 12 hrs.

1919 Corona
1893, 98. 1900 + 1901 Coronas.
1922 Corona
Flash. 1868 India Janssen + Lockyer.
Helium discovered. + 1870 Spain Young.
+ identified on earth in 1893

Solar Chromosphere Diagram
Map of Can + US + Show where astronomers were stationed in 1932

a narrow strip of central Ontario; previous to that was the 1905 eclipse visible in Labrador. In 1927 the path of totality passed across Central England and southern Norway; in 1929, Sumatra and the Philippines; in 1930, the South Pacific and Patagonia; in 1932 we shall have our own special eclipse; in 1934 an eclipse will be visible in Borneo; in 1936, Greece to Central Asia and Japan; in 1937, Peru; 1940, Brazil, South Atlantic and South Africa; 1943, China and Alaska; 1954, Northern Canada, Scandinavia and Russia. These few facts from tables calculated by an astronomer forty-five years ago will serve to indicate the travelling that must be done if one would attempt to observe several successive total eclipses.

Harper Halls Corona 1932.

Total Eclipse + Pyramids.

Conclusion. 1. Pyramids symbolize something permanent in contrast to life of man + nations – Not so.
2. Arab Poet We fade + we pass but the nuts remain
We change but they never — Not so.
3. Geologist ages of mt bldg. folding + upthrusting + epochs of erosion
4. Astronomer – pre-Galileo – i.e. Gk. Unchanging Sun + Stars Not so.

Universal law of change.
Change means development

Conclusion. Sheet anchor of the mind – something changeless – not in the physical world but in the realm of the spirit of Man.

Not given.

1. The perpetual round of strange
mysterious change.

2. 'Tis meet that changes should
control our being lest we trust in ease.

3. The majestic laws that rule your
rolling orbs
Thee depth of the unbounded universe
Above & all around
Natures unchanging harmony.

Everything in the physical world seems subject to the law of change — Is there nothing changeless & eternal on which to cast the sheet anchor of the mind? Just this vague harmony of Shelleys poem?

The vagest things — the immeasurable things are perhaps after all the most real that we experience That is where the physical world fades into the background & the realm of the Spirit of man assumes its true place.

The Sun & the Eclipse

Chem Assocn Am. Pres. Ch.

[Mr Geo. Lyman, Mr Geo. Lighthall
" Arthur Lyman Mrs Wilson Fairman etc]
" Doxy. & Mr Dickenson.

Introd. 'Arry, wots a star fish? Its a fish like a star
'Arry, wots a star, eatable like? Bless your bloomin eyes, how do I know
Lt Starts forth & 400 mph. to moon Sun Neptune Cents & Milky Way.

Slides. 1. M 31
2. Canes Ven.
3. M 101.
4,5 Milky Way & 7
6-9 Telescopes & Stellar Evolution Diagram.
10 Cygnus neb. & Meteor track.
11. Comet orbits & Temples Swift.
12 Eclipse slides — Newton.
Flash spectrum & Chromosphere diagram.
Prominences etc.
Balances. 10^{27} 10^{28}
Eclipse & pyramids.

Conclusion Pyramids, mts, crab poet, Geologist
Astronomer — Universal Law of change.
Realm of Spirit of man.

Wonders of the Universe

1. Y.M.H.A.
   1933 Jan. 11.
2. Extra Mural (Unemployed)
   Strathcona Hall Feb. 23. 4[15] pm
3. League for Hard of Hearing
   Symonds Hall Montreal Feb. 23. 8[15] pm.

From earliest times man has been interested in the stars - not only out of natural curiosity - but because the stars give him two fundamentally important things

(1) the measurement of the passage of time

(2) direction N. S. E. W.

It is very interesting to see how his ideas of the nature of the great universe outside our Earth have changed and developed from the very primitive, and often comical + quite erroneous ideas of the ancients to the ideas which astronomers have formed in recent years.

SLIDES.

1. Hindoo Earth
2. Ptolemaic Universe . B.C to A.D.
3. Hildegard of Bingen 1170
4. Earth & Sun & Seasons -
5. Diagram Sun & planets .
6 Moon .
7 "
8 "
9 Venus diagram
10 Mars .
11. Saturn & Jup.
12. Jups Satellites .
13. J H J. Cigar tube .
14. Jan. Sky N.
15 Feb. " N.
16. Bayers Urs. Min.
17. " Urs. Maj.
18. Plough Row & 50,000 yrs Lewis
19. Jan. S.
20 Mar. S.
21. Orion (Bayer)
22 " Extra focal.
23 Yerkes 40-inch.
24 Orion. 30' & 150' exp.
25. " Neb.
26. " horse head nel.
27 Feb. Sky S.
28 Pleiades extra focal.
29 " Maestlin 11.
30 " Galileo 33
31 Galileo's Telescope.
32 Berlin Babelsberg 26"
33 Pleiades Hertzsprung 2616

34. Solar spectrum.
35 Sun + arc
36 Stellar spectra
37. Diagram stellar evolution
38 " Balances - man + star.
39 16th Century Woodcut
40 Cygnus Neb.
40 M 33
41. Twin neb. etc
42 Whirlpool nel.
43 M 101
44 M 31.

Man not overwhelmingly insignificant

In the psalms of the Hebrew scriptures
What is man? — not how insignificant
+ unimportant — but rather how
wonderful a thing is man, how wonderful
the mind of man that can understand
+ find out so much about this
great universe, how divine the spirit
of man that can look out on the
harmony + beauty of the universe
+ respond with feelings of awe
+ reverence and solemnity.
The atoms + the stars play their part in the

great scheme of creation
+ it is for every man to
play his part likewise
faithfully + joyfully.

M Gaw

Strathcona Hall + League for Hard of Hearing
1933 Feb. 22 4[15] + 8[15]

SLIDES

1. Old Astronomer 1546.
2. Feb. Sky. N.
3. Bayer's Uro. Min. 1603 Augsburg Baroque
4. " " Maj. Star ~~Catalogue~~ atlas.
5. P. Motors of Dipper.
6. Winter Sky S.
7. Orion
8. " extra focal
9. " 30' + 150' exposure.
10. 24" Yerkes tel
11. 36 Neb. in Orion. Behold the throne of Chaos.
12. Milton visits Galileo.
13. Orion Neb. 60" Mt W
14. Transit Stars S.
15. Taurus + Pleiades. 7. nes.
16. Maestlin 1579 11
17. Galileo's tel. 1610
18. " Diagram 33 stars
19. Pleiades. 2616.
20. Newton.
21. " telescope 1672.
22. Spectrum
23. Lunic Coincidence
24. Stellar classes.
25. " Evolution diagram
26. Victoria tel
27. Mt. W. 100"
28. Interferometer
29. Star Sizes - Betelgeuse
30. " " Sirius
31. Yerkes 40"
32. 16[th] Cent. wood cut - shepherd
33. Crossus Neb.
34. " N. Am. Neb.
35. Orion Horse Head.
36. Persens Cluster.
37. Scorpius M. Way 11.
38. Spirals.
41.
42. Einstein + Rob.
43. de S. + as 600.
44. Lemaitre
45. Scales + Man + Star.
46. Newton
47. M 101

Behold the throne of Chaos + his dark pavilion spread Wide on the watteful deep.

LAW + ORDER + MANS PLACE between atom + star. Mind + Spirit

The Autumn Skies.

Y.W.C.A.
1932 Nov. 9.

The Autumn Skies

1	1546 Astronomer		
2	Oct sky N		
3	U. Maj. Bayer.		
4	U - Minor		
5.	~~Nov~~ sky N. Herc. + Cygnus)		
6.	Herc. Cluster		
7.	Cygnus Neb. 7h. exposure.		
8.	Oct. sky S.		
9.	Nov. sky S.		
10	Dec. sky S.		
11	Pleiades Maesthing	1579	11 stars
12	Galileo	1610	33
13.	Hertzsprung	1926	2616
14	March sky S.		
15.	Orion Neb.		
16	Eclipse diagram		
17.	eclipse map.		
18.	Corona Aug 31.		
19.	Milky Way (4) 3 n.e. stars. Scorpius		
20	" " (30) Sagittarius		
21.	M 31		
22	M 31 nucleus		
23	Diagram Scales.		
24	M 101		

Theories of Cosmology

Ancient & Modern

R. M. C. Montreal 1931 Oct. 22.

RASC. Theories of Cosmology - Ancient & Modern.

1931 October 22.

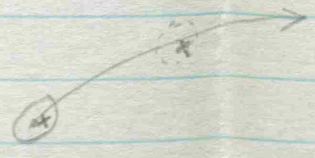
Slides. Hindoo Earth.
Egyptian Symbolic universe.
" Universe. Maspero's Dawn of Civilization
Temple at Hermopolis.
Homeric Cosmos.
Ptolemaic System.
Hildegrade of Bingen 1170
16th Cent. woodcut
Read. Copernicus 1543 (De Revolutionibus Orbium Celestium)
Galileo 1566 - 1642
" 's Telescope. 1610
Newton
" 's Telescope 1672
Read Kant 1755' Herschell Sir Wm. 1780
Read " 's Telescope 1795 4ft mirror.
" Diagram of Galaxy. Systematic Star Counts.
Kapteyn's Diagram
J.H.J. Diagram.
Milky Way (15) 3 n e stars M19 & M62.
9 " " regions.
" " (30)
Orion Neb.
Andromeda "
Whirlpool "
M 101
Clusters & Skies.

Circa 1900 Questions:
(1) Is the world finite?
(2) Is the Euclidean geometry, true & universally applicable?

(1) On Newtonian theory — see Einstein page.
Seeliger - arbitrary modification.
(2) Poincaré 1900 — see extra page.
Education of Henry Adams.

Inadequacy of Newtonian Mechanics & Grav. Law.
Mercury's Perihelion.

1905 EINSTEIN. Read Edd. Preface
1915 " uniform & accel.



T D

T' D'

Stephen Leacock
Newton

Gold is Gold.
Time is Time
& Space is Space.

$$S^2 = C^2T^2 + D^2$$

$$\Delta S^2 = C^2\Delta T^2 - \Delta D^2$$

uniform motion
Time + Space

EINSTEIN 1905 Special Theory. not antagonistic to Euclidean Space-time
1908 Minkowski at Cologne
1915 General Theory. — antagonistic to " "

Either Throw overboard the
Law of constancy of vel. of light or
throw over Euclidean for Gaussian Geom.

Read Eddington: Sp. T. + Grav. p. 181

World finite or ∞?

On Newtonian Theory. "The stellar universe ought to be a finite island in the infinite ocean of Space."
This is unstable, loss of light etc
see Einstein Th. of Rel. p. 106.
Seeliger suggested an arbitrary modification of Newtons Grav. Law.

Try a "finite" but "unbounded" universe.
see Einstein. p. 114. Riemannian - ie
quasi-spherical + finite.
with $R^2 = \frac{2}{\kappa\rho} = \frac{4\pi k}{c^2\rho}$
or $R^2 \propto 1/\rho$ ρ = av. dens.

$R = 10^{21}$ l.y. (Hubble 1926 400 Spirals)

i.e. Curvature is due to the matter in the world.
"homogeneous but not isotropic" (Silb. p 55
∴ call it a cylindrical (rather than spherical) world.

Einstein 1905 from Spec rel. + Euclidean line element $ds^2 = c^2dt^2 + (dx_1^2 + dx_2^2 + dx_3^2)$
wh. is ∞ + hence no satisfactory conditions at ∞
∴ he substituted $ds^2 = c^2dt^2 - dl^2$ which necessitated changing the grav. eqns by adding the Cosmological Term λg_{ik}

decade p 84
(Silb. p 68.

Geometry of the World.

Euclidean Surface. rods. —
non Euclidean curved surface geometry.

Riemann geom.

Einstein (x y z t) curved or warped due to matter in IT.

This req^{d} a modified Gravitation law. with a cosmical term λ

Read Edd p 161

This not a superimposed LAW.
but an identity arising from the geom.

finite but unbounded.

Rad. of curvature (Hubble) 10^{11} l.y.
1 l.y. $= 6\ 10^{12}$ miles.
several 1000 million years light returns on itself
Ghost Nebulae ? No —

DE SITTER 1917

Started with Einstein's Gravitational formula from Gen Rel + built up a "integral" representing a finite but unbounded spherical world both homogeneous + isotropic.

$ds^2 = \cos^2\sigma \cdot c^2 dt^2 - dl^2$

Curvature is an intrinsic property of the world. it is in fact an empty world.

Consequence of this model is recessional effect of distant objects resulting from de Sitter's linking of the time coordinate with distance in the $\cos^2 \frac{r}{R}$ factor of dt^2.

Thus a clock (hydrogen atom) at a dist. r will seem to go slow i.e. a red shift.

[This may sound fantastic, mysterious, absurd + unreal Californian correspondent - nonsense. - but observation + experiment confirm. ∴ perhaps it is our standards of sense + nonsense that are at fault!]

Common uncommon sense.

de Sitters prophecy 1917 3 rel. of spirals known to support him. by 1922 V.M. Slipher had 40 of wh. 5 were negative. Mt W. 400 spirals - Speed of recession ∝ dist. 500 Kmpsec per mega parsec.

WEYL
EDDINGTON
EINSTEIN

Electromagnetic phenomena as well as gravitational

Rival models offering no crucial test

∴ Thus far culs de sac.

WEYL — atomicity — electron + proton
no progress in sight.
1929 + 1931

LEMAITRE 1927 Brussels Acad.
1930 R.A.S. deSitter + Eddington

Intermediate solution betw Einstein + deSitter

Read see M.N.R.A.S. Feb. 1931. p. 414-15

Observation pt To expansion.

Theoretical considerations

(1) Edd. - Conversion matter to radiation → Contraction

(2) McCrea + "Tolman" — single condensation → contraction

(3) McVittie — "bodies condensing → Expansion.

(4) Le maître — "Stagnation" → Expansion.

