

A. Y. best Douglas

Lectures and Speeches

1920s

18.

Loc 2303.9
Box 1

To Sec. Extension Dept. (Lyon)

for session 1927-28

\$ 25 for inside ed.
\$ 15 for outside ed.

(1) Astronomy from Newton to Einstein.

Illustrated. Astronomical knowledge at the beginning of 18th. century - Newton's Contributions to Astronomy and Optics - Discovery of Uranus and Neptune - Development of Modern Astrophysics - Einstein's view of the Universe and the Astronomical verifications of his theory.

(2) The Signs of the Zodiac.

Illustrated. The mythological significance of the Constellations of the ecliptic in ancient Babylonian, Egyptian and Chinese Astrology - The movement of the Pole and the equinoxes, illustrated with a model - Methods of dating Pyramids, Stonehenge, etc. - True Nature of the Brightest Stars.

Ans.

Historical

Prehistoric : Natural units of time
Day, Month, Year.
Week - 7 wandered amid fixed stars
☉ ☾ ♀ ♀ ♂ Jup. Sat

3000 BC Babylonian Astronomy + Astrology

Astronomy : some sound observational knowledge

Tides + Phases of Moon

Cycle of eclipses (223 lunations), Constellations + path of Sun.
Earth as centre of universe.

Astrology the art or so-called science of deriving the fate + future of nation or dynasty from the relative positions of the stars

Babylonian Astrology spread eastward to China
~~Assyria~~ + India

4th Cent. BC. Babylonian Astrology began its triumphal march to the west invading the domain of Greek + Roman culture throughout Egypt.

Baby. Culture or Chaldean wisdom became to the Greeks + Romans the synonym of divination through planets + stars -

Reaction on Babylonia - stimulus to further scientific investigation in Astronomy

Greeks

Astrology became a science coequal with any science & the most conspicuous contribution of the Greeks was to elaborate the Individual Horoscope - character & fate of an individual from posⁿ of planets & stars at time of birth.

Astrology & Alchemy linked together & having a tremendous grip on mens minds until the 17th century

Sun	associated with gold
Moon	Silver
Saturn	lead
Venus	copper
Mercury	quicksilver etc.

Influences of astrology seen in literature - Old & new testament, Chaucer, Milton, Shakespeare, Significance of "Star of Bethlehem"
Influence seen in etymology: saturnine, lunar, disastrous, consider.

Astrological predictions in 16th & 17th century

1524 was predicted by Stöffler to be a year of universal deluge & so widely was it believed that Aurel President of Toulouse built a Noah's Ark. Actually it was a year of drought.

1577 Tycho Brahe observed a Comet & predicted that

a ruler would arise in the north who would lay waste Germany & die in 1632.
Actually Augustinus Adolphus came from Finland, overran Germany & died in 1632

1572 - a nova appeared & Bega predicted the second coming of Christ -

In England astrologers flourished till end of 17th Century. Francis Bacon denounced them hoping to bring about a purer more scientific form of astrology & chemistry.
Swift dealt the death-blow to astrology by his Satires: "Prediction for the year 1708" by Isaac Bickerstaff, Esq."

4.

Greeks: Astronomy, Math & Physics

- 600 BC Thales brought Geometry from Egypt.
+ developed math + astronomy
predicting a solar eclipse by means
of the Babylonian cycle 223 lunations
- Ionic
School
- 550 BC Pythagoras + his followers - Theory of numbers
Elementary theory of music
Astronomy still geocentric but not limited
to concentric spheres only - independent
motions of sun moon + planets
- Pythagorean Sch
- 350 BC Eudoxus: mathematical genius
His astronomical model of concentric spheres
+ epicycles to explain motions, retrogressions
+ stationary points of planets is "a marvel
of geometric ingenuity".
- 400 BC Plato + his school of Athens, The Academy
- Aristotle, his pupil encouraged philosophy
math + sci. Himself a careful observer
of nature, a biologist. "De Animalibus" an
accurate classification of land + marine biological
forms - whales among the mammals
- His astronomy was geocentric + epicyclie
+ the heavenly bodies were made of a fifth
element, distinct from the four terrestrial
elements, earth air fire + water, this fifth
- JK Book

substance being perfect, unchanging.
The earth was a sphere ~~was~~ proved by the curved shadow on the moon.

300 B.C. Euclid ~~the~~ ^{the} great geometer followed by Apollonius of Perga
The 8th Geometer (Conic Sections)
in B.C. 250.

300-230 B.C. Aristarchus of Samos suggested that the sun not the earth was the centre of the universe & that the earth, Mercury & Venus revolved around it.

But the greater popularity of the philosophy of Aristotle won the day, and the contributions to true science made by Aristarchus of Samos were hid away in writing for 16 centuries.

250 B.C. Archimedes - mathematician and physicist

250 B.C. Eratosthenes - measured the diameter of the earth by the difference in the length of the shadow cast at Syene and at Alexandria 5000 Stades distant. accurate to within 50 miles of polar diameter acc. to best authority or the modern equivalent of the stadia.

Alexandrine School.

150 B.C. He was librarian at Alexandria.

AD Hipparchus - star magnitudes etc.

125

Ptolemy of Alexandria: Astronomer, Geometer & Philosopher - compiled the wisdom of the great philosophers who preceded him, recorded many original observations and illumined it all with theories and speculations - so plausible & with such authoritative assurance that his work dominated the thought of men for 14 centuries - The Almagest - Aristotelean & Ptolemaic astronomy.

Bruno Giordano

1548-1600 Italian Philosopher

At 15 he entered the Dominicans at Naples.

For his original thinking + disagreement with some of the established tenets of the Ch. he was persecuted + fled in 1576.

Travelled to Geneva but Calvinism made no appeal to him. In 1581 he came to Paris "determined to see for himself the noble universe unclouded by the mists of authoritative philosophy and church tradition"

He accepted Copernicus' views + studied deeply the older Greek philosophers whom he preferred to Aristotle.

He expounded the philosophy of Ramon Lull (1235-1315) in England, France, Germany but eventually the Inquisitors captured him + after 7 yrs imprisonment he was burnt at the stake in Rome, 1600.

To Bruno philosophy is the search for unity.

Amid all the varying and contradictory phenomena of the Universe there is something which gives coherence and intelligibility to them — This unity is God — the 'causa immanens'. By His action the world is produced and His action is the law of nature, His necessity is true freedom. The Universe is a living Cosmos . . . a unity in myriad forms The soul of man is a living monad midway between divine intelligence and the world of external things. As a portion of divine life the soul is immortal. its highest function is the contemplation of divine unity, discoverable under the manifold phenomena of nature.

It may be wondered why we dwell thus upon Bruno when he was not an astronomer -

It is because, to quote the opinion of Prof. Hocking of the Deptmt of Philosophy, Harvard Univ., Bruno typifies for us the reawakening of the true scientific spirit.

Bruno had caught the significance of the message of Christianity - He that would save his life must lose it. Christ has said I am the way, the Truth + the Life. ~~He who~~ and Bruno realized that he who would find the Truth must be willing to empty his mind of all prejudice, all pre-conceived ideas for then only can the Truth whether of things spiritual or of things natural, enter in.

1473

Copernicus : Poland - Univ. Cracow.

to
1543

Took holy orders at Franenburg at mouth of Vistula.
Painting, medicine, theology, astronomy, math & mechanics.
He decided that in spite of Ptolemy's arguments to the contrary, the earth rotated daily giving the apparent motion of the stars, and he rejected Ptolemy's "crystal spheres" & the equal distance of all the stars.

He weighed the theories of Aristarchus of Samos against those of Aristotle & Ptolemy & decided in favor of the former, developing with consummate skill the heliocentric theory.

1548
-1600

Bruno Giordano : Italian Philosopher. Benedictine Naples.

1546
-1601

Tycho Brahe, Denmark, & the Uraniborg, Island of Hven.
not greatly influenced by Copernicus
Accurate observations for 20 yrs. last years in Bohemia.

1571
-1630

John Kepler - Wurtemberg
entrusted by Tycho Brahe with his observations
evolved his 3 laws of planetary motion
and much astrological nonsense.

1564
-1642

Galileo - Pisa
Champion of Copernican theory - Overthrew Aristotelian & Ptolemaic authority.
Pendulum, Thermometer,
Invented refracting telescope.

Sun spots, Jupiter's satellites, indiv stars of Milky Way, 3-fold nature of Saturn.
Libration of moon.

? 1611 Hevelius, Danzig - The Sternenburg -
-1687

1700 Jai Singh Maharajah of India
built 5 observatories.

1642 Isaac Newton Lincolnshire.

-1727 perhaps the greatest natural philosopher who has ever
lived, to bring order out of chaos & reveal to
mankind the great underlying harmony of Nature.

(1) Universal Law of gravitation.

(2) Optics - nature of light
reflecting telescope.

Mathematical insight - binomial theorem, diff + int'g calculus
the weapons with which he subdued so many of the
mysteries of natural phenomena.

Later years theological works on Daniel + Apocalypse of St. John
Westminster's Abbey Monument

1656 Edmund Halley friend + adviser to Newton

-1742 Magnetic Variations Periodicity of Comets. Halley's Comet
Southern Hemisphere Stars (St. Helena) 75-76 yrs.
Astron Royal 1720 1682
Lunar Observations to assist navigation.

1692- James Bradley aberration of light
-1762 + the nutation of moon's orbit.

Wm. Herschel - discovered Uranus with telescope

John Herschel - star magnitudes

1844 Fraunhofer

1859 Kirchhoff

Sir Wm Huggins - Study of Star Spectra

Sir Norman Lockyer - stellar temperatures - pioneer star classification into 2 branches

Henry Draper - 1st spectrogram photograph

Miss Cannon - Visual Classification 225,000 Stars

Prof Hale - Spectroheliograph

Slides of modern telescopes.

What these great telescopes reveal of the nature and extent of the Galaxies of stars around us will be the subject of next lecture.

Conclusion

I have tried to outline the gradual development of knowledge in the realm of astronomy. The progress has been, to quote the Astron. Royal for Scotland, "towards the light" towards a fuller realization of the Laws of Nature which govern all matter from the infinitesimal electron orbit within the atom to the vast clusters of stars that wing their way through space far out beyond our own galaxy.

To see unity and harmony emerging out of the vast complexity of the world about us is surely one of the sublimest achievements of the human mind & the great ^{sleeping} thinkers of the centuries ^{have been galley} the torch bearers, ~~by Alfred Joyce calls them~~ ~~are~~ best described and ~~I think~~ by Thomas Huxley ~~the~~ the brotherhood of men filled with the divine afflatus of the Truth Seeker.

Whitehead

One remark only seems to demand expression here. Science welcomes every change in its theories which new knowledge demands ^{as a triumph for} Science & the quest of Truth. Why has Religion in the Past dreaded any opposed changes & stood over on its defensive. Professor A. N. Whitehead the greatest living English Philosopher has said - "Religion will not regain its old power until it can face change in the same spirit as does Science." Religion is not a completed Revelation.

in times past - "It is the vision of something
which stands beyond, behind and within, the
passing flux of immediate things - - - - -

The worship of God is an adventure of
the Spirit.

The Study of Science is one way of
training the reason, of engendering a reverent
love for truth, and Dean Inge of
St Paul's Cathedral has written

"Trust in Reason which rests really on
Faith in the divine Logos, the self-revealing
Soul of the Universe."

Astronomy
+ its' historical
Development.

March 1926. St James's
Adult Forum.

OUTLINE OF LECTURE AT SHAWINIGAN FALLS
November 27, 1925.

IMMENSITIES OF TIME AND SPACE

The distribution of stars ~~in clusters~~ in space was first illustrated by means of slides of the so-called Spiral Nebulae, now known to be aggregations of many millions of stars, each cluster being far distant from each other cluster. Within each cluster the distance between individual stars is very great compared to their dimensions: thus if the diameter of a star be represented by one inch the distance to the nearest star will be of the order of one hundred miles.

One of the greatest star clusters we designate as "Our Galaxy" because the Solar System is a minute part of this aggregation and happens to lie near the centre of the cluster. Slides were shown illustrating many of the features of our galaxy as they appear from the Earth.

The formation of the Solar System by the chance happening of the tidal disruption of our sun in bygone times was outlined and views of sun, moon, and several of the planets and their satellites were shown.

The methods of finding the space-scale of the Solar System were next ~~enumerated~~ enumerated. Having established the Sun-Earth distance, it was shown how stellar distances are obtainable by trigonometrical survey in the case of the nearer stars.

The determination of the absolute magnitude of a star by the spectrum analysis of its light, and by the period of variation in its luminosity in the case of variable stars of the pulsating

Cepheid type was explained, and hence this gives another indirect method of determining star distances.

Slides of two or three of the great telescopes were shown and especially the 40-inch refractor of Yerkes Observatory with its spectrograph attachment. The spectral classification of stars was explained leading to the Giant-Dwarf theory of stellar evolution of H. N. Russell.

The theoretical investigations of Eddington together with the observations of W.S. Adams were referred to, resulting in the belief that the small companion of the great star Sirius has a density of about 30,000. This incredible density, from the terrestrial ^{standpoint} becomes reasonable when it is remembered that matter at stellar temperatures (20 million degrees or more, Centigrade) is very highly ionized. This means that the electrons forming the outer portion of each atom are missing from their orbits and hence the volume of each atom is reduced many thousand-fold so that much closer packing of the atoms is possible than under conditions of ordinary temperatures.

The recently adopted theory that the mass of a star is continually diminishing in order to supply the energy radiated into space was discussed, and the conclusion drawn from this by J. H. Jeans that if our Sun were once as massive a star as Sirius, then over a million-million years must have elapsed in order for it to have radiated away its mass to its present size.

In conclusion the contrast was pointed out between the period of development of a star, the duration of life upon a planet like

the Earth, and the span of a single human life. The photograph of the great nebula of ^{Andromeda} Orion was shown as summing up these ideas. The human mind in its brief day can solve the mystery of the distance of this star cluster so remote that light travelling 186,000 miles persecond requires 900,000 years to reach the earth.

Symmetries of Time & Space

Lyceum lecture

at

Shawomegan Falls

Nov. 27, 1925

1925 Nov. 9.

Immensities of Time & Space.

I have chosen an immense title because my subject is an immense one. If I were to ask the question, where am I, a partial answer might be given in many ways. You are in such & such a place in the Province. You are in Canada - you are in North America - you are on the Earth. You are in the Solar System - Each answer represents a broader point of view. and if we take the very broadest point of view which present-day knowledge permits us to take, our answer to the question where are we? would be something like this: -

We are in a vast, boundless, ^{thing beyond infinity,} Universe of Spacetime, in which at far distances from one another clusters of stars are to be found. Each cluster contains many million stars, ~~is denser~~ ^{near its centre} which though vast distances from one another within their own cluster, are yet more closely congregated near the centre, tend more or less to lie in a lens-shaped volume the outer stars spreading themselves away in long curved spiral arms as though within each cluster there were some mighty swirling force gradually unwinding the whole.

By the aid of a powerful telescope let us in imagination sweep the heavens, sail through the immensities of this Universe & see some of these great star clusters: these spiral nebulae

Slides of Spirals
Resolution into individual star images & their outward motion according to Van Maanen.

Now one of these Spiral Nebulae - a Great Star Cluster

2

Somewhat larger than most of the clusters, we designate by a special name, Our Galaxy. Near the centre of that cluster there is a star of somewhat less than average size perhaps, but in no way exceptional among its neighbours in temperature, or constitution & that star has had an interesting though probably not unique career. In remote bygone days when it was hotter & less dense than it is today & in a highly eruptive state, another star gradually approached rather near to it & caused great tides to rise on its surface & with a mighty cataclysm one tidal arm was drawn right away from its parent star - about $\frac{1}{100}$ of the stars mass being thus torn away from its surface. But the matter was not lost to the star forever, the gravitational attraction drew it round into orbital motion - gradual contraction & condensation took place about any nuclei & so in the course of countless ages encircling this star there came to be a system of 8 planets with attendant satellites and numerous much smaller bodies & clouds of minute fragments. For this star near the centre of Our Galaxy is none other than Our Sun and the 3rd planet from the Sun is our very own Earth.

* Slides - Looking out from earth -

Typical
Star.

Because our Sun is a typical star it is worth
while considering it in some detail.

3.

