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powerful, vivid, adventurous imagination; a sane, honest, logical, and critical insight, and a profound faith that beneath and behind the apparently mysterious phenomena of nature there is law and order and reason. Seek and ye shall find, knock and it shall be opened! But what do we find, and what does the opening of the door reveal? - Further mystery, and a wider horizon with a panorama of new marvels to excite the wonder and the admiration of the explorer. And even while he pauses a moment in wonder, he feels anew the challenge of the unknown. What lies just beyond the new horizon? Thus has knowledge advanced with the passing of the years.

This is true of every branch of human knowledge and it is particularly evident in the history of the sciences - biology, the mystery of life in all its various forms, animal and vegetable, visible and microscopic; chemistry, providing an inexhaustible revelation of atomic and molecular affinities; geology, with its marvellous record of the history of the earth, movements, convulsions and crumplings, uplifts and subsidences, the forces of erosion, climatic changes, the dawn of life and the development of forms of life both extinct and extant; physics, the study of energy in all its manifestations, radiant energy (from cosmic rays to radio waves) and bound energy as in the ultimate constituents of matter, the electron and the proton; astronomy, the study of the stars and the starlight, of the solar system with its planets and satellites, of the immense regions of gaseous nebulosity, of the myriad star galaxies sprinkled throughout this vast universe, and of the fundamental mystery of space and time.

II

From earliest times the heavens ~~must~~ have excited the wonder and the admiration of men. In the stars they found two very important things - time and direction. The movements, or apparent movements, of the stars, the sun, the moon, provide the time-pieces by which man has always regulated his life. The relative positions of the stars provide the direction signs by which men shape their course on sea or on land. But curiosity was challenged by the mystery of the universe and in every community no doubt there were men set apart and entrusted with the task of observing the sky with care and precision. The western world owes a tremendous debt to the thinkers and star gazers of the Euphrates valley.

For many centuries before the rise of Greece, the heavens had been studied with much diligence by the Chaldeans and the ~~other~~ wise men of Babylonia. Three or four thousand years before the time of Christ, they had mapped the heavens and plotted the apparent motions of the sun, the moon and the five planets visible to the naked eye, Mercury, Venus, Mars, Jupiter and Saturn, against the background of the seemingly fixed stars. With amazingly vivid imaginations these ancient star gazers had identified various groups of stars or constellations with animals, birds, dragons, fish, giants, and other mythical figures. One group of these constellations was of special interest and importance because it covered the broad belt around the sky in which the seven exceptional heavenly bodies (sun, moon and five planets) were always to be found. This great belt is called the Zodiac. So exact were the Babylonian observations of the apparent motions of the sun and moon and planets against the background of the star groups of the Zodiac that they could predict such events as eclipses of sun or moon, times of high or low tide, with some degree of accuracy; and due to the computations of such men of high scientific attainment as Naburiannu and Kidinu it was known that the cycle of lunar phenomena repeated itself every fifty-four years and one month.

All this knowledge as well as a great mass of unexplained observations of planetary positions came into the hands of Aristotle about 300 B.C., and the keen Greek minds at once began to construct a geometrical model of the universe to account for these motions. Even a casual observation of the heavens shows that the sun and moon move eastward relative to the almost unchanging background of the stars, but the planets move with less apparent regularity - sometimes eastward and sometimes westward. To portray these motions the early Greek astronomers had imagined the sun, the moon and each of the planets to be imbedded in a crystal sphere, one sphere for each. The outermost sphere was supposed to be the one in which all the stars were fixed, and as each of these eight spheres had to rotate about the earth at a different speed, and not always at a constant speed, there was inevitably a friction between their surfaces which was the cause of a mythical "music of the spheres," so delicate, so exquisite that the ear of the ordinary mortal man could not detect it.