(5) Is the recession of Spirals This expansion.

(a) Edd. assumes Yes

then Double Radius in 1400 million years

& in 10^{10} yrs. Spirals will be 10 mag fainter

& Total Mass of Universe 10^{79} protons

of Bubbles 10^{81} protons 10^{22} suns

on Einstein model

This leads to a difficulty in regard to the age of the Universe which seems too short for the 10^{14} years calculated by J H J for age of Stars

(b) Zwicky says high recessional velocities are partly at least a Spurious

effect due to the slowing down of light vibrations as the light travels through space.

(6) Does this expansion affect Solar System + Galaxy?

(a) Eddington says NO —.

(b) deSitter says Yes —

Analogy of space ~~time~~ with surface of balloon.

Conclusion

Read. Rice + Bacon

+ Weyl.

Copy. California letter to A.N.D. Oct. 1931.

Dear Sir

If you had taken the trouble to reread what you had written, I am sure you would never have permitted such nonsense to be published.

Hildegrade of Bingen. 1170.

Job. 38. 22.

Hast thou seen the treasuries of the hail or hast thou entered into the treasuries of the snow? By what way is the light parted which scattereth the east wind upon the earth?

Poincare about 1900

re Euclidean Geometry

I do not know whether it is true but I know that it will always be convenient.

Impact upon mind of Henry Adams Boston talking out of thought.

The Sun & Stars

Trafalgar Institute
Oct. 21, 1932.

The Sun & Stars.

Trafalgar Institute.

1. Introduction :— Paracelsus — whose eyes saw in the stars mere garnishry of heaven —

& Shelley — To whose passive ken
Those mighty spheres that gem ∞
were only specks of tinsel, fixed in Heaven.
To light the midnights of his native town —

Moving Slides
Earth.
Sun
Moon & tides.
Planets
Eclipses
Seasons

Ordinary Slides.
1932 Eclipse.
1922 "
Oct. Sky N — Bayer α Maj. α Min
" " S. + Augustin de Morgan 1590.
Nov. " S
Pleiades. Maestlin 1579. 11 Stars
Galileo 1610 33 "
Hertzsprung 1929. 2616 "
Milky Way 15° Scorpius 3 nes
" " 30. Sag.
M 31 Central portion
M 31 entire.
M 101 Urs. Maj.

Our Sun a Star
Our debt to the Stars.
they are our friends
Light & Heat sustain life on earth
Star dust ... we are.
Learn to love the stars for they are
the poetry of heaven.

McGILL UNIVERSITY
MONTREAL
THE MACDONALD PHYSICS LABORATORY

Astronomy

Solar System

+ Stars

Montreal High School
1935 Nov. 16. 10 am

M H S.
St Georges Sc. (Miss Matthews)
Trafalgar Sc.
Sp Lambert.
The Study.

I

5 Mechanical Slides.

II

Astronomy.

SLIDES.

1. Sun & planets - diagram.
2. Nov. Sky. N
3. Jan " N.
4. Ursa Maj - Bayer
5. " Min "
6. Nov. S.
7. Jan. S.
8. Orion
9. Flamsteed drawing
10. Gt. Neb. in Orion
11. Horsehead Neb.
12. Cygnus
13. Taurus & Pleiades 6.
14. Nasmyth 1579. 11.
15. Galileo. 1610 36.
16. Hertzsprung 1927? 2600
17. Diagram of star sizes
18. Milky Way - 7ER.
19. " " 40. Aquilae region
20. Whirlpool Neb.
21. androm Neb
22. Stellar Spectra
23. Giant dwarf sequence
24. Balances

III Questions [little boy volunteered to tell dipper story]

The Nature of the Stars

Sir George Williams College
Y.M.C.A. Montreal
1935 April 8.

Chem. of Stars.

Terrestrial Chemistry. 92 elements.
Simple & complex molecules.

Chem. of Universe as a whole is v. simple.
90% matter of Univ is at temp $> 10^6$ °C.

Int. of Star. & how studied.
Surface temp range.
Interstellar space — 3° Abs — v. low density. 1 atom/c.c.
cf. 10^{19} atoms/c.c. Terrestrial Atmos.

SLIDES.

1. H, He Ne, Ca etc Sp.
2. Solar Sp.
3. Line Coincidence.
4. Secchi types.
5. B — M "
6. Balmer & Paschen Series & aluminized mirrors.
7. M Stars esp. ο Cet.
8. Sun. Ald. Bet. & Mira Ceti diagram.
9. Orion Neb.
10. Planetaries Neb.
11. " Sp.
12. " "
13. Planet spectra.
14. Comet over Seine
15. Halleys.
16. " Sp.
17. " "
18. Elements not pres.
19. " abundance.
20. Partial Eclipse.
21. Flash Sp.
22. Solar atmos.
23. Stellar Evol'n Diagram.
24. Light — waves & runners. — Mystery of Light.
Undulatory & Quantum Theories
& Challenge.

Queen's Alumnae

Toronto Branch Dinner

1939 Nov. 24

Queens Alumnae
Toronto Branch. Annual Dinner.
1939 Nov. 24.

Dame P., Princ. Wallace, L. & G.

I am v. glad of this opportunity to be with you & to thank you for your warm kindly welcome. I know that B.R.H. holds a v. spec. place in your thoughts & I want you to know that I regard it a gt. honour to be there as Dean. There are in B.R.H. this session a remarkably fine group of girls. Some of them have as keen minds as it has been my privi. to work with in all the 18 or 20 yrs of my teaching. There are ~~some~~ a few of them who by no stretch of imagination or generosity can be called students. I promised the Principal very solemnly last June that I would try to be patient with these! My patience is taking the form of hammering upon them with all my might in the hope of drawing forth some spark of ~~appreciation~~ enthusiasm for the things of the mind.

There is so much beauty in the world around us. Do you remember that stately ecclesiastical phrase The wonder of the beauty that is manifest in the world. One covets for our young people

some appreciation of this.

And then there is silence that means so much to us - When we catch something of the music of the spheres - heard only in silence when the listening spirit is attuned to it. When there is so much dis harmony in the affairs of men & nations it is often difficult to recognize & feel the underlying harmony of the universe about us. We covet this for our students.

On the train last night I was reading the new Life of Lord Rutherford by my old chief Prof Andrade. & I was struck by R's words that we need "disciplined imagination." We covet this for our students. and this perhaps above all. That they may learn to discern that what is false is false & that what is true is true.

But I promised not to make a speech, so I shall just thank you again for your kind welcome.

Influence of Astronomy

Erskine & American Ch.
Fortnightly Club.
1937 March 3 17.

Influence of Astronomy.

Apology for not coming on Mar. 3 – Flu – Dr Pangloss ~~[illegible]~~ less appeal than normally that this is the best of all possible worlds –

One of the greatest mistakes in education is to teach subjects as though each were a thing apart – in a water tight compartment – neither influenced by or exerting an influence upon other branches of knowledge.

This evening I shall try to show how the theories and speculations in astronomy and the increase in knowledge of ~~regarding~~ the ~~vast~~ universe that astronomers have obtained as the centuries passed, have influenced not only other sciences, not only practical affairs, but also have influenced literature, philosophy and religious thought.

The practical aspects of astronomical knowledge.

TIME . DIRECTION

Astronomy stimulates the imagination & unlocks the rich mans strong box & the secrets of gt. institutes

Telescopes, mirrors of quartz, pyrex etc

Planetaria.

Influence of Astronomy in language.

" " " in literature. Keats Those silver lamps that burn on high –

" " " Philosophy. Shelley – eternal orbs that beautify the night

Those mighty spheres that gem infinity

Shakes –

Dante –

Lord John Russell: astronomy is the science of the harmony of infinite expanse.

SLIDES

1. Ancient cosmologies.
2. Jan sky S.
3. Orion
4. march S.
5. June S.
6. Anaximander
8. Ptolemaic
7. J.S Pleaskett.
8. C. of Galaxy.
9. m. way. 1.
10. Cygnus Veil neb
11. " Br + Dark neb. Blue.
12. " " Thr.
13. Orion neb.
14. Secchi types
15. Giant Dwarf sequence.
16. M 31.
17. M 31 cepheids
18. 16th Cent woodcut.
19. M 33.
20. M 101.

Virgil

Orion Dido's advice to Aeneas "Tell him that charged with deluges of rain, Orion rages on the wintery main."

"dire Orion roused the sea."

Koran God has given you the stars to be guides in the dark, both by land + sea.

Adrian
anaxyporas.
Egyptian
Ptolemaic
Pleiades Galaxy
field of spirals
M 31
M 81
spirals
Milky way.
"
Gascons neb.
Orion neb.
Pleiades series
"
"
Feb Sky South
Mar " "
Feb " N
M 101

√ No. of Stars in Galaxy. 10^{10}

√ Lord Riverdale on World War expenditure in 1937 £ $1.1\ 10^{10}$.

one for every star in our galaxy.

our apathy to war threat.

√ M.101. a dynamic universe of directed change.

chance — not the playground of chance.

Jeans, Brand, Whitehead.

Brand. For things have not come about by mere accident but through the determining mind.

Anon. The order of the world is no accident - religious insight is the grasp of this truth.

√ Infl. on Kant on Pascal, Spinoza, Smuts. Dean Inge.

Trust in reason wh. rests ultimately upon faith in the Divine Logos — the self-revealing soul of the universe.

√ Smuts: In ever varying degree the universe is holistic and organic through + through. The great values + ideals retain their unfading glory + derive new interest + force from a cosmic setting.

Atoms and Stars

R.A.S.C. Ottawa
1938 March 11.

for Classics Club
1940

Atoms & Stars.

As I crossed the boundary line this morning between Quebec and Ontario I could not help but be conscious of the change in air from the stifling atmosphere, the intolerant and intolerable atmosphere of my native Provence to the clear fresh free air of Ontario. People from my province find it an exhilerating experience to cross the border and breath the air of British freedom & justice.

Some of you may have heard that we have in my province a strange monster - a most indecent thing - an unBritish thing. They call it the Padlock Law.

a merry idea - Communal Atoms & Red Stars

Two more appropriate adjectives could not be found. Yet what wd. be the result?

M. Duplessis - prov. police - padlock!

They wd. expect us to discourse on Lenin & Stalin & bow down and worship them

Instead they wd. hear us discoursing on Betelgeuse and Antares and Aldebaran and Mira Ceti the great supergiant, cool, reddish stars.

and communal atoms? atoms & molecules now in the physical framework of one man - tomorrow in another, H_2O, CO_2, N_2 - In Julius Caesar, in you in me, in countless numbers of men, beasts, fishes & carrion crows. as the centuries roll on.

But let us forget these adjectives and come to grips with our subject.

Man's interest in stars is very old.

4000 B.C. Babylonians, Chaldeans, Assyrians battling for supremacy in fertile valleys of Tigris & Euphrates.

mapped constellations; noted 7 exceptions etc.
No idea of intrinsic nature of a star.

Man's interest in atoms is relatively recent.
The idea of atomicity of matter. Greek Philosophers.

Empedocles. earth. air. fire. water.
B.C. 450 circa

Leucippus
Democritus } real atomists.
Lucretius — contemporary of Cicero.

Translation by John Evelyn Esq of Surrey 1650
of Lucretius De Rerum Natura
" Nature with bodies unseen to the eye
all things doth manage "
atoms — "the seeds of all".

Aristotle had not been impressed with Democritus' ideas any more than the thinkers of the middle ages were impressed by Lucretius

I quote from Sir Thos. Heath on Aristotle.

Read p. xlvii. 4+1

Hence the dogma of the changelessness of the stars.

This dogma of changelessness rendered impossible the fusion of astronomy and physics. It hindered the progress of astronomy, and it shackled physics to the Earth for 1900 years.

SLIDES

1. Galileo
2. 1610 Telescope.
3. Sunspots.
4. Lunar mountains.

Thus he established the universal law of CHANGE.

a fusion of astron & phys. now theoretically possible

For wherever there is change, measurable physical change there is a field with which physics may enter.

SLIDES

5. Newton
6. "Different refrangibilities of the Rays of Light" 1675.
8. Solar spectrum.
7. Fraunhofer 1817
   Kirchhoff 1850 60.
   Huggins 1824 - 1910.
9. Huggins sketch. The Father of astrophys

It was he who first realized the significance of the tremendous possibilities to result from this fusion of atomic physics and astronomy.

Light has its origin within atoms

" is energy - it is as much a messenger from the star to us as if the star had turned a machine gun outward and sprayed everything in sight with bullets.

Analogy of boxer - blow to cheek - momentum, heat, chemical change and recoil of the man who delivered the blow.

So too light from a star - recoil of star. momentum transferred to retina, heat + chemical reaction + el. current up nerve

Result - an awareness we call seeing.

To change the metaphor - Light is a message in code. If we can find the code we may then be able to decipher the message.

SLIDES

10. H atom orbits. Read PASCAL
11 H energy levels Grotrian diagram.

Physicist in laboratory cannot verify this theory completely
∴ ask Vega + Deneb if these line series exist.

12. March sky N. Vega + Deneb.
13. Tel. 72" Vic. B.C.
14 Paschen + Balmer Series corroborating H atom theory.

Plate 3" x 15" Mole micrometer

SLIDES.

15. Lines of H. He. Ne. Ca.
16. " patterns Fe, Mn. Ni. C.
17. Secchi Types.
most of the 92 elements.

A chemist could make a very good guess as to what molecules will be found to exist at the high temperatures of stellar atmospheres. He would pick out those molecules having what he calls "high Heat of Dissociation" Such molecules as CN, CO C_2, N_2 TiO, ZrO, CH ~~NH_3, CH_4~~. These molecule, will survive even the high temperatures of many of the stars.
N, M, K, G, F, A stars.

SLIDES.