Slides of Sun - Photosphere, Reversing Layer, Chromosphere,
Sunspots, Prominences - Eclipse views.

DIST.

Scale of Solar System

To

Distance to Sun - Kepler's 3rd Law

SUN

3 Chief ways. (1) Velocity of light: Jupiter's satellites
and aberration of light. Stars change position around an ellipse in 19th c.
Stromwe.

to
EARTH

(2) Single phenomena such as transit of Venus

(3) From asteroid orbits - Eros, or direct survey
of planet distances - Sir D. Gill Ascension Island
1877. ^{on Mars} Angular position of Mars relative to a star almost
in same line of sight at star rise & star set. &
calculated his change of base.

(4) By Radial velocity variation in a year. hence vel. in our orbit
length of orbit out to Sun.



Slides of "Our Galaxy"

Solar System etc.
True nebulae - Pleiades
Milky way & dark nebulae

Beyond Our Galaxy -

Spirals.

SPACE

Having got the astronomical Unit - Sun Earth dist.
the Survey of the heavens becomes possible.

First done by (1) Herschel
(2) Bessel
(3)

Recent precise method of photography + measurement
has enabled 10^4 work to be done at a dozen different
Observatories, + several thousand of the nearest stars
are now known

Limits to this method -

ii Statistical method. Correlation of distance with
app. mag. and with proper motion.

iii Spectroscopic Method. Get Abs. Mag. from spectrogram
+ then associating this with the app. mag. deduce
the distance.

Slides Yerkes telescope + Obj. + Bruce Spectrograph
typical spectrograms, Cepheid variable

iv Cepheid Variables. Law of Period - Abs. Mag. Relation
Application to clusters + Spirals

Results: Distance scale of Universe -
arbitrary -
Light signal -

TIME

Of all the problems which the universe presents to the human mind none has been more persistent & the answers so diverse as that of the age of our Earth, our Solar System & the galaxy. Is it to be reckoned in hundreds of thousands of years or millions, tens of millions or millions of millions?

Just a year ago Prof. Eddington announced that as a result of his investigations into the ^{conditions} ~~structure~~ of the interior of a giant star he was of the opinion that there must be a continual loss of mass going on within a star to supply the radiation which it so lavishly emits into space. This is of the nature of an actual annihilation of matter - an unusual type of ^{atomic & electronic} fission under conditions of excitation existing only at temperatures of a million or more degrees results in the annihilation of the mass, its equivalent energy being radiated outwards.

The evidence for this revolutionary doctrine is very strong & the results to which the theory has led to are both striking & important.

Dr J.H. Jeans - Sirius = $2^{3.4}$ x Sun

Sun radiates 4.2×10^6 tons/sec. Time since size of Sirius 10^{12} yrs.

Confirmations by Binary orbits. Equipartition of Energy.

Conclusion as regards Solar Systems.

SIRIUS

Sirius Dwarf - $\frac{2}{5}$ mass of Sirius but only 3 times as large as Earth
only emits $\frac{1}{12000}$ light of Sirius - Density 50,000 1 ton/inch
Confirmed by the gravitational shift of its spectral lines -

Slide.

Quotation from "Discovering"

Guided by some of the great thinkers of today
our thoughts have traversed aeons of time
contemplating some of the changes taking
place with majestic deliberation throughout
the vastnesses of Space

"Time rolls in ceaseless course" —
A million million years suffice for
the birth of a star and its early
development; a few hundred thousand
years will tell the tale of the life of
mankind upon this planet; and as
for man, an individual man,
the years of his life are three score
years & ten and yet such is the
power of a great mind, that despite
the brevity of its allotted span
it can wrestle with the problems of
nature and learn something at least
of the immensities of space and time.

Numbers & Distribution of Stars.

To magnitude 20^m telescopically visible 10^9 stars
Extrapolated to 33^m + Gal 10^{10} "

Total no. of stars per Sq. degree in + invis at
Gal. lat. 0 is 5×10^6
Gal. lat. 90 7×10^3

95% of all stars are in zone $\pm 20^\circ$ of Gal. plane.

Stars brighter than 20^m are prob. only 3% of
the total no. of stars but they furnish
98% of our star light.

Integrated total light (visual) of whole sky is equivalent
to about 1200 (mean of 3 estimates) stars of
mag 1^m .

Immensity of Time & Space.

1. Universe of space time - clusters, our galaxy - a star - sun - system

2. Looking out from our Earth - Slides

3. Measurement of SPACE

(a). Sun-Earth dist. = astronomical unit

(b). Star distances
Survey -
Statistical - with p.m. -
Spec. // x

Slides DAD. parallax, Spectrograms
Cepheid Variables

Space Scales

4. TIME scale. Eddington Radiation by loss of mass
Jeans age of Sun

Sirius A + B.

5. EVOLUTION Slide diagram of Russell.

6. Conclusion Andromeda Nebula,
as in discovery.

Starlight.

Westmont High School Mar. 14, 1929.

Starlight

1. Astronomy - oldest sci.
Sun planets stars in crystal sphere
7 wanderers -
Time & direction
2. Early knowledge -
Eclipses, tides & moon
Greek theory of 5th substance
3. Copernicus . 1473 - 1543
Galileo . 1564 - 1642
Newton . 1642 - 1727
4. Analysis of starlight
Fraunhofer, Kirchhoff, Huggins
Elements.
Temps.
Velocities
Distances
Spirals
5. Stardust & Starlight
Live our lives in harmony with the law of nature
laws physical & laws spiritual.

Expanding Conceptions of
the Universe
and
Eddington's Reflections
on the
Seen + Unseen Worlds.

Christ Church Cathedral.
Dec. 5, 1929.

Introduction :-

I do not know why your President did me the honour to invite me to address you on the philosophical writings of one of the greatest living scientists - Prof. A. S. Eddington.

It has been said that "fools rush in where angels fear to tread." and on that occasion I acted the part of the angel and refused to undertake such a task.

His request however was a challenge that I could not entirely dismiss from my mind and I hope and trust that it is not too fool-hardy a venture upon which I am embarking now - to sketch the development of astronomy & physics to the present day & those modern concepts of the Universe which form the background from which a great scientific thinker ventures into the realm of philosophy and states his opinions regarding things natural and things spiritual - the material universe about us and the Unseen World.

An eminent philosopher was recently addressing the physicists and asserted that to him there is no Unseen World, — the only reality of which he knew anything was the concrete world about him. Furthermore free will completely disappears from his vocabulary — there is no such thing. Just as in the physical world about us effect follows cause & the phenomena can be equated mathematically in terms of the actions and reactions of electrons, protons, atoms, molecules — so too with every deed we perform.

Now my first and my last reaction to that form of philosophy is one of antagonism. But I must admit that finding myself standing before you this evening brings doubts into my mind regarding "free will"!

Why am I here? Not because I wanted to be! Is it because a very courteous & persuasive gentleman asked me to come? Not entirely —

~~Is it because I thought I ought not to refuse?~~
No I think not.

Is it because I thought I ought not to refuse?

Yes perhaps that is a partial answer.

Ought — that is the word I wanted to come to. Professor Eddington lays great significance on the word ought.

In the physical world things do what they ought to do — every atom, every star, every ripple of radiant energy does what it does.

because it is what it is — They behave as they ought to behave.

But we do those things that we ought not to have done and leave undone those things that we ought to have done — In the ^{the realm of spirit + mind} unseen world — the realm of ideals, of values, of abstract things like beauty, right, reverence & so on — the word ought as applied to human behaviour & thought has a significance entirely lacking in the realm of the physical world. L p. 35

Professor Eddington holds the chair of Astronomy at Cambridge University. Previously he had been assistant to the Astronomer Royal at Greenwich.

He is the foremost theoretical astronomer today — an able mathematician — a master of modern physical theories — author of several books on the Physical Constitution of the Stars, the Motions of the Stars, the Theory of Relativity — & most recently a book arising from the Edinburgh Gifford Lectures entitled The Nature of the Physical World.

He is a quiet, unassuming man of gentle strength of character — a Quaker.

a. s. Eddington. — Read JH Jeans.

Egyptian cosmology

Hindoo "

Homeric "

Ptolemaic "

Bayer's drawings

Hildegard of Bingen 1170

Copernicus

Galileo's Telescope

Newtons "

Yerkes "

Mt W. "

Star chart S. Jupiter

" " N. Aquila

Aquila 4^h 9 n. eye stars

" — 3 " " "

Andromeda.

Scales — man's place in Universe

Rivers & tributaries of Physics

Atomic models.

Light waves & quanta.

Spiral in U. Maj.

Duality of Light

Duality of Matter

Princ. of Indeterminacy

What is the concealed
essence

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

1. p. 331 (1 2 3 r4)
2. p. ~~228~~ 303
3. p. ~~303~~ 228
4. p. 321, 322, 323.
5. p. 327, 328.

Sci. + Unseen World.

6. Reality of God. p. 41
42
43
7. Personal God. p. 50.
8. Seeking p. 53
54
55.

Inmemories of Time & Space

The Far Vision

Ottawa : University Womens Club.
Jan 15, 1927.

The Far Vision

Introduction ..

Towards the close of the Great War it chanced that one day I was talking with Sir Auckland Geddes in whose Ministry of National Service in London I had been working for many months and in the course of his remarks on the outlook of things he made this statement Few men and fewer women can think in centuries.

I have often thought of those words and they have led me to try to take the far view, to have the far vision.

The far vision in every day life - in home life -
in municipal affairs, in political
national & international affairs.

The far vision in space
" " " " time, there are the great
needs of the present day -

How may the habit of the far vision be cultivated?
It is born in some men & women who have
a greatness of soul & spirit & sympathy - it is
this far vision that inspires a John Wesley
to say The world is my parish - It is
the awakening of the far vision in the
statesman of the world that is leading them
to think not merely of my Nation and
your nation but of a world wide League of
all the nations.

(written)

The proposition which I wish to place before you is that of all the studies open to the human mind today there is none that offers better training in the practice of the far vision there is none that offers such scope for the exercise of the far vision as does Astronomy.

Modern astronomy as a result of the efforts of the giant thinkers of the past & the present offers us a stupendous vision of the Immensities of Time and Space.

Androm Neb. 10^6 l.y. distant.

J.H.J. Solar radiation $4 \cdot 10^6$ tons sec.

Sirius \rightarrow Sun 10^{12} years.

Time rolls his ceaseless course. A million million years suffice for the birth of a star + its early development — a few hundred thousand years will tell the tale of the development of life on our planet — and as for man, an individual man, the years of his life are 3 score years + ten and yet such is the power of a great mind that despite the brevity of its allotted span it can grapple with the problems of Nature + learn something at least of the immensities of time + of space.

What is it that differentiates man from the beasts that perish? It is this divine attribute that he alone of Creation as far as we know is capable of a far vision in things natural and in things spiritual.

Milton has expressed it in his stately lines
 These are thy glorious works Parent of Good
 Almighty. Thine this Universal frame
 Thus wondrous fair Thyself
 How wondrous then
 Unspeakable.

The Fear Vision

Astronomy from Newton
to Einstein

Revised from Ottawa R.A.S.
Lecture Nov. 11, 1927.

Extension & Lyceum Lectures
St. Bonaventure Dec. 8, 1927.

4

g) Inexactness of Newton's laws
in Astron. - Precession of Mercury's perihelion
in Physics - Apparent increase of mass
with velocity -

Michelson Morley experiment -

Einstein's Relativity Theory -

a non Euclidean Spacetime Universe
where certain maths. relations more
all-embracing than Newton's, hold -
for low velocities & terrestrial distances
Einstein's laws reduce to Newton's -

- Tests
1. Mercury - 40" per century, Einstein 42.9"
 2. Light passing Sun is bent - 1.75"
Newtonian 0.87"
 3. Shift to red of light from
dense star - Sirius B -
 $\rho = 50,000 \text{ g/cm}^3$
1 ton/cm inch.

Einstein's Admiration for Newton

Slides

1. Newton
2. Barron
3. Copernicus
4. Galileo
5. " Tycho
6. Kepler
8. Reaction
9. Apple Tree
10. " Comet. 2
11. Path of Pole
12. Prism
13. Fraunhofer - Huggins
14. Herschel 40"
15. " Spectrograph
16. Spectra 2
17. Newton Telescope
18. V. C. B. S.
19. W. Herschel
20. J. C. ad.
21. La Verrier
22. Physics River
23. J. J. T.
24. As Eddington
25. Michelson
26. Mt. W. 100"
27. Interferometer
28. Chart of Heavens
29. Sirius Orbit
30. Type A Spectra
31. Milky Way 2
32. Nebulae Cygnus
33. Androm. M. 31
34. M. 101
35. Newton Statue T. C. Camb.

The Energy of Starlight.

St James Literary Society
Montreal.
March 6, 1928.

The Energy of Starlight

A. The development of science presents a dual aspect.

1. microscopically : ever growing complexity;
greater diversity - stars, stones, new molecules
new types, species, affinities, isotopes.

2. macroscopically : all-embracing natural laws
great underlying unity : ... intrinsic harmony.

In the reality of this vision -
all faith is dynamic.

B. In no branch of Sci is this gradually
emerging unity more evident than in Physics.

C. After contemplating this mysterious fundamental
entity, ENERGY, manifesting itself

the question .. Whence comes it.

1. bound - - - star dust.
a chance fragment of a great star in our
planet & man ... physical framework ..
of the earth, earthy stony.
we are such stuff as stars are made on.

2. unbound - - - starlight.
of star dust ... by starlight we live.

D. If astron. be the study of the stars
 astrophys is the study of starlight.
 oldest. . . . youngest yet
 one never ceases to marvel. . . . early astronomers.

E. Whence comes the energy of starlight?

Kelvin, Radioactivity, atomic Synthesis
 Annihilation.

Vast as is the store it is not limitless
 Whitehead "passing with a slowness
 in conceivable in our measures of time to
 new creative conditions amid which the physical
 world as we at present know it will be
 represented by a ripple barely to be
 distinguished from nonentity."

Degradation yet conservation

Physically wasting yet spiritually ascending

Alternative view. vast cycle.

F. Influence of Astronomy on human thought.

geocentric to heliocentric . . .

Study of starlight has not left us there

Sun not centre of Universe.

Our galaxy 10^9 . Known spirals. many 10^6
estimated no. of spirals 10^{15} .

Where is man in such a picture?

not where Gray impels him to be

The stars in their courses fight against
our petty anthropocentric sentimentalisms

Service A star or a soul is a part of the Whole
and weft in the wondrous Plan.

G. all down the ages, men of sci & poets alike
have drawn inspiration from the stars.

Ptolemy Mortal though I be, you 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.

Human thought has passed thro many phases since Ptolemy's day.

Knowledge has increased by leaps & bounds, old mysteries have disappeared but new ones take their place, old problems are solved but new problems arise.

When the mind of man tries to grasp the significance of the workings of Nature tries to realize the vastness of the Universe & to grapple with the great unsolved mysteries, perhaps it is something within him akin to mysticism which causes some chord within him to vibrate in harmony with those thoughts of Pope in his psalm of praise to an Immanent Divinity who

Warms in the sun, refreshes in the breeze
Glories in the stars & blossoms in the trees
Lives through all life, extends thro all extent
Spreads undivided, operates unspent
To Him no high, no low, no great no small,
He fills, He binds, connects & equals all.

Period of Revolⁿ Androm. Neb $17 \cdot 10^6$ yrs.

Mass. 10^9 suns.

The Signs of the Zodiac

1. Montegian Club Mar 22/27.
2. Revised for Lyceum Lectures
Mech. Inst. Dec. 1. 1927.
3. Miss Egan Sch. Feb. 8. 1928.
4. J.O.D. Quebec. Mar. 9. 1928.
5. Revised for R.A.S.C. Ottawa March 22 1929
6. " " St Andrews. East Nov. 20. 1931

The progress of Knowledge
can be attributed mainly
to 3 characteristics of mankind
curiosity
imagination
faith

Dean Inge

The dramatic fancy that creates
myths is the very material
of both poetry & sci -

Curiosity - in primitive man
what, where, how, what influence
Ulysses - sail beyond the sunset
Imagination -

constellations
crystal spheres etc

faith that there is order
in the universe.

The Signs of the Zodiac

Introⁿ

Astronomy the oldest science.