The later Greek astronomers elaborated the geometrical model by introducing epicycles and placing the earth slightly away from the centre of the revolving spheres. These conceptions dominated thought for over seventeen centuries and though they were ultimately shown to be fallacious, nevertheless, this belief in the rythmic, harmonious movements of the heavenly bodies, giving rise as it did to the idea of the music of the spheres was no idle fancy. After Copernicus had propounded the theory that the sun was the centre of the planetary system, the earth being simply one of the minor planets; and after Galileo, about the year 1610 had made observations strongly supporting this heliocentric theory, John Kepler established for all time the rythmic harmony of the solar system. As a result of his almost superhuman efforts in examining the observations of the times and positions of the planets, (made and collected during the long life of that picturesque astronomer, Tycho Brahe,) it was given to Kepler to discover three remarkable laws, the mathematical simplicity of which astonishes and delights the mind of man even as does some unexpected sequence of simple chords which may be found to form the basis of an elaborate and complex symphony.

Kepler's first law states that the orbit of every planet is an ellipse, the sun being at one of the foci. Now the conic sections - circle, ellipse, parabola, hyperbola - had been thoroughly studied in Greek times long before it was known that not only the first but all four of these would be found essential in the investigation of the motions of the celestial bodies. This is but one of many instances where progress made in one realm of thought for its own sake alone has later proved to be the sine qua non in the development of some entirely different branch of knowledge. Kepler's second law showed that while the planets do not move with uniform speed in their orbits, there is nothing uncertain or haphazard about their motions; the radius vector, or line joining sun to planet, sweeps over equal areas in equal times. This means that every planet increases its speed as it passes nearest to the sun and gradually slows down as it recedes from perihelion towards the more remote part of its orbit. So, too, the comets moving slowly on the outskirts of the solar system are obedient to the same fundamental law, their velocities increasing as they approach the sun round which they pass at their maximum speeds again to withdraw at lesser and lesser velocities.

The third law discovered by Kepler is often referred to in terms strongly suggestive of music - the harmonic law:- the squares of the periodic times of the planets vary as the cubes of their average distances from the sun. And then as the crowning glory of celestial mechanics, the Newtonian law of gravitation supplied the missing factor of proportionality, namely, the sum of the masses of sun and planet. Here, truly, is an heavenly lyric of surpassing beauty, and universal in its applicability, for whether it be Earth and Moon, or Earth and Sun, or Mars, or Jupiter, or Neptune, or the multiple stars like Algol and Mizar far off in the sky, or even twin galaxies in the remotest depths of space - all revolving systems are radiant embodiments of this celestial lyric.

III.

Without the harmonic law, astronomical knowledge would be very limited. Even within our own solar system we would be unable to measure the masses of the planets, while the masses of the stars would be an insoluble mystery. With the aid of this law, astronomers have weighed the stars, placed our sun as a very average dwarf star, found very few stars as much as one hundred times more massive and not one star as little as one tenth the mass of the sun. Here was a problem which aroused the curiosity of the astronomers. Supposing there were a time when all the matter of the entire galaxy was more or less evenly spread out as a vast gaseous nebula, then with the random movements of the individual molecules or atoms there would inevitably be formed places of greater concentration and these would act as gravitating centres of attraction. Thus stars would be gradually formed from the chaos of nebulosity, but it appears that there are upper and lower limits to the mass of the stars thus formed. How is this accomplished? By what system of weights and measures does Nature apportion out her clouds of gases to form each star - the old problem of Shylock, a pound of flesh, no more, no less - or to be more correct, not very many times more nor very much less. Spurred on by the challenge of this problem, Sir A.S. Eddington pursued a series of theoretical investigations, and when dawn came he had before him a beautiful example of the harmonious balance of natural forces. In the growing star three forces are making a bid for supremacy. Gravitation tends to augment the mass of the star and increase its density indefinitely, by attracting more and more matter to the star and drawing it nearer and nearer to the centre. But the more gravitation succeeds, the hotter grows the interior of the star, like the air compressed into a bicycle tire; and the higher the temperature the greater the kinetic energy of the atoms, hence the faster they move and the greater becomes the second force, the gas pressure, tending to expand the star against gravitation. A third force likewise comes into play more and more vigorously as temperature increases, the pressure of the radiation generated within the star. This radiation is of the nature of heat when the temperature in the star is low, but as temperature rises the star will begin to glow, radiations of the wavelengths of visible light being generated within it. At still higher temperatures more and more penetrating radiations, like X-rays, are generated within, and all these radiations rushing outwards towards the surface of the star, ultimately to escape into outer space, exert an outward pressure buoying up the gases composing the star.