18. Nov. sky S. Mira Ceti.
19. Diagram Size of o " .
20 Spectrum o ceti. Variable $3^m \pm 1$ to 9^m.
Period 320 days to 370 days.
Al_2O_3.
21. Spectra of Planets.
Jup. $NH_3 + CH_4$
Ur. + Nep. chiefly CH_4

SLIDES

22. Orion Neb.
23. Veiled neb in Cyg.
24. Cyg. wisps of glowing gas
25. Nebulae spectra.
26. Reflection nebulae.

We have seen how atomic physics has helped to unravel some of the messages of star light. Let us now consider for a moment how astronomy has answered some of the questions of the atoms. I call this the Tale of the Sky Larking Electron.

Sky lark - period of time at high altitude.
Ca + atom - electron raised to upper orbit
duration of time in excited state.

27 Eclipse flash
28. Chromosphere gases -
1/hundred millionth second.

29. Balmer Line Width Contrasts.

No problem exemplifies better the necessity for and the fruitful results of cooperation between atomic theory and astronomy than the investigation of the electrical fields and their

V.

influences upon radiating or absorbing atoms.

Theory of Stark + other physicists is very complete for H and He.

H lines are symmetrically broadened by field
He " are displaced to Red or to Violet
and new lines appear.

Are these effects found in starlight?
Very definitely yes.

A lightning flash in our earths atmosphere occurs when there is an electrical field of about 10 kv/cm, But these broad lines in the A stars can only be produced if some of the H atoms are at the moment of absorbing light in an el. field of 1400 kv/cm.

The He lines in the still hotter stars present a great problem.

It is a challenge both to the physicists and to the astronomer.

Some of us have been interested in it for over 6 years.

And we are still trying to make the He atoms in the Blue stars tell their story unambiguously.

SLIDE
30. Sky N. γ Peg + i Herc.
3rd brightest 9th brightest

Put Padlocks On 'Communal Atoms'

A large proportion of the knowledge of the physical nature of stars was made possible because of the development of atomic physics, declared Miss A. Vibert Douglas, M.B.E., Ph.D., of McGill University, speaking at a meeting of the Ottawa center of the Royal Astronomical Society of Canada at the Museum last night.

Miss Douglas, who is in charge of the astrophysics branch of the department of physics at McGill, spoke on "Atoms and Stars." Introduced by John McLeish, chairman, as one of the few women to achieve success in the field of science, Miss Douglas opened her talk with a reference to Quebec's padlock law. If she was giving her talk in Montreal and called it "communal atoms and red stars" the notice would not be on the board one day and the provincial police would be out with their "largest padlocks." And yet, Miss Douglas said, there were red stars and the atom was one of the most extraordinary examples of something communal. She said it was refreshing to come into Ontario where the "air seems purer."

Knowledge of the atom has been greatly increased by information which has come as the result of the study of the spectra of stars. Man's interest in the stars is older than the interest in atoms, dating back about 6,000 years to the Babylonians, Chaldeans and Assyrians. The study of atoms goes back about 2,000 years to the days of the Greeks. Miss Douglas illustrated her lecture with slides.

Introduced by Mr. McLeish, she was thanked by R. Meldrum Stewart, director of the Dominion Observatory. It was announced that Dr. E. A. Hodgson, of the Dominion Observatory, would be the speaker at the next meeting of the branch.

Will the light from those two stars help us to solve what is a real mystery with regard to the behaviour of helium atoms?

If time.
Parable of 2 investigators.
(abbreviated)

Many of the problems of atoms and of stars are inextricably bound up the one with the other.

Chairman. John McLeish

Atoms & Stars

1. Dominion Douglas Young People Soc.
   1934 January 21.
2. Y.M.C.A. Edst – Foreign Mens Club.
   1935 Dec. 1.

From Atoms to Stars.

To most of you, I have no doubt, atoms and stars represent the very extremes of thought In the realm of ideas you place them at opposite poles, and to see them united as the title of an address may sound to you as far-fetched and as ridiculous as though someone were to announce an address on Alexander the Great and Tiny Tim.

But it is not so – a more sensible and logical title for an address on astronomy could scarcely be found –

The 2 investigators of Dame Nature.

Speaking plainly then, atoms with their constituent entities, the protons, electrons, and positrons, the ultimate charges of electricity, the smallest known units of matter, are the building bricks of the material universe whether you are thinking of it be a particle of dust, a grain of sand, a snow flake, a boy, an elephant, a mountain, a moon, or a star.

Furthermore light has its origin within atoms – It is when the electrons within atoms change their positions & move near the heart of the atom that energy is liberated, hurled out from the atoms as radiations of light or heat or very penetrating rays – So that is why we can see a star – the atoms composing the star have hurled forth the energy which ripples across space to bring a message to such as can decipher it.

SLIDES

1. Snowflake
2. Snowflakes
3. M. 33
4. NGC. 4736.
5. Dawn sky. starlight + atoms + mols - in atmosphere
6 Balance - mans place
7. Mt. W tel.
8. Vic B.C.
9. Yerkes.
10. Stellar spectra.
11 Line coincidence
12 Doppler doubling
13. Jan 8th N
14. " " S - castor. 250yrs; 9d; 3d.
Orion
Taurus -
Venus - set -
15 Orion extra foral.
16 " 50' + 150'
17 Gt Neb. 24 inch
18 " " 60 inch. Behold the throne of chaos + his dark par. Spend wide on the wasteful deep.
19. Taurus extra foc (7)
20 Maestlin 1579 (11)
21. Galileo 1610. (33)
22. Galileo's Tel.
23. Hertzsprung - 2616 stars.
24. Milky Way 45. d Cyg.
25- " " (30) Sag.
26. M. 31
27. Dopplar Shifts of nebulae.
28. M 101 -

YMCA (Earl)
1935 Dec. 1.

Atoms & Stars.

SLIDES.

1. Balances.
2. Nov. Sky N.
3. Jan. " N.
4. Nov. S.
5. Galileo's Tel.
6. Y.O. Tel. 11 ins. 60ft focal length.
7. Newtons Tel.
8. Mt. W. "
9. D.A.O. "
10. Orion extra focal.
11. " 30' + 150' exposures.
12. " neb.
13. Jan Sky. Pleiades.
14 - 17. Pleiades extra focal. 1574 (11)
18. Double Cluster 1610 (36)
19. Cygnus Nel. 1928 (2600)
20. Dark neb. & Opth.
21. C of L
22. Solar Spectrum
23. Typical Gases.
24. Stellar Spectra
25. " Sequence diagram.
26. M 31.
27. Distances.
28. 16th Cent wood cut.
29. M 51 Can Ven.
30. aspiral
31. 2 "
32. M 101 U. Ma.

Questions:- Meteors. Nebs. Double stars. Densities of stars

Int. Y. M. C. A.

Mr Beall Sec.

Mr Merry Chairman of Board

Dr. McMurtry on Board

Conclusion: Stars + Atoms — Laws.

Stat Mystery — Spirit + Soul of Man

Glory of man his free will to choose to live in accordance with laws of his being — not laws + Spirit that God

Poetry of the Stars

Y.W.C.A.
Sunday Jan 5/30.

Poetry of one kind or of another appeals to almost everyone –

When a poet writes a poem, I suppose it is because the thing about which he writes has made a strong appeal to his emotions – sometimes it is something sad – or painful or even sordid — often it is something noble and gallant & heroic – or something romantic, mysterious or awe-inspiring — very often it is something in the world about him that is beautiful –

Astronomy – the study of the stars – the oldest of all the sciences — has throughout all the ages had associated with it both music & poetry.

The Music of the Spheres :– Long before the time of Christ, the Greeks had learned a great deal about the stars and the movements of the Sun and moon and planets, and they believed that these bright heavenly bodies were fixed in concentric crystal spheres which revolved round & round the Earth & as one sphere rubbed against those adjacent to it (for each sphere had a different motion) music was produced so delicate, so exquisite that the ear of ordinary mortal man could not detect it – only by a sort of mystic spiritual hearing could this music be discerned.

This idea permeated ancient thought; & literature of every subsequent age is full of allusions to it.

In the Bible

The morning stars sang together

The heavens declare the glory of God
& the firmament sheweth his handiwork
Night unto night uttereth speech ....
.... and the speech was music in the
ears of the philosophers of ancient times.

In the poem of Addison

The spacious firmament on high

In Shakespeare

There's not the smallest orb ... (1)

Alfred Austin

Within the hollow silence of the night (2)

Robt. Service

The stars throng out in their glory (3)

?

The astronomer has
.... caught
The deep pulsations of the world
Aeonian music, measuring out
The steps of time.

Poetry

Carlyle defined poetry as "musical thought"
Byron called the stars "the poetry of heaven"

Earliest known poem about the stars
was by Aratus 270 B.C.
This young poet was commanded by the King of Macedonia to put into poetic form all the descriptions of the constellations, etc. which Eudoxus a pupil of Plato had compiled from earlier records in B.C. 370
This poem begins with noble ascription of praise to the Creator & contains the words quoted by St Paul "for we are also his offspring".

John Kepler 1571–1630 (4)

Galileo 1609 Alfred Noyes.

Newton –

Wordsworth – The marble index of a mind forever
voyaging thro strange seas of thought alone

Shades of Telescopes –

Sunrise & Sunset

Ruskin — There is no solemnity so deep as that of dawn.

Shakespeare — The glorious sun (1)

Wm. M. Call — I walked at sunset (2)

Bliss Carmen — I took a day ... at last with evening (5)

Wordsworth — I have felt a presence (5)

Star Chart.

Shakes. Look how the floor of heaven is
thick inlaid with patines of bright gold.

Browning Whose eyes saw in the stars
mere garnishery of heaven.

Royse. All those cloudless throngs (4)

Poems of Moonlight & Starlight.

Alfred Austin When acorns fall (2)

Chas Sangster And now 'tis night (2)

Edmund Holmes night comes & stars (2)

Chas Heavysege
Starbride The day was lingering (4)

Pleiades. Tennyson Many a night I saw the Pleiads
Rising thro the mellow shade
Glitter like a swarm of fireflies
Tangled in a silver braid.

Milky way / Slides
+ Spirals
10^{10} stars round Sun.
other clusters.
Star packing + size.

Pope — Warms in the Sun (5)

Milton — These are Thy glorious works (8)

Conclusion

David — When I consider thy heavens the work of thy fingers, the Sun & the moon which Thou hast ordained — What is man —
not how small + insignificant
but how god-like, how full of potential energy
how divine is man — that Thou the God of
all Creation art mindful of him.
Man has his place in the divine scheme and like the atoms & the stars, he must play his part in harmony with the stately & glorious symphony of the Universe.

The Winter Sky

Girls Hi-Y.
YMCA Westmount
1939 Feb. 16.

Immanuel Kant. 1724 – 1804

2 things – moral law within the consciousness of man
– Stellar universe without.

Right & wrong.

Cosmos & chaos.

Ordered universe

1. Tel. sky N.
2. Bayer's Bear.
3. Tel sky S.
4. Orion
5. " ex focal.
6. " 30' & 150'
7. " neb.
8. Yerkes 40"
9. Orion Horsehead neb.
10. Taurus ex foc. Pleiades
11. Pleiades. 6 or 7 n.e.s.
12. " Maestlin 1579 11 stars
13. Galileo's Tel. 1610.
14. Pleiades Galileo. 36 stars.
15. " Hertzsprung 2616 stars.
16. Newton Tel.
17. 200 inch Tel.
18. 72 " "
19. Solar Sp.
20. Stellar Sp. Secchi.

Composition of sun & stars.
Our sun a star.
" earth of sun.
" bodies of earth :: star dust.

& by starlight we live.
& from the stars we derive those
impulses to think, to question & to
pause in silence & reverence before
the Creative spirit.

On Injecting some Astronomy into the Schools

Macdonald College
School for Teachers
1939 March 7.

Introd: I appreciate tremendously the privilege of addressing you for I am absolutely convinced that astronomy — the observation and study of the stars — is one of the most potent ways of stimulating and training those three fundamental characteristics of the youthful mind, without which in the mature mind there can be no real progress of thought and growth of knowledge, no genuine achievement — Curiosity.
imagination
faith.

Curiosity, a divinely implanted spark — the starting point of science or philosophy.

Imagination — The great scientists, musicians artists writers, statesmen, or men of affairs all possess winged imagination.
Ramsay Macdonald.

Faith — a child's faith that there is a basic reasonableness about things. Law, order, harmony in the universe.

I have found during 16 years of lecturing often on to groups of both children & adults that the stars bring an almost immediate & spontaneous response of interest — often enthusiastic delight — new vistas are opened imagination is fired

Astronomy opens up vast realms of symbolical imagery of mythological lore, of science and invention of literary allusion and philosophical speculation for those whose minds are that way inclined.

I am not advocating a definite programme of instruction in astronomy in our schools. I am suggesting that a few ideas pertaining to the heavens be handed out from time to time, like bread cast upon the waters or bread crumbs scattered to the four winds. I believe that no one can overestimate the ultimate value of having interesting facts & ideas thrown out to a class free gratis with no strings attached - no compulsion - no idea of ultimate test and examinations. These are the things that may fire the enthusiasm of a child, enrich his thoughts - set in motion trains of ideas that will lead him on and on.

Now what should we give to a child along these lines?

Do you remember Carlyle's cry in his later years - why did no one teach me to know the stars. to feel at home amongst the constellations? I do not know the exact words

1. Constellations + dozen brightest stars.

SLIDES

1. Dec 5. 8 1m. stars & Pleiades.
Colours.
Temp.

I gave too much detail here

2. Bet. diagram Why so bright? 272 l.y.
3. Sirius " A + B · Bessel 49 yr. ÷ P
Why B so faint?
4 Giant Dwarf series.
5. Pleiades 7
6. " Maestlin 1579. 11
7 " Galileo 1610 33
8 " Hertzsprung 1928 ± 2616
9. Oct Sky N.
10. Hamsteed
11. Feb. N. Cassiop guards.
Arcturus.
12. Urs. maj.
13. " Minor. conjectures de Morgan 1590. (p139)
14 Hildegard of Bingen 1170
Treasuries of the Soul + the Lightening
p 153
15. Aug Sky N. Find M31.
most distant obj. unaided eye can see
800 000 l.y.
16 M.31.

