A. Vibert Douglas

Publications

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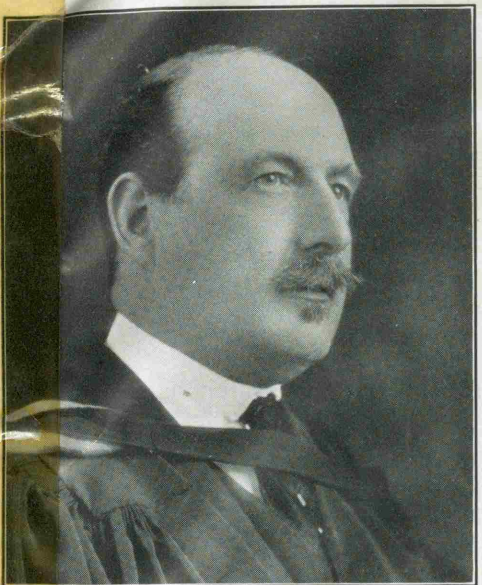
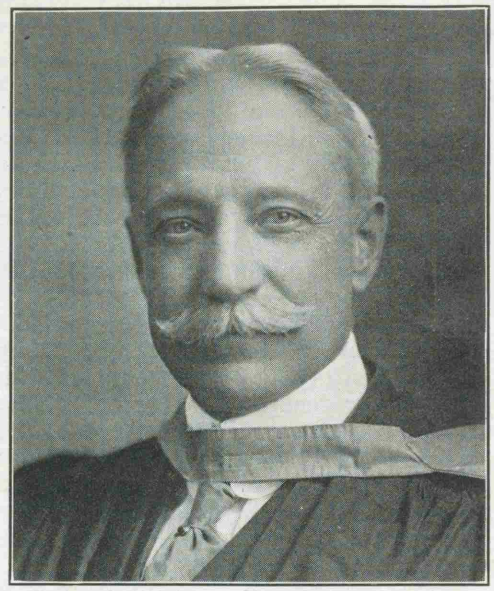


DR. LOUIS A. HERDT, one of the original members of the McGill Physical Society

DR. H. T. BARNES, President of the McGill Physical Society, 1904, 1907, 1914



PROFESSOR N. N. EVANS, one of the original members of the McGill Physical Society

The McGill Physical Society 1897-1915

The history of the McGill Physical Society is of far more than local interest. Beginning as it did in 1897 as a means of bringing members of the teaching staff together to discuss recent problems in physics as met with in their own researches and as reported in some half-dozen scientific publications, it became before five years had elapsed the arena in which new ideas met old ideas in deadly conflict. The eyes of the entire scientific world were for a time focussed upon McGill, as month by month discoveries of the most fundamental importance were revealed, culminating in the law of Radioactive Disintegration. That this has been the basis of so much recent work in Atomic Physics, is common knowledge; that the participants in those early meetings of the Society have, many of them, gone out to other universities in other lands to achieve more and more renown in their chosen fields of labor is well known; that the McGill Physical Society, which they helped to establish as a vital centre of scientific thought, has gone on fulfilling its purpose in the life of this university and has a tradition of which it is justly proud, it is the purpose of this article to recount.

On September 25th, 1897, a meeting was called for the purpose of forming a Physical Society. Those present were H. M. Tory, H. T. Barnes, F. H. Pitcher, L. W. Gill, and R. O. King.

Their object was to discuss original work in progress in the Macdonald Physics Building, to report on current scientific periodicals, and to promote physical research on the University. Professor H. L. Callendar was chosen as the first president, and Professor John Cox as vice-president. Of the original members of the Society, there are on the staff of this University today only three—Dr. H. T. Barnes, F.R.S., Professor N. N. Evans, and Dr. L. Herdt.

During the first year of the Society, perhaps the most interesting record is that of a meeting when Mr. Tory reported upon Sir J. J. Thomson's paper on Cathode Rays, and Professor Callendar tried *unsuccessfully* to obtain magnetic deflection of the rays as stated to have been obtained by Thomson.

In 1898 Professor Cox was president, and the new members included Professors Rutherford, Owens and Walker. It was at this time that the discovery of Radioactivity began to engage the interest of scientists in many countries. In the minutes for Nov. 7th, 1899, is found the first reference to the subject of radioactivity at McGill. Professor Rutherford reported at this meeting his paper upon Uranium Radiation and the Conduction produced by it.

In October of this year Professor Owens described his work on Thorium Radiation in the course of which he had discovered Thorium emanation. In December, Professor Rutherford reported the work of Madame Curie, Becquerel, and De Marcy on the radioactive substances, Radium and Polonium.

For the session 1900-01, Professor Rutherford was president and Dr. Barnes was vice-president. Amongst the new members was Mr. Soddy. At one of the meetings Professor Rutherford gave a demonstration of what was then called "The action of Radium."

An important piece of research was brought before the Society by Dr. F. D. Adams, whose investigations on the flow of rocks under pressure was of the utmost importance. At another meeting Professor Evans discussed the spectrum of radium. Interesting records are those of two consecutive meetings when Soddy and Rutherford led a heated discussion as to the possible existence of "bodies smaller than the atom."

During the following year Professor Durley gave a most interesting paper on the development of aerial navigation, describing the experiments of Lilienthal, Pilcher, Hargraves, Phillips, Langley, Maxim, Zeppelin, and Santos Dumont.

In April, 1902, the first open meeting of the Society was held, experiments being demonstrated to a large audience. It is recorded that "the meeting adjourned with God Save the King, played by Mr. Grier on the Singing Arc."

LIBRARY NOTES

Exhibit of Children's Books

An experiment in a co-operative exhibit was made when the Canadian publishers and Montreal booksellers joined with the library in a display of children's books which lasted from October 18 to December 20, 1924. The purpose of the exhibit was to give parents, teachers, and the friends of children an opportunity to see, not only the books of earlier years, but the best children's books now available, in order that the giving of books as presents and the development of home libraries for children might be encouraged.

The exhibit provided a general survey of books on children's reading, followed by examples of the chapbooks of a century ago, and the books which were favorites of the last generation. Many of these were kindly lent by friends of the Library. Cases of beautifully illustrated children's books were provided by Henry Morgan & Company, Ltd., Chapman's Book Store, Foster Brown Company, Ltd., and Miss Poole, and—a noteworthy feature of the exhibit—hundreds of books were supplied by the publishers to be placed on open shelves where visitors had the opportunity of examining the books at their leisure. The thanks of the Committee are due to Mr. H. Burton for his kindness in obtaining this material from Thomas Allen & Co., Blackie & Son, Copp Clark Company, Goodchild, Harcourt Brace Co., Hodder & Stoughton, Longmans, Green & Co., McClelland & Stewart, Macmillan Company of Canada Ltd., Thos. Nelson & Sons, Oxford University Press, and Ryerson Press. The exhibit was attended by over 500 people, among whom were a number of teachers and their classes.

Exhibit on Archaeology of the Mediterranean

On January 8th, Count Byron de Prorok, one of the most prominent of the younger excavators, gave a lecture, illustrated with motion pictures and colored slides, at the Royal Victoria College, on the ruins of Carthage and North Africa. In connection with this lecture an exhibit illustrating the archaeology of the Mediterranean was arranged in the Library Museum. The chief objects of interest were some of the sacrificial urns, lamps, jewellery, and early Christian relics excavated from the Punic tombs at Carthage last winter by the Count de Prorok, and Major Fred C. Shorey, who represented McGill on the expedition. A number of these objects have been presented to the University for its archaeological collection. Other cases were arranged to show the debt of modern life to archaeological research and the methods of the archaeologist. The exhibit gave opportunity for the display of fine illustrated books from the Library shelves on prehistoric archaeology, Egypt, Babylonia and Assyria, Greece, Asia Minor, Africa, and Italy. In each case the illustrations in the book were made more concrete by the display of a few fine examples of the art of each of these countries lent by the Art Association, Mr. F. Cleveland Morgan, Professor Ramsay Traquair, and Mrs. Arthur Colville.

This material was reinforced by the archaeological collection of the Affiliated Theological Colleges displayed in the reading room gallery to which five very interesting Armenian manuscripts have recently been added as the gift of Mr. E. C. Woodley.

There is at present throughout the United States a renascence of interest in archaeology and it is to be hoped that this subject, which has been somewhat slighted at McGill in the past, will take its place in the curriculum a sa study of wide historical and cultural value.

Sir Herbert B. Ames has presented five large ca[...] books from his parliamentary library; and Will[...] F. Gronau has given a collection of 453 [volu]mes o[f] general literature.

Gifts of special interest have been received [from] Beatrice Hickson, Mr. George Iles, Mr. F. Cl[...] Morgan, Mrs. Frits Holm, Miss A. E. Redpath, Mr. F. L. Wanklyn.

Dr. Casey A. Wood is at present in Ceylon lecturin[g] and preparing articles on birds. He has arranged for a series of paintings of Indian birds to be specia[lly ma]de for the Library.

Mr. G. M. Gest has placed on exhibit as a lo[an] a very fine example of a Lo-Pan or Chinese horoscope [and] compass combined.

Mr. and Mrs. R. R. Blacker have recently ma[de a] special gift of $7,321, for rare manuscripts and set[s of] periodicals for the Library of Zoology.

Inter-library loans continue to increase and t[he] catalogue of scientific periodicals in Canadian librari[es] has been of great assistance in extending this type o[f] library service.

A university bibliography of publications by member[s] of the staff from September 1, 1922, to June 30, 192[4] will be found as Appendix II (pp. 55–79) of the Annu[al] Report of the Principal for 1923-24.

The number of reprints of articles by members of th[e] university included in the series of university publ[i]cations has now reached a total of 186. The followin[g] have been added since September 1, 1924.

Addresses and Lectures—Currie: Canada Needs [a] Super-Civil Service; Smith: Judicial Control of Le[gis]lation in the British Empire. *Botany*—Scarth: The T[...] Action of Distilled Water and its antagonism by cat[ions;] Lloyd: The Vegetation of Canada; Lloyd: Conjuga[tion] in Spirogyra; Scarth: Can the Hydrogen Ion Conce[ntra]tion of Living Protoplasm be Determined? *Chemi[stry]*—Maass: Molecular attraction and molecular combi[nation] (bound together) Johnson & Larose: The diffusio[n of] oxygen through silver; *and* Dolid: Simple device [...] sodium flame; (bound together) Whitby & Mathe[...] Some heavy-metal salts of disubstituted dithiocarb[amic] acids; *and* Macallum & Whitby: Note on the mole[cular] refraction of natural and methyl rubber; Hatch[er &] Holden: Hydrogen peroxide as an oxidising agent i[n a...] solution. II; Maass & Morrison: Effect of Mole[cular] Attractions on the Total Pressure of a Gas Mixt[ure;] Whitby: The Acidity of Raw Rubber. *Enginee[ring]*—Von Abo: Secondary stresses in bridges. *Geology, [Miner]alogy and Metallurgy*—Graham: Mines and [...] Deposits of Canada. *History and Economics*—[...] McGill and Her Builders. *Medicine*—Abbott: [...] accessions in cardiac anomalies; Abbott: Lectures o[n the] history of nursing, with descriptive list of lantern sli[des;] Abbott & Dawson: The Clinical Classification of C[on]genital Cardiac Disease. *Physics*—Hachey: The ro[...] of melting ice suspended in benzine; Bieler: The [...] angle scattering of a-particles by light nuclei; S[...] note on the formation of heavy ice in a cryophorou[s...] The optical projection of the tracks of alpha par[ticles.] *Reports*—Annual Report of the Governors, Prin[cipal] and Fellows, 1923-24. *Art and Architecture*—Traq[uair:] The old architecture of the Province of Quebec.

The sixth year of the Society found Professor Rutherford again as president. His work on Thorium and Radium indicated that there are given out "three distinct types of radiation differing widely in their penetrating powers and intensities; that these two properties are inversely proportional to each other; that of these three rays, Alpha, Beta and Gamma, the last is by far the most penetrating." Mr. Soddy spoke on the Cause and Nature of Radioactivity, describing the separation by Professor Rutherford and himself of a substance which they called Thorium X, because of its similarity to Uranium X, discovered by Crookes. The following entry in the minutes must be quoted:—"The possibility of separating Thorium from its Radioactivity was discussed, but was shown to be an impossibility on the assumption that the rays are due to a disintegration of the atoms of Thorium."

Mr. Allan carried out an examination of the radioactivity from freshly fallen snow; Miss Gates examined temperature effect on excited activity; Mr. Cook studied the penetrating radiation from the earth's surface: and Rutherford and Soddy condensed radium emanation at about—150°C,—all of these phases of original research being reported to the Society.

It was at this time that Professors Owens and Herdt, began a valuable series of experiments upon the guidance of ships in difficult channels by means of a submerged wire carrying an alternating current.

In March, 1903, Rutherford announced his discovery that "Radium has the property of keeping itself at a temperature slightly above its surroundings, probably about 1.5°C."

Amongst the new members of the Society in its seventh year, 1903-04, were Mr. A. S. Eve and Professor Harkness.

Reports were given by Professors Rutherford and Barnes on the proportion of the heat emission of radium which is due to the radium itself and the proportion due to its emanations. During this session came Rutherford's announcements that the activity of radium was independent of concentration; that radium emanation is unstable, three distinct changes taking place in succession; and that radium has the power to ionize gases.

Dr. Barnes was elected president of the Society in 1904. In December a resolution was passed as follows: "that the McGill Physical Society express its deep appreciation of the great honor done to Professor Rutherford in the award of the Rumford Medal by the Royal Society of London for his researches in Radioactivity."

Amongst the papers presented to the Society were Ionization of gases by Rontgen and Radium Rays by Messrs. McClung and Eve; Radioactivity of Actinium by Dr. Godlewski; Heating Effects of Gamma Rays from Radium by Professors Rutherford and Barnes.

For the session of 1905-06, the presidency was held by Professor Cox and for the following year by Mr. A. S. Eve. An important paper was given by Professor Rutherford upon the Origin of Radium in which he gave evidence for believing that radium is a product of uranium. Other valuable contributions during this year were by Mr. Eve on the amount of radium in the earth and of radium emanation in the atmosphere; by Dr. Bronson on the constancy of the activity of radium throughout the temperture range of —180°C to 1600°C; by Professor Rutherford on the "production of radium from actinium."

In 1906 the congratulations of the Society were conveyed to Professor H. L. Callendar on the award of the Rumford Medal.

In 1907, Dr. Barnes was elected president, and his paper on Ice Formation is the first reference to a subject to which in subsequent years he devoted so much time and thought and to which he is still making most valuable contributions.

On January 30th, 1908, the Society held a public meeting at which an address was given by Professor Cox on "The Life and Work of the late Lord Kelvin," whose death had just taken place.

During the following session, 1908-09, when Professor Cox was president, an important paper was given by Mr. L. V. King on Vortex Rings and the Vortex Atom Theory of Matter. Mr. Higman, of Ottawa, lectured to the Society on electrical units and standards, reference being made to the work inaugurated at McGill on standard cells by Drs. Barnes, Bronson and Shaw. Another interesting contribution to the Society's meetings was made by Professor Harkness who spoke on the theory of the top.

In 1909, Dr. H. A. Wilson was elected to membership and to the Presidency of the Society. His paper upon the Relative Motion of Earth and Ether, the Michelson-Morley experiment and Ether Drag Theory is of unusual interest as it is the first mention before the Society of an experiment which has set in motion so many wheels of thought, leading the way to the revolution in ideas to which the scientific world is now endeavoring to adjust itself.

The President of the Society in 1910 was Dr. A. S. Eve, and amongst papers which are recorded must be mentioned Microthermometer Measurements of Marine Temperatures and the Measurement of Long Heat Waves, by Dr. Barnes; Atmospheric Absorption of Light by Mr. L. V. King; and Electron Theory and Positive Electricity by Dr. Wilson.