The pressure of light! Not many years ago the most learned man of science would have said that the pressure of light was as unreal, illusory, and fantastic as was the music of the spheres - an intangible figment of the imagination. But today the pressure of light is recognized as one of the major forces of nature. It preserves the equilibrium of the stars by balancing gravitational force; it prevents the stars from growing to abnormal size by blowing off with a mighty ~~rushing wind~~ outrushing hurricane of energy the excess gases that the rival force of gravitation would embrace and enfold with an insatiable hunger; it tosses up clouds of atoms of hydrogen and helium and calcium like spray from the surface of our sun, to heights of half a million miles, and radiating their distinctive lights of red and violet, these lofty clouds excite the wonder and the curiosity of the astronomer. Pressure of radiation is responsible, in part at least, for one of the phenomena which through all the ages has awakened the emotions and imaginations of men, the beautiful spectacle of the long, luminous tail of a comet. Pressure of radiation, acting with explosive violence, is probably the cause of the rejuvenation of a faint star, a phenomenon which occurs in the heavens from time to time and is [redacted] usually referred to as the appearance of a "new star", or nova. What the astronomer observes is the rapid brightening of a star never previously recorded as being other than steadily faint. In the course of a few hours or days its brightness may increase many thousand fold, after which it slowly and fluctuatingly loses its brilliance again. This is in reality a cataclysm of nature of a magnitude unparalled in the whole range of scientific knowledge. We know not how or why, but in such a star there has evidently occurred a sudden liberation of vast stores of hitherto locked-up energy, and this energy being released as radiation exerts [redacted] a pressure so tremendous that it lifts layer upon layer of the star's substance and hurls it outward in all directions with terrific velocity, and the light of the star breaking from its surface and rushing headlong through the turbulent luminous clouds of ejected gases wings its way outward into the vast regions of interstellar space, - ever outward, never slowing down, on and on, year after year, century after century - until in the fulness of time perchance a minute fraction of that out-streaming light falls upon the lens or the mirror of a telescope set up by man on the surface of a very small planet which revolves around one somewhat insignificant star. From lens or mirror this little glimmer of light finds itself hurtling through the prisms of a spectrograph which causes its component rays to spread out in order of wave length like the notes of a musical scale. There, in ordered array, it falls upon the emulsion of the photographic plate. Here its long journeyings come to an end for the radiant energy becomes transformed into chemical energy - the molecular readjustments in the emulsion which develop out as the photographic image of star light. But the transformation of energy takes place in such a way that every detail of the incoming light is retained and preserved in the photographic record. Thus it is possible for the astrophysicist to unravel the majestic story of such a star from the image of its light, just as a musician contemplating a printed score can reconstruct the full grandeur and solemnity of an immortal oratorio.

IV.

In a very beautiful sixteenth century example of the art of wood-cut, there is represented the earth with its hills and valleys, its towns, and its country side with trees, plants and animals; and over it the spherical dome of heaven containing symbolic representations of sun, moon, comets and stars. The dome of heaven rests upon a rim of high mountains, which the ancient cosmologists imagined to extend all around the earth. In the foreground the artist has portrayed a shepherd who, having climbed to the top of one of this chain of encircling mountains, has thrust his head and shoulders through the dome of heaven, and with a gesture of amazement is gazing at undreamed of marvels out beyond. The artist was evidently straining his imagination to the very utmost to conceive of wheels and spokes and strange cloud-like formations to place beyond the dome of heaven to excite the wonder of the adventurous shepherd. But how commonplace, tepid, insipid, and apparently uninspired are his imaginings compared with the actual marvels of the deep regions of space beyond the range of the human vision! By the aid of telescope and photographic plate the remote depths of space have yielded up some of their secrets, and the physicist in his laboratory collaborating with the astronomer has shown us a world of extent and grandeur undreamed of in earlier years.