Mankind has always studied the heavens

(1) because the heavens call forth his wonder, admiration and awe challenging the mind to read its secrets calling forth the deepest, profoundest reasoning and the loftiest flights of imaginative speculation of which the human mind is capable.

(2) because of the practical necessities of life :- Time, Direction.

7 wanderers and fixed constellations

7 wanderers all to be found in a belt of the sky 16° wide extending along the ecliptic and bisected by it - this belt is the Zodiac.

Divided by ancients into 12 constellations each given a sign.

Hipparchus 150 B.C. divided it into 12 equal sections 30° each.

Zodiac means Zone of Animals - all the constellations except Libra being living things

Symbolical signs - that for Aquarius ~~was~~ being the Egyptian symbol for water.

Babylonians, Egyptians & Chinese had mapped the constellations about 4000 B.C.

which first is uncertain.

Our constellations come through the Greeks from the Babylonians, Egyptian influence is apparent. ⁱⁿ Aquarius.

Ram	} spring	Crab	} summer	Scales	} autumn	Goat	} winter
Bull		Lion		Scorpion		Water Carrier	
Twins		Virgo		Archer		Fish	

These constellations referred to by Homer, Hesiod.

370 B.C. Eudoxus (pupil of Plato) wrote a full description of the heavens -

270 B.C. Aratus - young Sicilian poet at command of King of Macedonia embodied Eudoxus' description in a poem.

Poem opens with a noble ascription of praise to the Creator containing the words

"For we are also His offspring" quoted by St Paul at Athens.

* Hesiod advised ^{the farmers} to plough at the heliacal rising of the Pleiades & reap when they are in the evening sky -

Egyptian Denderah Planisphere B.C. 36.

Symbolical representation of Constellations.

Chinese Constellations have somewhat changed their names in Primitive, Traditional + Reformed Chinese Astronomy.

One set of associated ideas, Constellations, directions, seasons + symbol as follows

- Spring - East - Dragon - Wood
- Summer - South - Bird - Fire
- Autumn - West - Tiger - Metal
- Winter - North - Tortoise - Water

The eternal cycle of nature was represented by the ideas

- Wood overcomes Earth, arising from it.
- Metal " Wood, cutting it.
- Fire " Metal, melting it.
- Water " Fire, extinguishing it.
- Earth " Water, absorbing it.

Precession of Equinoxes

A slow motion westward of the equinoxes

first discovered by Hipparchus 125 B.C.

The year of the seasons less than sidereal year by 20 min.

Now 20 min is $\frac{1}{26,000}$ of a year. Hence

Total Period 26,000 years for γ to make a complete journey around the celestial equator.

Annual precession 50".26 westward.

Explanation by Sir Isaac Newton about 1670.

Gravitational pull of Sun & Moon on equatorial bulge of earth tends to produce a rotation \perp to rotation of earth on its axis - Hence result is motion \perp to disturbing force, i.e. precession of pole of earth. [cf Gyroscope]

Nutation or nodding of pole during precession results from changes in relative directions of pull of Sun & moon -

- α Draconis Pole Star about 3000 B.C.
- α Ursae Minoris (Polaris) will be nearest Pole in AD 2102.
- α Cephei will be pole star in 7500 A.D.
- α Lyrae (Vega) " " " 14,000 A.D.

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Astronomical Methods of Dating Ancient Temples.

Pyramid.

Prof. Piazzi Smyth (Edin)

asked Sir John Herschel to calculate what spectacular orientation of stars could be seen looking up the main passage & when this would occur.

He replied in B.C. 2170 the then pole star α Draconis would be vertically below true pole & Pleiades above at equinox. Hence Piazzi Smyth assigns this date to Great Pyramid.

(Pyramid - Facts & Fancies. J. Bomirch, 1877)
Archaeological arguments give greater age 3000-4240 B.C.

Denderah Temple

Lockyer : from time & direction of rising of
of Mrs. Majoris - 4950 B.C.

Stonehenge

Priests required clock stars to indicate approximately an hour before sunrise at different seasons for sacrificial ceremony to commence.

Stones or barrows marked position of sunrise at solstices, spring feast, etc.

(1) From direction of rising of Pleiades B.C. 1950.

(2) From " " " point of Midsummer Sun
it is now 1° away from Stonehenge alignment. \therefore B.C. 1680.

Sir Wm. Riggway laid little weight on Lockyer's work ascribing a much less ancient origin.

True Nature of the Stars

Spectrograms -

- 1. Spica & Virgo B2.
- 2. Regulus & Leonis B8.
- 3. Castor & Gemini A0

Really 4 stars d_1 , Spec. Binary P. 2.9 days.

d_2 " " P. 9.2 days.

d_1 & d_2 Visual Binary P. 346.8 years.

- 4. Aldebaran & Tauri K5.

- 5. Antares & Scorpii M2. ADSDington 0.042
Michelson 0.044
 i.e. greater than main orbit.

Star clouds & clusters + Centre of Galaxy + CN-

Ptolemy of Alexandria A.D. 180 (circa)

"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."

Pope's psalm to the Immanent Divinity 18th century.

[He]

Warms in the sun, refreshes in the breeze,
Glow in the stars, and blossoms in the trees;
Lives through all life, extends through all extent;
Spreads undivided, operates unspent!
To Him no high, no low, no great, no small,
He fills, he bounds, connects, and sustains all.

The Signs of the Zodiac.

St Andrews East. 1931 Nov. 20.

Slides. Moving Solar System
Eclipses. Aug 31, 1932. 4 pm.
100"
Sun, Earth, moon.
Zodiac still - coloured.
" moving

1. Dec. S. Sky.
2. Taurus Ψ Φ X region N. of aldebaran. Milky Way S.
3. " extra focal. 4 n.e. stars.
4. Pleiades
5. February sky
6. Gemini 5 n.e. stars.
7. March sky - (Talk about Leonid meteors).
8. May sky. 33 yr. comet orbit.
9. July sky.
10. Scorpio - extra focal.
11. Sagittarius
12. Sept. sky.
13. Nov. sky
- 14 } Drawings of Zodiac Constellations.
- 15 } Ptolemy "
- 16 } "
- 17 } Zodiac on Dome of Denderah Temple.
- 18 } "
19. Chinese Zodiac.
20. Precession + wandering of Ptolemy + hence
Ptolemy of Ptolemy in sky of Aries. Spring Equinox
Zodiac Hipparchus 150 B.C.
21. Wandering Ptolemy - diagram. 26000 yrs.
22. " " Chart.

MCGILL UNIVERSITY
MONTREAL

THE MACDONALD PHYSICS LABORATORY

23. Pyramid
24. Stonehenge
25. Stonehenge
26. Star Spectra - Solar.
27. Secchi's Types.
28. Stellar Evolution (Diagram)
29. Star sizes - (Diagram)
- 30 - 33 Newton, J.H.J. Sun. + De Sitter + ASI.
- 34 - 36 Spirals - Androm. Centre, M151. M101.
-

Byron :- Ye stars wh. are the poetry of heaven
Poetry - Navigation

Keats :- The poetry of earth is never dead
- No nor the poetry of the Stars.

Shelley :- The eternal robes that beautify the night
The majestic laws that rule yon rolling orbs
The depths of the unbounded universe
Above, and all around
Nature's unchanging harmony.

Telescopes and the Universe
They Reveal.

Lycium Lecture.
Mechanics Institute Nov. 21/29.

Introduction:-

No science has exercised a wider or more profound influence upon human thought through the ages than has astronomy.

From the geocentric theory of pre-Copernican days to the heliocentric viewpoint was a tremendous advance and produced a revolution in thought of far-reaching consequences. — no longer was the earth, and *ipso facto* MAN, the centre of the whole universe, the pivotal point about which all the heavenly bodies revolved.

And this advance was achieved without the aid of telescopes!

One never ceases to marvel at the achievements of the early star-gazers — the wise men of Babylonia, the arabs, and the Egyptians who mapped the heavens, gave names to the brighter stars and to the constellations (those arbitrarily chosen groups of stars whose names to this day bear witness to the myths, the folk-lore, & the unbounded imagination of those ancient peoples),

Sun, moon, 5 planets, seasons, tides, eclipses

But even the amazing ingenuity of the Greek geometers did not lead to completely satisfactory explanations of the motions of the planets, and so it came to pass that Copernicus about 1540³ trying by one hypothesis after another to find the laws of planetary motion, hit upon the great truth that the Sun and not the earth was the centre of the system.

Sixty seven years after the publication of Copernicus' book - and his own death - Galileo - one of the giants of the human race - constructed the first astronomical telescope. 1610.

The Siderial Messenger - Florence 1610.

Drawing of Orion Belt
+ Pleiades

[Maestlin (1579) 11 stars
Hertzsprung 2616 stars
1939]

Paris Obsy. Louis XIV. 1667. Leyden
Copenhagen

Isaac Newton . 1642 - 1729.

Wordsworth: The marble index of a
mind forever - Voyaging through
strange seas of thought - alone.

F.R.S. - Reflecting Telescope 1672
"Light is a heterogeneous mixture of differently
refrangible Rays"

Greenwich Obsy. Chas. II. 1675.

Sir Wm. Herschel

"looked further into heaven than any
man before him."

Uranus . 1781 Period 84 yrs. Dist. from \odot 1780 16⁶ m.

- (1) 20 ft reflector - 18 inch ^{mirror} lens - to survey
the sky in zones of declination counting
the density of the star fields & thus
producing a series of papers on the
"Construction of the Heavens" - wh. showed
that the sun was near the centre of an
irregular disk-shaped universe of stars -
researches referred to by Sir David Gill
as "almost inspired"

Visibility to 14th magnitude.

- (2) 2 foot reflector - used by Sir John
(3) 4 " " " less good - 1795.
40 ft focal length

"Census of the Sky" 1915-

milton: "Consider first that great or bright inferns not excellence"

Yerkes Obsy.

40"

Andromeda Galaxy.

42" discs for Russia

Sir Howard Grubb, Parsons & Co.
Newcastle-on-Tyne.

Yerkes. 24"

Orion Nebula

Yerkes Bruce

Barnard Milky Way

1. Perseus Clusters ⁵
2. Ophiuchus. ⁵

Hartmann Blink Comparator.

Harvard (Arequipa Peru

El Mistó volcano

Reflector 24"

Morehouse Comet 1908.

Metcalf - 16"

Spectrum

" types.

Miss A J Cannon

Sir Norman Lockyer -

(Simile of mankind + stars + evolution)

Mount Wilson
100"

Stellar interferometer. Michelson.
Betelgeuse 50×10^6 X our Sun

Mt. W. solar Tower + grating.

arcetri " " " 1924.
112 ft overall.

Victoria B.C.

72"

Mt Royal Telescope

Telescopes of the future

Mt. W. 200"

Prof. G. W. Ritchey - cellular or honey comb
mirrors.

Sina optical Lab. Paris clay.

Hildegard of Bingen who lived from 1099 to 1180 has left us this diagram illustrating the current cosmological beliefs of that age - towards the close of the pre-telescopic era -

A strange mixture of Pagan mythology (the action of the winds) of Hebrew ideas (the treasures of the hail & lightnings

Job. Ch. 38. v. 22. Hast thou entered into the treasures of the snow, or hast thou seen the treasures of the hail?

By what way is the light parted which scattereth the east wind upon the earth?

and of Greek philosophy (the 4 elements)

Contrast our present day picture of the Universe -

Spirals - 10^9 stars
 10^6 light-year separation
many millions

A spiral as seen from within: -
Our Galaxy. 10^{10} stars

No crowding -
age 10^{14} yrs.

Old viewpoint: Rbt Browning
whose eyes
saw in the stars mere garnishory of heaven

New viewpoint : Alfred Noyce.

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.

Conclusion

A universe whose magnitude passes
comprehension but whose orderliness and
obedience to law fill the mind of man
not with a blind and superstitious wonder,
but with a deeper wonder - a wonder
~~a~~ love born of knowledge - a Cosmic
Emotion which, to quote the words of
W.K. Clifford should be "an overpowering
stimulus to action, like the effect of the
surrounding orchestra upon a musician
who is thereby caught up and driven to
play his proper part with force and
exactness of time and tune."

For information re.

Gregorian +

Cassgrainian foci -

+ for Achromatic lens

Chester Moor Hall of Essex, barrister

+ mathematician 1733

+ later John Dolland (Copley Medal
R.S. London)

+ trial of patent dispute
by Lord Mansfield.

See Enyc. Britt.
"Telescopes"

1934 Apr. 20.

Poetry of the Stars .

Ottawa Women's Club.
Oct. 3. 1929.

W. Douglas

(1) Carlyle

Looking out on the noisy mania of the
world

Silence Music of the Spheres .

(2) Alfred Austin

(1)

The Music of the Spheres —

(3) Shakespeare

There's not the smallest orb which
thou beholdest
But in his motion like an angel sings
Still quivering to the young-eyed cherubins .
Such harmony is in immortal souls ;
But whilst this muddy vesture of decay
Doth grossly close us in , we cannot hear it .

Poetry, Music, Astronomy - these three
are not divided by wide gulfs.

What is poetry?

Carlyle : musical thought

Byron : Ye stars, which are the
poetry of heaven.

Alfred Noyse expresses Kepler's idea :-
1571 - 1630

He [Kepler] spoke of poetry as the "flowering time
of knowledge", called it "thought in
passionate tune

With those great rhythms that steer the moon
and sun;

Thought in such concord with the soul
of things

That it can only move like tides and stars,
and man's own beating heart, and the
wings of birds,

In law, whose service only sets them free!"

Sunrise

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

Sunset.

(1) Wm. M. Call

I walked at sunset by the lonely waves,
When autumn stood about me, gold and brown,
I watched the great red sun, in clouds, go down,
An orient King, that mid his bronzed slaves
Dies, leaning on his sceptre, with his crown.

(2) Shakespeare

The glorious sun
Stays in his course, and plays the alchemist;
Turning with splendour of his precious eye,
The meagre cloddy earth - to glittering gold.

(3) Wordsworth

I have felt a presence
②

Galileo's Telescope

Noyse p 138
p. 142.

Ridpath Library YP
N37 wa

Newton's Telescope

p. 192.

(Star charts)

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

Milky Way Slide

Noyse

... 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

Milton (visited Galileo
cosmological theories. probable
but unproven).

The Angel Raphael to Adam:

To ask or search I blame thee not; for
Heaven

Is as the Book of God before thee set,
Wherein to read his wondrous works,
and learn

His seasons, hours, or days, or months
or years.

p. 274

p. 275.

Some poems of Moonlight & Starlight.

1. Alfred Austin

When acorns fall (1)

2. Chas. Sangster (Canadian)

And now 'tis night (1)

3. Edmund Holmes (1876)

Night comes, and stars (1)

4. Chas. Henrysege (Canadian)

The day was lingering (3)

The Pleiades

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

The immensity of Time & Space
 appal the mind of the poet.

A. Marvel :

But at my back I always hear
 Time's winged chariot hurrying near
 And yonder all before us lie
 Deserts of vast eternity.

Milton.

"These are thy glorious works, Parent of Good,
Almighty! Thine this universal frame
Thus wondrous fair: Thyself how wondrous
then!
Unspeaking."

When the ancient Hebrew Prophet with his rich poetic insight, sought to describe (find a simile worthy to represent the) state of high reward ^{ultimate of my} for those who ~~sought~~ ^{searched after} for and found Wisdom, for those who ^{gave} lived their lives to the neglect of all ^{endeavouring} with the single purpose of lifting those about them to the highest that human nature can attain — it was to the stars of heaven that his thoughts + imagination turned + in them he found the only simile adequate to his purpose.

"They that be wise shall shine as the firmament, and they that turn many to righteousness as the stars for ever and ever"

Book - Astrology - notes

From Astrology to Astronomy

1925 Nov. 4th Wed. 3 p.m.

Windsor Hotel - 1st floor

Am. Women's Club -

(Mrs Luke
" Whittal
" Westbrook)

Oct 1¹²/25

From Astrology to Astronomy.

Prehistoric - Fixed Stars - Wanderers 2+5
S. M. ♀ ♀ ♂ ♂ Salt
hence 7 days = week
+ lunar month = 4 weeks
+ year when Sun regains its
posⁿ amongst the fixed stars.