Poetry of heaven - alfred Noyes. p132
Shelley. p142
Keats. p143
Shakespeare. Byron
Descriptions of sunset + sunrise

Barely mentioned

Experiment with students.
Basil Fletchers remarks.

Internationalism Treasure hunt down the centuries

Hip. Ptolemy, Cop. T Brahe Kepler, Gal Newton.
Le V. Struve, Guisterin de S. Le M.

omitted given at afternoon lecture for teachers with Sch. present

Heresy of finality. Never teach science dogmatically.

Recent Achievements in
Astronomical
Photography

Sigma Xi
1934 Dec. 19.

Sigma Xi

SLIDES :-

1 Barnards. ρ Oph.
2 " ν "
3 F.E.Ross. C. Volans.
4 "
5
6 Cygnus.
7 Mt W. "
8 Diagram of Galaxy.
9. 6 net.
10 Whirlpool nebula.
11 — 15 net.
16 Hubble diagram of variables in M33 M31
17.
18 Blink Comp.
19. Spectra
20 Chart graph of (vel — dist)
21. M 101.

Rayton Lens.

W. B. Rayton of Bausch + Lomb Co. designed a lens on prime of mic. objective — 2 inch aperture
$1\frac{5}{16}$ inch focal length
i.e. focal ratio F : 0.6
no lens approaching this speed was ever made even for motion picture work.
Hubble + Humason found 50% gain in speed.
Spectra of nebulae 1/8 inch long.

F.E.Ross Lens.

5 inch aperture
35" " focal length made by Zecker.
used at Mt. W. with 10 inch Cooke telescope
" " Flagstaff with 13 inch reflector.
Prints made by contact printing from second negatives.
Distortion avoided by contact printing on Eastman Process Pl.
of 1st pos and 2nd neg. Paper is E50 or Dup Eol.
Pt. I Milky Way from Sag. to Cepk.
limiting mag on original plates 17.m
" " " paper prints 16.m.5 for Dup Eol
" " " " " 15.m.5 for E 50.
Plates of low dec. show elongated images near S. edge due not to Lens but differential refraction.
Exp. times 3h to 5h.
area of each plate = 400 square degrees +
for tests of definition at edge see plate 18. Spiral near upper right corner NGC6946 13° from centre of plate.

Telescopes and what they reveal.

Rotary Club
Hawkesbury 1932 Jan 20.

Mod. pied
with experiments on lenses
mirrors
prisms
for Rasc
1932 Sept. 19 -

Telescopes & What they Reveal.

The progress of knowledge throughout all the ages has, I believe, been due to three outstanding characteristics of the human mind – at least of ~~those~~ minds ~~which~~ of those men who have been the great thinkers – the great pioneers in the search after truth – an insatiable curiosity –
a powerful, daring imagination
a ~~profound~~ & unshakable
faith .....

Before the invention of telescopes, men even 4000 years BC had learned a good deal about the stars.

positions
motions
planets
Eclipses
tides & the moons phases.

but because they had no means of analysing light they could read in the star light only its most obvious messages

SLIDES

There is something very inspiring about the universe that modern astronomy has revealed.

In this age of rush and noise and hurry, it is worth while sometimes to withdraw from it all and to look quietly at the stars – Perhaps thus we may obtain – to quote the very stately phraseology of Bacon "that improvement of the understanding, that elevation of mind .... which flow from the contemplation of the order of the Universe"

1. Dec. 5½. 5. Pluvides 7
2. Wrestling 1579 11
3. Galileo 1610 33
4 Hertzsprung 1929. 26.16.
5. Galileo Tel. 1610
6. Newtons Tel. 1672
7 Herschell. 1795 "Looked further into heaven than any man before him.
8 Yerkes. 40"
9. Spectrograph.
10. M.31 taken with Yerkes 40"
11 Mt. W. 100"
12 " Interferometer
13 Diagram of star diams.
Betelgeuse 300. 10^6 mi. diam.
14. Vic. B.C.
15 Contrast Astron prognostications 1500
16. Hevelius.
17 Sir Howard Grubb, Parsons & Co N. on Tyne 42" discs.
18. Berlin Babelsberg 47" reflector
19 " " 26" refractor.
20. Harvard 24" Reflector.
21 Greenwich
22 " Tel. Transit.
23. Solar Spectrum.
24 Stellar "
25 " Evolution diagram.
26 milky way 41. 9 n.e. stars. $4^h 5^m$. 1905.
27 M 101.

Telescopes - Great & Small.

with expts on reflection & refr.

RASC.
1934 Apr. 19.

1. Read: Galileo on his tel. p. 17. Camb. Read. in Ht. of Sci.
   & Orion & Taurus p. 28 24.

   Slides Gal. Tel. 610
   Orion & Taurus Sky chart
   " figure
   Taurus extra focal
   Pleiades series.

2. Expts. on lenses & refraction & focussing.
3. Newton's Tel. 1672.
4. Expts on mirrors 1667 Greenwich 1675
5. Early Observatories Paris & Hevelius 1642
6. Herschell Uranus 1781. see other notes. Tel etc to Mech. Inst. 1929 May 21
7. Modern instruments.
8. Spectroscopic work.
   Expl. Spectrum lines, bands.
   Tubes.
9. Stellar spectra.
   & atomic identification.

Slides of Spectra
& Giant, dwarf sequence.

Time, Clocks & the Calendar.

Drummondville
1933 Jan. 19.

Mechanics Institute
1933 Feb. 9.

Time - - - - -

Introduction

Time - passage of Time
inevitable inexorable, unhurried -
Now - future Past
The stately march of Time - we are all
aware of it - no one understands it -
metaphysical questions
Astronomers standpoint
Units of Time etc as in Th of T. Quart.

Conclusion

Uncertainty of Stellar time Scale
Unsolved problems are a challenge to
the astronomer - His conscience is stirred
but his imagination must give to keep height -
but his faith in the fundamental order
of Nature is unshaken. Time Rolls his
And now if you will forgive This attempt
at a pun ceaseless course
I began on Time
I continued on Time
and I shall end on Time
even though I have talked overtime!

SLIDES.

Moving slides. Day
Lunar month
Year.

Old. slides.

1. Ptolemaic Universe. Orders of 7 bodies
2. Week day names Diagram.
3. Earth & orbit & Seasons.
4. 3 values of Year.
5. Gnomon
6. Leap year - Equinox diagram.
7. World Calendar.
8. Jupp. moons (9) Periods 12h to >2 yrs
9. Galileo's ~~Tel~~ 1610
10. Ancient Gnomen & Dial.
11. Sundial
12. "
13. ~~Hourglass~~
14. Chinese Clepsydra
15. Gk " "
16. Harrisons Sea chronometer.
1753-9
won the £20 000 reward in 1764
Offered by ~~Geo.~~ III in 1713
Tested out on runs to & fro W. Indies & back
17. Loomis Chronograph.
18. " " 10 inch paper
1 pr in 3 hours

19. Solar term

20 Lunar term

21 Magellanic Cloud + Cluster

22 Pleiades Cluster

23 Herc. Cluster 15' are only.

Similar ⊙ around Sun we'd

Enclose 4000 stars

Star in ⊙ is 100 × Suns brightness

24 Perseus Double Cluster

25 Giant Dwarf Evolution Diagram

10^{14} yrs

26 M 31

27 Whirlpool Nebula

28 Twin Spirals

29 M 33 (Triangulum)

30 M 101 Mt W. 60 inch 4h 15m exp.

10^{10} yrs.

St unsolved problem

Age of the universe -

I

Lecture 1.

Early Astronomy.

The general title of this series of lectures is The Influence of Astronomy.

This influence must have been already at work at the very dawn of what we call civilization. For two of the most fundamental needs of mankind, living in even the most primitive communities, are dependent upon accurate observation of the heavens.
i The determination of time & the units of time and a system of chronology
ii. The determination of position and direction upon the earth. Homer - Roman Sicilus

In addn to these practical needs.

In every age there are a few men endowed with exceptional powers of observation and unbounded curiosity. Where these qualities are accompanied by a winged imagination, indomitable perseverance, a deep rooted faith that there are rational answers to be found in nature, that this is a cosmos not a chaos and a wholesome scepticism an honest critical judgment which refuses to accept as necessarily true the obvious

or the traditional answers to the great riddles of nature — here we have the qualities of mind and spirit and character that go to make a great man of science.

Where the winged imagination is unaccompanied by the honest critical judgement we have the magician, the astrologer, the alchemist — too often deceiving himself and (frequently) descending to play upon the ignorance, fear, superstition + credulity of his fellow men.

Now the astronomers and the astrologers, the good, bad and the indifferent - taken all in all - have exercised a tremendous influence upon human thought and action. We see this influence in philosophy, in religion, in literature, imbedded in our very language; we see the influence of astronomy in science, as a help mate of physics and of chemistry a bringer of new knowledge, new ideas into the realm of natural philosophy — and also having an influence in physiological science, in particular in radio therapy.

1. In Philos + Religion: If man is today the central fact of creation, it has to be so bec. of Spiritual reasons - not physical.

2. Literature: Psalms, Job, Enoch, Dante, Milton, Shelley, music of the spheres -

3. Language: Quintescence, saturnine, jovial, mercurial, lunacy,

4. Sci. - : Kelvin - range of temps - range of densities of matter - atomic behaviour,

Lecture 1.
SLIDES

1. Hindoo Earth
2. Egyptian Symbolic Universe
3. Hermopolis section
4. Homeric Cosmogony Homer b. 1100 - 900 BC.
5. Aug 8th N. (imagine seen from Babylon instead of from London)
6. Oct " N. (1am Aug)
7. Flamsteed - agreeing with 6 in orientation
8. Bayer - Little bear.
9. " gt. "
10. Aug. S.
11. Flamsteed.
12. Jan. S. Orion Taurus etc
13. Flamsteed
14. Zodiac Ptolemy.
15. Denderah Planisphere 1
16. " " 2.
17. Chinese Zodiac.
    Influence east across Pacific to Mayas etc. about 1 A.D.
18. Anaximander B.C. 611 - 545.
    Greek astronomy . . . - Thales. Anaximander Pythag. Plato Arist of Sam. Hipparchus.
19. Hipparchus - Precession
    Pole path amid constellations (Ball)
20. Pyramid 2170 BC α Draco near Polar P.C.
    Pleiades ~~Pleiades also visible~~ Piazzi Smith asked Sir J. Herschel
21. Sir J. Herschel.
22. Stonehenge B.C. 1680
23. " mid summer sun
24. Sir Norman Lockyer
25. Ptolemaic Universe D.p. 158.
26. Epicycles " " - Dante's Paradiso Heavens -
27. Apian's diagram Joh. D.P. 153 Real Encyc. p 77. 60.
28. Hildegard of Bingen 1170 AD.
29. Solar Eclipse BC 763.

Constellations 3004 000 yrs B.C.
Callisthenes
Eudoxus
Aratus D.p. 14.

(2)

Cont.

1. Ptolemy of Alexandria circa AD 180

"Mortal though I be, yea ephemeral if but a moment I scan the multitudinous circling of the stars, no longer on earth I stand but sit with Zeus himself and take my fill of the ambrosial food of gods."

" There is the influence of astronomy on one of the keenest minds of the 2nd century.

Prime Mover.

Whitehead. Sci & M.W. p. 202 "The ancient World takes its stand upon the drama of the Universe, the modern world upon the inward drama of the Soul."

Astron. & Physics gt influences on early philosophy. Physiology & psychology (Descarte's subjectivism & dualism - matter & soul - Locke, Wm James & Bergson) on modern philosophy. Whitehead's metaphysics arrives at God from physics via Princ. of Concretion

p. 249 :- "Aristotle .. the greatest metaphysician .. genius of insight ... general equipment of knowledge ... found it necessary to complete his metaphysics by the introduction of a Prime Mover - God."

"The phrase Prime Mover warns us that Aristotle's

Thought was enmeshed in the details of an erroneous physics and an erroneous cosmology.

.... In the place of Aristotle's Prime Mover, we require God as the Principle of Concretion. We conceive actuality as in essential relation to unfathomable possibility.

.... every actual occasion is a limitation imposed on possibility, and by virtue of this limitation the particular value of that shaped-togetherness-of-things emerges."

p.257. God is the ultimate limitation and His existence is the ultimate irrationality. For no reason can be given for just that limitation which it stands in His nature to impose. God is not concrete but He is the ground for concrete actuality. No reason can be given for the nature of God, bec. that nature is the ground of rationality.

.... The general principle of empiricism depends upon the doctrine that there is a principle of concretion which is not discoverable by abstract reason. What further can be known about God must be sought in the region of particular experiences, and therefore rest on an empirical basis. In respect to the interpretation of these experiences mankind have differed profoundly. p.257.

.... The worship of God is an adventure of the spirit

p.276

Can we summarize the influence of Astron. in literal interpretn of the words of the Psalmist - The heavens declare the glory of God

Does Nature reveal God?

No - Not to all types of Thinkers -

Means of faith + formation of character + spiritual upbuilding.

The transforming power of the Holy Spirit.

Pascal

"No other religion has asked of God power to live + follow Him -"

Pascal's ans - to ques. Does Nature reveal God?

Honesty of mind.

"God either is or is not... Reason cannot settle the matter ...

You must wager; it is not a matter of volition ... Your reason is no more hurt in taking one than in taking the other ... — but your happiness?

In choosing "heads" - that God is -

if you win, you win everything;

if you lose, you lose nothing.

Read Pascal p. 43. 45. Give ear to God -

A.N. Whitehead: Sci & M.W. p. 200 "There is a difference between ... (mental) reactions to the same stimuli"

II

2nd Lecture.

Impromptu. Introd.

Copernicus to Newton.

L da V. 8 t live perfect knowledge.