In February 1911, it is recorded that "Dr. Wilson moved a vote of congratulation to Dr. Barnes on his election as F.R.S."

The outstanding paper of the following year, when Mr. F. M. Day was president of the Society, was given by Dr. H. A. Wilson on the "Principle of Relativity." The position at that time can perhaps best be appreciated by the following entry in the minutes:—"The only experimental method by means of which the Principle of Relativity may be tested and one capable of yielding positive results is the determination of the variation of the mass of the electron with its velocity. This final experimental step was accomplished by Bucherer and showed that the variation of the ratio of the charge to the mass with velocity was that demanded by the Relativity Theory. The Principle of Relativity is now generally considered to be established experimentally and is assigned a place beside the Second Law of Thermodynamics as one of the general foundation principles of theoretical physics."

In 1912-13, Dr. Barnes reported further work on Icebergs; Dr. Eve on X and Gamma Rays; and Mr. King on Hot Wire Anemometry and on Fog Signal Machinery. In the following year Mr. A. N. Shaw described his investigations on the interference of Gamma Rays and on Contact Potentials.

In January, 1914, the Society cabled its congratulations to Sir Ernest Rutherford upon his knighthood, and in April of that year Sir Ernest visited McGill and addressed a large and enthusiastic open meeting of the Society upon the Detection of Atoms and their Structure.

Dr. Barnes was elected President for 1914-15. An important paper was presented by Dr. Eve on the Detection of a Single Electron. A special meeting was held on December 23rd, when Sir Ernest Rutherford again visited the Society and spoke upon the Spectrum of X and Gamma Rays.

The first sound of the great conflict which had been raging for six months in Europe, to be re-echoed from the pages of the Records of the Physical Society was on February 2nd, 1915, when Mr. L. V. King described the Marconi Military Wireless Apparatus.

It is not the purpose of this article to carry the story through the difficult years of war nor through the years of of readjustment that have followed. The scientific work of various members of the Physical Society during the war, work done both overseas and at home, should some day be recorded by one of those who participated in that mighty effort to apply the knowledge and technique of the scientist to the problems of warfare by land, sea and air.

While this article has confined itself mainly to the records of research carried out by the members, it must not be forgotton that the Society performs a dual function in accordance with the aims of its founders, namely, the presentation and discussion of original work and the dissemination of knowledge relating to the advances made by other workers in every related field of investigation. Thus the minutes record papers reviewing work done on every conceivable branch of physics and on the physical aspects of many problems belonging more directly to the fields of chemistry, biology, medicine, agriculture or engineering. One cannot glance through these records without being impressed with the fundamental place occupied by Physics among the Sciences—Physics both mathematical and experimental.

In these days of intense specialization and with the multiplication of scientific journals which pour into a library week by week, there is every possibility of an individual becoming engrossed in one line of work to the almost complete exclusion of a knowledge of progress in other branches. But the front line of knowledge must be pushed forward as a whole, not at isolated points only, and the pioneers at any one point must be kept aware of progress along the whole line. This is where the McGill Physical Society plays such a vital part in the life of the University, bringing together ever and anon workers in many fields and impressing upon all whom it influences the truth of the statement—*All Science is One Science.*

A. VIBERT DOUGLAS, Macdonald Physics Bldg.
February, 1925

Carthaginian remains exhibited in the Library Museum, Showing sacrificial urns, lamps, spear-head and early Christian relics. (*See Library Notes, page 23*)

METEORS[1]

By A. Vibert Douglas

NATURE can furnish pyrotechnic displays on a far vaster scale than most people imagine, for although everyone from childhood is familiar with the "shooting star," as a meteor is often called, comparatively few people witness the periodic returns of meteor swarms which at certain seasons of the year and in certain parts of the sky present a striking display. Still fewer have been privileged to see the heavenly fireworks in all the glory of the displays of 1866, 1833, 1799 and earlier visitations.

In the early hours of November 12, 1799, the noted naturalist and explorer, Baron von Humboldt, records that for three or four hours the sky, as seen from the coast of Venezuela, was ablaze with hundreds and hundreds of meteors,—some faint, some outshining the planet Jupiter, some comparable only with the moon, many leaving trails of luminosity stretching over ten degrees of sky, others bursting like skyrockets, and yet others again going out as suddenly as they had appeared. About thirty-three years later this magnificent display was again seen, and once more in 1866, but since that time no such spectacular display has recurred, though each year, and particularly last autumn, they have been looked for.

Lesser swarms of meteors, however, are encountered by the earth at certain seasons each year, and observation has shown that if the tracks of the meteors seen at certain seasons be drawn on a chart of the sky the great majority will be found to have travelled in directions which appear to radiate from a definite point. Thus these November 9th to 16th meteors are called the Leonids since their radiant lies in the group of stars known as the constellation of Leo, the Lion; the Andromedes come towards the end of November, the Geminids are at maximum on December 11th, the Lyrids about April 21st. The August meteors are known as

[1]Broadcast by request of the National Council of Education over CKAC, Montreal, November 27, 1931.

Perseids because their radiant point is in the constellation of Perseus. Every year, about August 11th, these meteors are most abundant, and for several nights following this date, anyone interested in meteoric phenomena may be well repaid for spending an hour or more about midnight or better still in the early morning hours watching the sky and noting how many meteors appear, how great a variety and diversity of types there are, and whether their apparent paths if projected backwards do indeed point to the constellation of Perseus. In addition to these there are many other annual showers.

The question naturally arises as to what these meteors are. Direct knowledge of their substance is possible because occasionally one is seen to fall to the earth and many such meteorites have been found or dug up in various places. They are stony bodies, sometimes almost entirely iron-nickel alloy, varying in size from a grain of sand to a great mass of several hundredweights. In fact, in Arizona there is a huge meteor crater made, it is surmised, by the fall of an immense meteoric body of many thousand tons which has buried itself deep in the earth. There are no records as to when this fell. Most museums have specimens of meteorites, and it is noticeable how often the surface layer shows definite signs of intense rapid heating, so intense that fusion has resulted and so rapid that the great surface heat has not had time to penetrate far inwards. This heat is the result of friction. A stony fragment almost as cold as the outer space through which it has been moving, in some orbit probably about the sun, suddenly enters the earth's atmosphere and, caught in the gravitational field of the earth, it swoops downward through the air. So great is the velocity that the friction between its surface and the air molecules gives rise to sufficient heat to cause its surface to become luminous and glowing, yet in the upper atmosphere the air is not dense enough to carry off the heat thus produced. The vast majority of the meteors seen in the sky never reach the surface of the earth, being completely burnt up before ever gaining the lower regions of the atmosphere.

If a small portion or chip of a meteorite be fused in an electric arc in front of a spectroscope, a photograph may be obtained of the spectrum of every element of which the meteorite is composed. Thus it has been proved that these bodies are composed of well-known elements—iron, nickel, cobalt, chromium, magnesium, sodium, calcium, silicon and also the less common terrestrial elements gallium and rubidium.

Much can also be learned by observation of the meteors which never reach the earth. Thus in 1798 two students of the University of Göttingen, Brandes and Benzenberg, stationed themselves a few miles apart each with a watch and a star chart on which he drew the path of every meteor observed, with a note of the time of appearance and duration of flight. Comparison of their records made possible a calculation of the distance of the meteors from the observers, the length of the path traversed in a known time and hence the speed of the meteor. The result of their investigation was to indicate that the average height of a meteor, when seen, is sixty miles. It is evident that higher accuracy may be obtained if photographic methods be employed. Several observatories have made extensive efforts to photograph meteors and much has been learned as a result of work in Russia, at the Harvard and Yale observatories, and in Great Britain.

In general, it may be said that the average meteor travels twenty-six miles per second, appearing as a luminous body at about 76 miles above the surface of the earth and disappearing at a height of 51 miles. The apparent track across the sky depends, of course, upon the direction of flight, being short if the meteor is approaching nearly head on, whereas if the flight is more nearly tangential, the path appears more elongated.

The apparent radiation of meteors from a certain constellation is entirely an effect of perspective; they have not actually come from those stars—the earth has, in fact, encountered a swarm of meteoric bodies travelling through space in roughly parallel paths. The study of the paths of meteor swarms has led to the interesting fact that certain swarms follow orbits like comets. The orbit of the Perseids seems to be that of a great comet of 1862 whose period is 120 years. This means that though the comet only passes near enough to the sun to be visible from the earth once in 120 years, there is a certain amount of fragmentary matter distributed all along its great orbit, and since the earth's orbit overlaps the comet's orbit at a certain place each year, we encounter and capture some of these meteoric fragments. The Leonids are in the orbit of Tempel's comet of 1866, whose period is about 33 years, so that it will pass close to the sun next November; the Andromedes follow the orbit of Biela's comet, which, at its 1846 return, was seen to have disintegrated to a considerable degree and which since then has disappeared entirely, the meteor swarms being evidently the last remnants of the lost comet.

It has been estimated at Harvard Observatory that a thousand million meteoric particles, averaging 2 mg. mass each, fall into the earth's atmosphere every day. It is obvious how important a rôle is played by this protecting blanket of atmosphere which catches and vaporizes all but the exceptionally large meteors long before they reach the surface of the earth.

A Princeton astronomer has calculated that the meteoric bombardment of our sun augments its mass 60 tons per second; but when we remember that by reason of its out-pouring of radiation, light and heat, it is losing four million tons of mass per second, we realize that the infall of meteors is trifling indeed in comparison with the outflow of energy.

Some meteors of exceptionally high velocity, up to 100 miles per second, have in all probability come not from fragmentary matter describing orbits within our solar system, but from inter-stellar space. The earth revolves about the sun with an orbital velocity of about 18.5 miles per second, a body falling freely from outer space toward the sun would pass the earth's orbit travelling about 26 miles per second; thus a meteor with a much higher velocity must have in addition to the velocity imposed upon it by solar gravitation and by terrestrial gravitation when it got within close distance of the earth, a velocity of its own which has brought it across vast regions of space before it entered our solar system.

It is just because some meteors may give us information regarding far-off regions of space, that the study of meteors forms a definite branch of astronomy.

Meteorites were often regarded with superstitious awe and veneration in early times, and there are frequent references to them in historic records, particularly in early Chinese chronicles. In one of these it is recorded that on a dark night in the year 687 B.C. "stars fell like rain."

Pliny tells of a meteorite "as large as a cart" that fell in Thrace in 467 B.C. This became an object of worship in one of the Greek temples. A famous meteorite, weighing 260 lbs., no doubt of the Leonid swarm, fell in Alsace on November 7, 1492. It buried itself several feet deep in a wheat field, but it was dug up and placed in the church of the adjacent village by order of the Emperor Maximilian.

In conclusion, we should remember that meteors, no less than the greatest of the celestial bodies, give evidence of the essential oneness of the universe—atoms in the earth, in our sun, in a meteoric fragment or in a far-off star are all bound together in a great unity, being what they are and where they are because each is what it is and the law of its nature is a universal law of all nature.

A meteor may be a very small fragment of matter in this vast universe, shining for but a fraction of a second, but in accordance with the motto of the Royal Astronomical Society of London, "Quicquid nitet notandum"—Whatever shines is to be noted.

In Memoriam: Mrs W E McNeill

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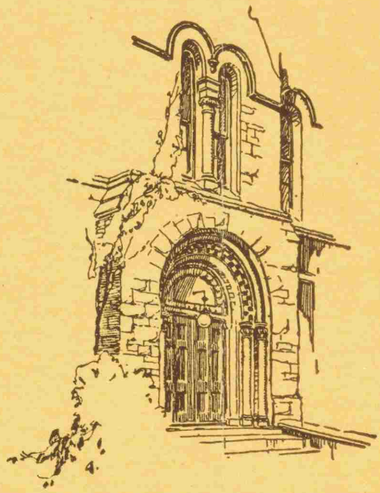

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TABLE OF CONTENTS

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THE LATE MRS. W. E. McNEILL
Whose death occurred at Kingston on March 29, 1948.
The above photograph was taken at the time Mrs. McNeill was Dean of Women.

The Queen's Review

VOL. 22 KINGSTON, ONT., APRIL, 1948 NO. 4

MRS. W. E. McNEILL

An Appreciation by Dean A. Vibert Douglas

HUMAN life is a garden in which grow great and small trees and many kinds of flowers. I shall have to leave it to others to find the symbolism for her early active years. For me, who knew her only during the last decade of her long life, it is as a little flower that I think of Mrs. W. E. McNeill. She rejoiced in the sunshine, in the beauty of the night sky, in the play of the wind, the falling of the dew, and the scents and sounds of the garden of life. She radiated kindliness and her gentle influence will live on in the lives of past students and in the memories of a host of friends.

Caroline Libby was born in Pittsfield, Maine. Her education was many-sided. In Boston, in a Quebec convent, in Paris and Berlin, in foreign travel, she acquired a mastery of French, German, Italian, and Spanish. At Bates College in Maine she took degrees in natural science; and there she held the positions of Dean of Women and Professor of French for several years.

In 1906 she was married to Dr. W. E. McNeill. They went first to Harvard and then, in 1909, they came to Kingston to make it their home for thirty-nine years.

In 1911 Mrs. McNeill was appointed Adviser of Women, and in 1918 she became the first Dean of Women at Queen's University. She served with gladness and devotion in this capacity until 1925. Subsequently she lectured in the Department of Spanish and gave special instruction in Italian. Her interest in her students never flagged and the names, faces, and achievements of many of them remained clearly in her memory to the end of her life.

Considerable travel on this continent, in Great Britain and in Europe, especially two visits to Italy, greatly enriched her life. It brought to her new experiences of beauty—and beauty in nature, in art, in literature, and in thought were prime necessities of her life.

In the later years her garden, poetry, music, and science continuously gave her much joy. She read poetry with deep feeling and she often found satisfaction in the exercise of her own gift for poetic expression. Until failing health prevented her, she was active in the Faculty Women's Club where her kindly and friendly spirit made many a newcomer feel a warmth of welcome.

Perhaps in nothing else was her character so revealed as in her dependence upon and her devotion to her husband. In his achievements as a scholar, his successes as an administrator, his eloquence as a speaker, and in the honours which came to him as Professor, Treasurer and Vice-Principal, Mrs. W. E. McNeill found her greatest joy.

On March 29, 1948, a rare and fragile flower folded up its petals and a gentle spirit entered into the unseen world.

Tribute

. . . . . . Many letters have come to Dr. McNeill from old students and friends, emphasizing over and over again a few, simple, fundamental characteristics of a great lady. Her loyalty to Queen's and its students, her kindness and wisdom, her gracious hospitality and quiet friendship, her understanding and ability made a deep impression on those who came into the circle of her influence. . . . . .

From the minutes of the Faculty Women's Club.

WORLD HEALTH ORGANIZATION

An account of the Fourth Session of the Interim Commission held at Geneva August 30 to September 13, 1947, by Malcolm R. Bow, Arts '08, Med. '11, D.P.H., Deputy Minister of Health of Alberta

THE World Health Organization was established at a Conference in the City of New York in July, 1946, which was attended by voting delegates from fifty-one nations and observers from thirteen nations (not members of the United Nations). Three major acts were concluded by the Conference: the signing of the charter of the World Health Organization; the appointment of an Interim Commission; and the transfer to the World Health Organization of the work of L'Office, International d'Hygiene Publique of Paris, created in 1907. The most important achievement of the Conference was the adoption of the constitution—a Magna Charta of public health—which was signed on July 22, 1946, by fifty-one United Nations members and ten non-member nations.