"Distance unexpressible by numbers that have name" - so wrote John Milton, and we recall that he visited the aged Galileo in Italy and no doubt the latter expounded to him the new views of the universe which his own observations with his astronomical telescope had done so much to establish. No doubt, too, Milton was privileged to see the telescope that Galileo had himself ~~invented~~ constructed, and to [redacted] look upon some of the [redacted] wonders of the external world which no eye had seen until Galileo turned his glass upon them - the four satellites of Jupiter, the ever moving, ever changing, dark areas on the surface of the sun, the star clouds of the Milky Way. Perhaps, too, Milton was shown the great Nebula of Orion, that vast abyss of wildly chaotic gases, some radiating light, some dark and lowering. Is it too great a flight of the imagination to guess that such a sight, perhaps that very sight inspired the lines in "Paradise Lost" -

> "Behold the throne
> Of chaos and his dark pavilion spread
> Wide on the wastful deep".

With the mathematical researches of Sir Isaac Newton a new era dawned - dynamical astronomy came into being; and with the invention by Newton, in 1675, of the reflecting telescope a new tool was placed in the hands of the astronomer by means of which to carve out the picture of still greater depths of space. Sir William Herschel, and later Lord Rosse, made telescopes after the Newtonian model, which revealed the first details of the Spiral Nebulae. Here was something to excite the wonder of mankind. The Andromeda Nebula, to the unaided eye, is merely a hazy, fuzzy ~~little~~ patch of light like a small puff of smoke; but in the telescope it is a vast aggregation of stars arranged in spiral arms extending out from a denser, more nebulous centre. Other spiral galaxies of stars even more striking in appearance were seen for the first time, The Whirlpool Nebula, for example. Today, at several Observatories, intensive study of the spirals is being carried on; more than 20,000 have been noted on photographic plates, while the spectra of the brighter ones are being obtained, and calculations of masses and distances attempted. The nearest of these spirals is so far away that the light from its stars only comes to us after journeying nearly a million years, while some of the more remote are known to be a hundred times more distant.

The study of the spirals has carried us very far away from the geocentric model of the universe. Men thought the earth was the centre of the whole revolving universe; but it was not so. Later they placed the sun at the centre of the system of planets and imagined that the stars lay more or less symmetrically in all directions; but it was not so. Herschel began the task of making systematic star-counts which has been carried on with greater and greater exactitude to fainter and fainter stars until, in recent years, it has appeared that the stars of our great galaxy are arranged in a vast lens-shaped volume of space extending much further out all around one plane than anywhere at right angles to this plane, that our sun is a quite ordinary star situated well away from the centre of the galaxy, so that looking out around us from this little planet near the sun, we see a very lob-sided picture of the galaxy. The Milky Way gives us our bearings relative to this galactic plane, but the number of stars that can be photographed in the direction of the constellations Sagittarius, Scorpio and Ophiuchus far exceeds the number in any other region. This leads to the conclusion that in that direction lies the centre of our galaxy comprising some ten thousand million suns. Perhaps many astronomers thought this was the main part of the material universe, but it was not so. Every one of the thousands upon thousands of spiral nebulae is a galaxy of millions of stars, comparable to our own galaxy.

We turn from the contemplation of the vastest things of which man has knowledge to the smallest things, the atoms and their constituents, the protons and the electrons. There is no greater achievement of the human mind than that which has revealed to us some understanding of atomic structure and atomic radiations. Heat and light from a candle, light from the electric spark that jumps from your finger to your kitten's head as you stroke her in the dark, are these phenomena worth a life long study? Assuredly the answer is in the affirmative for to elucidate these "commonplace" things, is to pave the way towards an understanding of the significance of the sunshine and the secrets of the starlight.

V.