Jacobi: Once upon a time there were one thousand years of NIGHT.

Contrast

Active period of Greek era

Pythagoras 500 BC. sphere + circle .. perfection to Ptolemy of Alex. 130 AD almagest.

Burning of alexandrine Library by Christian mob ~ 389 AD. followed by the dark ages of orthodox ignorance (de Sitter) Kosmos P. 18.

Dark period

to Copernicus. 1473 – 1543.

Bruno.

Prof. Hocking.

Spend study of Copernicus thru Italy, Switz. Fr. Eng. Germany.

Read. (2) in Nature Blue Bk p. 48.

Lecture 2. SLIDES.

1. Copernicus 1473 – 1543

   Bruno.

2. Galileo 1564 – 1642
3. " Telescope. 1610
4. 40-in. Yerkes Tel.
5. Y. O.
6. Sunspot group. CHANGE
7. Jupiters satellites.
8. Nov. Sky S. Orion – Pleiades.
9. Hyades + Pleiades. extra focal . . . . 7.
10. Maestlin 1579 11
11. Galileo's drawing 1610 36
12. Pleiades. Hertzsprung . . . 2616
13. Orion. extra focal.
14. " 30' 150' exp.
15. " great neb.
16. Tycho Brahe. Swedish nobleman -1586
17. Kepler 1571 – 1630 divinity at Tübingen
    math. at Graz
    assistant to T. Brahe-Prague
18. Isaac Newton – The marble index. 1642-1727.
19. Telescope 1672.
20. Herschel. Danzig.
21. Paris Obsy. 1667.
22. Greenwich 1675.
23. " 1925
24. " O ‖e.
25. D.A.O. 72 "
26. Mt-W. 100 "
27. " Dome
28. Mt Palomar 200"
29. Newton.
30. " apple tree. Voltaire ... CW Walker.
31. Precession.
32. Newtons tomb. Westminster Abbey

Newton

If I have

Latin Inscription -

Voltaire on Newton.

III

Lecture 3.

The Solar System.

John Stuart Mill: All inquiries are either into what is or into what ought to be: science and history belonging to the first division; art, morals and politics to the second.

Where does religion belong? Does it perhaps span the two?

I am thinking of an incident in the autobiography of the French dramatist Sacha Guitry — as a boy he was sent to a school run by the Brothers of some priestly order & he so hated it all that he determined to get himself expelled. So he gained admittance to the Sanctum of the Holy Father at the head of the school — an aloof scholarly man who never drew near to the boys in any way — & he announced before this august personage that he did not believe in God. Instead of the a wrathful sentence of expulsion he was amazed to hear the old man say very solemnly. My boy, you must believe in God, for God exists.

In any inquiry into what is, it is of fundamental importance to know & to keep in mind the particular viewpoint from which we happen to make our observations.

We view [illegible] from a moving platform.

→ G.D. 1880: To Candidates for ministry: Theology is the most comprehensive and transcendant of all sciences ... all true preaching is both a science and an art

So Scientific Method is applicable ←

Lecture 3. SLIDES.

1. Rel. sizes Sun & planets.
2. Orbits - to Mars.
3. " to Neptune
4. Seasons. Earth - read. H.G. Wells.
5. Moon
6. "
7. Sunspots
8. " vortices
9. Prominences. H_α
10-11 " Zurich, Catania.
12. " Woolly Elephant.
13 " Eruptive. 1919 May 29. Ca+
14 " Ca+ 1931 Aug 6. 290 000 mi. Petit.
15. Corona.
16. Phases of Venus.
17. Mars. Sat. Jup.
18. Saturn
19. Asteroid orbits - Eros.
20. Sir Wm Herschel.
21. " " 4th planet 1795. Uranus
22. J.C. Adams. Oct 21, 1845 to Airy. Neptune.
23. Le Verrier. 1846
24. Pluto. Mar 2 & 5 - 1930. Flagstaff Dr Slipher
26. Comet orbits.
27. 1744 Comet.
28. 1843 ".
29. Halley.
30. " Comet 1910 May 28.
31. " " Bayeux Tapestry.
32. " " orbit.
33. Meteor at Ensisheim 1492.
34 " Crater. Arizona. 4000 ft diam 600 ft deep
35. Comet spectra.
36. J.H. Jeans
37. Origin of Solar System.
38 Milky Way. 30. (other worlds ?

Alfred Noyes

. . . all those cloudless throngs . . . D 132

glittering stars and all those
glimmerings where the abyss of space

Shelley:

Below lay stretched the Universe D 14

is powdered with a milky dust
each grain a burning sun.

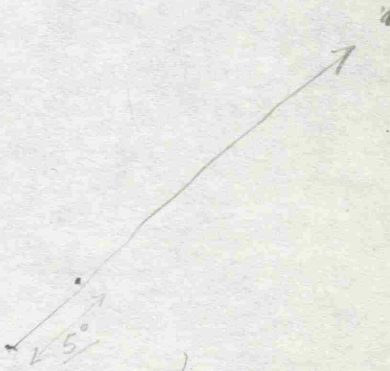
Conclusion.

Star Dust.

Star Light

We are such stuff as stars are made on.

TV



4th Lecture

Stars and Nebulae

Concln.

Read p. 2 3 from Atoms to Stars

Golden Arrow.

Golden Sunbeam.

Last we were considering the Size of a Typical Star - our Sun.

Let us inquire what man as a physical

4th Lecture

SLIDES

1a Scales - man star - atoms.
1. July N.
2 " S.
3. Dipper. now ± 200 000 Proper motions
1718 Edmund Halley Sir. Arct. Aldebaran.
Sir. 1".3 per an. 1°. in 2000 yrs. 4/3 moons diam.
Universe not STATIC.
Barnards Runaway Star 190 yrs. moons diam.
4. Feb. Sky S. Sirius Bessel. 1844
5. Sirius path in sky. Father of Sidereal Astronomy
6. " orbit. Bessel, Alvan Clarke, Eddington.
7. as. add.
8. a a michelson
9. Interferometer.
10. Sirius A. B. Sun diagram.
11. Betelgeuse.
12. Novae - Variable Stars
13 " Light Curve.
14 Planetary Neb.
15. " " Spectrum.
16. Milky Way 11. δ Sco. π Sco. 8 n.e.s
17. " " — P Oph. 700 — 1000 l. y.
18 " " 23 58 Oph.
19. " " 13. α Sc. Cluster M4. P Oph + 5 Oph.
20. " " — Cygnus N. Am. Neb.
21. N.G.C. 6960 — Mt. W. 100" 7½ exp.
22. Orion Neb. Mt. W. 60".
23. " Belt Horsehead Neb. Sirius Degye even in tel.
24 Milky Way 1. Perseus Clusters
25. Herc. Cluster. M13.
26. 34 glob. Cl. in S. Milky Way. 93 + 10 in Mag. Cl.
27. 6 clusters.

28
29
30

Time up

SLIDES. cont^{d}.

28. W. Herschel. Diagram. Star Counts.
29. " & Kapteyn.
30. Jeans diagram.
31. C. of Galaxy. Sagittarius Star Clouds. Barnard.
* 32. " Ross. Data on C. of G & Rotation.
33. M 31 Most distant n. c. object.
34 " . . . 40 Cepth. Variables.
35 " 100"
36 " nucleus.

New Era with discovery of External Galaxies.
Read from Atoms to Stars p. 2-3.

* Galaxy.
Plaskett. Diam. 90 000 l.y.
Sun to Centre 32 000 l.y.
Rotational Vel ⊙ 275 Km/sec.
Period 224×10^6 yrs.
Total mass of Galaxy 16×10^{10} suns.

V

5th Lecture

Starlight

Of star dust are we made
and by star light we live.
We are such stuff as stars are made on.
Literally true of the physical body + life of man.

Introd^n Voltaires Creed.

Something very akin to Old T. ideals
To do justly, to love mercy + to walk
humbly with God.
Not the sentiments of a Semi atheist.

The Nature of Starlight

Light – dual nature.

Matter – " "

2 of mysteries
Mod. investigations
led to Bom. of Indeterminacy.

5th Lecture. SLIDES

1. The quanta runners.
2. H He Ne Ca.
3. Solar Spectrum.
4. Lunic Coincidence
5. Spectra of Planets. NH_3 CH_4
6. Sir Wm. Huggins. (Kirchhoff. 1824–1910.
7. Y.O. Spectrograph.
8. Stellar Spectra.
9. Dr A. Cannon D.Sc. Oxon.
11. B_0 — M_c
12. Giant dwarf sequence.
13. Doppler Shift.
14. Doppler Doubling.
15. Nebulae.
16. Earl of Rosse M 51.
17. M 51.
18. M. 33.
19. M 33 Hubble. 42 Variables - 850 000 l.y.
20. Nebula enshrouded galaxies.
21. Later type galaxies.
22. Twin Neb.
23. Face-on nel. NGC 7217.
24. M 181
25. NGC. 4736. 1½ mil l.y.
26. Coma Ber. nel. H V 24. 5 hours exp. M 13 60"
27. Spectra eeus F 0.6 aperture 2 inch focal length 1 5/16 "
28. Graph. length of spectrum 1/8 inch.
29. Einstein + de Sitter Rabindranath Tagore.
30. de Sitter + Eddington. Two Negatives.
31. Jeans — gr. mathematician. 1. mystic might into nature + the problems of the Universe of stars
32. A.S. Eddington (2) Indian mystic
33. M. 101. on whom the kingdom of the mystery of life - its system - rests so heavily that "Life is a constellation" an unpremeditated defect.

1

Like the wheel of Indian mysticism
it is a summons to Contemplation

M 101

not a static universe
it is dynamic — change — & further
change that is directed.
not mere repetition of a mechanism
all change in the phys. world is towards
unavailability of energy.
In spite of the optimism of Bp Headlam to
the contrary — there is not one jot of evidence
in the whole range of physical phenomena
for the reverse process going on.
Prof. Whitehead sums it thus — the universe
is physically wasting but spiritually
ascending. (and it is not easy to discover
just what he means)

No the Cosmos is not a Soulless repetitive mechanism.

There is another attitude of mind
Addisons poem: and all the stars —

Forever singing as they shine
The hand that made us —
The morning stars sang together

That is the other extreme of thought — Let us
see what modern science has to say.

Eddington (1) see Religion of Scientists FRS's
pp 53, 54.

Now let us ask Whitehead what has been
the influence of Science on thought.
(2) see Lecture 1. quotation.

Prime Movers
This phrase led L. da V to write.

(3)

Necessity →

Necessity thou mother of the world

Shelley. (3)

It is interesting to note the impact of astron. ideas upon Shelleys mind.

"Innumerable systems rolled.

(4)

Influ. of Shelley on an immature mind like that of Beverley Nichols.

"The poet hath said.

And now I turn to Sir James Jeans

calculation of the probability of universe coming to its present degree of organisation & complexity purely as the result of Chance.

Overwhelmingly small.

∴ a Creator + director

Bruno reached this conclusion as a pure speculation or intuition. "For things have not come about by mere accident, but through the determining mind".

Whitehead The order of the world is no accident — The religious insight is the grasp of this truth.

Jeans from the sheer mathematical beauty & sublimity of physical laws

"The great Architect of the universe appears to be a pure mathematician."

Eddington objects to that & works in The Nature of the Physical Universe p. 282 & Two Worlds. "The crudest anthropomorphic image of a Spiritual Deity can scarcely be so wide of the truth as one conceived in terms of metrical equations" (5) I think it is of the very essence of the unseen world that personality should dominate it!"

(5) Summary of Edd. ideas in Lecture on Jeans & Edd. 1930.

In Conclusion I quote two Sentences

Edd: Man is a being to whom truth matters

Inge: Trust in Reason (Clem of Alex) which rests ultimately on Faith in the divine Logos the Self revealing soul of the Universe —

See subsidiary notes 1–3 replacing this —

M101 Wheel of Indian philosophy

The call to contemplation.

→ Age of Universe · 10^{10} yrs.

Probability of this actual assembledge of energy by pure chance – $10^{42,000,000}$?

∴ a Creator.

Mathematical expression of laws of phys + astro led J.H. Jeans to refer to "The Architect of the Universe must be a pure Mathematician"

Eddington is not satisfied with this. The mathematician can build up a symbolic universe – but it is a map – not an actual universe.

"There are regions of the spirit untrammelled by the symbols + measurements of science."

see Quot. fr. Edd. fr. New Pathways of Sci

The Spirit of Seeking. You will understand the true spirit neither of Sci nor of religion unless Seeking is placed in the fore front

Man is a being to whom TRUTH matters

It is more important to seek for truth than to lazily acquiesce in orthodox beliefs.

The Winter Stars.

M. W. Cl.
1938 Nov. 19.

The Winter Sky.

Orion
Taurus
Canis Major
" Minor
Gemini
Auriga

Colours Temp- Sizes

Mythology

Sirius - The Dog Star [less than 10 l.y. distant.]
The Honey star.

Pliny : honey collected after rising of Sirius was always good. If Sirius were in conjunction with Venus Jup. or Merc. the honey was endowed with heavenly power to cure diseases of eyes, bowels, &c. even to restore life to the dead.

Orion

Virgil Aeneas sailing towards Italy

To that blest shore we steered our destined way
When sudden dire Orion rous'd the sea
all charged with tempests- rose the baleful star
and on our way pour'd his watery war.

Dido's advice to Aeneas to delay his sailing

Tell him that charged with deluges of rain
Orion rages on the wintry main.

Orion the hunter in Greek mythology chases the Seven maidens (Pleiades) but is confronted by Taurus the Bull. — or seven deeves.

Orion in Babylonia is identified with Merodach the great hero warrior, proud and defiant. Creation myth. p. 27. ash of pride.
Hebrew parallel is Nimrod

His audacity in trying to climb up the heavens into the Zodiac is symbolically referred to in Isaiah reproaching the Babylonian king the successor to Merodach. Thou hast said in thine heart I will ascend into heaven. I will exalt my throne above the stars of God.