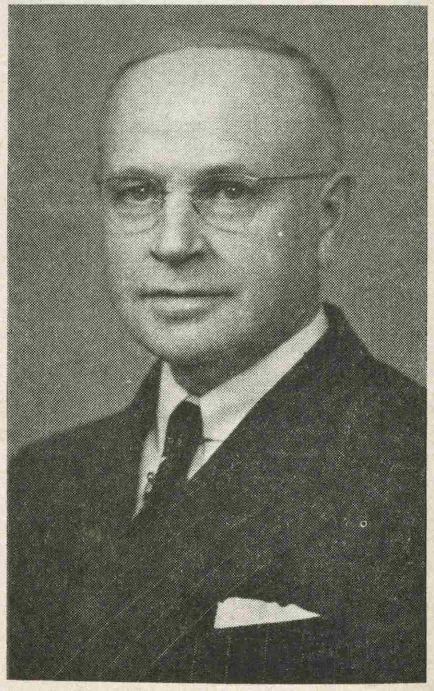
The Interim Commission which was set up to carry on until the permanent organization comes into operation, consisted of representatives of eighteen nations, namely, Australia, Brazil, Canada, China, Egypt, France, India, Liberia, Mexico, The Netherlands, Norway, Peru, Ukrainian S.S.R., U.S.S.R., United Kingdom, United States, Venezuela, Yugoslavia. All the above mentioned nations with the exception of Liberia, Mexico, and the Ukrainian S.S.R., were represented at the September, 1947, Conference.

The Canadian delegation was composed of the following: Dr. G. D. W. Cameron, Med. '27, Deputy Minister of National Health, Ottawa; Dr. T. C. Routley, General Secretary, Canadian Medical Association, Toronto; Dr. Leon Gerin Lajoie—a former President of the Canadian Medical Association; Mr. John Halstead of the Department of External Affairs, Ottawa; and the writer.

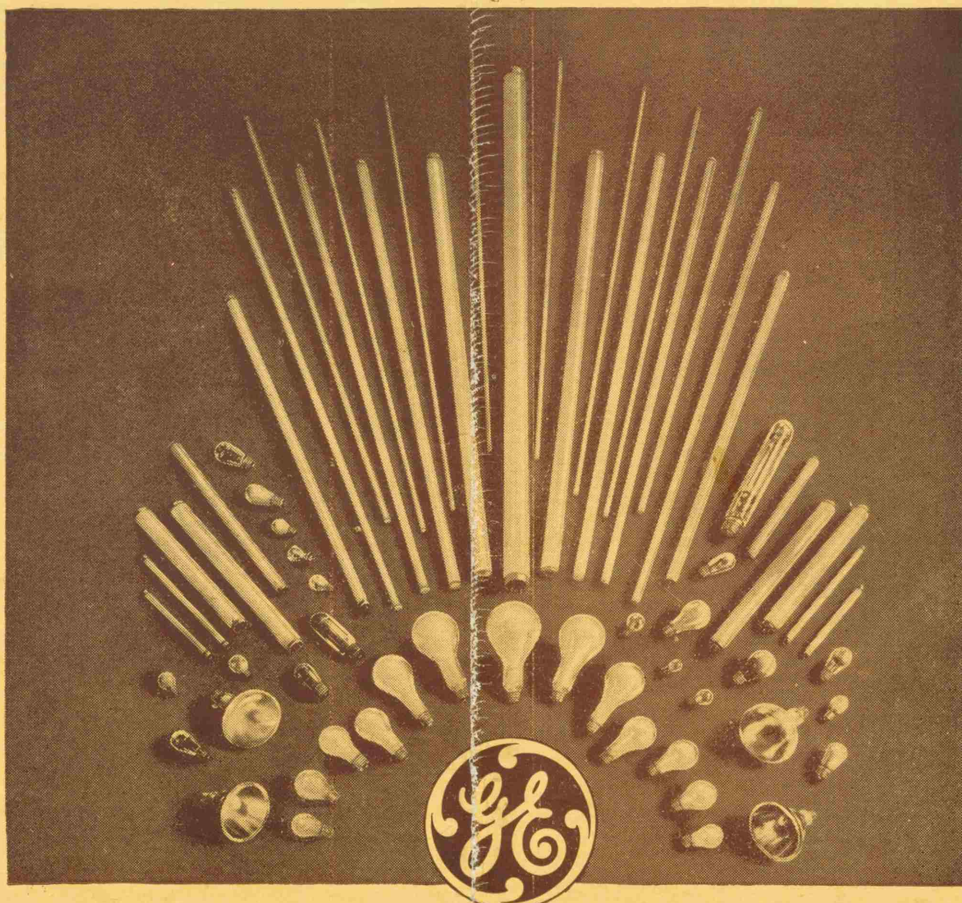
Observers were present, representing a number of International Voluntary Organizations: The United Nations, UNESCO, International Relief Organization, International Labour Organization, International Children's Emergency Fund, International Civil Air Organization, L'Office International d'Hygiene Publique.

The various delegations consisted of from one to five members and it was a most stimulating experience to meet the leaders in public health from various parts of the world and to take part in the deliberations of the conference. It is hoped that the constitution of W.H.O. will have been officially ratified by a sufficient number of nations to enable the first meeting of the World Health Assembly to be held during the present year, as it is important that the permanent organization be in operation without further delay.

Among the interesting personalities at the Conference were the following: Dr. Aly Tewfik Shousha Pasha, representative of Egypt; Doctors P. Z. King and Szeming Sze, representatives of China; Lt.-Col. C. Mani, representative of India; Dr. C. E. Paz-Soldan, representa-



DR. M. R. BOW



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A MULTIPLE RAINBOW SEEN ON THE ST. LAWRENCE RIVER.

BY

By A. Vibert Douglas

Reprinted from the Journal of the Royal Astronomical Society of Canada
October, 1929

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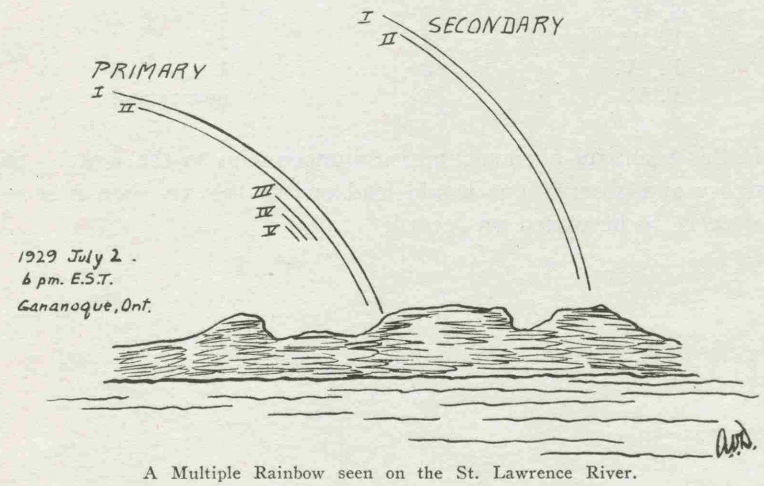
1929

A MULTIPLE RAINBOW SEEN ON THE ST. LAWRENCE RIVER.

By A. Vibert Douglas

On July 2, 1929, at about 6 p.m., E.S.T., a gusty west wind brought showers over the Thousand Islands near Gananoque, Ontario, and a rainbow was seen having certain features never before observed by the writer.



A Multiple Rainbow seen on the St. Lawrence River.

The primary bow was very intense. The violet of its inner edge merged into another but fainter red, yellow, and green bow. The fainter secondary bow also showed this double effect. But the unusual feature was that near the base of the primary bow there were clearly visible, for several minutes, a third and fourth reddish-violet band and momentarily a fifth was distinctly seen against the dark grey-blue background of the sky. Between the third and fourth a faint yellow and green were just distinguishable, but only the red-violet bands of the fourth and fifth were seen. The accompanying sketch indicates approximately the positions of the successive bows, as drawn immediately afterwards from memory. The following estimates of relative intensities are likewise from memory and are based on an arbitrary scale with 1 for the bow just visible P.V. and 10 for the intense outward rim of the primary bow P.I.

Rainbow	Relative Intensity	Approximate Duration.
P. I.	10	5 min.
P. II.	8	5
S. I.	7	5
S. II.	5	5
P. III.	4	2
P. IV.	2	1
P. V.	1	momentary.

If this beautiful phenomenon is as uncommon as the writer's experience and observations would lead one to believe, then it seems to deserve to be placed on record.

[*Reprinted from "Discovery," Vol. X, No. 118, October, 1929.*

The Mystery of Motion.

By A. Vibert Douglas, Ph.D.

Macdonald Physics Laboratory, McGill University, Montreal.

After discussing the various kinds of motion observed in the universe, the author asks whether astronomers have reached the climax in their survey of the motion of heavenly bodies. Interesting possibilities arise.

"NEVERTHELESS it moves"—Galileo, the aged thinker, bowed down in body and weary in spirit before his inquisitors, may not have spoken these words of stubborn defiance, but there is no doubt whatever that they represent the secret thought of that mighty intellect, in spite of the outward recantation forced from his lips in that tragic hour. Gone was the static earth of early eastern thought, gone was the geocentricism of the Chaldeans and of the majority of the Greek thinkers. Aristarchus of Samos had speculated more wisely than he knew, and the cautious Copernicus had set forth with compelling logic the theory of a rotating and revolving planet.

Still Unsolved.

The mystery of motion ! This substantial earth, this *terra firma* beneath our feet, is not the motionless centre of the universe, but is a spinning, wobbling, curving, swerving, ever moving speck of stellar substance tracing out some exquisitely intricate path in the immensities of space. Three centuries have rolled by and still there are wise men striving to unfold the mystery of the true motion of the earth. Much has been learned but, like the evening mist in the Tyrolean mountains which dissolves away as you approach only to close in again with elusive, rosy fingers beckoning you towards the next defile, so this mystery of motion leads the astronomer on and on towards the hope of full understanding only to baffle him again with vague suggestions of motions on a still vaster scale—motions and yet other motions superimposed on the motions of which he has certain knowledge.

Let us try to visualize the path in space followed by a point on the earth's surface. You, reader, may be the point, and perhaps you are situated near Lat. 51° N., Long. 0°. If the earth had no motion except its spin, the diurnal rotation on its axis which gives the succession of night and day, then you would describe a succession of perfect, coincident circles. Wearying of this monotony, you might wander about a little, walk along the street, cycle about a quiet countryside, motor to a neighbouring town and back—then your path or locus would no longer be a perfect circle but would show minute irregularities, small deviations from the smooth line, loops, cusps, curves, and microscopic zigzags. If, venturing further afield, you travelled towards the equator, your locus would become an expanding spiral. If you approached the poles, the spiral would grow smaller and smaller until at either pole your locus would shrink to a point.

But conditions are not so simple. The axis of the earth is not fixed in direction, but is wobbling like that of a slowly spinning top. Thus, instead of a succession of perfectly coincident circles we have each successive one tilted slightly relative to the previous one, and thus we picture a distorted closed spiral, bent, flattened, warped. This wobble is known as Precession, and is caused by the gravitational pull of the moon and the sun on the earth's equatorial protuberance. One complete wobble takes place in about 25,800 years, so that this effect upon the locus is barely perceptible from day to day, yet cumulatively it is very great. A further complication is introduced by the fact that this wobble is itself uneven, being now greater, now lesser according to the relative positions of moon and sun with reference to the plane of the earth's equator. The sinuosity thus imposed upon the precessional wobble is known as Nutation.

Thus, due to spin and wobble alone, a dweller at the equator is being carried through space at a speed of about 29 miles per second, while he who lives in Lat. 51° is borne around his spiral path at about 18 miles per second.

Orbital Motion.

As John Kepler discovered in the seventeenth century, the earth's orbit about the sun is an ellipse. In a little more than 365 days the earth makes its complete journey of something like 580 million miles around this orbit. Apart altogether, then, from spin and wobble, every point on the earth is being rushed through space around and around the sun at the rate of about 19 miles per second. The speed is greatest when the earth is in the part of its orbit nearest the sun, and decreases somewhat when at apogee or greatest distance from the sun. Endeavour now to combine these motions : the daily rotation, the long period wobble, and the yearly revolution. Truly it is a fantastic and beautiful locus that is being traced out by each of us as the hour-glass measures the passage of time.

It was the inspired researches of that rare genius Sir William Herschel that first gave mankind the vision of a yet vaster motion which we were undergoing together with the sun, the moon, and all the planets and satellites of the Solar System. Close observation of the stars had revealed the fact that they are not "fixed" but freely moving bodies, and that it was quite possible to measure the changes in their relative positions from year to year, from decade to decade. The motions of many thousands of stars are now known with considerable accuracy, but in Herschel's day there were only seven stars whose motions were accurately measured. Yet with a boldness and a daring typical of his genius, Herschel set out to deduce from these seven observations the motion of the sun through space. Since he knew no reason why the stars should be moving in any particular direction he assumed that the mean velocity of any random group of stars, taking account both of the magnitude and of the direction of the motion of each, would be zero ; and that if it were not zero then the resultant mean velocity was really an apparent effect due to the motion of the Solar System in the reverse direction. In this way he arrived at the conclusion that the sun is moving with a velocity of about 12 miles per second towards a point which lies in the constellation of Hercules between the bright, well-known stars Arcturus and Vega. This point towards which the entire Solar System is drifting is referred to as the Apex of the Sun's Way. All subsequent analysis of the vast accumulation of recent data as to the motions of the stars and star clusters, has confirmed in a very striking way this earliest determination of Herschel's, locating the Apex in the same region of the sky and finding the velocity of the sun to be of the same order of magnitude—approximately 12 miles per second.

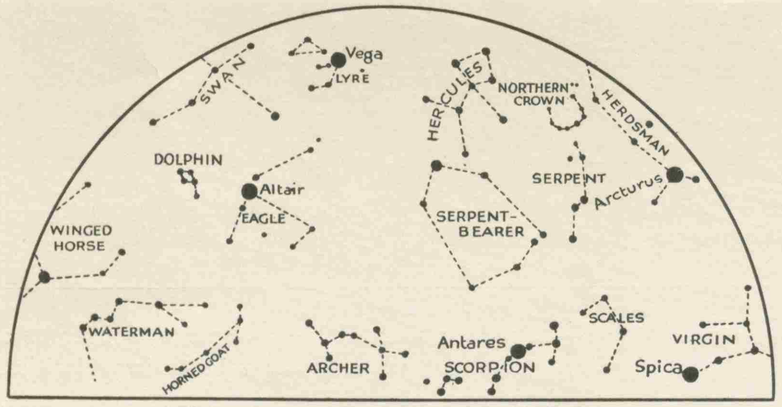


Fig. 1.
THE HEAVENS FROM LATITUDE 50° N.
Brightest stars in region of greatest star density, where the centre of our galaxy is believed to lie.

Small but none the less important differences in the various determinations of Solar Motion and Apex, as determined from specially selected groups of stars (as, for example, the B stars, very bluish and mostly very distant ; the Orion stars ; the stars of the Pleiades group ; the Ursa Major stars ; the globular clusters), have proved that the assumption of random motion requires some modification. Just as each planet and satellite has its own peculiar motion as an individual, but partakes of the general motion of the solar system as a whole, so each star may have its random peculiar motion and yet certain groups of stars may have a group motion as well. Thus there are recognized clusters of stars, the members of which have a common space velocity ; and when many stars scattered throughout many parts of the sky are found to have a kindred motion, this is referred to as "star streaming."

Two major star streams are well recognized, and various theories have been proposed in an effort to explain their motions. Is this vast assemblage of ten thousand million stars to be compared to two intermingling swarms of bees ? Or is it really just one swarm, of ellipsoidal as opposed to spherical shape ? All the stars of this assemblage, or let us call it the galaxy, are inevitably subjected to the gravitational attraction exerted from the mass-centre of the galaxy. Where is this centre ? Are the stars perhaps revolving about it in elliptic orbits ? As one cosmologist, Dr. L. Silberstein, has suggested, perhaps the galaxy is unstable and many of the stars, following hyperbolic orbits, will recede farther and farther from the centre of the galaxy and eventually escape entirely, passing out into intergalactic space.