This lure of mystery becomes, in the life of the man of science, a great driving force. It never leads to a life of ease, it rarely leads to wealth, but it brings its own reward nevertheless. When Professor Einstein was awarded the Gold Medal of the Royal Astronomical Society in London in 1926 for starting "a revolution in scientific thought to which, as yet, we can see no end, to which indeed we can hardly imagine an end", to quote from the President's address, his reply revealed the true source of happiness which results from this pursuit of the unknown. This is the translation of a paragraph from his letter of acceptance and thanks:- "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......"

There is a freedom of thought, an unconstrained spirit of adventure in the very atmosphere in which the scientific worker lives his life. Possibly nowhere is this more alive and intensely real than in the realm of cosmological investigation at the present time. In earlier times the average man looked upon the heavens with awe, but it was an awe born largely of ignorance and superstition, a dread that the forces of nature were hostile. Today man likewise looks outward towards the heavens and contemplates the universe with all its, as yet, unsolved mysteries, and he too is conscious of a feeling of awe and wonder, but it is an awe born of certain knowledge that the heavens declare their kinship with the earth - things celestial and things terrestrial are not two, but one in the evidence they bear to the fundamental unity of all nature, the underlying harmony of the universe.

But there is something rigid and creed-like about the average man's beliefs. It is a rude shock to him to find that the absolute truth of an idea of long standing is questionable - whether it be a doctrine of salvation, a doctrine of capital and labour, a law of supply and demand, or a law of universal gravitation set forth for all time (so men assumed) in simple stately terms by Sir Isaac Newton. To such an one it is inconceivable that the men of science can not only view with equanimity but actually welcome the accessions to knowledge which seem to undermine their fundamental theories, to upset their elaborate hypotheses. He sees them as poor unfortunate sailors dangling from broken rigging amid the flotsum and jetsum of a wreck, shaken in spirit and mind, bewildered, disappointed and dismayed. It is wasted sympathy. The sailors dangling in the torn rigging are not broken in spirit, they are not even fundamentally perturbed. This is for them a real adventure and already in imagination they see a yet more stately, more seaworthy ship arising from the wreckage, and all their mental energies, all their skill of experimental technique, are turned towards that task. "A theory is a tool, not a creed"[*] , and often the most valuable achievement to the credit of a tool is that it aided in the making of a still better tool than itself.

* Sir J.J. Thomson, O.M., Physicist, Master of Trinity, Cambridge.

No one familiar with scientific thinking can wade through the interminable *Education* of Henry Adams (interminable is here used quite literally, for one pictures him as still attempting unsuccessfully to complete his education in the spirit world) without being struck with just this static attitude towards the scientific theories of his day. He exemplifies most strikingly the attitude of the average man towards changing scientific thought. He went to Paris about 1900 and there came into contact for the first time with speculative geometry. He found men pondering over the geometry of the world and he was amazed, staggered, shaken to the very foundations of his intellectual being, by the simple utterance of the great Poincaré regarding Euclidean geometry - "I do not know whether it be true, but I know it will always be convenient". We can see how perplexing, how incomprehensible to the average person is the game of the modern geometers who, like children trying to fit together the mosaic of a picture puzzle, have been attempting to fit the observed facts of nature first into a cylindrical universe (Einstein), then into a spherical model (de Sitter), and lastly into a bold new model, the expanding universe of today. (Lemaître)

Quo Fata Vocant - this is the motto of a famous British regiment, the Fighting Fifth, the Northumberland Fusiliers, and it might well be the motto of the typical man of science. Whither the Fates - the Unknown - the Mysteries of Nature call - thither will the feet of the man of science lead him in the great struggle for knowledge. Without dogmatic prejudice, without rigid preconceptions, with untrammelled mind, he carefully and hopefully feels his way forward into the misty regions of thought, while to his ears ever and anon there comes "the deep music of the rolling world".

A.V.D. 1933 March 24.

Subsequent symposia dealt with Internal and external causation of scientific ideas; International cooperation and diffusion in science; Medicine and industrialization in history; Physics and metaphysics in the scientific revolution; Aspects of the history of thermodynamics: theory and practice; Problems of Source Materials in the history of science; Relations between theories of ~~evolution~~ heridity and evolution (1880-1920); Classification and systematisation in the sciences; Cosmology since Newton; and an added symposium Human implications of twentieth century communications technology. All the papers at these symposia were given by invited speakers.