Unique significance of Zodiac - Ovid - How Phaeathon drove his fathers chariot - path way of the Sun.

Pleiades. see p. 218.

Gemini - Babylonian Triad of Stars C + P + crescent moon
Castor + Pollux p. 320, 323 -
see Lays of Ancient Rome.

Taurus - Sign or Standard of Joseph.
Ephraim of Reuben
Lion of Judah.

Golden Calf was Taurus ∴ Star worship
p. 193.

Isaiah
Jeremiah p. 145

Σ. Surface.

Light 60 sec x Sun.

8000°F

1300°C

30,000 x 10^6 x ⊙ vol.

3000 x ⊙ diam.

Period 27 yrs

1 yr in eclipse

Planets Comets & Meteors

Y.M.H.A. 1935 Dec. 14.

12a Morehouse Comet 1908 Sept. Greenwich.
12. Morehouse Comet 1908. Nov. H.C.O.
13. Comet orbits.
14. Halley's C.
15. " " against star field
16 " " 684 A.D.
17 " " 1066
18 " " Bayeaux Tapestry 1066.
19 " " May 28 1910
20 Great C. 1843 Rome (+ Orion)
21. " " 1744 Paris.
22. Superstitions attitude to comets, meteors etc. A.D. 1000.
23. Fall of Meteor Ensisheim 1492. Alsace.
24. Corkscrew meteor. 26 m p s. 70 miles up. 10 50 " "
25 Arizona Meteor Crater. 4000 ft diam 600 ft deep.
26 Jan. Sky S.
27 Feb. " "
28 Dec " N., cygnus region.
29. Mt W. 100 inch
30 Cygnus neb + meteor 100-inch Mt W.
31 Solar Spectrum
32 Gases spectra
33. Milky way 40.

Quicquid nitet notandum

Planets, Comets & Meteors.

The great vast physical universe is made up of many millions of clusters of stars each cluster far away from all the others. Each cluster is itself composed of over a thousand million stars + much gaseous matter. Each star is a large ball of thin gases about 330,000 times as massive as the earth on which we live. Because it is so massive it is necessarily very hot inside. This energy of light + heat passes out through the gases forming the outer layers of the star + spreads out through space in all directions.

One star in one of the great galaxies of stars has had a very interesting life. Many thousands of years ago it happened to come very close of another Star . . . .

SLIDES

1. Cajun shaped tidal wave.
2, 3 orbit diagrams
4 Rel. sizes - sun + planets.
5. Seasons
6. Venus
7. Mars
8 Mars. Jup. Sat.
9. Jup + satellites.
10 Saturn
11 Pluto

1

Astronomy in Babylonia & Egypt.

McGill Extension Lecture.
1937 Oct. 12.

1

Influence of Astronomy

i. In Babylonia & Egypt.

The stars have from earliest times excited the interest and the curiosity of mankind. There has been the driving force of practical necessity and in addition the urge of pure curiosity.

Direction
Time.

SLIDES.

1. Oct sky N.
2 " S.
3 Jan S.
4 Apr. S.
5 July S.
6. Bayer Urs Maj.
7 " "
8 Hamsteed - Sagittarius group.
9. " Orion "
10 " Aquarius "
11 " N. polar "
12. " S. polar vacancy
∴ date of Baby. obsns 2700 B.C.
13. Precession. model & slide of Zodiac
14.-18 Projections from astron of Bible - Maunder.
19 Eclipse Slide Sidon to Nineveh 763 B.C.
20. Chinese Zodiac.
21.-22 Egyptian Denderah.

The Influence of Astronomy in Babylonia & Egypt

Babylonia Assyria Chaldea
Babylon Nineveh Ur

Influenced E. S. W. & N.

Urge to observe heavens: Time
Direction.

Constellations

7 wanderers

→ Babylonian Pantheism

Creation → Astron. of Bible p. 27–30
Cf. Tiamat myth + Genesis 1.

Hebrew revulsion to mythical + the
superstitious beliefs of Babylonia.

Sun → R.S.S. p. 126 Sun + moon hieroglyphics
plates.

Moon → Ashtoreth; Moon Goddess, Queen
of Heaven 87–90

→ Eclipses – p 120 Shade

Astrological assoc^n of Evil influence with Saturn. p. 135 -
[Illogical nature of astrology p. 248.

→ Constellations p. 154.

Centre of unmapped space of sky was S. Pole at time of mapping
i.e. 2700 BC.

→ Precession Model
4 Royal Stars. Equinoxes & Solstices.
p. 160.

Babylonian Tablets 12 myths for 12 Signs of Zod. Bull led until after 700 BC. ∴ as Flood myth is 11th Tablet - Aries was leading ∴ not as old as 700 BC. i.e. Aquarius.

p. 177, 181

3

Leviathans p. 196
Dragon, Serpent, watersnake
Hydra.

Crescent Moon + 2 stars
Read p 320-21
Show plate p 318
322

Egypt — Dendorah Planisphere
Symbolical universe.
Pyramid
School of Alexandria
400 BC — 700 AD
Library destroyed 389 AD. Theodosius
Ptolemy
p.5. Invasion by bastard science Astrology

10 day week (like Babylon) became 7 day under Jewish influence

23. Egyptian Symbolic Universe.

24 Section at Hermopolis

25. Pyramid. Piazzi Smith 2170 BC.
α Drac. up passage.
Pleiades up slope?

26. Stonehenge Norman Lockyer.
B.C. 1680 from Sun, or 1950 from Pleiades
Sir Wm Ridgway says must be less ancient.

27 Pyramids + Total Eclipse Slide.

Concln It is not necessary to overstate my case - Obviously astronomy has had a great influence upon the scientific thinking, the speculative thinking & the religious thinking of all these early peoples.

Double Stars

Science Club Argyle J. H. School
1938 Jan 14.

1938 Jan 12.

Double Stars.

Looking out at the stars you see here & there two so close together that your attention is specially drawn to make observations on them.

Sometimes merely a perspective effect

" actually a multiple star system
i.e. two stars in revolution about their c.g.
or even three or 4 or more stars belonging to one dynamical system.

Visual double stars. ε Lyrae.

α Geminorum Castor
2.m0 ; 2.8

α' sp. bi. 2.9 dp. 44 l.y. dist.
α" " " 9.2 " 340 yr. period.
79. ast u. apart.

Sir Wm. Herschel 1782 catalogue 269 double stars
1784 " 434 more.

† G. W. Struve.
Burnham
Aitken

of the charted 100,979 stars to 9.m0
5,400 are double stars.

W. Struve	105·3	
O "	·296	
Burnham	55·1	
Hough	237	
Hussey	766	
Aitken	2,05·7	at Lick resolving power 36" ker 0".14
all others	440	12" " 0".42
	5400	

SLIDES

1. 1" arc. & human hair.
   spider DIADEMATA.

2. 25 nearest stars.

3. " " " 8 are doubles.

4. Jan Sky. N. algol P 2d. 20h 49m. light drop. 2m.3 – 3m.5
   Faith p. 239, 240 Duration of Eclipse 9h.66.
   ζ Ursa Maj. Mizar 1889 spec. P 20.5 days.
   [Xi] ξ Ursa Maj.
   ξ1 ξ2 } 61 yrs.
   ξ1 Sp. binary P. 66 days.
   ξ2 " " P 10 days.

5. Nov. N. Castor see p. 1.

6. Kepler.
7. Ellipse.
8. Newton – Law of grav. Osc.
9. " Apple tree limb
10. Spectrum of Sun.
11. Doppler Shift. Pickering.
12. Bessel. Sirius binarosity. 1844
13. Sirius Orbit 49 yr.
14. Eddington.
15. Sirius A & B diagram. Wsadams approx 1924.
16. Jan. Sky. S. Sirius p. 17. Red note Bk.
17. Newtons monument Wabbey.

Stars + Atoms p48
p 124

Sirius System

P 49 yrs.

1844 Bessel
1862 Alvan Clarke
1914 W.S. Adams - Sp. Class - White.
1924 Eddington - Mass Lum. Law.
1925 W.S. Adams - Red Shift.
Obs. 19 km/sec. Theoret. 20 km/sec.

B 12" dist from A = 2 a.u = Sun to Uranus.

1/10 000 as bright.

Mass.	A 2.4 ⊙	B 0.96 ⊙
ρ	A 0.42	B 30-50,000.
rad.	A 1.8 ⊙	B 0.034 ⊙

Procyon System

1862 Anwers (German Astron.
found its path sinuous curve.
1896 Lick saw comp. 36" tel.
5" dist. (Their resolving
power is 0".14)

P = 40.23 yrs.

1/100 000 Light of Procyon.

Mass 3/5 ⊙ Proc. 1.24 ⊙

Mean dist. 14 a.u.

ρ > 60 000.

Binary stars - Centrifugal force balances gravitation.

hence find mass of stars.

Range of masses - 10^{32} gms — 10^{35}

[Sun $2\ 10^{33} = 2\ 10^{27}$]

Plaskett's Twins (Monoceros) 75 ⊙

63 ⊙

Pearce's Giants. HD698. 134 ⊙

50 ⊙

Stones E Aurigae - 150 ⊙ ?

The Music of the Spheres.

Douglas Ladies Literary Circle
1932 Feb. 19.

The music of the spheres is a music which
the physical ear of man can never hear.
Keats knew the beauty & value of
inaudible music when he wrote

Heard melodies are sweet, but those unheard are
sweeter. . . .

Out of the depths of a very ancient past. . .

DAWN- Rbt. Bridges.

. . . delicat as the shifting hues
that sanctify the silent dawn with wonder-gleams,
whose evanescence is the seal of their glory,
consumed in self-becoming of eternity;
till every moment as it flyeth cryeth "Seize!
Seize me ere I die! I am the Life of Life."

Music of the Spheres — SLIDES

1. Egyptian Symbolic
2. " Hermopolis - Maspero
3. Hindoo hemisphere -
4. Homer's Cosmogony
5. Ptolemaic "
6. Hildegarde of Bingen - 1170 "Treasuries of the hail & lightning".
7. 16th Century wood cut

Actual wonders & Marvels revealed by Telescopes.

8. Twin Neb. Jth.
9. Flattened Spirals - Virgo & NGC 7217.
10. M 181. Urs. Maj.
11. M. 33 Triangulum
12 Whirlpool M51. Can. Ven.
13 ~~St. Neb. of Orion~~ M31
14 M31 centre.
15 M31 end
16. M31 Centre - blue ground.
17. ~~St.~~ Neb. Orion
18 Neb in Orion Horses Head.
19. Cygnus Nebulosity: 4h 45m.
20. Cygnus. N. Am. Neb. & network
21 Cygnus. Network Neb. 7th exposure.
22. Sagittarius.
23 Perseus Cluster. 5 n.c.s.
24 ρ Ophiuchus Read.
25 ~~Solar Prominences - May 29. 1919.~~ 400,000 miles high.
26 Sunset sky in before 17.
27 M.101.

Alfred Noyes:

... All those cloudless throngs of glittering stars
and all those glimmerings where the abyss of space
Is powdered with a milky dust, each grain
a burning sun. . . . .

Rbt. Browning:
. . . whose eyes
Saw in the stars were garnishry of heaven.

Milton:
Behold the throne of Chaos
and his dark pavilion spread
Wide on the wasteful deep.

Distance inexpressible by numbers that have name.

Job. 38.22.
Hast thou entered into the treasuries of the snow? or hast thou seen the treasuries of the hail? By what way is the light parted which scattereth the east wind upon the earth?

The Sun & His Family

Howick P.Q.
1930 Nov. 14.

The Sun & its Family

Aratus 270 B.C.
Ptolemy 100 A.D

Astron the oldest science

3 or 4 000 B.C. Chaldeans
Egyptians
Chinese etc.
mapped the heavens.
7 wanderers.
motions - eclipses - tides.

from Geocentric to Heliocentric idea.

Slides :- 1. Egyptian Symbolic Universe
2. Ptolemaic System
3. Hildegarde of Bingen. 1170 AD

Job Hast thou entered into the treasuries of the snow? or hast thou seen the treasuries of the hail? By what way is the light parted which scattereth the east wind upon the earth?
38. 22.

Copernicus d. 1543.

Describe Solar System.

4. Rel. sizes of Sun & planets.
5. Sun. Size
temp
Spots
6. " Rotation 24 to 35 days.
7. Sunspot. 11 yrs. Elect & mag.
Correlations.

8. Prominences.

9. "

10 Mt Wilson Solar Tower. 150 ft. ↑ 80 ft ↓

11 Arcetri 80 ft ↑ 32 ft ↓ 1924

12. Stellar Spectra & Solar G0.

13. What stars are made of.

Greenwich. 1675 Chas II

14 "

15. Transit ⊙ Long. 0.

16. Paris. 1667. Louis XIV.

---

17. Moon full 240,000 mi.
1/81 mass of earth.

18

19 " 8 dys. Yerkes.
" 7 dys. Paris

20 Eclipses. 1932 Total Solar.
Mtl. Brear Sorel.

---

21 Planets.
Habitability — Venus & Mars.
Pluto.

22. Planets Spectra. atmospheres.

23. Saturn Rings.

24. Asteroids. Total 1/3000 mass of earth
Eros orbit. Earth & Mars 35 10^6 miles
15 miles diam " " Eros 14 10^6 "

25. Comets. Orbit.

26. Bayeux Tapestry 1066.

27 Drawing of Halley's C. 1066

28 " " " 684
Nuremberg Chronicle

29. Photo. Halley's C. 1910. May.

30 Spectrogram " "

31 " Diagram

32. Photographs of distant Comet

33. 1882? Comet over Paris.

34. Milky way 9 n. eye stars

Story of 2 stars age of S. System 2000.10^6 yrs

35. Balances. 10^{37} atoms = 1 man
10^{28} men = 1 sun.

36. Milky Way.

Rope "all those cloudless throngs of glittering stars — all those glimmerings where the abyss of space is powdered with a milky dust — each grain a burning sun".