One question which has very naturally arisen in the minds of astronomers is this—If we could view this galaxy from far out beyond the limits of the Milky Way, what would it look like ? Would it perhaps look like a spiral nebula ? Modern astronomy has discovered many thousands of these nebulae and found them to be each a galaxy of many million stars. In each of these there appears to be a central mucleus where the stars are less isolated from one another, and outside this the stars are grouped along

great outward sweeping arms and the main or preponderating movement of the individual stars is outward along the arms. If, instead of viewing one of these vast spirals from without, you viewed it from the vantage point of some star fairly near the nucleus, how would it appear ? Would it present the appearance with which we are familiar in our own galaxy as seen from near the sun—a strongly marked, though somewhat irregular, galactic concentration or Milky Way, globular clusters, open clusters, star clouds, and the phenomena of star streaming ? It is quite plausible, indeed it is almost certain, that these are just the characteristics that would be observed, and therefore it is at least a justifiable guess that the great aggregation of stars in which our sun has his place is in reality a spiral nebula. Assuming tentatively that this is the case, the astronomer seeks to interpret the known facts of the distribution and movements of the stars in the light of this hypothesis. First then let him discover, if he can, where is the nucleus, the centre of the galaxy.

Several regions of the sky have been proposed in this connexion, but the most favoured position has been in that richly star strewn portion of the Milky Way which lies in the constellation of Sagittarius. Quite recently at Harvard Observatory a systematic search for the region of greatest star density has confirmed the belief that the centre of the galaxy lies in the direction of the great star clouds in Sagittarius.

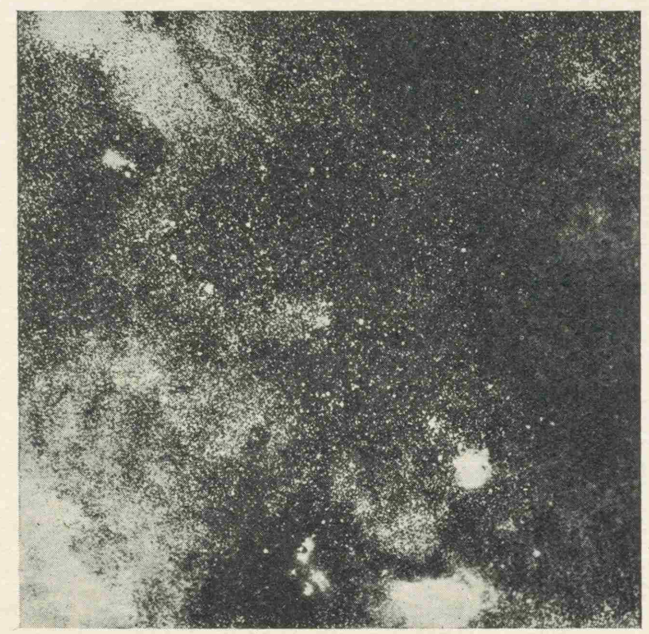


Fig. 2.
SAGITTARIUS.
Photograph of a region in Sagittarius north of the Great Star Cloud, from a 4 hour exposure by Barnard.

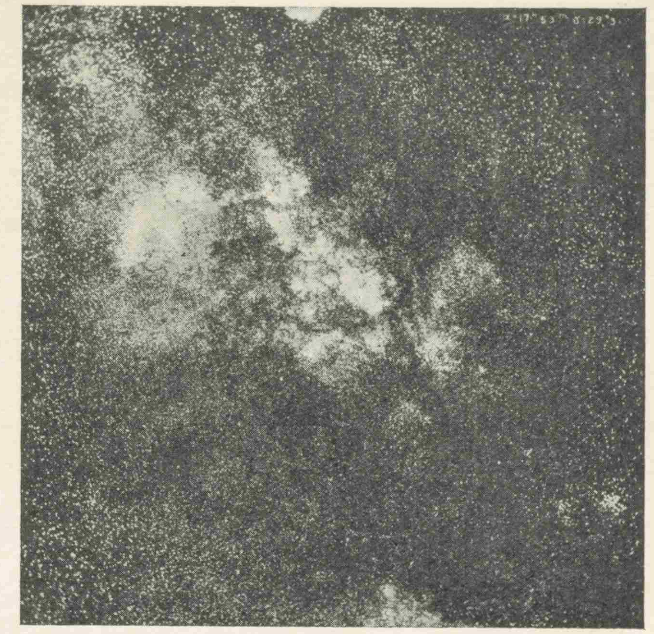


Fig. 3.
STAR CLOUDS IN SAGITTARIUS.
The Great Star Clouds in Sagittarius, from a 3 h. 58 m. exposure by Barnard.

Fig. 1 shows a portion of the heavens as they appear from about Lat. 50° N. looking south on an August evening. The zodiacal constellations Virgo, Libra, Scorpio, Sagittarius, Capricornus, and Aquarius lie low in the sky. The Milky Way comes down through the constellations Cygnus (Swan), Aquila (Eagle), Sagittarius (Archer), and portions of Ophinchus (Serpent-bearer) and Scorpio. Fig. 2 is from a four hour exposure by the late Professor E. E. Barnard of the upper western part of Sagittarius just below Aquila. It shows in striking manner the contrast between these bright portions of the Milky Way with their myriad stars and the darker regions to the westward where obscuring nebulosity—perhaps it is cool gaseous matter, perhaps it is meteoric dust—pervades interstellar space in this direction and almost completely cuts off our view of the stars behind it.

The great star clouds of Sagittarius are beautifully shown in Fig. 3, and the dark nebulosities of the adjacent constellation, Ophinchus, just to the westward, also present a remarkable appearance. Star counts indicate that as the dark nebulosity shown in the lower right of Fig. 3 is approached from every side, the number of stars is increased. The conclusion of Shapley is that if the obscuring curtain were not there the region of maximum star density, the nucleus or centre of our galaxy, would be revealed. Rich star clouds lie to the west, and a beautiful

Fig. 4.

THE GREAT NEBULA IN ANDROMEDA.

A spiral aggregation of a thousand million stars far out beyond the Milky Way, distant a million light years from the solar system. (From a Yerkes Observatory photograph.)

star cluster is situated near by. Behind this cluster and extending most densely to the north of it, is this vast, mysterious, enshrouding nebulosity completely hiding from our view the centre of the galaxy which is believed to be at a distance of some 47,000 light years in the direction of the background just above the cluster in this photograph.

Spectroscopic observations of the nearest spiral nebula, the Great Nebula in Andromeda (Fig. 4), has revealed the fact that it is in rotation about its centre, its period being of the order of seventeen million years. Is our great galaxy likewise in rotation? The distinguished Dutch astronomer, Oort, believes this to be the case, and he has calculated to what extent such rotation would affect the apparent motions of the stars as measured from the earth in different directions. Similar speculations have been made by two other astronomers, Lindblad and Schilt, while the first observational confirmation was announced by J. S. Plaskett of the Dominion Astrophysical Observatory in 1928. Quite recently Plaskett has produced more weighty evidence for the reality of this rotation, his study of the motions of some 800 very distant stars leading him to the conclusion that they are revolving about the central nucleus of the galaxy in a period of approximately one hundred million years.

Further confirmation of this vast galactic motion is afforded by a remarkable investigation recently concluded by O. Struve. He has studied the spectroscopic evidence for the presence of calcium atoms throughout the galaxy. Eddington had calculated a density of 10^{-24}, equivalent to about one atom per cubic centimetre, for this calcium substratum filling interstellar space. Struve's observational data points to a lesser density, 10^{-26} or one atom per 100 c.c. He has pointed out that this means that one per cent of all the matter in the galaxy is evenly spread out as a gaseous substratum, while ninety-nine per cent is condensed into stars and dense nebulae. But the relevant point in this connexion is that this widely disseminated calcium is found to partake in the galactic motion of rotation.

Have we now reached the climax in our survey of the motions of the heavenly bodies? We have noted the spin and wobble of our planet as it moves round and round the sun, which is itself speeding away towards the Hercules stars and simultaneously being carried around a vast orbit about the centre of this galaxy of ten thousand million stars. But what of our galaxy? Dayton Miller has made observations which may be interpreted as evidence for a galactic velocity of several thousand kilometres per second, but until confirmation is forthcoming it cannot be seriously considered. Undoubtedly, however, our galaxy is travelling through space as well as rotating about its centre. All the spiral nebulae have velocities relative to our system, and herein lies yet another mystery—why are these external far-off galaxies almost without exceptions speeding away from our galaxy with velocities of the order of several hundred miles per second? Are their velocities real or in part an illusory effect impressed upon the starlight as a result of its long journeying during many millions of years from one galaxy to another? Are these other galaxies and our own to be regarded as units in a super-aggregation having motions of its own, rotation, perhaps, and space velocity? Where is the centre of this super-system? If our giant galaxy be near it, then perhaps the recessional velocities of the other galaxies are to be explained as are the outward moving stars along each unwinding arm of every spiral galaxy —the super-system is perhaps a super-giant spiral!

These are questions to which to-day no answers can be given. The mystery of matter, the mystery of light, the mystery of motion! They baffle yet they challenge us, they over-awe, yet they inspire.

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Note on Ionization Clouds in an Expansion Chamber

By A. VIBERT DOUGLAS, M.SC.

(Presented by DR. A. S. EVE, F.R.S.C.)

1. The ionization effects produced by point discharge in an expansion chamber have been described by C. T. R. Wilson[1] and N. R. Campbell,[2] both of whom made measurements of the voltage required and the percentage of expansion necessary to produce fog, and commented upon the violent eddying and evanescence of both positive and negative clouds.

2. The writer endeavoured recently to obtain photographs of various typical configurations assumed by the ionization clouds produced in a Ray Track Apparatus.[3] The sources of light employed (Pointolite, 1000 Kilowatt tungsten, Cooper Hewett Mercury Arc.) proved insufficient for the purpose, on account of the extremely short exposures which are necessary, owing to the rapid changes and eddying motion of the clouds. Careful diagrams were made, however, illustrating the typical features observed.

The glass cylinder forming the wall of the expansion chamber was bored in two places at opposite extremities of a diameter, and at a level just well above the highest position of the piston. Into each bore was inserted an ebonite plug, through the centre of which was a fine steel needle, its point projecting about 0 .7 cm. into the chamber and to its other extremity being soldered a flexible wire which could be connected to the source of potential.

Discharge was produced either by means of Leyden jars or a Wimshurst Machine. The latter gave the more satisfactory results and produced the beautiful convection swirls represented in the diagrams.

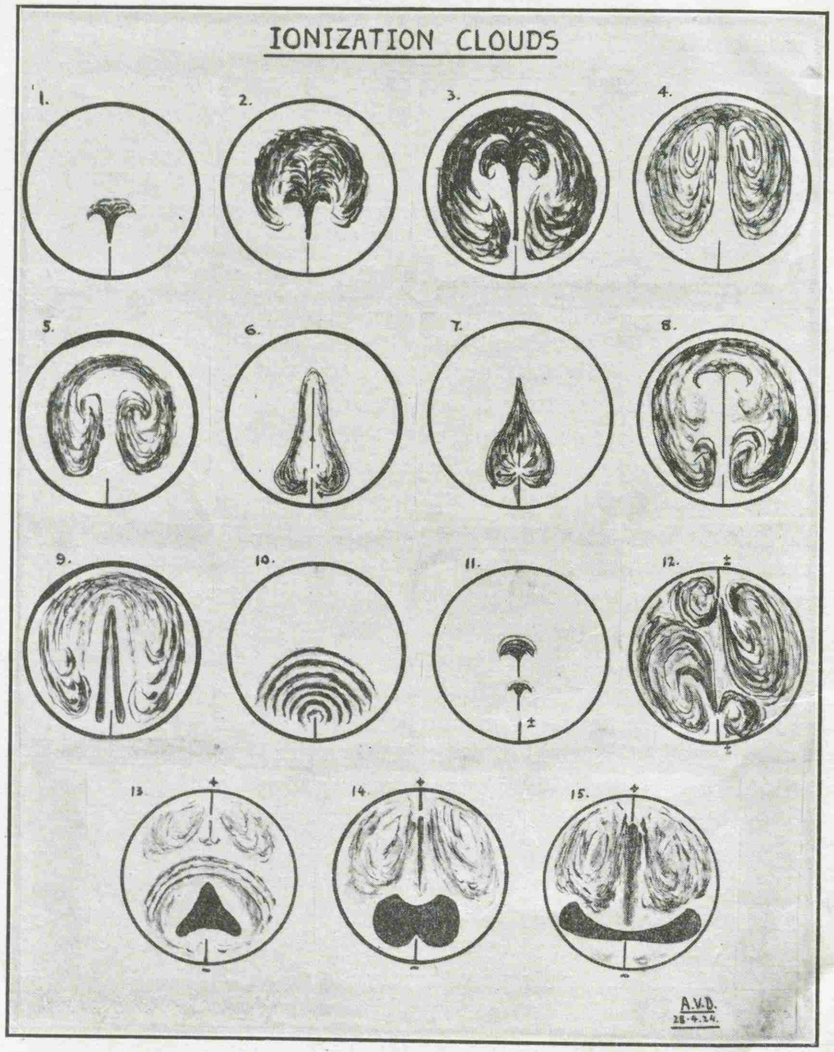
3. The conditions which gave rise to each of the configurations here shown will be briefly indicated.

(*a*) *Single needle connected to either positive or negative terminal of Wimshurst.* Fig. 1 represents the cloud puffed off from needle point when the handle of the Wimshurst is turned very slowly and stopped as soon as discharge begins. Fig. 2 represents a slightly more intense discharge, and if turning be gently continued convection is set up

[1] C. T. R. Wilson: Phil. Trans. 192 A., 1899, p. 403.

[2] N. R. Campbell: Phil. Mag., VI, 1903, p. 618.

[3] Cambridge & Paul Instrument Company, Ltd., Cambridge, Eng., No. C. 12667.



filling the chamber as in Fig. 3. This gives place to violent eddying and turbulence if the rate of turning be increased. The after-effect on ceasing to turn is a semi-stationary cloud of two lobes, Fig. 4, gradually changing into Fig. 5 and dissipating in about two seconds. If turning be recommenced gently, the remnants of the previous clouds are drawn in towards the needle and then up on either side of a fine discharge which issues from the point (Fig. 6). But if turning be sharply and vigorously recommenced, discharge takes place from the point not only forward but outward (Fig. 7); the next instant, however, this configuration is replaced by the one previously described, the whole discharge appearing to be driven forward by the pressure of the convection swirls coming around on either side of the needle (Fig. 8). If vigorous turning be suddenly stopped, discharge sometimes continues for three or four seconds, Fig. 9 being typical of the final stage of cloud production.

It very often seemed impossible to distinguish any difference between the clouds produced by positive and negative discharge, but in general it seemed evident that a slightly greater potential was required to produce the positive discharge and that an intense narrow forward discharge was more characteristic of the positive, while a symmetrically-shaped glow surrounding the point was more generally associated with the negative.

(*b*) *Single needle with sudden discharge from Leyden jar or electrophorus.* Clouds as in Fig. 2 and 7 were frequently observed and occasionally a beautiful ripple effect was produced by clouds in apparently concentric rings as in Fig. 10.

(*c*) *Two needles, like discharge.* The same terminal of the Wimshurst connected to both points produced opposing convection currents which were asymmetric as in Fig. 12, due probably to the needles being not exactly opposite one another and in the same straight line.