Astrology - Indian - see Enc. Brit.
see p. 4, 5, 6. Assyrian
Superstition + credulity

Astronomy -

Gks - Hipparchus maps
Ptolemy AD 150

Copernicus b. 1473 - 1543

Tycho Brahe 1546 - 1601

Kepler - 1571 - 1630

Galileo 1564 - 1642 - telescope - refractor

Newton 1642 - 1727 - " - refractor

Gradual perfecting of instruments +
amassing of facts, observational + theoretical

Slides of Solar Systems
of Stars
of Clusters & Nebulae -

Astrophysics

Huggins, Lockyer

What the spectrograph reveals -

What they are made of
Phys. condns -

Rad. vel -

Distance -

Conclⁿ

Philosophical reflections

Unity of all Nature

Vastness yet oneness

By Star light we live

& we are as far as our physical bodies

are concerned nothing but Star dust.

Miss Lake Walnut 0710
Choice of the following

3/

(1) Immensities of Space
& Time -

Wed. Nov. 4th

3 p.m.

Windsor Hotel
Am. Womens Club.

Nebula
Star Cluster

The story of the star that became
our Sun -

Solar System -

Telescopes - Spectrograph -

Philosophy of Astronomy -

(2) ✓
From Astrology to Astronomy ✓
Historical ✓

4

See Enaycl. Brit. Vol. 2.
p. 795 et seq.

Astrology & Astronomy

Get Slides of Astrolabe. p. 792, 3.

Astrology : the art or sci of divining the fate & future of human beings from indications given by Posⁿ of stars (Sun moon planets etc)

Astrol + astron intermixed until 16th Cent Copernicus

Earliest Astrology - Ancient Babylonia - 3000 B.C.

↳ Spread to China, Egypt, ^{Aegyptia} Greece, Rome, etc.

At first only of public not individual interest as signifying intention of the gods towards the race as a whole & the King in particular or his dynasty.

4th Cent. B.C. Bab. Astrol. began its triumphal march to the west invading the domain of Gk & Roman culture & throughout Egypt

Chaldaean Wisdom (priest of Babylon) became to Gk & Roman the synonym of divination thro planets & stars

In Gk hands (Hipparchus etc) Astrol + Astron both grew far beyond Babylonian limits in harmonious progress. Hip. 130 B.C. precession of equinoxes - idea of classification of star magnitudes -

Individual horoscope from posⁿ of planets & stars at time of birth is the most significant contrib of Gks to astrology. Adopted by Arabs, Jews & Christians

& carried almost unaltered into Middle Ages as "Judicial astrology" a pseudo-science on equal footing with "Natural Astrology"

which covered true observational records
of star positions + Solar planetary motions

Identification with the 7 wanderers of parts of
human body + certain metals -

- Sun gold
- Moon silver
- Saturn lead
- Venus Copper
- Mercury - quicksilver
- Mars iron

Thus alchemy developed
side by side with Astrology
even Tycho Brahe + Kepler
having their chem. labs. to
discover the propps of the
metals -

Astrological predictions

1524 predicted by Stöffler to be a year of
universal deluge - actually one of drought. but
the President Auriel of Toulouse built a Noah's Ark.
Tycho Brahe from 1577 Comet predicted a ruler from
the N. who wd lay waste Germany + die in 1632.
In truth Augustus Adolphus came from Finland,
overran Germany + died in 1632

Kepler prophesied

Beza from the 1572 Nova - the 2nd coming of Christ
astrologers flourished in England Lilly + Fludd,
till time of Fr. Bacon who denounced both
astrologers + alchemists - hoping for a reformed
more "scientific" astrology + chemistry -

In England Swift dealt the death blow to
astrology by his satires on an almanac writer.
"Prediction for year 1708 by Isaac Bickerstaff, Esq."

Professors of Mother Shipton (lines 1488-1561) Pul. 1662
end of world 1881 -

6

Astrological Allusions

Chaucer, Milton, Shakespeare -

Influences on language

Contemplate, consider, jovial, saturnine
lunacy, disastrous

Thomson: (Seasons)

Who can count the stars of heaven
Who sing their influence on this
lower world.

Shakes: Comets importing change
of times & states.

Brandish your crystal tresses to the sky

Dante: --- Each soul restored to its
particular star.

Henry vi. 1.
Believing it to have been taken
Thence,

Astronomy Ancient & Modern.

1. Ch. of Messiah
Nov. 25 / 29.
2. Drummondville
Feb. 4, 1930
3. Montreal Women's Club.
Mar. 10, 1930.
4. St Andrews Inst.
Jan 23, 1921.
5. Hawkesbury
Jan 20, 1932

Introduction :-

Ancient astronomy is a vast subject -

Modern astronomy is a yet vaster subject -

All that I can hope to do tonight is to give you a brief outline of what ancient astronomers achieved and the Universe they portrayed and then to sketch as best I can the results of modern astronomical research leading to our present conception of the Universe - almost overpowering in its grandure.

When mankind first straightened his spine & turned his face upward toward the stars, he must have been filled with the wonder and the curiosity - which are still the characteristic features of his approach to the subject of astronomy.

Consciously or unconsciously, he regulated his life by the stars - Units of Time.

Furthermore it is from the relative positions of the stars that man finds his direction upon the surface of the earth -

3000 or 4000 years B.C.

NABURIANNU
KIDINNU

records at Babylon
by 360 yrs
period 54 yrs - 1 month

constellations
? wanderers.

Ecliptic
Zodiac

Tides & Eclipses
Precession

Hipparchus 150 B.C.

370 B.C. Eudoxus (pupil of Plato) wrote a full description of the heavens - constellations, etc.

270 B.C. Aratus the poet at command of the King of Macedonia put Eudoxus' work into a poem. Paul familiar with this :- opens with noble ascription of praise to Creator "for we are also his offspring."

Chaldeans

Early Cosmologies

Precession.

Stonehenge. Sir Norman Lockyer

Rising of midsummer sun 1680 B.C.

Pyramid Prof. Piazzi Smyth B.C. 2170

Archaeological evidence. 3000 - 4240 B.C.

Hildegard of Bingen 1170.

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

early astrolabes, etc

Hevelius circa 1670.

Galileo's telescope 1610.

Pleiades. Maestlin 1579. 11 stars.

Galileo. 1610 36 "

Hertzprung 1929 2616 " .

Milton:—

Nor. sky.

Aquila region of n. eye stars. 4^h 5^m. exp.

Orion

Cygnus

Magellanic cloud

Spirals.

Man's place in the Universe.

Conclusion:

The ancient star gazers looked upon the heavens with awe — but it was an awe borne of superstition and ignorance. Today we look upon the heavens with a healthier awe — an awe borne of certain knowledge that the heavens declare their kinship with the earth. Things celestial, things terrestrial — they are not two but one in the testimony they bear to the intrinsic oneness of all creation — the underlying harmony of the Universe.

The astronomer has —

"Come on that which is, and caught
The deep pulsations of the world
Æonian music, measuring out
The steps of time —"
— and space!

But we must not be so
overpowered by the immensity of the
Universe that we forget that we
are a part of it & each part is
essential to the whole.

"A star or a soul is a part of the whole
and weft in the wondrous plan."

Every man, every atom, every quip of radiant energy,
every atom — must play its part in the great universal
Symphony.

Man - the aggregation of matter with a
spark of divine life within it, endowed
with a mind that is eternally restless
& filled with unquenchable curiosity
regarding the universe about him and
his place therein.

The stars, the atoms play their parts
in the great symphony of nature
in accordance with the laws of nature
& so too man must play his
part in the great symphony in
accordance with the laws of his
being - laws natural and laws
spiritual.

Drummondville Lecture - Feb. 4/30.

anc. astr. a vast subject
mod. " a yet vaster "

Typical Astronomer: grey haired
black man

What I hope to do this evening is to give a brief outline of the achievements of the ancient astronomers and of their ideas of the Universe - ideas so fantastic to us today - and then to trace the great revolution in thought brought about by Copernicus + Galileo + Sir Isaac Newton and the new era of astronomical investigation and discovery which then began leading to our present knowledge of the Universe as a Universe so vast, so tremendous as to be almost overpowering -

When man first appeared upon this earth as an intelligent being he at once, consciously or unconsciously, regulated his life by the stars -

Time - direction,

Egyptians, Babylonians, Arabians, Chinese, Hindus

Chaldeans of Babylon → Greeks → Modern Western World

3000 or 4000 B.C.

Constellations

7 wanderers

Ecliptic

Eclipses + Tides

360 yrs. obs. of lunar eclipses with at Babylon
Naburiana + Kidinnu Cycle 54 yrs 1 mth

Callisthenes brought these records from Babylon to Aristotle in Greece about 350 B.C.

Only comparable record in modern times is Greenwich Meridian Observations since 1750.

See p. 1. Eudoxus + Aratus - omitted

SLIDES :- Early Cosmologies -

Drummondville Feb. 4/30 + Montreal Womens Club Mar. 10/30

SLIDES

Ptolemaic cosmology - music of spheres.

Homans "

Hindoo "

Egyptian "

Egyptian Symbolic "

Comet 1000 AD - fear + superstition

Bayeux Tapestry - 1066. Halley's

Halley's Comet 684 A.D. - 1066

Paris Halley's - circa 1750

Hildegard of Bingen 1170 -

Copernicus d. 1543

Galileo d. 1642

" Telescope 1610

Newton

" Telescope 1668

Persian Astrology

Drakes " (2)

Keplers (2) 1700 Banting

Forbes

Int. W.

Vic. B.C. - Plunkett - gold medal

N. Sky

S. Sky

Orion - 5 n. eye stars

Pleiades 2616 stars Hertzsprung - 1919

" 38 " Galileo 1610

" " Messier 1579

Aquila - 5 n.e.s. 4^h 5^m exp

Diagram of Galaxy. (2)

Sagittarius cluster 10¹⁰ stars in our Galaxy.
nature, spacing - collisions

Birth of Solar System

Spirals - (2) M. 31

M. 101

Scale of masses. atom
sun
star
giant dwarf, fusion

Astronomy for
Social Service Workers.

Yana Jan 25. 1927

These vast distances in space between star
+ star & the still vaster distances between star
cluster + star cluster — the millions of stars
& the million millions of years during which
they have slowly formed and developed, all
these ideas stretch the mind of man to the
breaking point & exceed his comprehension.
What is the meaning of it all? Has it
a meaning? Can man know the meaning?

• Full many a gem of purest ray serene
The deep unfathomed caves of ocean bear
Full many a flower is born to blush unseen
and waste its sweetness on the desert air.

And Nature has strewn her stars in space
with an equal prodigality — "to waste their
radiance on surrounding space" ?
But is it waste ? That man should feast
his eye upon the glistening gem or breathe the
fragrance of the wild rose is very nice for him
but does that ^{fulfill} the ~~cause~~ purpose for which the gem or the
rose was created? Our only answer as
far as I can see is to be found in the
thought that all Nature ^{expressing itself} by the fulfilment
of the laws of Nature glorifies the God of Nature
The Great Spirit, the Creator.

The spacious firmament on high
and all the blue ethereal sky
The spangled heavens a shining frame
Their great original proclaim

In Nature's ear they all rejoice
and utter forth a glorious voice
forever singing as they shine
The hand that made us is divine.

and what of man? He is a part of
Nature, made of star dust imbued
with the divine spirit of Nature the
Creator & Sustainer of all Nature, and
he too like the gems, the flowers, the
stars must ~~eff~~ reach his fullest
expression in accordance with the Laws
of his being for thus and thus only
can man in harmony with all Nature
glorify his Creator.

I am addressing a body of Social Service
workers - You believe that the Universal Law
of action & reaction, the Law of mutual
influence that rules inexorably throughout
the material universe rules also in the
realm of spirit, the realm of human affairs.
It is because
1 You are working to influence the lives of
others so that their lives may be fuller & richer
& more complete - not as a result of attempts to
be unnatural to evade the laws of our
nature but rather to live & expand & develop
as a part of the general scheme of things in
nature - this is why I consider it a
great honour to be with you this evening.

For a star or a soul
is a Part of The Whole
and next in the Wondrous Plan.

From Atoms to Stars -

McGill Extension Lecture
March 12, 1929.

From Atoms to Stars

- Growth of Knowledge
curiosity-
imagination
faith.
- Dean Inge The dramatic fancy that creates myths is the same mat. of both poetry & sci.
- Investigator - barrier
Greyhound.
- " Greek
Pascal.
Rutherford.
atoms protons electrons.

- Immensities
ellipses
visions
- Solar System, galaxy, spirals. SLIDES
sizes pinhead - golfball, balloon
Distances - slide Truck will put a girder round about the earth in 40 min.
packing - minnows
- Man between atom & Star Slide.

- Parable. 2 investigators & Dame Nature.
- Astronomer asks:

1. What is light? SL
2. What are stars made of? SL
3. How hot are they? SL
4. What pressure? 35 Balmer lines 10^{-3} atm.
27 at photosphere 10^1 atmos.

$[35]^2 = 1200$

Physicist asks :- How dense can matter be?

What is the "average life" of?

2. How long will an excited Ca^+ atom last? SL
SKY LARK SL
100 million
3. How much energy to ionize Vanadium? SL
La 57 4.9 volts 134+
Yttrium 39 6.6 volts 62-
89+
50-

Hg 136
Au 19.0
Pt 21.4
Swiss 3000
Van M. 100000
2.4 x 10¹⁰

From Atoms to Stars

*McClintock Extension Lectures
March 12, 1929.*

Stars and Starlight.

Zion
New Sellaers Church, Carter St. Nov. 26, 1928

Constellations,
Early observers,
Telescopes,
Solar Systems
Stars, nebulae + clusters

1. We think of the years of patient study + observation on the part of a long line of men imbued with a divine curiosity to find out the Truth about Nature.
2. We think of the gradually expanding vision of the Universe the immensity of time + space + of the no less marvellous realm of the infinitely small the atoms + electrons whose movements in the far off stars + nebulae give rise to the radiations by which alone we can know of the stars existence.
3. We think of the harmony of natural laws throughout the Universe.

+ what of man with his free will to live in harmony with the laws of his physical + spiritual nature, his ability to chose to add to this great harmony of the Universe or to be a discordant note marring the great symphony.

Let us live like the stars shedding light + radiance about us + adding our notes to the great psalm of praise for the whole Creation that glorifies its Maker. ~~the~~

Notes on Slides of
Barnard Milky Way Atlas.

W. D. Phillips
26, 1-29.

Milky Way Slides - approx 9° 5y. to 5° 3y.

Edwin Emerson Barnard 1857-1923

1. Double Cluster in Perseus

1904 5^h 55^m exp.

5 naked eye stars. 3 clusters.

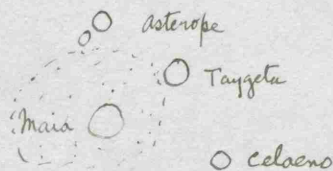
3. Perseus & Taurus

1914 6^h 41^m.

7 n. eye stars. light & dark net.

4. Pleiades

1905 3^h 48^m.



○ Pleione
○ Atlas

○ Alcyone

○ Electra

○ Merope

Tennyson:

Many a night I saw the Pleiads rising through the mellow shade,
Gleeting like a swarm of fireflies, tangled in a silver braid.

5. Nebulosity in Taurus

1907 Jan. 5^h 29^m.

8 n. eye stars 22 Barnard Dark regions.

9. Gemini SE of Messier 35

1905 2^h 0^m.

4 n. eye stars 3 clusters

→ Neptune extreme LHS. ☽ Comet 1905 III Giacobini

Milky Way Slides

11. $\delta + \tau$ Scorpii & Libra

1905 Apr. 8^h 40^m.

8 n. eye stars. 2 asteroids at R.H.S. lower in Eurydice.

12. ν Scorpii centre

β " R.H.S.

1905. 4^h 55^m.

6 n. eye stars.

13. Great Nebula of ρ Ophiuchi

650-1000 ly.
(Shapley)

ρ oph. at centre

λ Scorpii Antares lower left.

Cluster lower right.

1905

4^h 30^m.

9 n. eye stars.

14. Dark Lanes in Ophiuchus

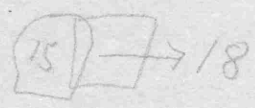
1905 3^h 0^m.

4 n. eye stars. 11 dark B. objects.

15. Scorpius & Ophiuchus

1905 3^h 42^m

3 n. eye stars 5 clusters



19. Region N. of θ Ophiuchi

θ at lower edge.