The mind of man cannot but be somewhat appalled by the immensity of Space & the immensity of time - but we make a mistake if we allow ourselves to forget that we are ourselves a part of this Universe

Every atom, every electron, every ripple of radiant energy has its part to play in the great Whole So too man with his powers of thought & feeling - man an aggregation of matter with a spark of divine life within it, endowed with a mind eternally restless - man has his part to play in the great Symphony of Nature.

McGILL UNIVERSITY
MONTREAL

THE MACDONALD PHYSICS LABORATORY

Stars Near & Far

OBM
1930 Apr. 3.

Ancient ideas re Universe

Hindoo 1
Egyptian 2
Constellation names
+ diagrams 6 or 7.
April pm. Chart.
Orions Belt.
aquilae photos 2. Chance of collision.
Cygnus 1
Here 1
Spirals 2.

June
July N + S. 8
Aug
Sept.

Sunset glow.

All the beauties of nature should
give us pleasure & inspiration
Ps. 19 v They that turn many — —
— — — as the stars forever.

The Challenge of Astronomy

Ch. J. Messick
1930 Dec 10.

The challenge of the Stars is a challenge which mankind throughout all the ages has recognized and accepted.
It is a challenge with a two fold character (1) The practical necessities of life - the need for keeping track of the passage of Time, the need for a Calendar the need for a means of finding direction surveying and navigation - these requirements have forced men to study the heavens. These problems have challenged some of the greatest thinkers in Babylonia, Egypt, China, Greece + our modern world.

(2) The deeply implanted curiosity in human nature - human yearning + longing - the urge to find out the Truth about the universe around him - has led some of the greatest intellects of every age to accept + welcome the challenge of the stars - to give their lives to the resolving of some at least of the great mysteries of the vast universe - What are the stars, where are they, how many are their number, what is their influence upon the Earth + what is our relation to them in the vast scheme of the Cosmos?

Slides.

1. Copernicus
2. Galileo
3. " Telescope 1610
4. Sunspots
5. "
6. Moon
7. "
8. Solar system diagram
9. J.H. Jeans
10. Milky Way in Cygnus
11. Galaxy diagram
12. " "
13. Cigar title.
14. planets
15. Newton (Wordsworth:- The marble index
of a mind forever voyaging through
strange seas of thought alone)
16. " Telescope. 1672
17. Herschell
18. Geo Couch Adams.
19. Le Verrier.
20. Solar spectrum
21. Stellar spectra
22. Norman Lockyer
23. Eddington
24. A.A. Michelson
25. January sky
26. Diagram of giant stars
27. Dec sky
28. Sirius orbit
29. " Diagram
30. Nov sky
31. Pleiades ~~Galileo~~ Maestlin 1579 (11)
32. "
33. " ~~Maestlin~~ Galileo 1610 (33)
Hertzsprung. - (2000)

34. Yerkes telescope 40"
35. Berlin 26"
36 Mt Wilson
37 Vic B.C.
38 Orion Nebula
39 Cygnus Neb
40 Perseus Cluster
41 Milky Way (H.C.O.)

The challenge of astronomy is a challenge to the mind & to the imagination - to grasp something of the immensity of space & of the immensity of Time - and it is a challenge to the spirit of man to

Surely we are not wrong in believing that the fact that man can respond to this Challenge of the stars forms one of the strongest & surest grounds for assurance that he is something more than a physical entity, something more than a speck of matter in the eternal scheme of all things -

Stars & Starlight

Scouts' Association
Bishop St.
1931 Feb 19.

Planets Moons & Stars.

1 Sun & spots
2 Sunspots
3 " rotation.
4 Prominences. May 1919.
5 Diagram S. Syst.
6. Mars. Saturn Jupiter.
7. Moon nearly full
8 " 7 days
9 Eclipse
10 Comet. 1882 (?)
11. Halleys. 682. predicted for 1758.
traced back to 1066
12. " 684 & to B.C. 87. Ref. by Pliny.
13 " Orbit.
14 Pluto
15 EROS.
16. J. H. J. Cajar
17. Milky Way. Aquila $4^h 5^m$,
9 n.e.s.

Chance of collision
— minimus —

18. N story Jan. Feb. 9 p.m.
19. Urs. Maj. Bayer. Bavarian attorney
1603. made catalogue
of 1277 stars - post & Mag.
20 Urs. Min. mythology - Tail sabong?
21. S. Story
22 Diagrams of Constel.
23 Bayers Orion.

24. Orion – extra focal.
25 Orion. 30' + 150' exp.
26 " Neb. H + O chiefly.
27 Betelgeuse. Diagram of Size.
28 Constel. Taurus. extra focal.
29 Pleiades – Maestlin 1579 11 nebs.
30 Galileo's Tel. 1610.
31 Pleiades " " 33 stars.
32 " Modern Tel.
Hertzsprung 2616.
33 Newtons Tel.
34 Vic. B.C.
35 Mt. W.
36 " " interferometer.
37 Yerkes Obsy.
38 " 40-inch.
39 " Dome from outside
40 Cygnus region.
41 Diagram of Galaxy.
42 Perseus Region 5 nebs.
43 glob. cluster in Herc.
44 solar spectrum
45 stellar "
46 stellar evol^n diagram.
47. Scales "
48 M31
49 Golden arms + Sunbeam.
50
51 Spirals.
52

The 1932 Total Solar Eclipse

Rasc. Mechanics Inst.
1932 Apr. 21.

Boy Scouts (Macdonald Physics Bestro)
1932 April 23.

SLIDES.

1. Eclipse diagram
2. " map - full track
3. " " P. Arne.
4. " " Mt Harper Hall.
5. " " USA

Moving slides of 1. Solar System.
2. Earth moon.
3. Eclipse partial & annular.
4. " shadows.

6. Corona Pickering 1889. 1st corona. 1869 wet plates
7. " 1893 Chile
8. " 4 photos.

Streamers may be 3 × diam.
Brightness ½ to 1 × full moon.
at Max^m Sunspots few streamers + circular corona.
at min " corona extended + unsymetrical + long streamers
Min 1933 or 34 ∴ we may expect good streamers.

9. Corona 1900 Barnard + Ritchey.

Unknown gas called Coronium
Spectrum now identified with Oxygen.

10. Prominences 1919 May 29 ACD Crommelin
11 " Woolly Elephant.
12 "
13 "
14 "
15 "
16 "
} coloured. Spectroheliograph set for Hα.

17. Sunspots - Solar rotation equator ≐ 25 dys.
lat ± 35° 26 "

18. " showing motion

19. " vortex

20. Moon - irregular mountainous edge

21 " full - Pariseux, Paris.

22 Baily's Beads. Howard Russell Butler
1923 Sept. 10.

Use of Baily's Beads in determining edge of path.

23. Flash Spectrum. Young Spain 1870

24. Fraunhofer Spectrum.

25. Line Coincidence.

26. Flash Sp. Arcs. Mitchell.

27. Diagram of heights in Chromosphere.

28 Newton. Prediction of Eclipses.

29. Nineveh Eclipse B.C. 763 June 15

Amos VIII. 9.
Sun shall go under at
midday.

Joel. II 31 Sun turned into
darkness.

Chaldeans 4000 yrs ago
Saros 18 yrs.
35 oys at Babylon
Naburianmu + Kidinnu 54 yrs 1 mon

30 Newtons Statue Trinity
Newtons law of gravitation
Planetary motion
Satellite motion.
Sun - Earth - moon tables.
Greenwich. Nautical Almanac
office.
Eclipse calculations Washington
Naval Obsy. Washington.

Previous to 1923. predictions
15" to 20" wrong.
New tables for 1923 California eclipses
on time.
1925 Eclipse 4 or 5" late.
Why? E.W. Brown.
Importance of wireless time signals
for exact timing of arrival
of shadow.

31. Newton's tomb. Westminster

32. Eclipse 1925 Jan 24
Howard Russell Butler.

33 Eclipse in Egypt.
Stars visible.

Scientific parties.
Cambridge.
London.
Ottawa.
Harvard.
Mt Wilson + Others USA.
+ McGill plans

And so we can all look forward with high expectations to the last day of August 1932 + if the clouds will permit a clear view, it should be an event which none who witness it will ever forget.
In the spectacle of that 100 seconds

In the solemn & impressive
Spectacle of that 100 seconds
with the deliberate, unhurried
approach & departure of the
shadow, perhaps we shall
feel like saying with the
inspired poet, Dante,

His glory, by whose might all things
are moved
Pierces the Universe.

and with Shelley we will pause
to consider —

The majestic laws
That rule yon rolling orbs,
- - - - -
Above and all around
Natures unchanging harmony.

Boy Scouts Lecture.

1932 April 23.

SLIDES.

1. Total Eclipse. Egypt. ~~B.C.~~
2. " Munich BC 763
3. Newton
4. Diagram of shadow
5. Map. 1.
6. " 2
7. " 3
8. " 4
9. Corona 1893
10. " 1889.
11. Moon
12. "
13. Partial
14. Corona 1900
15. Butlers Painting 1923 Bailys Beads
16. 4 Coronas
17. Prominences H. ~~Yerkes~~.
18. Sunspots
19. "
20. Galileo's tel.
21. 1919 Prominences
22. Butlers 1925 Painting Prominences
23. Italy & Spain Prominences H.
24. 25.
26. Arcetri Tower.
27. Yerkes. tel & obsy
28.
29. " Cal from. 290 000 miles.
30. Met-N. 100 " & Solar Tower.
31.
32. Sunlight
33. Flash
34. Chromosphere diagram
35. Scales.

Recent Investigations
of
Milky Way

Rasc.
1936 Dec 4

R.A.S.C. Dec. 4. 1936.

Investigations of Milky Way -

1. Ara the altar in mythological symbolism of the Constellations -
Smoke from the altar rises up the sky as the Milky Way in Scorpio Sagittarius Ophiuchus

2. Galileo investigated Milky Way → p. 48, 49.
Read - Source Book

2 Slides. 3. Herschel - Herschel + Kapteyn -

4. Photographic study - Barnard . 1857 - 1923 -
Atlas. plates 5° sq. to 9° square

→ see Milky Way notes on 18 Slides MW. 1 - 41

5. Photographic Special lens designed by F.E. ROSS -

→ 1. Cygnus + Cepheus - 20° × 20° i.e. 8½ inches at arms length.
(Lowell) 3 hrs

2. Sagittarius 1934 Nov. C. of Galaxy -

3 Sag + Sco. " "

6/ Rotation of Galaxy.

Oort
Plaskett
Struve -
Joy
& Pearce

Red Note Book
p. 9, 22

7/ Clusters in Galaxy -

1. Slide. from Chapley
34 gl. cl. in S. Milky Way.

5 Slides.

2. Distribution of Clusters -

3 Stl. in Hercules 15' are in Sky
$= 10^7$ a. u.

Similar sphere round Sun wd. enclose
4000 stars.

5 Slides { Spectrum - gain Sun stars net - Read Huffers (Stratton)
Plaskets Model of Galaxy. Sun to α Centauri 4.3 l.y.
M31.

8/ Nebulosity - Br. + Dark -

Recent work by Struve + Story
+ by Struve, Elvey + Roach -
+ by Minnaert
+ by Stebbins + Whitford.
+ by Lamar

7. Red + Blue nebulae 1 slide

4 papers in last Sept ap. J. 1936

Halley Lecture J. S. Plaskett. 1936. J Rasc May -

TOTAL 35 SLIDES

Astronomy
ancient & Modern.

Y.W.C.A.
March 24th
1932.

SLIDES

1. Astron prof. 1546
2. Egypt. Universe
3. " " Symbolic
4 Hindoo "
5. Homeric "
6. Ptolemy "
7. Hildegard. " 1170. Job. 38.
8. Feb. Heavens. N.
9. Gt Bear - Bayer.
10. Dipper stars ± 200,000 yrs.
11 Little Bear. Bayer. read de Morgan.
12. Feb. sky S.
13. Pleiades Maestlin 1579.
14. Galileo's drawing. 1610.
15. Pleiades 2616. 1928 Hertzsprung
16. Orion Bayer.
17. " extra focal.
18. " 30' & 150' exp.
19. " Gt. Neb.
20. " Horse head neb.
21. Galileo's tel. 1610
22. 40. inch
23 Newtons.
24 100. inch
25. Eclipse diagram.
26. Map. Can
27 " USA.
28 Total. 1900
29 16th Cent woodcut.
30 Gull nebula
31. Whirlpool "
32. Virgo neb
33. Trum neb.
34 M. 33. Δ
35. M 31
36. Scales. 10^{27} 10^{28}
37. M 101.

4 of 4 moving slides

Applications of the Scientific Method in Astronomy

Science Section
Teachers' Convention
Montreal High School.
1933 October 6.

The Application of the Scientific Method in Astronomy.

I regard it as a privilege & honour to address the Science Section of this Teachers' Convention and I thank you, Mr Chairman, for your invitation to speak on this subject.

I feel very strongly that it is not of primary importance to fill a child's head with the facts of astronomy or of any other science, but it is of primary importance to train the students into the right habits of thought and ~~conduct~~ investigation — the scientific method, so-called. and it is of primary importance to recognize & to encourage the development of three main characteristics of the mind of man - the three attributes to which we owe all progress of knowledge, Curiosity, imagination, and patient indomitable faith.

Curiosity — an honest, serious, insatiable curiosity. I have recently been reading the life of Voltaire that giant intellect, that indomitable spirit who fought a life long struggle against ignorance, injustice, superstition, intolerance and inhumanity with his inspired pen and what was his early training? — to question everything - take nothing on authority that he could think out or work out for himself.

a critical questioning mind is the first essential.

Imagination — Much learning, without the divine spark of imagination, leads no where. The great men of science of past & present the Newtons, Darwins, Bohrs, Rutherfords, Einsteins, Eddingtons have all been endowed with winged imaginations. "The dramatic fancy which creates myths", says Dean Inge "is the raw material of both poetry & science".