(*d*) *Two needles, unlike discharge.* The two needles were connected interchangeably to the two terminals of the Wimshurst. It was found that the negative discharge commenced first; but when once started, the positive discharge dominated the expansion chamber and the negative point either became the centre of such confusion of cloud motion that it could not be mapped or else the negative discharge seemed to cease entirely. If, however, an earth-wire were touched to the positive, the negative at once came into vigorous action and continued to produce effects as described in (*a*) until the removal of the earth-wire when the positive would immediately recommence to fill the chamber with its clouds as in Fig. 3 and 8. On slowing down the Wimshurst and just before stopping it a cloud as in Fig. 1 would take shape in front of the negative point repelling the positive cloud slightly.

Sometimes fully two seconds after the Wimshurst had stopped and all discharge had ceased, fine clearly defined puffs as in Fig. 1 or 11 would commence to leave one or other of the points, but never both at the same time. This discharge, visible as intermittent puffs due to the piston action, might continue for as much as five seconds.

Some striking effects were obtained when the points were raised just a shade above the discharge potential by the slightest pressure applied momentarily to the handle of the Wimshurst. These are indicated in Fig. 13, 14 and 15. From the negative point very bright but highly evanescent rounded or triangular clouds were given off, sometimes one type following the other alternately. If after one cloud slightly too much pressure were applied to the handle, the next discharge was straight ahead severing the cloud into two lobes. That the negative discharge requires slightly less potential difference is apparent in Fig. 13, where very little discharge is leaving the positive point, but an extremely small increase in pressure on the handle brought the positive discharge out with a strong forward intensity which repelled the negative cloud as in Fig. 14 and to a greater extent still in Fig. 15. The difference in luminosity of these two discharges was remarkable, the negative being an intensely bright flash, complete in shape and no sooner seen than gone; while the positive was a dim diffuse convection swirl with only one clean-cut bright line of discharge up the centre.

(*e*) *Vortex Ring Discharge.* Under any of the conditions above described there not infrequently occurred either a positive or negative discharge which took the form of a small distinct vortex ring.

The writer has pleasure in attributing to the suggestions of Dr. A. S. Eve, F.R.S., this preliminary investigation of an interesting and elusive phenomenon, which seems to warrant further study in order to obtain quantitative measurements and satisfactory explanations of the various configurations so definitely producible.

REPORT ON OBSERVATIONS OF TOTAL ECLIPSE BY BOY SCOUTS, AUGUST 31, 1932

By E. Russell Paterson

Note on Reports of 1932 Aug 31 Eclipse
by A. V. D.

p. 210.

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May-June, 1933

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1933

REPORT ON OBSERVATION OF TOTAL ECLIPSE BY BOY SCOUTS, AUGUST 31, 1932

By E. Russell Paterson
Boy Scout Secretary for Province of Quebec

PROBLEM—The service which was requested of the Boy Scouts by the Eclipse Committee of McGill University was to try to establish the two lines marking the edges of the shadow path where these two lines crossed the Province of Quebec. In order to do this, it was suggested that lines of Boy Scouts be placed for observation at various points, each line extending for about a mile, with the boys at close intervals, the lines of boys being at right angles to, and with their centre on, the lines where it was calculated that the shadow edge would pass. Each boy was to make observations from which it could be estimated afterwards whether he stood inside or outside the shadow when it passed, and it was therefore hoped that it would be possible to obtain several points on each edge of the shadow path marking its extreme limits. When these points were joined up, the actual path of the shadow would be indicated, and it would be possible to check the calculations as to the position of the shadow area which had been made before the event.

Results in General—Unfortunately the results obtained appear to be largely negative. The parties of Scouts placed on the western edge of the shadow path were prevented by weather conditions from making any observations whatever, as was the most northerly party placed on the eastern edge. Three other parties on the eastern edge were able to make detailed observations of a more or less definite nature, but in two cases the complete parties appear to have been within the shadow path, while in the third case the estimation of the location of the edge is questionable owing to clouds at the important moment.

Data—It was necessary first of all to obtain an estimation of the location of the eclipse path, and, in a letter dated June 15, Dr. R. Meldrum Stewart, Director of the Dominion Observatory, kindly supplied the following data:

	Western Limit				*Eastern Limit*			
	Latitude		*Longitude*		*Latitude*		*Longitude*	
3.23 p.m.	46°	6.0	74°	10.5	46°	43.6	72°	14.1
3.24 "	45	42.5	73	50.1	46	19.6	71	53.7
3.25 "	45	19.0	73	29.4	45	55.6	71	33.0
3.26 "	44	55.5	73	8.5	45	31.7	71	12.1

Maps—It was next necessary to have this information transferred to maps, giving continuous lines marking the estimated shadow edges on which convenient points could be chosen for the placing of observing parties of Scouts. The maps to be of any value must be of large scale, and Topographic Maps, 1 inch to 1 mile, issued by the Department of National Defence, were finally chosen as being most suitable for the purpose. A number of these sheets were obtained covering most of the regions over which the calculated lines of the shadow edges passed. Where the eastern edge crossed the St. Lawrence River, no Topographic sheet was available, and a river pilot's map of this section, which also showed details of the shore lines, was used. The problem of plotting the shadow limit lines on these maps was no easy one, as the co-ordinates given by Dr. Stewart were widely spaced, and somewhat laborious calculations of interpolation were required to fix the positions of the lines on the large scale sheets. Mr. W. Bruce Ross, of the Department of Mathematics, McGill University, very kindly undertook this work, and provided us with the lines carefully marked in all regions required.

Lectures—To interest the Scouts in the observations, and to provide them with information which would enable them to observe intelligently, a series of lectures was given in the localities from which the Scout observers were to be drawn. Dr. A. Vibert Douglas, of McGill University, kindly gave an illustrated lecture on the Eclipse to Montreal Scouts on April 23. Between this date and June 17, lectures were given by myself in St. Johns, Three Rivers, Shawinigan Falls, Quebec, and Sherbrooke, and a lecture in French was also given in St. Johns by Dr. G. Gardner of the University of Montreal, who is also a Scoutmaster. All these lectures were illustrated with slides kindly loaned by Dr. Douglas. In some cases there was a large attendance of the general public as well as of Scouts.

Plan—It was planned that eight parties of Scouts should be placed in position: four on the eastern, and four on the western line, the points chosen being spaced as widely apart on the lines as circumstances permitted. Each party was to consist of about 35 boys placed at 50-yard intervals, thus covering a mile of ground. The parties were drawn from the nearest Scouting centres. Each boy was provided with:

(*a*) An Information Sheet (see below, "Instructions to Observers"), telling him exactly what to look for.

(*b*) A Question Form (see below), giving four questions to be answered by him immediately after the shadow passed. These questions were taken from a question form used in connection with a total eclipse visible in New England a few years ago. From the answers received, it was hoped that it would be possible to tell exactly which boys were inside, and which outside, the shadow.

(*c*) A piece of exposed photographic film through which the sun could be observed.

Positions of Parties—The eight parties included 254 observers, and were as follows:

Western Edge—

Party 1—Montreal Scouts, 22 boys, directed by Scoutmaster E. R. E. Chaffey, stationed along Cote St. Luke Road, N.D.G., centred on its junction with Clanranald Avenue.

Party 2—Verdun Scouts, 40 boys, directed by Scoutmaster A. A. Smith, stationed along the bank of the Aquaduct, centred on a small bridge over which the calculated line passed.

Party 3—St. Johns and Delson Scouts, 35 boys, directed by Rover Leader J. Reid. This party was driven in private automobiles 10 miles west of St. Johns to the De Lery junction of the King Edward Highway.

Party 4—St. Johns and Lacolle Scouts, 35 boys, directed by Scoutmaster G. Ellis. This party was driven in private automobiles 15 miles south of St. Johns on Highway 14 to a point between Ile Aux Noix and Lacolle.

(Parties 3 and 4 were organized by District Commissioner Roy Wilson and District Secretary Chas. Maxwell of St. Johns.)

Eastern Edge—

Party 5—Three Rivers Scouts, 17 boys, directed by District

Scoutmaster Thos. Jones. This party was driven 35 miles east of Three Rivers on the south shore of the St. Lawrence, and stationed between two light-houses conveniently located with the estimated line half way between them, near St. Jean Deschaillons.

Party 6—Quebec Scouts, 40 boys, directed by District Scoutmaster George H. Cartwright. This party was driven by autobus 35 miles southwest of Quebec to a point near Lourdes. The Scouts were stationed along the road north of the Bécancour River where the calculated line crosses that stream. A summary of their reports is attached. (The organization of this party was greatly assisted by Col. Wm. Wood of Quebec; it included equal numbers of French-speaking and English-speaking Scouts.)

Party 7—Thetford, East Angus, and Cookshire Scouts, 30 boys, directed by Scoutmaster S. Bateman, stationed near St. Gerard The Scouts were placed along the road on the northwest shore of the St. Francis River, centred on the point where the calculated line crosses the river. A summary of their reports is attached.

Party 8—Sherbrooke Scouts, 35 boys, directed by District Scoutmaster C. G. Price. This party was driven in private automobiles 45 miles northeast of Sherbrooke to Galson, where the estimated line crosses Highway 28. A summary of their reports is attached.

Observations—No results whatever were obtained by Parties 1 to 4 on the western edge on account of heavy clouds.

Party 5 obtained an excellent view of the early stages of the eclipse, but at 4.20 p.m., when about 95% of the sun's surface was covered, a very heavy dark cloud intervened, and when it cleared away the moon's disc had commenced withdrawing from the rim of the sun. These few minutes of cloud, therefore, spoiled any chance of observation.

Party 6 had better fortune. Conditions were reported as ideal at the western end of their line, but progressively worse towards the eastern end, and here the heavy cloud at the time of totality also interfered with exact observation. An attempt was made, however, by nearly every boy to judge the time of totality at his station, and while many estimates are obviously out of step, yet there appears to be a progressive diminishing of the period from the centre of the line to Station 8. The Officer in charge of the party suggests that this point represents the edge of the shadow path, 550 yards northeast of the calculated position. He admits, however, that sky conditions were not at all satisfactory for accurate observation, and we suggest that this result be accepted only as a possible corroboration of more definite results obtained elsewhere.

Parties 7 and 8 enjoyed perfectly clear sky. All stations in these two parties reported themselves within the shadow path. The periods of total darkness, curiously enough, seem to have been estimated as shortest at the centre of each line—a fact which cannot possibly have any significance.

Accuracy of Observations—The first three questions asked on the question form were answered by practically all members of Parties 6, 7, and 8. A number of answers were given to the fourth question, but owing to the indefiniteness of the general result of the observations, these answers do not appear to be worth transmitting in this report, though the papers are available if the information would be of value. Some observations reported by the boys may obviously be disregarded as being quite inaccurate. The answer to question 2 (length of time of totality at his station) has been taken as throwing most light on the position of the boy with relation to the shadow path. The periods of totality given by a few Scouts were obtained by the use of watches: in the majority of cases these periods were estimated, and carry just that value which such estimations usually have, the general trend of the calculations being the feature on which conclusions may safely be based. Some Scouts, particularly those forming Party 7, had been drilled beforehand in the estimation of time in seconds, and the results obtained by this party appear to have the most consistent trend.

Conclusions—Basing our conclusions on the results obtained from the three parties on the eastern edge which had the opportunity of making observations, we suggest in general that the eastern edge of the shadow path was farther to the northeast than the lines given us on our maps. Judging from the rather unsatisfactory observations of Party 6, the line marking the edge was at least 550 yards farther northeast than the calculated position, and judging from the more definite reports of Parties 7 and 8, this distance may be raised to at least 700 to 900 yards.

While we regret the lack of definiteness in the report we are able to make, we welcome the opportunity of arousing interest in astronomical things through our lectures. The feelings of those boys who had nothing to observe but a heavy bank of clouds were well expressed by one youngster in Party 1, who disgustedly handed in his question form endorsed, in the jargon of the baseball leagues, "Eclipse postponed on account of rain".

INSTRUCTIONS TO OBSERVERS

When the total eclipse of the sun occurs on August 31st the shadow of the moon will pass across the Province of Quebec from Northwest to Southeast. The shadow will be 103 miles wide. The task of our Scout observing parties will be to try to determine exactly where the eastern and western edges of the shadow pass, *i.e.,* the two lines which will mark the extreme limits of total darkness on the ground, "the shadow path". The positions where the scientists think these lines should pass have been calculated for us as carefully as possible. We are to stretch several lines of Scouts across these calculated lines to make observations. If each Scout can report after the eclipse has passed whether he was inside or outside the shadow path, we can tell just how far along the line of Scouts the shadow of the Moon reached.

It is important that you should understand how to tell whether you are within the shadow path or not. If there is any instant when no portion of the sun's surface is visible to you, you are inside the path. The sun's light will disappear in a series of bright dots: if the dots appear on the far side of the sun before they disappear on the other side, you are not inside the shadow. There must be at least an instant of TOTAL covering of the sun's face.

Another test is whether you see the corona of the sun—a region of soft, pearly-grey light surrounding the spot where the face of the sun is covered by the moon. If you can see the Corona, even for an instant, entirely surrounding the sun, you are within the path of the shadow. If you cannot see the Corona, or see it only part way around the sun, you are outside the shadow path.

On reporting at your assembly point, a paper will be handed to you on which are four questions. These will indicate the exact things you are asked to observe at the moment of the eclipse, and your answers to these questions will enable our officials to judge whether the position in which you were placed for observation was inside or outside the path of the shadow.

You will also be provided with a darkened glass through which to look at the sun while the eclipse is progressing. Do not attempt to watch the sun without this glass right up to the moment when the light of the sun is disappearing; injury to your eyes may result if you are careless in this matter.

QUESTION FORM

Question 1.—If the sun is not quite eclipsed at your station there will always be a bright edge of the sun visible, or perhaps only a single point.

One bright point may appear on one edge of the sun before the other has entirely disappeared. At your station was there any time at which no bright edge of the sun was visible? Answer YES or NO ....

Question 2.—If the bright edge of the sun entirely disappeared, how many seconds elapsed before another bright part of the sun became visible? Answer .... seconds.

Question 3.—The fringe of light surrounding the sun and called the corona is fully visible only if the face of the sun is entirely covered. At your station was there any time at which you could see the corona all around the sun? Answer YES or NO ....

Question 4.—If you are on a hill near the edge of the shadow path, you may be able to see the shadow advancing across the country. If so, what buildings or other landmarks were inside and what were outside the edge of the shadow?

Landmarks inside of the shadow ....

Landmarks outside of the shadow ....

Scout's Name .... Group ....