1905. 3^h 30^m.

5 n. eye stars 4 clusters 31 dark B. objects.


18. Ophiuchus & Scorpius

1905. 4^h 33^m.

8 n. eye stars 6 clusters 40 dark B. objects.

θ oph. upper L quadrant.

Milky Way Slides

20. Ophiuchi Region
R. centre
1905 4^h 45^m.
7 n. eye stars. 43 dark B objects.
2 clusters 3 asteroids.
23. 58 Ophiuchi Region
1905 4^h 0^m.
2 n. eye stars 2 clusters 18 dark B. objects.
30. Sagittarius Region
1905 4^h 5^m.
4 n. eye stars. 4 clusters 13 dark B. objects.
Messier 8 nebula upper R. quadrant.
Uranus Top centre 
40. Aquila Region S.W. of δ Aq.
1905. 4^h 0^m.
5 n. eye stars 6 dark B objects.
[This slide is side on L.H.S. is S. Top is E.
B 138 is likened to a long black lizard crawling S.]
41. Altair & Aquila Region
& at lower left.
1905 4^h 5^m.
9 n. eye stars 13 dark B objects.
42. Deneb & Cygni Region
1905 3^h 10^m.
10 n. eye stars 7 dark B. objects.

4

Milky Way Slides

9 Milky Way Regions each 23° diam.

1. Cygnus N. am. hel. ~~and~~ southwards
showing longitudinal division of M. Way.
2. Sagittarius M11. to M8.
3. Southern Sagittarius + into Scorpius
M8 + gr. clouds of Sag. + down to \odot Scorpii.
4. Aquilae &c.
showing diffusion to E + clean cut W. edge.
5. Southern Aquilae + Northern Sagittarius
[sometimes called]
Scutum
6. \odot Ophiuchi at centre + Sagittarian
+ Scorpius regions
7. Aquilae [links 4 + 5]
8. great clouds of Sag.
E. of 6.
9. great clouds of Sag to ρ Oph.
S. W. of 6.

at arms length from my eye is 25 inches

∴ sky arc of 23° is equiv to

$$\frac{23}{57.3} \text{ of } 25 \text{ inches held at arm length} \\ = 10 \text{ inches}$$

57) 575 (10

Birds Beasts & Giants
in the Sky.

McClint Extension Lecture
at Mt. High School.
Nov. 16, 1929.

Introduction:

If you had lived 2000 or 4000 years ago and someone had asked you

What are the stars?

What shape is the earth?

You would probably have replied that the earth is a great flat surface and the stars are points of light imbedded in a great crystal sphere which revolved about the earth every day.

- SLIDES:
1. Egyptian Universe
 2. " Symbolic universe
 3. Hindoo Earth.
 4. Homeric or early Grecian
 5. Ptolemaic System. (Earth a sphere)

MOVING SLIDES:

Earth is an oblate spheroid.

Day & night.

year & month.

Constellations of Zodiac.

SLIDES :

1. Nov. sky N.
2. " " S.
3. Mrs. Min. Bayer 1603 Bavarian attorney
1277 star positions + maps.
4. Mrs. Maj.
Mizar, Alcor.
5. Orion
6. Polar Constellations
7. Orion, Dog, Bull
8. Galileo's Telescope. 1600
9. Newton's " 1672.
10. Yerkes "
11. Mt. Wilson.
12. Victoria B.C.
13. Galileo's Drawing of Pleiades
"Sidereal Messenger" 1610
14. Barnard's Photo of Pleiades $3^h 45^m$.
Hertzsprung 1929. 2300 Group Stars.
Tennyson "Many a night I saw the P.
15. " Milky Way $3\frac{1}{2}^h$.
5 m. eye stars

16. Globular cluster in Hercules.
 1. diam 10^7 a. u.
 2. similar sphere about sun would enclose 4000 stars.
 3. Stars in \odot are 100 x sun's brightness.
 4. Line - represents \odot to α Centauri.
17. Orion - γ neb.
18. Cygnus nebula 7^h exp. Mt. W. 100"
19. Diagram - Scales.
atom : man :: 10 men : Star.
20. Star Distances - Table.
Packing: 4 or 5 millions in Atlantic.
21. Milky Way in Cygnus -

Conclusion : The study of the stars today is no less interesting, no less inspiring, no less a challenge to the imagination than it was in the bygone days when men saw in the configurations of the stars - birds and beasts, dragons and giants.

BLUE GIANTS AND RED DWARFS.

The stars are immense bodies of very hot glowing gases. If you put a star on one end of an imaginary see-saw, you would have to put ten thousand million-million-million-million men on the other end to balance it.

The hottest stars shine with a bluish light and we call them blue giants, The coolest stars glow with a reddish light and they are either very small and are called red dwarfs or they are tremendously large supergiant stars.

This change of colour with temperature is partially illustrated by sending an electric current through a wire. The wire gets gradually hotter until it glows with a dull red light changing to bright red, then yellowish and then, as we say, "white hot". If we could heat it still more it would become "blue hot". Astronomers believe that in the course of many many millions of years a star gradually passes from its early red supergiant state through the yellow, white and blue giant stages and then during many billions of years through the white, yellow and red dwarf stages.

How some of the gases in the stars radiate light of distinctive shades is shown in a darkened room by forcing an electric current through vacuum tubes containing small amounts of hydrogen, helium and other gases.

Charts of the sky showing the stars visible on December evenings were shown and by means of mechanical slides the story of our sun, a typical yellow dwarf star, was told. In this connection a comet with streaming tail was projected across the lecture theatre and its tail explained by the analogy of a current of air blowing its tail and the pressure of sunlight forcing the tail always in the direction away from the sun.

In conclusion some remarkable photographs of the stars in the Milky Way were thrown on the screen and the well known nursery rhyme was adapted to the strict requirements of modern science as follows;

Twinkle, twinkle little star,
How I wonder what you are,
Up above the world so high,
Like a diamond in the sky.

* * * * *

Twinkle, twinkle little star,
I can see you as you are,
Here a great, big giant blue,
There a dwarf of reddish hue.

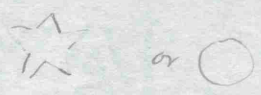

Twinkle, twinkle giant star
Shining brightly from afar,
A million million years change you
From red to yellow, white to blue.

Twinkle, twinkle little star,
Still you shine though dwarf you are;
Blue to white to yellow, red
Ere a trillion years are sped.

Twinkle, twinkle every star,
Whether bright or faint you are.
Yours the light by which we live,
Thank you for the joy you give.

Tidal in Ocean Skies
EARLSON, INC. CO.

Blue Giants & Red Dwarfs

1. How many have ever seen a blue giant?
a red dwarf?
a yellow dwarf?
2. Not men but Stars - see saw 10^{28} men
3. Different sizes & colours - blue giants red dwarfs red supergiants
Hot wire
4. Shape of a star How many points?  or  Diffraction
5. Slides - sky charts.

Rigel	M 10000 x 0	Rigel	M 48 x 0	Vega	61 Cygni
	540 l.y	A, B.	9 l.y	Denel	M 0.1 x 0
					10 l.y
					1838 Bessel.
					only 10 stars nearer to us
6. Biggest star (not the heaviest) Betelgeuse - 1 cu in weighs $\frac{1}{10^6}$ of 1 cu in air.
Smallest star Sirius B 1 cu in 1 ton Mercury dish
7. What the stars are made of - Discharge tubes.
8. The Story of a Yellow dwarf.
Tides. Solar system.
Earth. Precession
9. Comets Slide, tail first - model - fan
10. Slides - The stars are the Poetry of Heaven Byron

Hillier
please
by Dec 27

Blue Giants and Red Dwarfs.

The stars are immense ~~gaseous~~ bodies of very hot glowing gases. If you put a star on one end of an imaginary seesaw you would have to put ten thousand million - million - million - million men on the other end to balance it.

The hottest stars shine with a bluish light and we call them blue giants. The coolest stars glow with a reddish light and they are either very small and are called red dwarfs or they are tremendously large ~~in fact~~ supergiant stars.

This change of colour with temperature is partially illustrated by sending an electric current through a wire. The wire gets gradually hotter until it glows with a dull red light changing to bright red, then yellowish then ^{or} we say ~~to~~ "white hot". If we could heat it still more it would become "blue hot".

Astronomers believe that in the course of many many millions of years a star gradually passes from its early red supergiant state through the yellow, white and blue giant stages and then during many billions of years through the white yellow and red dwarf stages.

Some of the gases in the stars radiate light of distinctive shades is shown in a darkened room by forcing an electric current through a vacuum tubes containing small amounts of hydrogen, helium and other gases.

Why stars seem to have points was shown by diffraction of a beam of light by a fine wire grid

Charts of the sky showing the stars visible on December evenings were shown ~~on the screen~~ and by means of ~~some~~ mechanical slides the story of our sun, a typical of fellows dwarf star, was told. In this connection a comet with streaming tail was projected across the lecture theatre and its ~~tail~~ ^{tail} explained by the analogy of a current of air blowing its tail ~~out~~ and the pressure of sunlight forcing the tail always in the direction away from the sun.

In conclusion some remarkable photographs of the stars in the Milky Way were thrown on the screen and the well known nursery rhyme was adapted to the strict requirements of modern science as follows.

Twinkle twinkle little star
How I wonder what you are
Up above the world so high
Like a diamond in the sky.

* * * * *

Twinkle twinkle little star
I can see you as you are
Here a great big giant blue
There a dwarf of reddish hue.

Twinkle twinkle giant star
Shining brightly from afar
A million million years change you
From red to yellow, white to blue.

Twinkle twinkle little star
Still you shine though dwarf you are
Blue to white to yellow, red
Ere a trillion years are sped.

Twinkle twinkle every star
Whether bright or faint you are.
Yours the light by which we live
Thank you for the joy you give.

Blue giants & Red Dwarfs

1. How many have seen a blue giant?
a red dwarf?
a yellow dwarf?
2. ~~4~~ The stars - See saw 18 star 10^{28} men.
great super giants; giants; dwarfs; little little dwarfs.
Range in Vol. $10^6 : 1$
3. Colours - Blue, white, yellow red + invisible:
Expt gradually heat a wire
+ a heating filament
4. star shape 5 points - Diffraction with grid
Balloons.
5. Red Supergiants, yellow giants, blue giants
Westminster Bridge Slides N & S. in Dec.
6. Discharge tubes H, He, Li, Sr, Na
7. ~~7~~ The Biggest star. Balance to show density.
The little little little white dwarfs
Hg bath + 20 lb. wt.
1 ton per cu. inch
8. A tale of a yellow dwarf.
moony slides of solar system, tides etc.
Precession model
Comets + elect fan
10. Slides + Rhyme.

Twinkle twinkle little star
How I wonder what you are
Up above the world so high
Like a diamond in the sky.

T — t — little star
I can see you as you are
Here a great big giant blue
There a dwarf of reddish hue.

T — t — giant star
Shining brightly from afar
A million million years change you
From red to yellow, white ~~to~~ blue

T — t — little star
Still you shine though dwarf you are.
~~From~~ Blue to white to yellow, ~~and~~ red.
Ere ~~that~~ a trillion years pass overhead,
are sped

Twinkle twinkle every star
Whether bright or faint you are
Yours the light by which we live
Thank you for the joy you give —

Dresses.

Red

Blue
Grains.

1976

Xmas

Ottawa

University Women's Club

~~Nov. 20, 1926~~

Jan 15/27

Immensities of Time & Space

of The Far Vision

1. A.C.G. Think in centuries.
The far vision in daily life - in home life, in municipal affairs
in political + national + international affairs
the far vision in space . are the great needs of the present
" " " " time . day.

2. How may the habit of the Far Vision be cultivated
By the study of History, by Travel, by the development
of that greatness of soul + spirit + sympathy which makes
a Wesley say The World is my Parish, of which makes
all true statesmen say not my Nation + your Nation but
a world wide League of all Nations.

Of all the studies which are open to the mind of man there is
none that offers such training in the ^{practical} Far Vision or such scope for the
exercise of the far vision both in space + time as does Astronomy.

I want to trace briefly the development of man's knowledge of the Universe
~~in which he finds himself~~ from the limited knowledge and
superstitious theories of the early Astrologists to the vast
accumulation of facts before us today which have spread
before ~~us~~ us the stupendous vision of the Immensities
of Time + Space.

I want to describe some of the methods of
investigation whereby the astronomer is today able
to reveal some of the secrets of starlight and to
give you a glimpse of the stupendous vision of
the immensities of Time + Space.

The far vision is essential to scientific progress
all science is essentially one science. & nowhere
is this more evident than in the great advances in
our knowledge of the Universe resulting from the
cooperation between physics & astronomy & the
development of the subject now designated by
the compound name astrophysics.

Aristotle, Galileo ^① _②, Newton ^③ _④, Fraunhofer ^⑤

Babylonian astronomy + astrology
Chinese records

Greek astrology
astronomy, math, philosophy

Influence of Aristotle through
Ptolemy's Almagest

Revolt under Bruno, Copernicus, Galileo

Observations of Tycho Brahe + Herchelius
Theories of Kepler, Newton

Telescopes + Modern Era
Astrophysics + The Secrets in Starlight

Elements, Temps, Motions, Masses,
+ Distances

Solar System + Stellar Galaxy
+ Spiral Nebulae

Conclusion Time rolls his ceaseless course
etc - - -

What is it that differentiates man from
the beasts that perish? It is this divine
attribute that he is capable of a far vision
in things natural + things spiritual.

Greek Contribution to Knowledge

1. Makers of Sci. Hist.

Ionian Sch.

640-550? BC.
Thales - 1st love
of Sci from Egypt

600 BC
predicted eclipse - May 28, 585
founded Electrolatics - by friction in
Amber

Pythagorean Sch.

Math of -

Pythag. 572-497? BC

Geom + Arith
Sound - stretched
strings

Plato

Sch. of Athens

The Academy

one of his students was Aristotle d 323 BC

Geom + the mathematics
left Athens + became tutor to alex the grt
+ on his accession to throne Alex founded the Lyceum
Aris. walking up-down the avenue discussing
with his pupils gave the name Peripatetic School

Politics, Ethics, Metaphysics, as well as Science
Numerics of Elements - motion, gravity.

Alexandrian Sch.

See Eratosthenes

OPEN LETTER NO. 12

RT. HON. W. L. MACKENZIE KING,
Prime Minister and President of the Privy Council,
Ottawa.

Dear Sir:

Why does Canada prohibit the importation of goods made by convict labor? Is not the main reason our unwillingness to expose Canadian labor to competition of that kind?

Then why should we be willing to expose Canadian labor to the competition of goods made by child labor? The competition is just as unfair in the latter case as in the former. Towards the goods themselves, we as consumers should feel even greater repugnance. But we prohibit the one, while we actually encourage the other by the imposition of duties that are no deterrent at all!

It is notorious that the cotton mills of the Southern States, and particularly the cotton and woollen mills of England, employ large numbers of children below the age where we permit them to be employed in Canadian mills. Our manufacturers do not complain of child labor laws; on the contrary, they approve of them. But is it fair to our manufacturers to expose them to the competition of goods made by a class of cheap labor that they themselves are forbidden to employ?

Is it fair to the adult workers in the cotton and woollen mills of Canada to declare that their wages must be forever tied down by the pitiful rates of pay for which children can be hired by the cotton and woollen mills of England?

If we would scorn to profit by the labor of our own children, why should we be willing to profit by the labor of children of other countries?

Are we to protect our children, while they are children, only to acquiesce in their being broken after they are grown up?

Is the saving of a few cents, on our purchases of cottons and of woollens, a matter of greater importance to us than the preservation of the principle upon which one of our most commendable pieces of legislation is based?

Yours respectfully,

J. J. GIBBONS,
President.

J. J. GIBBONS LIMITED
Advertising Agents.

Winnipeg, Toronto, Montreal.

Bruno Giordano . 1548-1600 - Italian Philosopher

at 15 he entered Dominicans at Naples -

for his original thinking he was persecuted & fled in 1576. #

Geneva 1579 - Calvinism made no appeal - various places

Paris 1581 - "determined to see for himself the noble universe, unclouded by the mists of authoritative philosophy & Church tradition

Accepted Copernicus' views (1473-1543) & used them as a lever to push aside the antiquated system of Aristotle whom he hated preferring the older philosophers Lucretius, Anaxagoras, Heraclitus, the Pythagoreans, neo-platonists & especially Nicholas of Cusa

Offered Chair of philos. at Paris on condition of his taking Mass
He refused but was allowed to lecture & he expounded

a certain logical system the Ars Magna of Raimon Lull.