At the same time as many as seven other meetings might be going on to hear and discuss papers on Science and technology in antiquity, or from antiquity to 1600; and developments since 1600 in Mathematics and mechanics ~~since 1600~~; Physics and Astronomy ~~since 1600~~; Chemistry and Pharmacy ~~since 1600~~; Biological and medical science; ~~since 1600~~; Earth sciences ~~since 1600~~; Technology and engineering; ~~since 1600~~; History of sciences of man; Science and society; Problems of philosophy, methodology and historiography.

Some papers of special interest to astronomers and other natural philosophers may be mentioned.

The "father of algebra", Al-Khwarizmi (780-850) was the Court Astronomer at Baghdad. From the title of his work Al-Jabr comes our word algebra. He "transformed number from its arithmetical character as a finite magnitude into an element of relation and of infinite possibilities ... a step from 'being' to 'becoming'." To serve practical needs "he applied algebra to matters of inheritance, legacies, partition, lawsuits and commerce". This paper was presented by Dr A. A. Al-Daffa of Saudi Arabia.

Soviet perspectives on Giordano Bruno (1550-1600) which have been overlooked by western scholars were summarized by F. Hamlyn Dennis (London). These include Bruno's 1591 suggestions that there are yet other planets in the solar system than the six known ones; rotation of the sun and stars around an axis; the existence of innumerable bodies similar to our sun and he opposed anthropocentrism.

K. D. Mathur (U.K) discussed the origins of Indian astronomical observatories as connected with accurate determinations of time for religious ceremonies in the Vedic period, c. 1500 BC. and the great activity of Jai Singh in the early 18th century under the Mogul emperor's instructions.

Fouad Aintabi (Syria) outlined the indebtedness of the first professor of astronomy at Oxford, John Greaves,

* omitted by Editor

to ~~his contemporary~~ Ibn Yunus (950-1009), arab astronomer who contributed to the study of solar and lunar eclipses and to both plane and spherical trigonometry.

*{Interesting papers on Soddy and Fajans and on Soddy at Oxford were given by Lawrence Badash (USA) and A D Cruickshank (U.K.) and on the radioactive isotopes and isomers, so named by Soddy, by N. Feather (Edinburgh).} * E. G. Forbes (Edinburgh) has located hundreds of letters from and to the first Astronomer Royal, John Flamsteed (1646-1719), including correspondence with G. D. Cassini and in latin with Johannes Hevelius of Danzig. Owen Gingerich (USA), continuing his dedication to Copernicus and De Revolutionibus, discussed sixteen copies of the 1543 and 1566 editions in Scottish libraries, with special reference to the two copies in Edinburgh, one of which belonged to Adam Smith, both richly annotated in Wittenburg in the early years of publication.

* Insert * — Other papers on Soddy were given by M. I. Freedman (USA), M. Tanaka (Japan), ~~and~~ T. J. Trenn (Fed. Rep. Germany), J. W. van Spronsen (Netherlands)

V. D. and M. V. Parkadze (USSR) described relations between Georgian and British physicists after 1700. Alexander Bagrationi returned with Peter the Great from Great Britain ~~and~~ where he had been present when Peter I conversed with Isaac Newton. Antony and D. Bagrationi subsequently made known the works of Boyle, Cavendish and Young. Exchange of students with Tbilisi and of magnetic and cosmic ray data between Abastumani and Britain continues.

R. M. Pedersen (Denmark) reviewed the 1782 paper of Patrick Wilson of Glasgow who demonstrated the constancy of stellar aberration by comparing the effect using an ordinary telescope with that of a water-filled telescope tube. S.D. Sharma (India) claimed that the Indian astronomer ~~Ketakar~~ Ketkara made the first accurate predictions of Pluto and also predicted a smaller planet beyond Pluto basing his calculations on cometary orbits especially Halley's comet 1910, after which he wrote to Flammarion giving the positions. For the larger his ~~?~~ distance of about 39 A.U. and period ~~450~~ 242 yrs. agrees remarkably well with the values 39.44 A.U. and 247.7 years for Pluto discovered in 1930, twenty ~~?~~ years after Ketkara's prediction. For the smaller, planet X, his prediction was a period of 458 years and distance 59 A.U. Sharma has calculated the present position of planet X using the constants of Ketkara and some recent data used by Dr Brady of California who is likewise interested in a transplutonian planet.