Station	*Name*	*Yards from Estimated Line*	*Question* 1	2	3
1	Fournier	900 East	Yes	Clouds	No
	(Station 1 at road intersection)				
2	Giroux	850	Yes	55″	
3	Laberge	800	Yes	50	Clouds
4	Marois	750	Yes	60	No
5	Wright	700	Clouds		
6	Jess	650	Clouds		
7	Hunter	600	Clouds		
8	Scott	550	No		No
9	St. Cyr	500	Yes	6	No
10	Bazin	450	Yes	7	Clouds
11	Desy	400	Yes	6	No
12	Racine	350	Yes	6	No
13	Arthur	300	Yes	25	No
14	Martin	250	Yes	34	No
15	Warner	200	Yes	35	No
16	Carpenter	150	Yes	35	No
17	Burridge	100			
18	Davy, R.	50		2	Yes
19	Davy, H.	—	Yes	35	
20	Good	50 West	Yes	40	No
21	Bergeron	100	Yes	50	Clouds
22	Legare	150	Yes	40	Clouds
23	Fournier	200	Yes	2	Clouds
24	Giroux	250	Yes	15-20	No

Station	Name	Yards from Estimated Line	Question 1	2	3
25	Ross	300	Yes	15	Yes
26	Squarey	350	Yes	18	Yes
27	Adanakis	400	Yes	6	Yes
28	Poulin	450	Yes	4	Yes
29	April	500	Yes	5	Yes
30	Fr. de Smet	550	Yes	10	Yes
31	Girard	600	Yes	11	Yes
32	Langlois	650	Yes	36	Yes
33	Martel	700	Yes	20	Yes
34	Bernier	750	Yes	28	Yes
35	Beaule	800	Yes	25½	Yes
36	Dion	850	Yes	28	Yes
37	Denis	900	Yes	31½	Yes
38	Gillard	950	Yes	9	Yes
39	Wardwell	1000	Yes	10	Yes
40	Beauchemin	1050	Yes	32½	Yes

SUMMARY OF REPORTS—PARTY 7—NEAR ST. GERARD

1	Bourgault	650 N-E	Yes	11″	Yes
2	McCallum, A.	600	Yes	11	Yes
3	Seeley	550	Yes	10	Yes
4	Bateman, M.	500	Yes	11	Yes
5	Nakash	450	Yes	10	Yes
6	Maywood	400	Yes	9	Yes
7	McCallum, D.	350	Yes	9	Yes
8	Drummond	300	Yes	9	Yes
9	Smith	250	Yes	10	No
10	Bindman	200	Yes	5	Yes
11	Trinfield	150	Yes	8	Yes
12	Donaghy	100	Yes	8	Yes
13	Talmage	50	Yes	7	Yes
14	McCallum, V.	—	Yes	4	Yes

(Mr. Bateman, in charge of party, stationed himself here and timed period of totality carefully with his watch as 4 4/5 seconds.)

15	Bateman, J.	50 S-W	Yes	3	Yes
16	Bowen	100	Yes	3	Yes
17	Cooper	150	Yes	15	Yes
18	McNaughton	200	Yes	20	Yes
19	Fearneley	250	Yes	20	Yes
20	Bailey	300	Yes	28	Yes
	Mr. Darker		Yes	28	Yes
21	Luxford	350	Yes	30	Yes
22	Pennoyer	400	Yes	29	Yes
23	Taylor	450	Yes	28	Yes

Station	*Name*	*Yards from Estimated Line*	*Question* 1	2	3
24	(Position unoccupied: unsuitable for observation).				
25	Drennan	550	Yes	24	Yes
26	Molson	600	Yes	23	Yes
27	Standish	650	Yes	23	Yes
28	Yatt	700	Yes	23	Yes
29	Pope	750	Yes	23	Yes
30	Goff	800	Yes	22	Yes

Note—Station 14 (central line) was at Switch 3, 1214 feet (taped) along track northeast from railway crossing.

SUMMARY OF REPORTS—PARTY 8—NEAR GALSON

1	Spackman	850 N-E	Yes	20″	Yes
2	Wilson	800	Yes	20	Yes
3	Bennett	750	No	20	Yes
4	Edwards	700	Yes	17	Yes
5	Herring	650	No	17	Yes
6	Leech	600	No	17	Yes
7	Metcalfe	550	No	17	Yes
8	MacAllister	500	Yes	10	Yes
9	Badams	450	Yes	6	Yes
10	Campbell	400	Yes	5	Yes
11	Johnston	350	Yes	5	Yes
12	Shea	300	Yes	5	Yes
13	Bell	250	Yes	5	Yes
14	McLean	200	No	3	Yes
15	Lothrop	150	Yes	5	Yes
16	Fournier	100	Yes	2	Yes
17	Kinnett	50	Yes	2	Yes
18	Mayotte	—	No		Yes
19	Bishop	50 S-W	Yes	2	Yes
20	Quinn	100	Yes	4	Yes
21	Megor	150	Yes	15	Yes
22	Whittingham	200	Yes	15	Yes
23	Echenberg	250	Yes		Yes
24	Jackson	300	Yes		Yes
25	Murphy	350	Yes		Yes
26	Stewart	400	Yes	9	Yes
27	Barrett	450	Yes	9	Yes
28	Glass	500	Yes	9	Yes
29	Palmer	550	Yes	9	Yes
30	Jones	600	Yes	8	Yes
31	Christison	650	Yes	7	Yes
32	Sarrasin	700	Yes		Yes

Station	*Name*	*Yards from Estimated Line*	*Question* 1	2	3
33	MacAllister	750	Yes	9	Yes
34	Trussler	800	Yes	8	Yes
35	Muzzey	850	Yes	7	Yes

NOTE—Station 18 (Central Station) was established 175 yards south-west from road corner in Galson.

Observers at Station 34 and 35 were Scoutmasters.

TEMPERATURE READINGS TAKEN BY

Scout G. A. Bergeron, of Quebec, at Station 21, Party 6.

3.30 (D.S.T.)	88°	4.20 (D.S.T.)	75
3.40 (D.S.T.)	90	*4.24 (D.S.T.)	72
3.50 (D.S.T.)	90	4.26 (D.S.T.)	73
4.00 (D.S.T.)	84	4.40 (D.S.T.)	74
4.10 (D.S.T.)	78	4.50 (D.S.T.)	76
4.15 (D.S.T.)	76¾		

*Totality.

NOTE ON REPORTS OF OBSERVATIONS OF THE TOTAL SOLAR ECLIPSE 1932 AUGUST 31

By A. VIBERT DOUGLAS

In the "Report of the Expedition from the Royal Observatory, Greenwich, to Observe the Total Eclipse of the Sun on 1932, August 31", by C. R. Davidson and J. Jackson ("Monthly Notices, R.A.S." 1932, November) it is recorded that the observed time of 2nd contact was 3 or 4 seconds later than the computed time for Parent, Que., and that the duration of totality was 99 sec. as compared with the 102 sec. computed. The suggestion is made that this discrepancy in the duration of totality is due possibly to two causes, first, a very slight (less than one second) error due to the metronome, and, secondly, a shortening of the period of duration on account of the lateness of 2nd contact, which is ascribed to a flatness on the Moon's limb at that particular point.

In the report of Father Emil Cambron, S.J., of the observations made by members of the expedition from the Collège Sainte-Marie at Ile Saint-Ignace near Sorel, it is said that while second contact appeared to be one second fast, third contact was eight seconds fast; in other words, duration of totality was only 93 seconds instead of the predicted 100 seconds at that station.

In the "Report on Observations of Total Eclipse by Boy Scouts, August 31, 1932", by E. Russell Paterson, the very important conclusion is reached that the eastern edge of the shadow probably lay from 550 yards to 900 yards north-east of the computed line. It is very greatly to be regretted that the unfavourable weather so general across the Province of Quebec on that date frustrated much of the work so admirably planned by Mr. Paterson, for complete records from all the parties of Scouts on the western as well as on the eastern edge of the shadow belt would have been of the utmost importance and value. They are, however, to be congratulated on what was achieved, and it seems to be worthy of notice that their result has a very definite bearing on the problem involved in the discrepancies between computed and observed duration of totality mentioned in the previous paragraphs.

Both Parent and Ile Saint-Ignace are situated on the west side of the computed central line, the former about 5 miles S.W., and the latter somewhat more. If the entire shadow path were several hundred yards further N.E. than calculated, as the observations of the Boy Scouts might indicate, then of necessity the duration of totality at all places west of the computed central line would be lessened and the time of second contact would be slightly delayed relative to the computed time. Furthermore, this lessening of the duration of totality would be more marked for the place further from the central line. This leaves unexplained the one second discrepancy in observed second contact at Ile Saint-Ignace, but it ties in well with the other facts above mentioned. It therefore seems likely that this was a contributory cause, even though not the entire cause, of the shorter periods of totality recorded in the reports of both these expeditions.

McGill University,
1933 March 23.

WITH THE AUTHOR'S COMPLIMENTS.

To ______________________________

Note on the Interpretation of the Wegener Frequency Curve.

BY

G. VIBERT DOUGLAS, M.Sc. (McGill) and

A. V. DOUGLAS, M.Sc. (McGill).

Extracted from the Geological Magazine, Vol. LX, No. 705, March, 1923.

London: DULAU & Co., Ltd., 34-36 Margaret Street, W. 1.

[*Extracted from the* GEOLOGICAL MAGAZINE, Vol. LX, pp. 108–11, March, 1923.]

Note on the Interpretation of the Wegener Frequency Curve.

By G. VIBERT DOUGLAS, M.Sc. (McGill) and A. V. DOUGLAS, M.Sc. (McGill).

WEGENER bases his theory [1] of the drifting continents on the assumption that there are two distinct levels to be taken into account, the surface of the masses of "sal" which form the continents and the surface of the "sima" in which they float. His justification of this fundamental assumption appears to be based on the frequency curve obtained by measuring heights positively and depths negatively from sea-level, and plotting the frequencies [2] of such measurements as in Fig. 1. Because two maxima appear, Wegener draws the conclusion that therefore two layers must be considered as having been acted upon to produce the elevations and depressions of the earth's surface, and he implies that there would be but one maximum (Fig. 1, dotted curve) if only one layer were involved.

The questions which present themselves are whether the above conclusions are justified, or whether the frequency curve does not admit of an altogether different interpretation.

1. Consider what the frequency curve would be on the assumption of only one surface layer being acted upon to produce elevations and depressions. A perfectly symmetrical spherical surface or oblate spheroidal surface subjected to the horizontal and vertical forces producing diastrophism, would, if studied in vertical sections, probably show a wavy contour—a series of anticlinoriums and synclinoriums resembling a curve compounded of sine-curves of greater and less wave-length, the term "sine-curve" being used not in its strict mathematical sense, but descriptively, to imply that the general outline of the elevations would be represented by curves convex outwards and of the depressions by curves concave outwards [3] (Fig. 2). Constructing the frequency curve representing the systematic compilation of the data from all such vertical sections, the result could not differ essentially from Fig. 1, that is, it would show two distinct maxima. This is evident from the geometry of a true sine-curve (Fig. 3), which would give rise to a U-shaped frequency curve of heights and depths, unless accidental irregularities were superimposed on the sine curve producing "tails" to the frequency curve as in Fig. 1. Where the sine-curve is sloping

[1] A. Wegener: *Die Entstehung der Kontinente und Ozeane*, 2nd ed., 1920.

[2] Wegener expresses the frequencies as percentages of the total area of the earth's surface, and he adopts a vertical interval of 100 metres. Thus the frequency assigned to + 1000 is the percentage of the earth's surface occupied by land between the 950 m. and 1,050 m. contours.

[3] It is not suggested that the profile of any given section of the earth (taken, for example, around a certain line of latitude) would be capable of being represented accurately by a Fourier Series; but it might probably resemble, in its main outline, a portion of the graph of some such series.

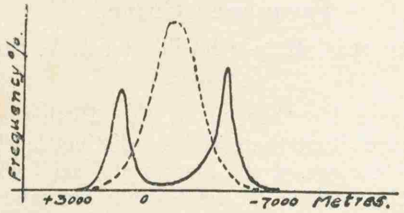

FIG. 1.

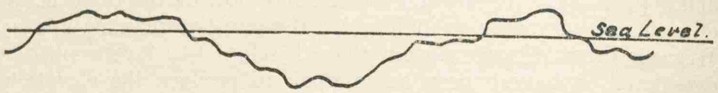

FIG. 2.

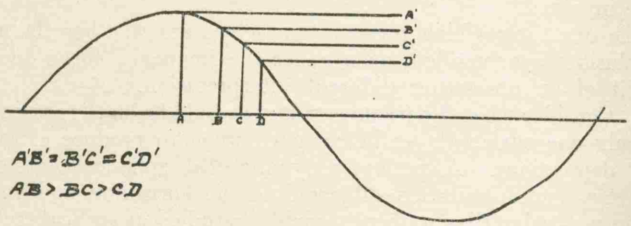

FIG. 3.

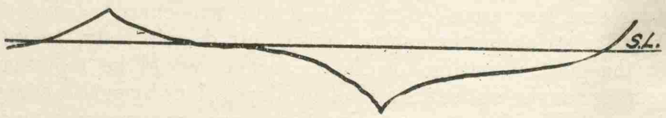

FIG. 4.

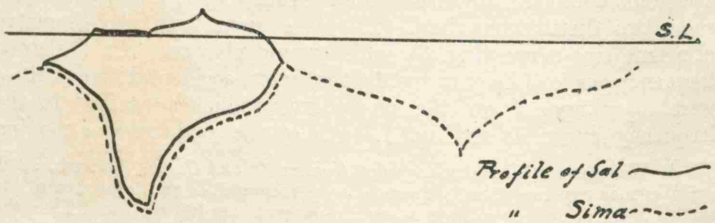

FIG. 5.

FIGS. 1–5.—The Wegener frequency curve and various profiles.

rapidly the frequencies are necessarily small, and where the tangent to the curve approaches the horizontal the frequencies are great, because the frequencies are proportional to the projections on the horizontal of elements of the curve cut off by parallel, equispaced, horizontal lines representing small equal increments of height, and these projections are greatest under those portions of the curve where the tangents are horizontal or nearly so. Hence one maximum occurs for heights and one for depths.

The frequency distribution obtained in the manner above described, would be in all essentials identical with that obtained from the Hypsometric Curve. (This curve, of irregular cusp form, should not be interpreted as representing a profile.)

It is thus shown that the fact of there being two maxima does not in itself preclude the idea of one surface layer only.

2. Consider, now, what type of contour of any representative vertical section would lead to a frequency curve showing only one maximum. This curve could only arise if the sectional contour were of the form of cusps (Fig. 4), regular or irregular, with the point of inflexion corresponding to the position of the maximum frequency. The general form of the curves on either side of the greatest elevations would then be concave outwards, and of the curves bounding the depressions convex outwards, in contrast to the case already considered. It should be noted, however, that unless this cusp contour were perfectly symmetrical the frequency distribution could not be a symmetrical curve as shown in Wegener's diagram (Fig. 1, dotted curve), but would be represented by some form of asymmetrical, single-maximum curve.

The case of the regular cusp contour may be dismissed at once as impossible. The case of an irregular cusp surface is certainly improbable. If land elevations were due solely to volcanic action, a contour of this nature might conceivably arise, but terrestrial forces other than volcanic are the predominant causes of continental uplift. Those portions of the land surface which present a cusp-like form owe their shape not to structural folding but to erosion, and in any case are insignificant compared with the main undulations of the earth's topography. What forces would lead to a contour of this kind in the depressions of the ocean floor it is difficult to imagine, if we except the highly improbable case of a gigantic " sink ".

3. The hypothetical case of two definite layers falls into two classes, according as we assume a profile for each layer of the " sine-curve " type or of the " cusp " type. The former would certainly show two maxima, but not necessarily only two maxima, since it is quite possible that the " sal " would show two predominant frequencies, one representing the average elevations, the other the average depressions; and likewise the " sima ". If, however, the " sal " and " sima " are actually one, then individual ups and downs are likely to be merely small effects, superimposed on greater

undulations, and the frequency curve smooths itself down to the inevitable two maxima.

The latter or "cusp" type might lead to a frequency curve of either one maximum or two. It would lead to two maxima, corresponding to the average points of inflexion of the surface of the "sal" and of the "sima", if and only if "sal" and "sima" were sufficiently distinct not to be merged in one general cusp profile on a larger scale embracing both (Fig. 5). In this latter case, only one maximum would be obtained. This possibility is suggested by the diagram given by Wegener in another connexion, showing the "sal" floating as an island in the "sima".

The writers are indebted to Mr. Philip Lake and to Mr. G. U. Yule for valuable advice.

The object of this note is (1) to show that Wegener's two-maxima frequency curve is capable of being interpreted in more than one way, so that the deduction which he draws from it, though not impossible, is certainly not conclusive; (2) to show that Wegener's single-maxima frequency curve cannot bear the interpretation which he puts upon it.