(1235-1315) Later to England, London & Oxford - further philosophical & metaphysical works - foreshadowing Spinozism

Then France, Germany (Luther) & Inquisitors captured him

Stood him to Rome - 7 yrs imprisonment & then burned at St.

To Bruno philosophy is the search for unity.

Amid all the varying and contradictory phenomena of the Universe there is something which gives coherence & intelligibility to them

This unity is God the Causa immanens. By his action the world is produced, and his action is the Law of nature, his necessity is true freedom. . . . That which determines ^{involuntarily} ~~must have~~ somewhat in which

its determinations can have existence. This other of God, which is in truth one with Him is matter. The Universe then is a living Cosmos . . . a

unity in myriad forms mones monadum. The soul of man is a thinking monad, midway between divine intelligence & the world of external things. portion of divine life the soul is immortal. Its highest function is the contemplation of divine unity discoverable under the manifold of objects.

MCGILL UNIVERSITY

TEN EXTENSION LECTURES

THE STORY OF SCIENCE IN THE DOMAINS OF PHYSICS AND ASTRONOMY

WEDNESDAYS 8.15 - 9.15 P.M.

JANUARY, FEBRUARY AND MARCH, 1926

MACDONALD PHYSICS BUILDING

(1)	The Greeks and Romans	C. W. Stanley	January 20
(2)	The Dark and Middle Ages	W. T. Waugh	January 27
(3)	Copernicus, Kepler, Galilei, Newton	A. H. S. Gillson	February 3
(4)	Gilbert, Oersted, Ampere, Galvani, Volta, Ohm.	E. S. Bieler	February 10
(5)	Kelvin, Helmholtz, oule	A. S. Eve	February 17
(6)	Light (Subsequent Advances)	J. S. Foster	February 24
(7)	Heat " "	A. N. Shaw	March 3
(8)	Sound " "	H. E. Reilley	March 10
(9)	Electricity " "	D. A. Keys	March 17
(10)	Astrophysics	A. V. Douglas	March 24

The fee for these ten lectures is \$5.00. Tickets should be obtained **in advance** at the Bursar's Office.

Members of the Staff and Graduate Students may attend if they obtain complimentary tickets **in advance** from the Registrar's Office.

Individual lectures 75 cents, to be paid at the door.

The object of the course is to illustrate the advance of scientific knowledge, with some emphasis on individual achievement and personality.

Halley's Comet

Jan. 66

Probably the sword mentioned by
Josephus as standing over
Jerusalem
(Wars. Bk VI. Chap V.) Shortly
before its fall.

Aristotle mentions it B.C. 467.

Babylonian Talmud (see Olsky Aug 1910)

1066
66

75

Royal Astronomical Society of Canada
Montreal Centre

1000 (13 $\frac{1}{3}$)

250

225

250

A meeting of the Society will be held on Wednesday December 9th at 8.15 p.m. in the Macdonald Physics Building.

SPEAKER - Dr. Henroteau, Dominion Observatory, Ottawa.

SUBJECT - Variables of the Cepheid Type.

1066

1911

75) 845 (11

75

95

75

20

Members of the Council of the Society are reminded that a meeting of the Council will be held immediately at the close of the general meeting.

The Secretary will welcome any suggestions that any member of the Society may be able to offer regarding possible speakers or other matters pertaining to the meetings of the Society.

1607

75

1683

A. Vibert Douglas
Secretary.

Macdonald Physics Building,
McGill University.

1911

1682

76 | 229 | 3
 | 228 |

Astrophysics

McClure Extension Lectures

March 1926

Slides

Astrophysics

Galileo
Kepler
Fraunhofer
Kirchhoff
Huggins

Introduction: Aristotle to Hale

Vic. Be. A. How spectrograms are taken :- (light & a prism -
 Yarkes tel. spec. Remind of atomic source - λ lines, abs. lines Rosette Stone
 Describe Yarkes 40-inch spectrograph

Secchi Takes HD Types B. Star spectra Classification - Secchi & Harvard H&C
 Miss Cannon

Tables from Struik's Page (1). Identification of lines - elements in stellar atmosphere
 (2). Temperatures of stars: Pitsdani, Coblenz, Saha
 (3). Densities

[Diagrams] (4). Giants & Dwarfs -
 Abs. Mag. - hence Distance (or Spec. P.)

[Diagrams] (5). Radial Velocities - show repeats M.W. Keble, some taken up with equator

C. Theoretical considerations with observational work

Asid. It contributes to scientific thought

(1) Asid. (a) Radiation Pressure - Limits of Mass

Interior of Star: Mass Luminosity Law

(2) H.N. Russell Giant Dwarf evolution Theory - gas laws

(3) Edd + J.H. Jeans (b) Loss of Mass by radiation

(4) Modified theories of evolution - isolation of Supergiants - Hertzsprung

(5) Edd + Fowler, Guggenheim (c) Range of densities

[Feintly] D. Confirmation of Theory for Sirius Dwarf

Conclusion

March 24, 1926.

Astro Physics

The young sci. of

Aristotle Galileo

Newton 1675 Composite nature of light.

1802 Wollaston 7 lines

1814 Fraunhofer 574 lines

Foucault -

1859 Kirchhoff

Huggins

Star spectrograph. Telescopes -

Arcturus.

Rosetta stone - Chem of Stars + Phys. Conditions

Secchi

- Lockyer

- Miss Cannon

- Arc & Spect

H.N. Russell + Fraun + Dwarfs - A.S.E. Loss of Mass - J.H.J. diagram.

Doppler -

A.S.E.

Stellar temps -

" Diamns

- Michelson

(Arc. 0".024 M

"0.020 E

200x O.

Cosmic Rays.

$\frac{1}{3000}$ Light from Andromeda $2 \frac{1}{2}$ million years.

Sirius.

8.8 l.y.

P 48 yr - 49.3 (actual)

Mars B = $\frac{1}{6}$ mass A.

Brightness B = $\frac{1}{10000}$ A.

Spec. B Fo A A₂

Asr. shift 20 km/sec - T 8000 P 53000 R 19,600 km

ad. 21 P 60000 R 20000 approx

Uranus

$\frac{1}{27}$ diam of Sun

Sir. A 60x vol of O.

11th - mtg. Phys Soc.

wed

$$\frac{3}{6.5} \\ 2.17$$

$$1 \text{ lb} = 454 \text{ gms}$$

$$E \text{ in ergs} = mc^2$$

$$= 454 \times 9 \times 10^{20}$$

$$= 4086 \times 10^{20} \text{ Ergs}$$

$$= 4 \times 10^{23} \text{ ergs}$$

$$= 4 \times 10^{16} \text{ joules}$$

$$= \frac{4086 \times 10^{16}}{1.356} \text{ ft lbs}$$

$$= 3 \times 10^{16} \text{ ft lbs}$$

$$= 1.5 \times 10^{13} \text{ ft. tons} \quad - 15 \text{ million million}$$

W = f x d.
= mg x d.

Density diamond 3.5

" coal 1.2

Volumes are inversely
as densities.

∴ 3 cu. cent.
coal
would give
only 1 cu. cent.
of diamond.

~~or Maple Syrup
50 gal. sap
to get 1 lb
Sugar~~

Disk Hg
↓ wt.

∴ to raise 500 ft. say from river to reservoir

$$\text{no. of tons water} \quad \frac{3 \times 10^{10}}{32.2} = 10^9 \text{ Tons}$$

or Height of Mt Everest. from sea level 29000 ft.

$$\text{no. of tons} \quad \frac{1.5 \times 10^{13}}{29000 \times 32.2} = 1.5 \times 10^7 \text{ tons}$$

or 15 million Tons

Translation of letter to R.A.S. from Einstein
on award of Gold Medal Feb. 12, 1926.

He who discovers a line of thought which permits us to penetrate even a little deeper into the eternal mystery of Nature, is greatly privileged. He, who, in addition, is encouraged by recognition, sympathy and help from the best minds of his time, experiences more happiness than anyone can realize.

In this spirit I thank you from the bottom of my heart for the great honour of which you have found me worthy.

J.H.J. Presentation Address:- Einstein started a revolution in scientific thought to which as yet we can see no end, to which, indeed, we can hardly imagine an end.

Ed. Creed

Astrophysics
Evolution of Consciousness
March 1926

I have tried to outline some of the great achievements of
astrophysics & some of the great problems which it is facing & I
have attempted to show how astrophysics is built upon the accum

All experience is an Arch — an Arch the words
which Tennyson puts into the mouth of his
Greek Hero — Ulysses — an Arch where through
gleams that untravelled world above man's
fades forever & forever as I move —

At every stage in the evolution of thought
this has been true — Each advance of knowledge
serves to widen the horizon beyond which is
the vast region of the Unknown.

For ten weeks our thoughts have been guided
along the Corridor of Time from Greek Era
to the present day. We have traversed that Corridor
in the footsteps of a long succession
of torchbearers, to borrow a metaphor from
Calped hoxse, men who have given their lives,
often in a literal as well as in a metaphorical
sense, to the task of revealing the Truth — men
differing in race, in temperament, in outlook, in
every possible way save one which unites them
forever ^{in a great Brotherhood} ~~for its experience~~ by Huxley they are
all men filled with "the Divine afflatus" of
The Truth Seekers.

United in an
unshakable
Brotherhood
described by
Huxley as the
Brotherhood of
men filled with the
Divine afflatus

We pause at the threshold of Tomorrow. Through the
Great Arch of Past & Present Experience we finally
discern vague outlines of an unknown world
whose mysteries challenge & beckon us and ^{we may believe} ~~it is our faith~~ that
The Present & the Future will ^{not be wanting in} ~~provide~~ the torchbearers
who will light the way on and on to a fuller

& richer
realization
of the ^{great mystery} ~~harmony~~
of Nature.

Stars + Atoms

Ras. C.

November Lecture

1927

Race Lecture
Nov. 3 / 27

"Stars & Atoms"

A.S. Eddington. 1927. Clarendon Press, Oxford.

1. The Author : 1. Stellar Motions 2. Math. Theory of Relativity.
3. Space, Time & Gravitation.
4. The Interior of a Star. 5. Stars & Atoms.

2. The Book : Its scheme & style.

Scientifically accurate.

High literary merit

Rich in simile & metaphor.

Quiet humour

Typical of the man. The courage of a lion

The soaring spirit of an eagle rising to heights
of speculation daring unsurpassed by poetic fancy.

The caution of the deep & honest thinker, who
returns from his flights of the imagination
to weigh carefully his evidence & give restrained
and guarded utterance to conclusions.

3. Introduction p. 9. read.

4. Our Sun a typical star : its surface - temp., cyclones, etc.
its interior - methods of probing.

- (1) what is there - protons, electrons & penetrating radiation
(2) physics tells how these behave.

p. 12. read.

p. 14-15.

p. 20.

"Stars & Atoms" (2)

5. Range of brightness 4^M to $+12^M$ 10^{16} mag 10^6 x the amount of light.
 " " mass Read p. 24-25

Radiation pressure Digress to mention Pleiades Twins

Read p. 26-27-28.

monoceros
 $+6^{\circ} 13' 09''$ $6^m 0$
 $75^{\circ} 0, 63^{\circ} 0$

* Struve's Quadruplet:
 27 Canis Maj.
 C+D around A+B 3.2 yrs.
 A+B 121 days -
 B+C 8 days.
 $\frac{A+B}{C+D} = 1$ $A+B+C+D = 950 \odot$
 If A=B=C=D then each = 238 \odot

Mass - Luminosity Law.

MNRAS. March 1924 - a paper so important in itself so far reaching in its influence - almost revolutionary in its effect that all considerations of stellar evolution take it as a turning point - before & after.

Dense Stars - p. 38 read (38-39)

6. Chap. 2. The Story of Algol or The Missing Word or The False Clue.

The Story of The Companion of Sirius or The Nonsensical Message.

Algol. A, B, C. A+B 2 days. 2 hours AB about C in 2 yrs.

$\frac{A}{B} = 5$ mass ratio $\frac{A}{C} = 2.5$

Sirius once a clock star - Bessel 1844 elliptic orbit $P=49$ yrs.

\therefore a companion Alvan Clark 1862

Read. p. 48 Sirius B $\frac{4}{5} \odot$ mass, $\frac{1}{360} \odot$ slight, yet A-type.

" $\frac{1}{6}$ mass of A. $\frac{1}{10,000}$ light of A.

Betelgeuse contrast to Sirius B.

mass = $35 \odot$ $\rho = 0.000001$ 10^{-6} radius = orbit of Mars i.e. to include orbit of Earth if not of Mars.

Apparent paradoxes of Relativity Theory p 83 merry mischievous delight

P. W. Bridgman's Logic of Physics

Concepts "operational" point of view. or meaningless questions.

bits & black holes

7. Chap. 3.

Age + Energy of the Stars -

Older theories: Contraction, Radio active,

Sub atomic (synthesis) energy.

Annihilation $E = mc^2$ ergs.

Latter essential if stellar evolution from gaseous giant along main sequence is to hold.

Read: p. 109.

p. 113 (2)

~~p. 115~~

Finis

p. 121 ✓

Conclusion

I have but touched upon a few typical portions of this book, but I hope inadequate though it certainly has been that there has been sufficient said to convince you that this is well worth reading - a valuable addition to ~~popular scientific literature~~ ^{the literature of science} high water mark sciences and high water mark literature.

In ~~this book~~ ^{astrophysics} our minds are led outward and outward into the glorious depths of space and ~~there~~ ^{at the same time} inward and inward into the marvelous profundities of the atom and at each extreme we are confronted with mystery, mystery which challenges the minds of men to yet greater efforts.

Douglas

The Yankee Club
Lib. Work

R. as. C.

Jan. 9 1926

R.A.S.C. (The Yerkes Obs. + its Work)

Introdu - Hist - Lens - Bldg. Staff. Director + Observers
+ 2 fellows +
11 photographers
1 astronomer
1 instrument maker.

A. Visual work. 40" Double Stars Burnham
Asteroids Van Biesbroeck.
Comets
Variable Star magnitudes Ross.
Comet seekers. Sweeping.

B. Photographic Work. 40" planets + asteroid
star plates for magnitudes
1/4 plates. + proper motions
Bruce. Barnard. Wilby Way
Ross P.M. + variable charts.
Plates + Blank

24" reflector. magnitude work
with grating.
Comets
Clusters + nebulae.

12" refractor - Hales instrument
daily photos of Sun.
occasional of moon.
+ visual work on grating
Spectra of Sun.

C. Spectrographic. Zeiss + Objective prism - Comets.
40" + Spectro heliograph. Lee.
Bruce Spectrographs. 10,000 1,2+3.
7,881 1 prism plates.
chiefly B + A.

Radial Vels. measurements
Orbits - + detection of 200 spec. binaries
Research on stationary Ca + Na clouds.
Spec. // x new fields of investigation
A type. 500 stars + several 1000
Spec. gas -

Lens. 40" Crown av. 2" Alvan Clark.
 Flint av. 2 1/2" \$100,000 lens only

Each surface reflects 5 1/2%
 + each lens absorbs a certain amount
 total % transmitted is 75%

Field of view 1° nearly i.e. just meets takes in
 whole disc of Sun or moon.

Magnification x60 + eyepieces to x250 x1000 or 1200
 $\frac{\text{area of lens}}{\text{area of pupil of eye}} = 40,000$ i.e. light gathering
 power.

<u>Bruce Telescope.</u>	Barnard	Franklin Adams.
10" doublet	Petzvald lens	Cook lens.
Brashear	16 ^m Star in 1 ^h	16.9 in 1 ^h
\$7000-	no coma or spherical aberr.	Coma + spherical images get spherical.
	except on rim regions images get elliptical but remain clear cut.	

Field of view. 50 sq. degrees.

Visual Work. (all visual prior to 1900)

40" Film Micrometer

Burnham 1871 - 1899 over 1000
on to 1906.

Barnard. Star positions in clusters.

Ran. Biesbroek - Binary Orbits
Variable Star maps.
Cont. of former work.