R.W. Smith (London) spoke of the 1910 – 30 period when speculation ran riot as to the nature of spiral nebulae with reference to the Milky Way system. In this connection letters between ~~Ejnar~~ Ejnar Hertzsprung and Eddington, written in 1916-17 and recently discovered at the University of Aarhus throw light on their thinking. In the discussion which followed ~~this pointed out it seemed~~ this paper and the Cosmology Symposium on the following day, it seemed — To p.6

appropriate to remind the young speakers particularly that as early as 1914 in his Stellar movements and the Structure of the Universe, Eddington had made his own position very clear, namely that the spirals were themselves galaxies completely outside our galaxy; only by adopting this hypothesis did he see any prospect of progress.

M. A. Hoskin (Cambridge) opened the cosmology symposium with a review of the eighteenth and nineteenth century thinking about the solar system, the number of stars and the nature of nebulae and star clusters. J. A. Bennett (London) spoke of the part played by the great reflectors of Herschel and Rosse. N. S. Hetherington (U.S.A.) carried the story into the present century with its tremendous technical developments and wealth of new knowlege, which the contributions of Shapley, Hubble, Oort and others helped to interpret. The advent of radio astronomy opened an entirely new chapter of astronomical observation, both complementing and extending what optical instruments have achieved. The interpretation of all this new knowledge was discussed by G. J. Whitrow (London) who outlined several phases of development of theoretical cosmology. The first began with Einstein in 1917, and led on to de Sitter's solution.

Then in 1922 and independently in 1927 came the models of an expanding universe of A.A. Friedmann and Georges Lemaître, developed further by H.P. Robertson from 1929 - 33. New avenues were opened up by E.A. Milne, Dirac and Eddington. A yet different approach was made by Hoyle, Bondi and Gold in 1948 with their "steady state" assumption. Only as observation has penetrated deeper and deeper into space in the nineteen-sixties has evidence accumulated against this and in favour of the evolutionary universe. And so the quest for a more fully satisfactory theory goes on and on, and will continue to go on as long as new knowledge poses new questions.

Two special events must be mentioned. An opening public lecture by Professor Trevor Soper (Oxford) entitled the Scottish Enlightenment drew attention to the remarkable period when the fame of great thinkers like Adam Smith, Thomas Carlyle, James Simpson and others of similar ~~intellectual~~ stature drew the eyes of all Europe to Scotland as the intellectual centre of the western world. On a subsequent evening in St. Cecelia's Hall, ~~the~~ a fortunate minority of us were delighted with three compositions by Mozart, Borodin and Dvorak beautifully performed by the Edinburgh Quartet.

of Denmark, Kepler of Germany, Galileo of Italy, Sir Isaac Newton in England, LeVerrier in France, Struve in Russia, Hamilton in Ireland, Saha and Chandrasekhar in India, Hale and W.S. Adams in the U.S.A., Plaskett in Canada, Rosseland in Norway, Edlen in Sweden, Kapteyn, de Sitter and Oort in the Netherlands, Yukuma in Japan, Lemaître in Belgiam, Mills in Australia. I have now mentioned men in twenty countries and their contributions to astronomy, both theoretical and observational, span 22 centuries.