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NOTE ON THE RANGE IN SPECTRUM VARIATION OF α URSÆ MINORIS.

By A. Vibert Douglas, M.B.E., Ph.D.

Monthly Notices of R.A.S., Supp. 1930.

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Vol. XC. No. 9.

NOTE ON THE RANGE IN SPECTRUM VARIATION OF α URSÆ MINORIS.

(Plate 17.)

BY

A. VIBERT DOUGLAS, M.B.E., PH.D.

Note on the Range in Spectrum Variation of α Ursæ Minoris.
By A. Vibert Douglas, M.B.E., Ph.D. (Plate 17.)

(*Communicated by the Secretaries.*)

1. That α Ursæ Minoris is a variable star having a period of $3^{d}.968$ is well established. The photographic light-curve determined by Hertzsprung * has an amplitude of $0^{m}.171$. A variation in spectral type was recorded by Henroteau † in 1924, but as far as the writer is aware no attempt has been made to determine the range in spectral classification.

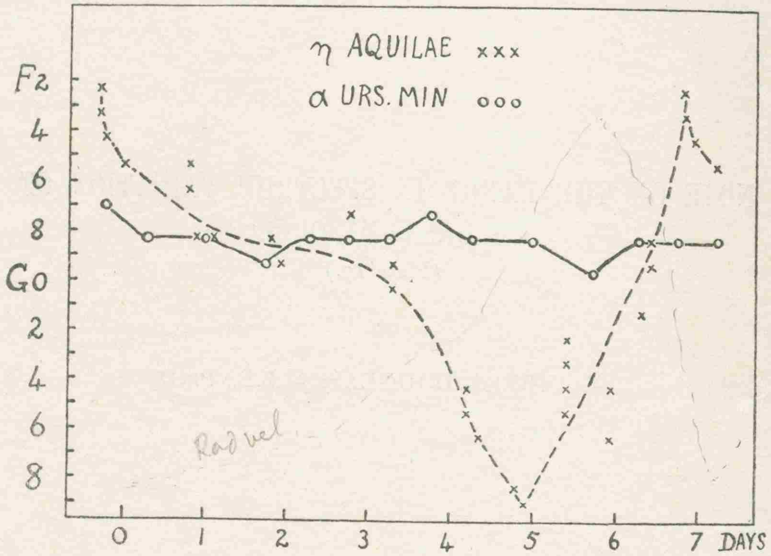

Fig. 1.—Periodic variation of spectral class.

The cyclical changes in the spectrum have been made the subject of an investigation ‡ carried on jointly at the Dominion Observatory and at McGill University, as part of a programme of study of such changes in a large number of Cepheid variables. In this connection microphotometer tracings were made at McGill University of over fifty spectrograms of η Aquilæ and of more than ninety spectrograms of α Ursæ Minoris. These were all 1-prism spectrograms of the Dominion Observatory. These two series, covering every phase of both stars, have formed the basis of comparison by means of which the range of spectrum class of α Ursæ Minoris has been determined.

The period of η Aquilæ is $7^{d}.176$. The manner in which the spectral class changes during this period was noted by Van der Bilt § who gave

* *A.N.*, **189**, 89, 1911.
† *Pub. Dom. Obs.*, ix., 1, p. 52, 1925.
‡ *Pub. Dom. Obs.* (in press).
§ *Ap. J.*, **44**, 286, 1916.

Fig. 2.—Microphotometer tracings of spectrograms of (1) η Aquilæ near zero phase; (2) α U Mi near $3^d{\cdot}0$; (3) η Aquilæ near $4^d{\cdot}7$.

as the extreme range A8 to G5. Shapley,* some years later, announced that the range was F2 to G9. In the accompanying diagram, fig. 1, the writer has combined Van der Bilt's observations with Shapley's range by lowering each of the former four spectral class subdivisions, the dotted curve being the result.

In comparing the microphotometer tracings of each plate of α Ursæ Minoris with those of η Aquilæ, four regions of the spectrum were selected for separate comparison, namely :

A—the region about λ 4535,
B— ,, ,, ,, λ 4481,
C— ,, ,, ,, λ 4340,
D— ,, ,, ,, λ 4227.

The spectral class to be associated with each region on each tracing was then determined by means of the broken curve in fig. 1, and recorded, together with the corresponding phase. Averages were found for each group and are shown in Table I., together with the weighted means. In fig. 2 the tracings of three spectrograms are reproduced.

TABLE I.

Range in Spectral Classification of α Ursæ Minoris.

Phase. d d	A.	B.	C.	D.	Mean.
0·0–0·5	F8	F8	F8	F8	F8
0·5–1·5	F8	F8	F7	F7	F8
1·5–2·0	G0	F9	F8	F8	F9
2·0–2·5	F8	F8	F8	F9	F8
2·5–3·0	F8	F8	F7	F7	F8
3·0–3·5	F7	F8	F8	F8	F8
3·5–0·0	F8	F7	F7	F7	F7

Criteria : A—region of spectrum about λ 4535,
B— ,, ,, ,, λ 4481,
C— ,, ,, ,, λ 4340,
D— ,, ,, ,, λ 4227.

2. While it will be seen that the greatest variation given in Table I. is F7 to G0, it should be recorded that individual observations exhibited a much greater range, portions C and D of several spectra of Polaris strongly resembling spectra of η Aquilæ which, from the phase relation of fig. 1, were to be associated with a class as early as F5 or as late as G5. Reference to Van der Bilt's observations, however, shows that in the case of η Aquilæ the estimation of spectral class might vary over four subdivisions for a given phase. To what extent the exceptional extremes in the spectra of Polaris represent real physical extremes in the state of the star or are merely accidental spurious effects due to many causes, such as plate exposure, grain, microphotometer focussing,

* *Harv. Circ.*, **313**, 1927.

sensitivity, etc., it is impossible to say, and little importance is attached to them compared with the mean values.

These means, ranging from F7 to F9, have been plotted against phase, and, as seen in fig. 1, the resulting curve shows two features: (*a*) that the average spectral class is F8, in agreement with the Henry Draper classification; (*b*) that the variations in the spectrum accompany the variations in magnitude, the maximum F7 being about at the phase of maximum light and the minimum F9 near the time of minimum light.

3. I am very grateful to the Director and to Dr. F. Henroteau for the opportunity afforded me of studying the spectrograms of the Dominion Observatory.

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Corrected Copy

1963

THE ORIGIN OF THE PLANETS*

By A. Vibert Douglas

Man has been endowed with mind and with an insatiable curiosity which leads him to look out upon his surroundings, ask questions and seek to find answers. He is first conscious of himself and his immediate environment, then he begins to consider other people and the earth on which he dwells—land and sea and atmosphere, rocks, soil, insects, birds, fish, animals, and the luminous bodies in the sky, sun, moon, planets, stars.

From what he perceives he very soon learns to infer the existence of things which he does not see. He learns to generalize, and where there are no simple answers to his questions, he begins to speculate. He forms theories and tests their validity in the light of further knowledge.

To the seeker after truth a theory is a tool not a creed; and willingness to alter or discard a theory, if it prove unsatisfactory as new knowledge is gained, is of the very essence of honest truth seeking.

One of the questions that has been asked in every age is the origin of the earth. It is part of a wider question, namely, the origin of the solar system, and this in its turn is part of the still vaster question, the origin and development of the entire physical universe.

Many early peoples formulated creation myths and allegories. The poetic account current amongst the early Hebrew people, as set forth in Genesis I, is by far the most dignified and lofty of any of which there is record. "In the beginning God created the heaven and the earth."

No one knew, 2500 years ago, that the earth was not the centre of the universe. Today we know that our planet is one of nine planets moving in elliptic orbits about the sun, and that four planets are smaller and four very much larger than the earth, while the sun is more than 700 times as massive as all the planets together, and is so hot that it is completely gaseous and radiates heat and light continuously at five hundred thousand million million million horsepower. Nor did anyone know until recent years that our sun is one star amongst 100,000 million stars in this great galaxy, and that there are many million other galaxies. Truly man's conception of God must be no small timid limited conception, if He be the Creator of all the vast universe in which the most profoundly beautiful mathematical laws are found to control electrons, atoms, stars, and radiant energy. The Psalmist wrote: The heavens declare the glory of God. The more science has discovered of the vastness of the universe and of the operation of the laws of nature, the greater is that glory.

The German philosopher Emmanuel Kant in 1755 and the French

*Adapted from a radio address over CKWS, Kingston, February 10, 1952.

mathematician Laplace in 1796 gave speculative accounts of the origin of the solar system which influenced thought throughout the nineteenth century. The sun was assumed to be surrounded by a disk-like gaseous nebula out of which, by processes not well understood nor well formulated, the planets were supposed slowly to condense, and satellites to condense about the planets or at least about some of them. But increased knowledge of the dynamics of the solar system made these theories untenable about fifty years ago.

In 1910 two American scientists, Chamberlin and Moulton, formulated the Planetesimal Theory. Another star was presumed to have approached close to our sun some 3000 million years ago, (and there are sound logical reasons for these large numbers) and this resulted in loss of some of the sun's gases which would circle round the sun, condense into small solid aggregates and these into planets and satellites and swarms of meteors.

Two British scientists, Jeans and Jeffreys, developed the tidal theory, putting it on a mathematical basis consistent with assumptions which seemed reasonable at the time. The passing star would draw out a great tidal wave of solar gases and from this matter the system of planets and satellites would slowly be formed. Subsequent critical study of this theory, chiefly by Professor Harold Jeffreys himself, has led to its abandonment. It cannot explain all the known features of the solar system. The list of criteria about the solar system which a theory must explain to be acceptable grows greater and greater as our knowledge increases.

Russell in the United States and Lyttleton in Great Britain suggested that our sun was once one member of a binary star system and that a passing star collided with the sun's companion star knocking it out of the sun's gravitational field but hurtling some of its disrupted gases towards the sun, and from these gases the planets were formed in the course of time.

An Indian, Banerji, proposed a variation upon this, supposing the sun's companion star to have been a pulsating variable star thus facilitating its disruption.

A young Yorkshire scientist, Hoyle, proposed another idea in 1945. His name is now well known because of his BBC and CBC broadcasts describing his hypothesis that the sun's companion became a supernova, an exploding star with the liberation of energy taking place off-centre, thus hurling itself, by recoil or "back kick," out of the sun's influence but hurling its disrupted gases towards the sun to be captured and in due time to condense into planets. Hoyle has a most amazing confidence in his own theory in spite of many very serious inherent difficulties. Relatively few astronomers agree that this is a hopeful approach towards a solution of the origin of the planets; but may the day never come when the CBC will deny its facilities to a serious thinker so long as he expounds his views without holding up to ridicule the scientific, philosophical, or religious views of those with whom he differs.

Let us now consider what many astronomers believe to be the most encouraging line of attack on this vastly complicated problem.

We leave the cataclysmic theories and consider a star whose motion in the galaxy carries it into one of the many vast regions of diffuse nebulosity consisting of atoms, molecules, and small particles like smoke or fine dust. In 1944, in Germany, C. F. von Weizsäcker investigated the turbulent motion, the vortices and counter eddy currents that would be set up in the shell of a nebula which would form around the rotating star. He showed by calculation that successive rings of successively larger vortices would arise and between these, in what might be called ball-bearing eddies, matter would tend to collect. The resulting sequence of distances and diminishing densities of the aggregates resembles the actual sequence of the planets. This is a theory of great promise and many scientists, e.g. the Astronomer Royal Sir Harold Spencer Jones and Professor Gamov, consider it the most successful theory yet proposed.

Kuiper in the U.S.A. has criticized von Weizsäcker's theory in some respects and has proposed a modification. He concludes that not within the roller bearings will condensation occur, but within the larger primary vortices which will become unstable and give rise to internal eddies from which planets and their satellites might be formed. Kuiper has recently elaborated his ideas in fifty pages of closely reasoned arguments, assumptions, and approximate calculations.

This new Nebular Hypothesis is very different from those of Kant and Laplace. It is based on vastly greater knowledge of physics, astronomy, and mathematical methods. I have not attempted to explain technical ideas—angular momentum, retrograde motions, Roche's limit, ionization, vapour pressure, and many other factors which must be taken into account. Nevertheless I have tried to give some idea of the magnitude of this complicated problem, rendered the more difficult because we do not know and cannot yet observe whether there be few or many other stars which have a family of planets like our sun's system.

Only since 1942 have we known that any other star possesses even one planet. In that year and the next, K.A. Strand drew attention to the binary star 61 Cygni, and Renyl and Holmberg to the binary 70 Ophiuchi. In each of these systems a third component of mass so low as to place it in the category of a planet has been inferred, though not observed. not confirmed

The two visible stellar components, A and B, of 61 Cygni revolve in orbits about their common centre of gravity in a period of 720 years. Much is known about orbital motion as a result of the work of Kepler and Newton. Observed deviations from a Keplerian orbit imply the existence of a third body whose mass and orbit can be calculated. From the motions of A and B, Strand has established not only the existence of C, but the fact that it revolves about either A or B in 4.9 years and that its mass is only sixteen times that of the planet Jupiter or one-sixtieth of the sun. Too small to be called a star, 61 Cygni C is the first body classified as a planet to be found outside the solar system.

In the richest starry regions of the Milky Way is another binary system, 70 Ophiuchi. Its visible component stars A and B revolve in an 88-year period. They, too, show deviations from true binary star orbits, necessitating the conclusion that a third body C exists. Between 1914 and 1942 at an American observatory 97 plates were taken of this pair, and another 29 plates were borrowed from Germany and from South Africa, from all of which the conclusion is reached that C revolves in an orbit around either A or B every 17 years. Its mass is about one-hundredth of the mass of the star to which it is a planet.

Might there be life on these planets, vegetation and animal life such as have come into being on the earth in the course of many millions of years? Terrestrial organisms of self-reproducing cells are known to require special chemical and environmental conditions—abundance of carbon and hydrogen, water vapour, and a limited range of temperature being only the most obvious. While the central mystery of life remains a mystery, no logical reason forbids the assumption that living cells will come into being wherever in nature the requisite chemical and physical conditions exist. In the case of the other members of the solar system no close approximation to the essential terrestrial conditions is found: too scorchingly hot if near the sun; too utterly cold if in the outer orbits; no atmosphere whatever, or atmospheres almost devoid of oxygen and water vapour but rich in carbon dioxide, or methane, or ammonia as cirrus clouds of crystals hovering over a frozen ocean of solid ice.

Examining the data for the two non-solar planets we find that 61 Cygni C revolves about its star in an elongated elliptic orbit which brings it in to about the sun-Venus distance but carries it far out beyond the sun-Mars distance. The average distance of this planet is therefore much greater than the sun-earth distance. Both for this reason and because its star is much cooler and less luminous than the sun, the temperature may be too low to be conducive to life even if the other conditions were favourable.

Cooler also than the sun, though to a lesser extent, are 70 Ophiuchi A and B, but 70 Ophiuchi C revolves around one of them at approximately six times the sun-earth distance. It is thus more remote from its star than Jupiter from the sun. Jupiter is believed to be wholly incased in ice, so that the likelihood of life on 70 Ophiuchi C is negligible, in so

far as temperature plays a decisive part. What the chemical and the other physical properties of these unseen non-solar planets may be we do not know.

When one pauses to consider that the galaxy of which our sun is one humble member is composed of some hundred thousand million stars, and that there are possibly a hundred million such galaxies within reach of our powerful telescopes, the conclusion is justified that many planetary systems must exist whether the number in any one galaxy be large or small. Amongst all these some few here and there in this galaxy or in another may happen to provide those very conditions of environment in which living cells may develop. This is a vague statement but it is based on long years of observation and research in which much precise knowledge has been gained. The past ten years have added their quota. What new knowledge will the next few years reveal? Perhaps astronomers will find indirect evidence of planets about many other stars, and perhaps in the years not too far distant a direct observation will be made of some non-solar planet. But in any case the search for answers to the problems of astronomy and cosmology will go on because man is so made that he cannot resist the challenge of the unknown.