Comet positions

not $\frac{1}{d^2}$ but approx $\frac{1}{d}$

∴ rapid falling off in light &
diff in getting sufficient positions
to determine orbit accurately.
& hence its ephemeris.
see Discovery of Comet δ . 1925.

Comet Seeker -

Slide of Telescope

Photographic Work.

40th Ritchey 1900 + 01 -

adapted the gr. telescope as a Camera.

Since object glass is achromatic for rays to wh. eye is most sensitive, yellow + green a colour filter is introduced cutting out the blue + violet + then by using isochromatic plates sensitized for visual rays, a sharp photograph is obtained.

Finest plates of moon, star clusters + neb. obtained to that date (some now excelled by Mt Wilson)

1904 Parallax work began under Schlesinger.
Contd now by Lee → 1041 * not completed
Plate measurement in 2 coordinates.

(Proper Motions.)

Bkgd. of Standard Stars

310 plates out of 400 were used by Lee. 12^m. a 10 in each area.

Ross. Planets

p.e. $\pm 0''.009$
Kepler's Selected areas 206
Suggested 1905

Van. B. Comets + asteroids.

Parkhurst + Farnsworth. Star fields with gutter
restan or grid for
magnitudes

Photographies Cont 2

Bruce ^{see details}
Barnards . 50 Milky way plates
with dark objects & all charts.
Messier clusters, Dreyers & Herschels &c.

Ross Repeating plates for
Blinking for high p. m.
& variables.

24" mirror . made by Ritchey
Comets (for 2 mos after 40" had
lost them)
Magnitude work.

Zeiss U.V. Camera
& objective prism
Magnitudes
& Comet Spectra.

8 Aug 30th
M. Sept 7th

A type Binaries may be 6^m
H.D.C. Burnham
True binaries - Boss
Separation >

Observation cards - BD charts or
Carte du Ciel
with 1900 Bas positions corrected for Precession
by Van B's chart.

Borowski

Spectrographic Work.

Bronze Spectrograph attachment.

Comp. Spectra - 2 or 3 mag bl. per wk

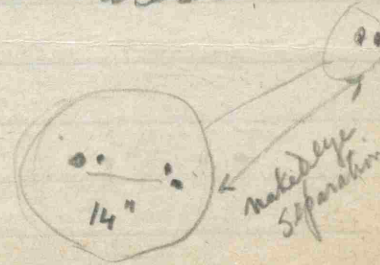
over 10000 spectra taken.

by Frost, Adams, Barrett Lee & Struve -
Rad. cells.

200 spec. binaries detected
& many orbits.

Mizar Alcor

3.4 4.0 4.2
As. 11 Abs 2.0 1m. 1 Air



Reprints

Spec. 11x work.

Astrophysics
& The Modern
Conception of
The Universe

Apr. 1926.

St James Cl

Astrophysics & the Modern Conception of the Universe.
→ In the beginning God ----- + there was Light

All our knowledge of the stars must be learned from the study of star light for they send us no other message.

Light. What is light - a partial answer only is possible for many mysteries still surround this universal phenomena of nature in spite of the study of light made by the greatest scientists of our own scientific times.

Physics gives us a partial answer.

Energy the great fundamental entity of the Universe.
Diverse forms of energy: Light, heat, electricity, motion, matter.

All Matter is composed of 2 units: proton & electron
All the 90 odd chemical elements are definite groupings or aggregations of protons & electrons

H. He Li N O Cu Au Pb Uv

Electron orbits + orbit changes → Light.

Electromagnetic energy -

Cosmic rays, γ X UV - Vis. Infrared. Hertzian Radio

Star light can be photographed & studied in 2 ways

(1) Direct photographs give star images & hence relative apparent brightness, positions, & by comparisons of photographs taken at a few months to many years intervals star velocities & distances may be obtained in many cases.

(2) Spectrograms - the analysis of the light from individual stars in order to discover their physical nature, what they are made of, how hot they are whether single or binary stars and many other things.

A. Identification of elements

B. Classification of spectra + temperature scale
+ giant + dwarf stars

The Solar System.

Sun :

+ planets

Scale

Collision or Tidal theory.

Velocity: 100 m.p.h. Aviator.
2400 m.p.h.

1. Round Earth at Equator 10 days.
2. To Moon 100 "
3. To Sun 106 years
4. Saturn 1000 "
5. Neptune 3000 " *outpost of Solar System*
6. α Centauri 27×10^6 "

Velocity of light

186000 m.p.s.

1. to Moon $1\frac{1}{2}$ sec.
2. Sun $8\frac{1}{2}$ min.
3. α Centauri $4\frac{1}{3}$ yrs.
4. Arcturus 47 "
5. Polaris Since Time of Drake *Crusades to Drake*
6. Edge of Milky Way 30 000 yrs.
7. Andromeda Nebula 900 000 yrs.

Scale

Diain of Sun	800 000 mi	=	1 inch	
"	" Earth 8 000 "		$\frac{1}{100}$ inch	
Dist. Sun - Earth	10^8 "	=	100 inch	= 8 feet.
" Sun - Neptune	3×10^9 "	=	3000 inch	= 83 feet.
" Sun - α Centauri	10^{13} "	=	10^7 inch	= 100 miles.

Solar System

	Diam	Distance	Year	Satellites	Remarks
Sun	800,000				Prominences H _a 9000 mi. Ca. 20,000 mi
Mercury	2,700	36 10 ⁶	87 dy.	0	
Venus	7,500	67 10 ⁶	224 dy.	0	
Earth	8,000	92 10 ⁶	365 dy.	1	Moon 240,000 mi distant $\frac{1}{81}$ mass of Earth. light comes 1 $\frac{1}{2}$ "
Mars	4,000	141 10 ⁶	687 dy.	2	
Jupiter	87,000	483 10 ⁶	12 yrs	8	
Saturn	76,000	886 10 ⁶	29 yrs	10	
Uranus	30,000	1780 10 ⁶	84 yrs.	4	disc. by Sir Wm Herschel
Neptune	33,000	2790 10 ⁶	165 yrs	1	computed by J. Adams. & LeVerrier

Relativity of all measurements

The island of Montreal would seem very very large if measured in inches and square inches - but its area is insignificant when trans continental distances measured in thousands of miles are considered

So too this solar system vast as it appears compared with terrestrial distances sinks into insignificance in comparison with stellar distances -

Scale of Galaxy - Light years.

Our Galaxy - Configuration & extent.

Estimated no. of stars to magnitude 20^m ... 10^9
Milky Way.

Beyond the confines of our galaxy - far far out in space are other galaxies - the great spiral nebulae.

Many hundreds are known but they are so far away that the ordinary methods of determining the distances of the nearest stars are quite inadequate & recourse has to be made to indirect methods of estimating distance.

Cepheid variable stars & Distance

Andromeda nebula 900,000 light years.

Thus we gain some idea of the Immensity of Space
there is also to be considered an Immensity of Time.

The stars tell a story of a vast development from
nebulousity to extreme brightness & rarity of matter
great mass tremendously expanded then to more
& more condensed form with less & less radiation
intensity until like our Sun they are but Dwarf
Stars & passing gradually but inevitably
through this stage to extreme density & low
luminosity we suppose they merge into dark
bodies.

J.H. Jeans has shown that the time required
for our Sun to pass from the stage in which
Sirius now is, a giant star, & one of the most
beloved of all stars to us to its present stage
radiating energy equivalent to the energy of
4 000 000 tons of matter per second is 10^{12} yrs.

Immensities of Time — Immensities of
Space — the scale of this universe is many
thousand, thousand times vaster & grander than
our ancestors ever dreamed of. The greater our
actual knowledge the greater too our realization
of its incompleteness, of the great mysteries not
yet revealed

and ever greater must become our conception of
the Creator, the Great Prime Mover & Sustainer
of the universe.

This has been expressed in that stately verse
of Milton:

Milton: -

These are thy glorious works, Parent of good,
Almighty! Thine this universal frame
Thus wondrous fair: Thyself how wondrous then
Unspeakable.

Wordsworth:

I have felt a presence that disturbs me with the joy
of elevated thought; a sense sublime
of something far more deeply interfused
whose dwelling is the light of setting suns
And the round ocean and the living air
And the blue sky, and in the mind of man:
A motion and a spirit that impels
all thinking things, all objects of all thought,
And rolls through all things.

Our thoughts go back through the centuries to an earlier
poet who looked up at the starry heavens with a feeling
of admiration and reverence akin to worship.
Knowing far more than he knew of the majesty &
harmony of this universe, with what augmented
meaning can we say with him

The heavens declare the glory of God and the firmament
sheweth His handiwork - - -

When I consider thy heavens, the work of thy fingers,
the Sun & the Moon which Thou hast ordained.

What is man - how marvelous is the mind of man, how
divine must be the Spirit of man that God, the Creator
the upholder of all Nature, is mindful of him -

① Natural Science Club
of
R. V. C.

Some Secrets of Starlight

Nov. 10, 1926.

② Stars Near & Far

Emmanuel Ch. Dec. 13, 1926.

③ ditto

St. Vicar Church Feb. 21, 1927.

④ Starlight & Star Dust: St. Ann's Ch. Feb. 25, 1927

Madam Pres & Fellow Students

I am more pleased than I can tell you that the Royal Victoria College has at last formed a Natural Science Club. I think there is a place for this society amongst the activities of the college and I hope that every student will give it the heartiest support irrespective of what particular line of study you may be following.

The time has gone, if it ever existed, when knowledge could be divided into separate water-tight compartments. All knowledge is related, interrelated & correlated with all other knowledge. All knowledge forms one great vast whole and our little minds wander about for three score years like children (to borrow somewhat of the simile of Sir Isaac Newton) finding a gem here & a gem there. And remember that the collection of gems of thought which is most varied is likely to be of the greatest intrinsic value.

It is not impelling that the ~~first~~ topic ~~to be~~
selected for the inaugural meeting of this new
society should be Astronomy. For astron.
has an intimate connection with our everyday
lives - Do you realize that we regulate our
lives by the stars - our units of time & our
determination of time being entirely dependent
upon the motions or apparent motions of
the stars? our surveys & navigation being done by means
of the positions of the stars? Do you realize that life on the earth
is entirely dependent upon the stars - that but
for their heat and light we could not live?

Do you realize that not only are we
dependent on the stars for the sustenance of
life but that we are in very literal sense
made of star dust? - our bodies are
composed of star dust for they are made of
the substance of the earth - of the earth, earthy
yet because of the earth \therefore starchy - for
our earth is a sample of the substance
of which our sun is composed & our sun
is but one star in a great galaxy of
millions of stars and our galaxy is but
one of myriad galaxies of stars scattered

throughout the vast spaces of the
Universe & ∴ ~~we~~ ^{our bodies} are a typical specimen
of star dust - of the material of which
the physical universe is composed -

Do you realize that as well as
being physically nothing more - & indeed
what more glorious could we be made of than
star dust? - & deriving our life from
the energy of starlight - the spirit of
man finds in the contemplation of the
stars one of the highest & noblest sources of
inspiration? 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 rather
how sublime must be the mind of man - how
divine must be the spirit of man that the
problems & mysteries of nature unfold themselves
at his searching & awaken the feelings of awe
& reverence expressed by Milton: These are
thy glorious works - Parent of good
Almighty - Thine the universal frame
Thus wondrous fair - Thyself how wondrous then
Unspeakable -

Wordsworth.

I have felt a presence that disturbs me with
of elevated thought; a sense sublime ^{the joy}
of something far more deeply interfused
Whose dwelling is the light of setting suns
And the round ocean and the living air
And the blue sky, and in the mind of man:
A motion and a spirit that impels
all thinking things, all objects of all thoughts
And rolls through all things.

If this Society helps to make that
living spirit of Nature more of a
reality more of an inspiration to
each of you, it will I believe
have accomplished the purpose for
which it has been formed.

O.P.M. Jan 6, 1927.

+ Y.W.C.A. Club Jan 7, 1927

2 or 3 000 yrs ago Heliocentric

Copernicus

Galileo

Newton

Telescopes

Sun & Moon etc.

Stars

Time - Greenwich -
Navigation

Search for Truth about Nature

Curiosity - a divinely implanted attribute
Yorker Day

Star Cluster - What a star is -
good vis to naked eye -
hundreds of thousands to telescope
millions to get more pictures
Photo plate

Milky Way -
Spirals -

Spirals -

Immensity of Space & Time

Marvel of Small Things

Beauty & orderly arrangement in crystals
of snow flakes -

The Heavens declare

The Stars & the Snow flakes - the 86 things of Nature
& the little things of Nature point to an all-wise, all-powerful
Creator & it is our faith that He is a God of Love.

Stars Near + Far.

Emmanuel Ch. Monday pm
Dec. 13.

It is a pleasure to me to come here this evening because I think it a great pity that people generally do not know more about the stars - There is no science as venerable as that of Astronomy and none I believe that makes a profounder appeal to the human mind + evokes greater effort on the part of the imagination.

It is fitting that we should take an interest in the stars for 4 reasons -

- (1) Our daily lives are regulated by the stars

Time etc
Direction
- (2) all life upon the earth is dependent upon starlight
- (3) as far as our physical framework is concerned we are star dust
Our bodies are of the earth earthy etc...
- (4) In the contemplation of the stars mankind finds his highest inspiration

Invocation to all Nature

O ye Sun & Moon bless ye the Lord

O ye Stars of Heaven " " " "

praise Him & magnify His
power

Addison - The spacious firmaments on high

Isaiah - They that have seen His light

shall shine as the stars

for ever & ever

David - When I consider

Milton - There

Quinta 1675

71. 1814

Kil. 1859.

~~Starlight + Star D~~

Star Light + Star Dust.

Summary ① As for our phy framework - star dust

② All life veg. animal & human life on this planet is dependent upon star light.

Of star dust we are made & by star light we live.

③ The spirit of man finds in the stars one of the greatest & noblest sources of inspiration.

The heavens declare

Spurred on by a divinely implanted curiosity - there have been in all ages men who have given their lives to the search for truth

There are thy flowers, works P. of food Alen
thine this wine from their words find
Thyself new words & thou
waspeak.

Text books - & Refs -

Scope of course R + T +

geophysics
cosmogenic
islands
Dynamics

Atomic Physics
& Nuclear Theory

3 states

Weight & Mass -

Pendulums

2

Lab methods

Rolling sphere ex
constant mirror

Simple

Compound

Riverside

Kater's Pend.
Inertia experiments

At all periods in the history of mankind there have been men who dedicated their lives — often in a literal as well as in a metaphorical sense to the quest for Truth — the search for Truth regarding things seen and things unseen. All knowledge thus gained enlarges our vision of Reality; at the same time impressing upon us with greater insistence the realization that Absolute Truth — The Whole — is far vaster than our finite minds can ever fully comprehend.

The great Thinkers of every age are like painters each adding a little to the vast picture of the Truth.

Astronomy is one of the oldest of the sciences. From the earliest times men have studied the face of the heavens for two main reasons. (1) Practical

Calendars

Time

direction

(2) The heavens have always commanded the the wonder the curiosity, the imaginative speculation, the awe and admiration of mankind.

Our earliest records date back to 3000 B.C.

Starlight &
Star

Shaw Memorial Ch.
Feb. 25/27

Immensities of Time & Space

McClintock Lyceum Lecture

Pointe Claire

Jan. 28, 1927.

Astronomy the oldest of the sciences.

From earliest times

The stars have always commanded the attention of man - whether it be primitive man or the people of the present day - the heavens challenge the wonder, the awe, the curiosity, the speculative imagination of mankind.

Not only so but the stars command his serious study for in the sky is seen the one great natural calendar - our units of time the day, the week, the month, the seasons the year & the determination of time whereby all the clocks or time pieces of the earth may be regulated - all this depends upon the movements or apparent movements of the stars. On the stars too primitive man & modern man must depend for his direction - his surveys, his navigation by sea, land or air.

3000 B.C. Babylonian astronomy,
& astrology, alchemy, mythology.

Greek contributions to knowledge.

Wireless Messages from the
Milky Way.

Melville Young Peoples Soc.
Oct. 21st 1929.

The Milky Way . early uncertainty
Galileo's telescope + discovery
Barnard's career + life work

Milky Way Slides

Nature of "light" as a wireless message

Information it gives regarding
nature of stars + their
distribution

Centre of Galaxy + Rotation

Spiral speculations

Conclusion Mr Ramsay Macdonald at the
McGill Convocⁿ that very morning made a plea
for imagination + the full play of fancy.
May I commend to your attention the study of
Astronomy, the study of the stars as offering
the finest possible opportunity for the exercise
of these qualities of mind, leading inevitably
to the deepest stirring of the emotions of
awe + reverence.