Think of the fun you can have with the great lawmakers from Moses and Hammurabi and Solon down the centuries; with poets from Homer and the Hebrew author of Job and Omar Khayyam and Dante as a start; with artists and musicians, or with the makers of medical science. I am convinced that teachers and parents cannot begin too early to direct children's thoughts to our deep indebtedness to people of other countries. ~~and~~ I believe, too, that what children remember best is often the thing that an enthusiastic teacher tossed in out of a blue sky, so to speak, obviously not part of the course on which examinations will be held — just something of so much interest to the teacher that out it comes with a "take it or leave it" attitude, and perhaps for that very reason a not insignificant proportion of the class will remember it -

Space

Thinking in centuries can be a voyage of exploration which carries our thoughts far back beyond recorded history — back with the archaeologists to the citys of Mycene overlooking the plain of Argos ~~and through~~ in the years of Agamemnon and the Trojan wars; back ten centuries further to the city of Knossas in Crete in the ~~[illegible]~~ days of ~~the Minoans~~ King Minas and to Egypt where ~~to~~ the Temples of the early Pharoahs & challenge the imagination; back with the geologist a hundred times even that into the remote past a million years and ~~far more~~ when the early forms of life were evolving from the primitive ~~ocean water~~ cells of living, self-reproducing forms in ocean, on land and in the air.

~~Tennyson has caught the majestic~~

An Arab poet thought in centuries only when he wrote: Men come and men go, but the mountains remain,
Men change but they never.

Tennyson was thinking in units of ten thousand centuries when he wrote of the changing form of the earth's surface:

The hills are shadows and they flow ~~from form~~
From form to form and nothing stands,
They melt like mist, the solid lands,
Like clouds they shape themselves and go.

Astronomers look even farther back than do the geologists. As they look farther and farther out into space with great optical telescopes ~~and the photographic plate, given long exposures,~~ and with ~~the~~ giant radio telescopes, ~~now~~ they are looking farther and farther, back in time ~~into the past~~. Light from the sun takes just over eight minutes to travel the 93 million miles from sun to earth, and over four years to come to us from the next nearest star. Our knowledge of the remote stars of the Milky Way is of how they were radiating 50 thousand or more years ago. As to other galaxies far out beyond the limits of our own, the nearest are distant about two million light years and the most remote photographed to date are five thousand million light years distant. Even within our galaxy astronomers are now finding criteria for estimating the age of clusters of stars, one of which may be seven thousand million years old.

These figures may ~~have~~ mean much to the scientist but the average person is numbed by their magnitude; and so we turn to the poets, one of whom has* ~~The Canadian poet Charles Heavysege has caught the stately drama of the stars:~~

. . . . . . the golden chime
Of those great spheres that sound the years
For the horologue of time;
Millenniums numberless they told,
Millenniums a millionfold
From the ancient hour of prime!

* ~~come on~~
Come on that which is and caught
The deep pulsations of the world
Aeonian ~~Aeolian~~ music, measuring out
The steps of time.

The Canadian poet, Charles Heavysege, has caught the stately drama of the stars thus:

But men do not advance wisely by only looking backward. Alfred North Whitehead has said that "whatever be the subject which we teach, our main task is to inculcate how to inherit, appreciatively and critically. What our students should learn is how to face the future with the aid of the past." If we have given our students the perspective gained by thinking in centuries past, so too they must realize that for many millions of years to come literally millions of years, our sun is likely to maintain conditions on this earth favourable to the continued and progressive life of mankind. Not in our lifetime, but none the less urgently to be worked for, is the fulfilment of Pasteur's far vision, "I hold ~~that~~ the unconquerable belief that science and peace will triumph over ignorance and war; that nations will come together not to hinder but to construct and that the future belongs to those who accomplish most for humanity".

In a world where there is so much evil, so much suffering, where, in W.B. Yeats' words,

The wrong of unshapely things
Is a wrong too great to be told.

let us try to give our students the perspective to think in centuries, the zest and faith to believe that ~~though while~~ though

All things fall, [they] ~~and~~ are built again
And they who build them again are gay.

Let us help them to respond to the challenge of Lascelles Abercrombie in his poem:

This, then, is yours: to build ~~exult~~ exultingly
High and yet more high,
The knowledgeable towers above base wars
And shameful surges reaching up to lay
Dishonouring hands upon your work and drag
Down from uprightness your desires, to lag
Among low places with a common gait.
That so Man's mind, not conquered by his clay,
May sit above his fate,
Inhabiting the purpose of the stars
And trade with his Eternity.