Faith - a patient unshakable faith that there is order & harmony in the Universe. This world about us is full of mysteries but it is our faith that it is not a hopeless jumble of inexplicable things - it is a Cosmos not a chaos — that is what I believe we ought to and can impress upon children — Seek and ye shall find.

But the SPIRIT OF SEEKING alone is insufficient - we must train the youthful seekers after knowledge to follow out that logical procedure known as the SCIENTIFIC METHOD of investigation.

The Scientific Method.
Observation
Experiment.
Tentative hypothesis. TOOL NOT CREED
Deductions from it
Crucial tests.
Enlarged, modified or new theory.

Applications of Sci. Meth. in Astronomy

1. Ancient Cosmology - Hindoo & Egyptians. imagination only.
Geocentric, Chaldeans, Greeks - Ptolemy
Aristarchus of Samos. 300 BC.
Heliocentric Copernicus 1500 BC.
Galileo.
Tycho Brahe Kepler Newton.
Universal Law of Grav. orbits of planets sats, comets
binary stars. etc but NOT a Creed
but a TOOL.
EINSTEIN - a sharper tool.
precession of Merc's orbit.

2. Solar System. orbits, ~~sizes~~ masses etc. but Why & how?
Laplace, Chamb, J.H.J., Jeffers.

3. Motions - Proper motions. 1718 Halley - Arcturus & Sirius
Radial - Dopler. 1° + 0.5 since ~~Ptolemy~~ Hipparchus 150 B.C.

4. Nebulae - Recession Why - Expanding Space
- a new tool.

5. Time Scale

Finally, I urge upon you the importance of fanning into a lively flame the true SPIRIT of SEEKING

The Value of Astronomy

Progress Club, Montreal
Windsor Hotel + C.H.L.P.
1934 April 24.

The Value of Astronomy

To a gt many people ... astron. ... nothing of pract. value ... stars ... Stelly. specks of tinsel set in heaven to light the midnight of his native town
profession ... hobby ... CNR.

Oldest sci. when primitive man first .. Time, Dirn.

1. Dirn.

2. Time. nat. units. astron day constancy or inconstancy.
Calendar of Chronology. 45 BC. Sosigenes. J.C.
1582 AD. Clavius. Pope Greg. XIII.
1752. England. 11 days.
Tropical Yr. 365.24220 dys.

L. of N. 41 nations. Switz. Greece.
Easter Mar. 22 to Apr. 25 Gt Brit. Germany, Italy, Japan, Belgium Holland.
Sweden, Irish Free State.
Yugo Slavia + Canada.

3. Assisting progress of other Sciences
Helium 1868 eclipse. Lockyer. 1895 Sir Wm Ramsay. Challenge to chemist.
Range of phys. condns Temp ... ~~Density~~ Density ... osmium 22.5
< 1lb/cu in iridium 22.[illegible]
Sirius 1 ton/cu. in. platinum 21.5

4. Influence on human thought as seen in philosophy, religion, literature + the arts.
[illegible] has exercised a more profound influ. geocentric ... helio centric
no longer earth, ipso facto MAN.
Sun average, [illegible] one of millions.
Same chemical composition — unity of creation ... respect for inert matter.
.. body .. We are such stuff as stars ...
If thus we bestow a place of honour the phys. substance how much more mind + spirit
spirit of adventure, spirit of seeking

5. Astron. tends to produce the habit of thought that I call "the far vision"
Frequent or even occasional contemplation of the universe, the majestic sweep of natures forces .... stretches imagination. forces one away from narrow ego centric localized pt. of view.
a tonic, stimulant, a discipline reacting on outlook in everyday affairs.
Far vision needed in national + international affairs. League of Nations
Think in centuries.

Stevens Report: I find the antidote to the dishonest, selfish, narrow mean spirit
There is no doubt that ... less discordant world ... if breadth of vision of astron.
disinterested honest. spirit of seeking
Fr. Bacon 300 yrs ago. "the desire to seek, patience to doubt, fondness to meditate, slowness to assert, readiness to reconsider, carefulness to dispose + set in order, ... a man that hates every kind of imposture."

Stars Near & Far

Pointe Claire
1937 April 28.

Stars and Starlight.

There is a Latin sentence that has become the motto of British astronomers and they have it on their crest.

Quicquid nitet notandum.

Whatever shines is to be noted.

Edgar Allan Poe has referred to the astronomers as men whose task is:

"To seek for treasure in the jewelled skies."

This treasure is not gold or silver nickle or copper

It is knowledge -

partly useful knowledge in the practical sense.

Terrie direction:

partly pure knowledge - the satisfaction of man's unending search for truth

The Spirit of SEEKING.

Stars Near & Far.

SLIDES

1. Feb sky S
2. Crab Nebula Taurus.
3. Maestlin 1579. 11 stars.
4. Gal. 1610 36 "
5. Hertzsprung 2616
6. Orion Neb.
7. July sky - S.
8. Cyg X.
9. Antares nebulae. red & blue.
10. Herc. Cluster.
11. July sky - N.
12. Perseus. 5 n. e. s.
13. Cygnus N. am Neb.
14. " Dark & br. nel.
15. "
16. Spectra of stars.
17. " Sun
18. " Types.
19. " Line coincidence.
20. " Solar chromosphere
21. " Dopple doubling
22. " " shift.
23. Suns family.
24. Gal. tel. 1610
25. Newtons " 1672
26. Newtons Statue - Wordsworth.
27. Y.O. tel. 40.
28. Mt W. 100
29. " Palomar 200
30. Giant - Dwarf sequence
31. HR P diagram
32. M 31.
33. M 51.
34. M 33 double with variables (42)
35. M 33
36. M 101.

Astronomy introduced
into Science teaching
in Schools –

Habits of thought.

Strathcona Academy Teachers Assocⁿ.
Outremont.– 1936 Jan 21.

Princ - Mr Walsh
Teachers - Miss Hibbard
Miss Holland - Met in train from N.S. June 2. 1937. Math teacher
Miss MacKay

SLIDES.

1. Feb. N. What a child can see + observe.
2. Jan 8.
3. Feb. S.
4. Bayer's Urs. Maj. 1603 ~~1570~~.
5. Flamsteed N. Polar Constellations
6. Bayer Urs. Min. Read ~~Ptolem~~ Augustus de Morgan.
7. Ptolemaic Diagram
8. Sun + planets orbits diagram
9. Cop.
10. Galileo
11. " Tel.
12. Newton. Tel.
13. Stellar Spectra
14. Line Coincidences
15. H, He Ca Na lines.
16. Solar Atmosphere
17. Giant - Dwarf diagram
18. Balances
19. Orion Bayer. 1603
20. Extra focals - Orion
21. Gr. Neb.
22. Cygnus Neb.
23. Pleiades 7
24. " 11 1579 Maestlin
25. " 36 1610 Gal.
26. " 2616 1929. Hertzsprung
27. Cyg. N. Am. Neb. 3 h. exp.
28. Aquila + M. Way. 9 n.e. stars.
29. Sag. C. 7
30. M. 101
31. M. 31

Dynamic picture -

Astron thus inspires our picture of the Universe - the universality of the reign of law - laws of motion, of conservation of energy, law of change - "strange mysterious change" - It tends to break down our petty self centred egotism, to give us the habit of "the far vision" in time + in space - And did the world ever need them of far vision more than it does today. It is our privilege + duty as teachers to try to send out into the world year by year more men + women of courage, honesty of thought, imagination, disciplined minds, enthusiastic in the search for Truth.

In a recent address in Scotland, Gen. Smuts quoted these words from a classical writer —
Happiness is freedom and freedom is courage.

Where there is great courage, courage of mind and courage of spirit — there we may look for the fruits of freedom — happiness and achievement. This is the first thing we want to achieve in our schools and colleges - to inspire boys & girls, men & women to face life courageously - ~~with to meet~~ the difficulties & hardships, the joys and the disappointments of life with courage.

Secondly we want to develope honesty of thought honesty in facing facts, honesty in gathering & collating the data of observation, honesty in drawing conclusions and deductions, honesty in stripping the trappings from the essential truths.

Thirdly we must try to stimulate curiosity — and an honest scepticism should never be discouraged, crushed & dulled.

Fourthly we must encourage the free play of vivid imagination winged imaginations that soar up and out and beyond the usual confines of thought - it is men & women thus endowed who rise to be the leaders in the world of affairs, of business, of science, of art & letters.

These qualities, these attributes of thought are essential to first class achievement - but they are not alone sufficient there must be training in the Scientific Method

1. Systematic collection of facts.
2. Formulation of theory — A TOOL NOT A CREED.
3. Deductions
4. Crucial tests -
5. amended theory .... HERESY OF FINALITY
SPIRIT OF SEEKING.

Jeans and Eddington.

James Hopwood Jeans and Arthur Stanley Eddington are two of the most outstanding men of science of our day and generation.

Both of them were born in England, Jeans in London in 1877 and Eddington in Kendal in 1882. Both became Wranglers in the Cambridge Tripos and were elected to Fellowships in Trinity College after becoming winners of the Smith's Prize. Both men have distinguished themselves in mathematical researches in physics and astrophysics while Jeans as a cosmologist and Eddington as a Relativist and Philosopher, have won world-wide recognition and profoundly influenced modern thought. Both are Fellows of the Royal Society and are past-presidents of the Royal Astronomical Society.

Jeans lectured in applied mathematics at Cambridge and at Princeton and published his Dynamical Theory of Gases and his Electricity and Magnetism before 1912. The theoretical researches of Poincare, Roche and Sir George Darwin captured his interest with the result that he carried the investigation of the equilibrium forms of rotating bodies a stage further than the earlier workers had done and applied the "pear-shaped fission theory" to the formation of binary stars; the "equatorial emission theory" to the formation of a star galaxy or spiral nebula; and he carefully investigated the "tidal disruption theory" of the formation of the Solar System.

Jeans attacked the problem of the age of the stars from three different approaches and concluded that all the evidence pointed to an age of ten million-million years. He has studied and speculated upon the internal physical state of the stars, the source of their radiant energy and the course of evolution both for an individual star and for the Universe as a whole.

Eddington was Chief Assistant at Greenwich for several years prior to 1913 when he was appointed Plumian Professor of Astronomy at Cambridge University. His first well known work was on star streaming. Next came his realization of the important part played by radiation pressure in the equilibrium of a star - this gave for the first time a logical explanation of the observed facts about the small range in values of the masses of

the stars as contrasted with the very great range in their luminosities. Since 1916 Eddington has produced one important paper after another dealing with the Internal Constitution of the stars. In 1924 he found a relation between the mass and luminosity of a star which has had far reaching consequences, and over this and other points he has waged almost uninterrupted warfare with his critics Jeans and more recently Milne. As Professor Eddington has humorously remarked - onlookers will feel sure that some corpse is stretched upon the ground but the disputants will disagree as to whose corpse it is!

Remarkable confirmations were made within the last ten years at Mt. Wilson observatory of predictions that had been made by Eddington from purely theoretical considerations regarding the immense size of stars like Betelgeuse, about 300 times the diameter of the sun; and the very great density of a star like the dwarf companion of Sirius - more than one ton per cubic inch.

As an exponent of the Relativity Theories, Eddington ranks first amongst British writers. But he has also been a contributer to these theories, his "world-building" with mathematical symbols starting from the least possible number of assumptions, and arriving at a map or graph of the universe containing the relations of mass, momentum, stress, gravitation and electromagnetic phenomena places him with Einstein, Weyl and De Sitter as amongst the foremost constructive mathematical thinkers of the age.

(5) Read at St Annes Sc. for Clergymen 1936 Aug 7.

As a philosopher, Eddington is Platonic in his insistence upon the intrinsic part played by mind in the picture of the Universe which man constructs for himself. He stresses the purely symbolic character of the world built up by the measurements of the physicist. The underlying reality is untouched by these methods of approach. Einstein, Weyl, and De Sitter attempt to produce models of the universe, Eddington labels the result of his world-building as merely a map or graph of the actual world. We can put "symbolic" knowledge, the result of physical measurements, into this map, but "intimate" knowledge, the essential contribution of the mind, cannot be introduced. With regard to atomicity and the Indeterminacy principle, he believes that here we are touching the most fundamental aspects of the physical world, in contrast to the laws of conservation of energy, gravitation, and so on- laws which are not primary but are of the nature of identities inevitably true because of the way in which man, as man, sees and interprets the world about him.

Being a Quaker with sincere mystical insight, Eddington lays great stress on the reality of the unseen world. His philosophical approach as a scientific man

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gazing at the question is through "intimate" knowledge, with its dependence upon Mind, and through man's consciousness of the passage of time - the sense of "becoming" - and consideration of the significance of the word "ought", a word having no meaning as applied to the purely physical world where what an atom or a star does and what it ought to do are always one and the same thing. The essence of Eddington's attitude of mind may be found in these passages from his own writings:-

"Scientific investigation does not lead to knowledge of the intrinsic nature of things........We are dealing in physics with a symbolic world....... The measure numbers which are all that we glean from a physical survey of the world, cannot be the whole world... We all know that there are regions of the human spirit untrammelled by the world of physics..... Life would be stunted and narrow if we could feel no significance in the world around us beyond that which can be weighed and measured with the tools of the physicist or described by the metrical symbols of the mathematician....... You will understand the true spirit neither of science nor of religion unless seeking is placed in the forefront.... Our belief is not that all the knowledge of the universe that we hold so enthusiastically will survive in the letter; but a sureness that we are on the road." If our so called facts are changing shadows, they are shadows cast by the light of constant truth. So too in religion we are repelled by any confident theological doctrine which has settled for all generations just how the spiritual world is worked - but we need not turn aside from the measure of light that comes into our experience showing us a Way through the unseen World -

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Edward Schaffner

McGill - 1930 Jan. 25 -
Toronto 1930 Jan. 18
Ottawa 1930 Nov. 25.