Secrets in Starlight

Melville Ch. March 16, 1927.

Secrets in Star Light

Introductⁿ Simile of painters
Astronomy the oldest + no science
has had a greater influence on the thoughts
of mankind or more powerfully moulded
the conceptions of the Universe.

1. Early Astron. Babylonian, Gk.
+ Copernicus, etc to Newton.
2. Gravitational Astronomy
Astrophysics.
3. Theory of Solar System
4. Our Galaxy + beyond.

Conclusion.

There are 10^9 ^{average} suns in one island
galaxy + there are 10^{15} galaxies
all this radiant light + heat passing
out into space - Why?

We must get away from the
anthropocentric viewpoint.

Quot. Full many a gem of purest
ray serene, The deep unfathomed caves
of Ocean bear, Full many a flower is
born to blush unseen + Waste its fragrance
on the desert air

+ Nature has scattered her stars with
an even greater prodigality -

Is it waste?

Developing in acc. with the laws of their
natures they thereby fulfil the purpose of
their creation + glorify the God of Nature.

The late Bp. Boyd Carpenter 1912 on Dante said that
the great lesson of Dante's poems was this
"Man cannot attain unto the highest without
surrender of spirit to the God who gave it."

This is the theological way of expressing the
same great truth that Astronomy and all
Natural Science teaches - whether it be a
star, an atom or a man it can only
achieve its fullest development by perfect
harmony with the laws of its nature,
the Universal Laws of all Nature

For a star or a soul
Is a part of the Whole
And weft in the wondrous plan.

Sir Isaac Newton
and his influence
in Modern Astronomy

"qui genus humanum ingenio superavit"

Brooklyn Institute
of Arts & Sciences
Feb. 17, 1928.

Astronomy from Newton to Einstein

In every age there have been men who stood out from their contemporaries by reason of the magnitude of their achievements, by force of personality, or by greatness of intellect.

At very rare intervals there appears a giant among the giants — such an one, a super-giant among the greatest thinkers of all times was Sir Isaac Newton.

Born Dec. 25, 1642 at Woolsthorpe Lincolnshire
entered Trinity College Cambridge at 18
graduated B.A. 1665

Winter of 1664-5 plague in Camb. returned to Woolsthorpe & having discovered the method of Infinite Series he calculates the arc of a Hyperbola to 52 figures

Invented Fluxions (Differential Calculus)

Fellowship 1667

Lucasian Professor (succeeding Barrow) 1669

(a) State of Astronomical Knowledge
at time of Newton's birth

Copernicus	1473-1543
Galileo	1564-1642
Tycho	1546-1601
Kepler	1571-1630

Mathematics
Geometry good
arith. } primitive
alg. }

note
1933

Binomial Thm. Diff. & Int. Calc.

1667 Principia Bk I. 3 Laws of Motion, Hierarchy of forces,
Theory of Orbits, & disturbing forces.

Bk II. Hydrodynamics, waves, tides,
vel. of sound in air, motion of a projectile
in a resisting medium.

Bk III. Application to Solar System, angular
rotation & polar flattening, lunar theory,
tides, high & low, mass of moon, precession
of Equinoxes.

At age of 73 Newton solved the problem of orthogonal
trajectories in 5 hours.

Lagrange wrote of the tremendous, overwhelming genius of
Newton that the Principia was the greatest
production of the human mind.

amongst unpublished papers Adams & Stokes found a
calculation of angular rotation of moon's orbit
giving the value (3° ?) (actually observed) amending an
earlier computation which had given half this value.

(b) Newton's contributions in Math (Dynamics) & Gravitational Astronomy -

- (1) Force
Momentum
Laws of Motion -
- (2) Universal Law of Gravitation.
 - i. Orbits of moon, planets, comets
double stars
 - ii. Tides - Dynamics of a particle
mass at c.g.
 - iii. Wandering of pole, precession

(c) Newton's Contributions in Physics, Optics -

- i. Prism, Refraction, Spectra
leading directly to spectroscopy, the most
powerful of all methods of probing the
secrets of space
Fraunhofer, Kirchhoff, Huggins
Spectral types + elements
- ii - Reflecting Telescope -

(d) Sir Wm Herschel's Reflecting Telescopes
+ discovery of Uranus 1781
P. 84 yrs - dist. 1780 10^6 mi.

Celestial Mechanics - true & actual posⁿ of planets
John Couch Adams 1845 } Neptune P. 165 yrs.
Le verrier 1846 } dist. 2790 x 10⁶ mi.

② To understand the tremendous advances in modern astrophysics, consider the development of physics in the last 100 yrs. How the successes of Newton by experiment & by math. research have disclosed a universe unknown to the man who made these advances possible

i. Faraday & Clerk Maxwell
+ electromagnetic energy

ii. J.J.T., Rutherford, Bohr
electrons, protons, theory of atoms
+ spectroscopy

③ Modern Astrophysics -

Temps, luminosities, distances

Mass-luminosity laws

+ angular diameters -

True nature of spiral nebulae

5
Betelgeuse

Why so bright?

Type M + comparatively distant yet so bright.

ca. E.: because so great a surface area,
estimated angular diam $0''.051$

Michelson + Pease 13 Dec. 1920 - $0''.047$

Its parallax $0''.02$

Hence diam $215 \cdot 10^6$ miles

(or radius $250 \cdot 10^6$ km.)

Volume $50 \cdot 10^6 \odot$

Density approx. $10^{-6} \odot$

Mass 10 to 100 \odot

Sirius B.

Why so faint?

Visual binary $P = 49.3$ yrs.

Hence its mass $0.85 \odot = \frac{1}{6}$ mass A.

abs. mag. $11^m.3 = \frac{1}{10,000}$ brightness A.

Type. F0 or A8.

$\therefore T_e = 8000^\circ$

ast.

$$L = \pi a c R^2 T_e^4$$

\therefore Radius $18,800$ km

$<$ radius Uranus.

\therefore Density $\rho = 60,000$ gms/cc
 $= 1$ ton/cu. inch.

Verified by W.S. Adams 1925.

Predicted Einstein shift to red $\frac{d\lambda}{\lambda} = \frac{M}{c^2 R}$
equiv. to 20 km/sec.

Shown to be from 19 to 26 km/sec.

Cosmic Rays

Why is Andromeda nebula so faint?

Estimated mass $10^9 \odot$

yet J.H.J. says only $\frac{1}{3000}$ light

At McEil & R. (1900?) penetrating radiation
Dr We measured its rate of falling off upwards
Two Germans in balloon found increase at
great heights.

W. Kohlhorster in ice cave in Jungfrau
detected cosmic radiation more penetrating than
 α or γ rays & most intense when Milky Way
crosses zenith.

Millikan in Rocky Mts. found intensity
not much changed with axial rotation.

A.S.G. says probably due to nebulous matter
in our galaxy.

J.H.J. says this solves the Andromeda mystery.
Radiant energy generated as very penetrating
cosmic rays in nebula or at centre of
a star are stepped down in escaping
from a star but large proportion leaves
nebula in its original form and
hence poverty of Androm. neb in rays
of visual range.

M31 can supply 50% of the effect noted
by Millikan.

Andromeda Nebula 17 106
Centrifugal force balanced by
gravitational attraction
Mass 3,000,000,000 suns

Dates in Newton's life

Born Dec. 25 1642 Woolsthorpe
 Entered Trinity 1660
 Playne 1664-65.
 B.A. 1665
 Fellowship 1667
 Lucasian Prof. 1669
 F.R.S. 1672

[At meeting when elected his paper on Refracting Telescope was read
 First paper given by himself "Light is a heterogeneous mixture
 of differently refrangible Rays"]

Principia published 1687
 Warden of the Mint 1696
 Master of the Mint 1699 → Recoinage
 "Opticks" published 1704
 2nd Edn Principia 1713
 3rd Edn Principia 1726
 Newton died 1727.

Historical & Theological Writings

Observations on the Prophecies of Daniel & Apocalypse
 of St John
 Lexicon Prophetarum
 Church History
 History of Creation
 Paradoxical questions regarding Athanasius

Ornithology

Against Middle Ages mysticism, Newton wrote
"Like effects in nature are produced by like causes,
as breathing in man & in beast, the fall of stones
in Europe & in America, the light of the kitchen fire
& of the sun, the reflection of light on the earth
& on the planets."

(8)

Permeating all the branches of Astronomy and Physics of today is the influence of Sir Isaac Newton.

In view of the prevalent fashion of our times to glory in pulling down our idols - in view of the many misleading statements which occur & recur in the public press regarding the overthrow of Newton by Einstein I cannot refrain from remarking that all the researches of Einstein & his Theory of Relativity have not in any sense robbed Newton of his imperishable fame. Relativity has given a broader view than ever before & has enhanced the value of Newton's laws & methods by showing them in their true perspective. The more elaborate & complete mathematical equations of Einstein contain within them as a particular case the equations of Newton & indicate that in dealing with distances so great as those which separate one star cluster from another & with velocities so great as to be comparable with the vel of light their modifications are required in the Newtonian laws to make them agree exactly with the observed facts of nature.

7

Sir Isaac Newton died on March 20, 1727 at the age of 85 and in the Chapel of Trinity College there was erected this statue - He holds in his hand a prism symbolical of his researches into the nature laws of light.

Wordsworth, looking at that statue wrote of his face - The marble index of a mind forever
Voyaging through strange seas of thought - alone.

Newton's own comment on his work & achievements is well known but deserves repeating.

"I know not

see back page. foot.

In a lecture on the Trend of Modern Astronomy given in the beautiful hall of St John's College a few years ago, I heard the Astronomer Royal for Scotland use this expression The Trend of modern Astronomy is Towards the light. Towards the light - a striking phrase whether interpreted metaphorically or literally.

What finer tribute can be paid to any man than to say as we now do of Sir Isaac Newton that his influence upon human thought in the age-long search for Truth was preeminently "Towards the Light."

1933 Annotation from Sir Rbt Ball

"It is the infinitesimal calculus that has given to math. sci. its potent grasp over some of the inmost recesses of nature. By this invention of Newton & Leibnitz, this subtle & exquisite contrivance, we attack these problems in detail."

Leibnitz - "Taking mathematics from the beginning of the world to the time when Newton lived, what he had done was much the better half."

Lagrange The Principia - the greatest production of the human mind.

Literal Translation of Latin inscription on
Newton's Tomb in Westminster Abbey :-

Here lies

Isaac Newton, Knight,
Who by a Vigour of Mind almost supernatural,
First demonstrated

The Motions and Figures of the Planets,
The Paths of the Comets and the Tides of the Ocean.

He diligently investigated

The different Refrangibilities of the Rays of Light
And the Properties of the Colours to which they give rise.

An assiduous, sagacious, and faithful Interpreter

Of Nature, Antiquity, and the Holy Scriptures

He asserted in his Philosophy the Majesty of God
And exhibited in his conduct the Simplicity of the Gospel

Let Mortals rejoice

That there has existed such and so great

AN ORNAMENT OF HUMAN NATURE

Born 25th Dec. 1642. Died 20th March 1727.

Brewster's Life of Newton p. 300

"a short time before his death.. This memorable sentiment

"I do not know what I may appear to the world; but to myself I seem to have been only like a boy playing on the seashore, and diverting myself in now and then finding a smoother pebble or a prettier shell than ordinary while the great ocean of truth lay all undiscovered before me."

Sir Isaac Newton
and his Influence on
Modern Astronomy -

R.A.S.C. (Ottawa Centre)
March 11, 1927

Sir Isaac Newton & His Influence
on Modern Astronomy.

Throughout the history of mankind there have been in every age men who stood out from their contemporaries by reason of the magnitude of their achievements, by force of personality, or by power of intellect. At very rare intervals there appears a giant amongst the giants and such an one a super-giant among the greatest thinkers of all times was Sir Isaac Newton.

On the 20th March 1727 Sir Isaac Newton died at the age of 85 and on the 20th March 1927 in the parish church of Grantham, Lincolnshire near to the village in which Newton was born, the Bp. of Birmingham will preach a commemoration sermon, and anyone who has ever heard that deep unusual voice can just hear him rolling forth those stately words from the Apocrypha. Let us now praise famous men

On the preceding Saturday - (a week from tomorrow) the greatest intellects of Great Britain will gather each to pay his tribute to the achievements of Newton, the Astronomer Royal, Sir J. J. T., Sir J. Larmor, Dr A. S. Eddington, Dr J. H. Jeans, Whittaker to name but a few - the greatest of the land assembled to honour the memory of a greater than they.

I offer no apology for venturing of page my humble tribute to the memory of the greatest Natural Philosopher, for though it be of necessity - a very humble tribute it is none the less a very sincere one.

Slide Isaac Newton was born on Dec 25, 1642

Early days + admission at 18 to Trinity - 1660

Isaac Barrow. Geometry - optics.

(a) State of Astronomical Knowledge up to Newton

Slides: Copernicus, Galileo, Tycho, Kepler.

(b) Newton Contribution in Mathematics

- + gravitational astronomy
- (1) Force, momentum, laws of motion
 - (2) Universal Law of Grav. appl. moon, sun + distant stars.

Tides. Dynamics of particle - mass as if at centre -

Wandering of pole -

Application in all orbit theory. Comets

Binary stars -

Mathematics involved in work of Poincaré, Roche, de Sitter, Darwin, etc. on Equilibrium forms of rotating fluids leading to present Tidal Theory of Cosmogony -

Mechanics
Hydrostatics
Hydrodynamics

c) Newton's Contribution in Physics - Optics.

Prism - spectra - refraction
leading directly to modern Spectroscopy
that most powerful of all agents for
probing the secrets of Space.

Fraunhofer, Kirchhoff, Huggins
Spectral types of stars
Substances radiating + absorbing.

Newton saw the difficulty re lens images
hence his Reflecting Telescope.

d) Sir Wm Herschel made Reflecting Telescopes

+ discovered Uranus P. 34 yrs.
1781 dist 1780 10^6 mi

Newtonian celestial mechanics found
discrepancy between calc. position
→ actual position.

John Couch Adams 1845 Neptune
Leverrier. 1846 P. 165 yrs
dist 2790 10^6 mi

(e) To understand the tremendous advances in modern astrophysics, it is necessary to turn aside for a moment and consider the development of physics in the last 100 yrs. How the successors of Newton by experiment and by mathematical research have discovered a universe unknown to the man who made their researches possible.

(1) Faraday + Clerk Maxwell
+ electromagnetic energy.

(2) J.J.T., Rutherford, Bohr + Sommerfeld.
electrons, protons + spectroscopy.

(f) Three examples of cooperation between Astronomy, Math + Physics which are typical of modern astrophysics

(1) Betelgeuse why so bright?

(2) Sirius B why so faint?

(3) Andromeda neb. why so faint?

Newton's Theological Works & Historical.

- Observations on the Prophecies of Daniel & the
Apocalypse of St John
- Lexicon Propheticum
- Church History
- History of Creation
- Paradoxical Questions regarding Athanasius.

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B.A. Cantab 1665. 1664-65 winter plague. Left

Cantab & having discovered method of Infinite series he
Calc. are of Hyperbola to 52 figures.

Invented Fluxions. (Differential Calculus)

Fellowship Trinity 1667

Lucasian professor (succeeds Barrow) 1669
(first all of Lectures Optics)

F.R.S 1672 + at the meeting when he was elected his
description of Refracting telescope was read -

his first paper given by himself at next meeting Light is a
Heterogeneous mixture of differently refrangible Rays -

1666 at Woolsthorpe subject of gravit, begun
Voltaire is authority for Apple anecdote.

from Kepler's Laws - Newton proved Inv. Sq. Law of
Attraction towards Sun

Did earth's attrⁿ extend to moon?

Halleys influence on Newton. Saw MS. De Motu
+ unco publication - hence Philosophiae Naturalis
Principia Mathematica. published 1687

1694. Age 55 Appointed ~~Chancellor of Cambridge~~ ^{Master of the Mint}

1713 2nd Ed. Principia (age 71)

1644
71

EN 45 p. 300, 259.

In his old age he wrote - See next page
I do not know.

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