THE PROGRESSION OF STELLAR VELOCITY WITH ABSOLUTE MAGNITUDE. By Professor A. S. Eddington, F.R.S., and Allie Vibert Douglas.

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THE PROGRESSION OF STELLAR VELOCITY WITH ABSOLUTE MAGNITUDE.

BY

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AND

ALLIE VIBERT DOUGLAS.

The Progression of Stellar Velocity with Absolute Magnitude.

By A. S. Eddington, F.R.S., and Allie Vibert Douglas.

1. Several investigators have shown that there is a correlation between the velocities and luminosities of stars, intrinsically faint stars moving faster on the average than bright stars. It is of great importance to determine the amount of the change of velocity per magnitude. Spectroscopic parallaxes, now published in considerable numbers, provide good material for this determination. When used in conjunction with radial velocities no special difficulty arises; but when used in conjunction with proper motions some care is necessary, as the crude direct method is likely to give fallacious results.

The spectroscopic parallaxes, besides affording the absolute magnitudes, have to be used in order to convert the angular proper motions into km. per sec. When by accidental error too bright an absolute magnitude is assigned, the star is located too far away and the deduced linear speed is too great; similarly, if the assigned magnitude is too faint, the linear speed is too small. There is thus a tendency falsely to attribute high velocities to (supposed) bright stars and low velocities to

faint stars. To take an extreme case, if all the stars observed were of the same true brightness, the uncorrected investigation would show a decrease of velocity in the ratio $(2{\cdot}512)^{-\frac{1}{2}}$, or 0·63 per magnitude. In practical cases the effect of the accidental errors of the magnitudes is smaller; but the *accidental* error of the magnitudes produces a *systematic* error in the deduced change of velocity which is usually considerable, and it may even mask the true progression of velocity with brightness which is in the opposite direction.

The purpose of this paper is to show how to eliminate the effect of accidental error in the spectroscopic absolute magnitudes. If the degree of precision of the observations is known, the true progression of velocity with magnitude can be obtained by the method here given. We have applied the theory to a discussion of the largest homogeneous group of stars available, viz. the giants of type K.

2. Let m be the true absolute magnitude,

μ the observed absolute magnitude,

$\mathbf{v}$ the true linear velocity,

v the calculated linear velocity (*i.e.* using the parallax corresponding to μ instead of m).

Then

$$v = \mathbf{v}e^{-q(\mu - m)} \quad . \quad . \quad . \quad . \quad . \quad (1)$$

where $q = 0{\cdot}4605$. The value of q is found by considering that if the error $\mu - m$ were 5 magnitudes, the distance and linear speed would be altered in the ratio 10. Hence $e^{5q} = 10$.

In a homogeneous group of stars such as the K giants, the absolute magnitudes are usually found to be distributed according to a frequency-law agreeing closely with the error-law. Accordingly we shall have

$$\text{Frequency of } m \text{ to } m + dm = \frac{k}{\sqrt{\pi}} e^{-k^2m^2}\, dm \quad . \quad . \quad (2)$$

$$\text{Frequency of } \mu \text{ to } \mu + d\mu = \frac{k'}{\sqrt{\pi}} e^{-k'^2\mu^2}\, d\mu \quad . \quad . \quad (3)$$

$$\text{Frequency of an error } (\mu - m) \text{ to } (\mu + d\mu - m) = \frac{h}{\sqrt{\pi}} e^{-h^2(\mu - m)^2}\, d\mu \quad (4)$$

and by the well-known law of addition of accidental errors

$$\frac{1}{k'^2} = \frac{1}{k^2} + \frac{1}{h^2} \quad . \quad . \quad . \quad . \quad . \quad . \quad (5)$$

The mean absolute magnitude of the group is here taken as the zero-point from which m and μ are reckoned. Here h is the measure of precision of the observations of absolute magnitude, and k' must be calculated from the statistics under discussion.

Suppose that within the range of magnitude covered by the group, the variation of velocity with absolute magnitude can be represented by

$$v = a + bm + cm^2 + \ldots \quad . \quad . \quad . \quad . \quad (6)$$

Our problem is to determine the coefficients of this formula from statistics of μ and v. By (1), (2), and (4) the sum of the v's for all stars between μ and $\mu + d\mu$ will be given by

$$\Sigma v = \int_{-\infty}^{\infty} \frac{h}{\sqrt{\pi}} e^{-h^2(\mu-m)^2} d\mu \cdot \frac{k}{\sqrt{\pi}} e^{-k^2m^2} dm \,.\, (a + bm + cm^2) e^{-q(\mu - m)} \qquad (7)$$

The integration is for all values of m (erroneously observed as μ). This reduces to

$$\Sigma v = d\mu \cdot \frac{hk}{\pi} \exp\left\{\frac{\frac{1}{4}q^2 - k^2(h^2\mu^2 + q\mu)}{h^2+k^2}\right\} \int_{-\infty}^{\infty} (a + bm + cm^2) \exp \left\{-(h^2+k^2)\left(m - \frac{h^2\mu + \frac{1}{2}q}{h^2+k^2}\right)^2\right\} dm$$

$$= d\mu \cdot \frac{hk}{\pi} \exp\left\{\frac{\frac{1}{4}q^2 - k^2(h^2\mu^2 + q\mu)}{h^2+k^2}\right\} \left\{a + b\frac{(h^2\mu + \frac{1}{2}q)}{h^2+k^2} + c\left(\frac{h^2\mu + \frac{1}{2}q}{h^2+k^2}\right)^2 + \frac{c}{2(h^2+k^2)}\right\} \frac{\sqrt{\pi}}{\sqrt{(h^2+k^2)}} \,.$$

The number of stars contributing to this sum is by (3) and (5).

$$\frac{d\mu}{\sqrt{\pi}} \frac{hk}{\sqrt{(h^2+k^2)}} \exp\left(-\frac{h^2k^2\mu^2}{h^2+k^2}\right).$$

Hence by division the mean value of v is

$$v = \exp\left\{\frac{\frac{1}{4}q^2 - k^2q\mu}{h^2+k^2}\right\}\left(a + b\frac{h^2\mu + \frac{1}{2}q}{h^2+k^2} + \ldots\right) \quad . \quad . \quad (8)$$

At present the data are not likely to be sufficiently extensive to justify an attempt to determine c, and we shall therefore confine attention to the coefficients a and b.

The following practical procedure is indicated :—Having calculated from the observational data the mean value v for a suitable number of mean observed magnitudes μ, we next calculate

$$v' = v \exp\{-(\tfrac{1}{4}q^2 - k^2q\mu)/(h^2+k^2)\} \quad . \quad . \quad . \quad (9)$$

and find by least squares the best representation of v' as a linear function of μ, viz.

$$v' = a' + b'\mu.$$

Then by (8)

$$a' = a + \tfrac{1}{2}qb/(h^2+k^2) \qquad b' = h^2b/(h^2+k^2) \quad . \quad . \quad (10)$$

so that a and b can be found.

An example of this method is given in § 4.

3. An alternative method is to assume for the law expressing increase of velocity with magnitude the form

$$\log_e v = a + bm.$$

The factor $(a + bm + cm^2)$ in (7) must now be replaced by e^{a+bm}. Carrying out the reductions by the same method as before we find that

$$\log_e v = a' + b'\mu$$

where

$$a' = a + (b+q)^2/4(h^2+k^2) \qquad b' = (bh^2 - qk^2)/(h^2+k^2).$$

It may be noticed that the progression of velocity with magnitude, b', shown by the crude statistics will not even be in the same direction as the true progression, b, unless $b/q > k^2/h^2$. It would be easy to find cases in which this inequality is not satisfied.

The importance of the correction arises from the fact that we have generally to deal with a group of stars extending over a very limited range of magnitude in which the actual dispersion of the magnitudes is not incomparably greater than the dispersion due to observational error. It is now generally understood that the giant and dwarf divisions must be treated separately, as it is not anticipated that a continuous formula would be likely to cover both groups together.

4. The following investigation relates to the stars from type G8 to K2 inclusive, brighter than absolute magnitude $3^{\text{m}}{\cdot}5$ (which seems to be the dividing line between giants and dwarfs) contained in *Astrophysical Journal*, **53**, p. 13 (1921) "Parallaxes of 1646 Stars," by Adams, Joy, Strömberg, and Burwell. Proper motions were taken from Boss's Preliminary General Catalogue; stars not included in Boss's Catalogue were omitted, as it was thought that they might have been selected for special reasons. 287 stars remained.

In order to eliminate the solar motion, the cross-component of proper motion at right angles to the direction towards the solar apex was calculated for each star. These were converted into linear velocity by using the spectroscopic parallaxes. The stars were arranged in order of absolute magnitude and divided into five groups containing approximately equal numbers. The mean linear cross-velocity v and the mean absolute magnitude μ for each group are given in Table I., the unit of v being one astronomical unit per annum, or 4·74 km. per sec. In order to reduce the accidental effect of a few excessive motions the table also contains the mean values when (1) the three largest velocities in each group, and (2) the six largest velocities in each group are omitted.

TABLE I.

Limits of Group.	Mean μ.	v (all).	v (−3).	v (−6).
m m	m			
−3·6 – +0·4	−0·27	3·35	2·67	2·19
+0·5 – +0·8	+0·67	3·97	3·36	3·06
+0·9 – +1·2	+1·05	3·43	2·86	2·40
+1·3 – +1·7	+1·49	3·57	3·13	2·80
+1·8 – +3·4	+2·37	3·68	3·08	2·68

The mean magnitude for the whole group is $+1^{\text{m}}{\cdot}01$, and the average deviation is $\pm 0^{\text{m}}{\cdot}691$. Hence $k' = 1/{\cdot}691 \times \sqrt{\pi} = 0{\cdot}817$.

We have assumed that the probable error of a magnitude determination is $\pm 0^m \cdot 3$.* Hence $h = \cdot 477/0 \cdot 3 = 1 \cdot 59$.

By (5) we then find $k = 0 \cdot 952$.

The values of $v'/v = \exp\{-(\frac{1}{4}q^2 - k^2 q(\mu - 1\cdot 01))/(h^2+k^2)\}$ for the five groups are respectively

$$\cdot 844, \ \cdot 946, \ \cdot 991, \ 1 \cdot 045, \ 1 \cdot 164.$$

Hence we obtain the following table:—

Table II.

Mean μ. m	v' (all).	v' (−3).	v' (−6).
−0·27	2·83	2·25	1·85
+0·67	3·76	3·18	2·89
+1·05	3·40	2·83	2·38
+1·49	3·73	3·27	2·92
+2·37	4·28	3·59	3·11

The linear formula best representing these values is $v' = a' + b'(\mu - 1\cdot 01)$, with

$$a' = 3\cdot 56, \quad 2\cdot 98, \quad 2\cdot 60$$
$$b' = \cdot 501, \quad \cdot 479, \quad \cdot 446.$$

Hence by (10), $v = a + b(m - 1\cdot 01)$, with

$$a = 3\cdot 52, \quad 2\cdot 94, \quad 2\cdot 56$$
$$b = \cdot 681, \quad \cdot 652, \quad \cdot 606.$$

The values in the last two columns, corresponding to the omission of the largest velocities, are naturally smaller than those for which all velocities are included, and they should be multiplied by the proper compensating factor. If out of N velocities the n highest are omitted, the error-distribution is cut short at a velocity x $(=kv)$ given by

$$\int_x^\infty e^{-x^2}dx = \frac{n}{N}\int_0^\infty e^{-x^2}dx \quad . \quad . \quad . \quad . \quad (11)$$

And the mean velocity is then

$$\int_0^x xe^{-x^2}dx \div \int_0^x e^{-x^2}dx$$

instead of

$$\int_0^\infty xe^{-x^2}dx \div \int_0^\infty e^{-x^2}dx.$$

The compensating factor is thus found to be

$$\frac{1}{1-e^{-x^2}} \cdot \frac{N-n}{N}$$

* The authors give the probable error as $\pm 0^m \cdot 4$; the lower value adopted here will at any rate not exaggerate the effect which we are studying.

where x is found by solving (11). This factor is $1\cdot 12$ when the three highest are omitted, and $1\cdot 22$ when the six highest are omitted. The corrected values are thus

$$a = 3\cdot 52, \quad 3\cdot 29, \quad 3\cdot 12$$
$$b = \cdot 681, \quad \cdot 730, \quad \cdot 739.$$

Multiplying by 4·74 to reduce to km. per sec., and measuring the absolute magnitude from zero instead of $1^m\cdot 01$ the final formulæ are

$v = 13\cdot 4 + 3\cdot 22m$ km. per sec. (all stars)

$v = 12\cdot 1 + 3\cdot 46m$ „ „ (15 rejected)

$v = 11\cdot 3 + 3\cdot 50m$ „ „ (30 rejected).

The three formulæ agree so nearly that it is scarcely necessary to decide which is the most trustworthy; but as a general rule we might expect that the omission of the three highest velocities out of fifty would remove all difficulty from excessive velocities of exceptional stars, and we accordingly take the middle solution as definitive. Of course, the formula must not be extrapolated beyond the range for which it is derived, viz. from $-0^m\cdot 3$ to $+2^m\cdot 4$. In this range the formula gives an increase of velocity from 11·1 km. per sec. to 20·4 km. per sec., a ratio of 1·84.

It is of interest to compare this result with that of Adams, Strömberg, and Joy, who have worked on the same material.* Their division most nearly corresponding to ours is the group of giants from K0 to K9. Their formulæ gave a velocity ratio for a change of 2·7 magnitudes

from proper motions 1·19

from radial velocities 1·93.

Our result, 1·84, agrees with the radial velocities, and at the same time we see why the uncorrected result from the proper motions was so small. An examination of our Table I. reveals no clear indication of a change of v with μ; it is only when the masking influence is removed that we are able to obtain the progression of v with m.

5. Calculating the probable error of our determination of b in the usual way, we find that the increase of velocity is

$$3\cdot 46 \pm 0\cdot 65 \text{ km. per sec. per magnitude.}$$

The probable error is as low as could be anticipated theoretically,† and, so far as internal agreement is concerned, the result would appear to rank as a good determination. But a little consideration shows that its trustworthiness depends on the accuracy of the assumed probable error of the spectroscopic magnitudes. We have made another solution assuming a probable error $\pm 0^m\cdot 4$ instead of $\pm 0^m\cdot 3$. The result (rejecting three highest velocities in each group) is now

$$v = 7\cdot 7 + 7\cdot 54m \text{ km. per sec.}$$

* *Astrophysical Journal*, 54, 189. See especially Table III.

† If we have two groups each of 144 stars separated by an interval of $2^m\cdot 5$ with average velocity 15 km. per sec., the change of velocity per magnitude should be given with a probable error 0·6 km. per sec.

The progression of velocity with magnitude is more than doubled. This result is certainly too high, and it shows indirectly that the spectroscopic parallaxes for this group must be rather more accurate than their authors claim. Reference to the table of probable errors (*Ap. J.*, **53**, 27) shows that the prospect of determining h with greater precision is not very hopeful. It is rather disappointing to find that lack of precision of this constant stands in the way of a more successful determination of the important quantity b. But at least it is desirable to know what is the difficulty to be overcome in arriving at a solution of this problem. An increase in the number of stars observed will not diminish the difficulty. If it is not possible to deduce useful results when the probable error of the absolute magnitudes is taken into account, results obtained by neglecting it must *a fortiori* be worthless; in that case the inclusion of proper-motion data in the investigation can only tend to spoil the results obtainable from radial-velocity data which are not subject to this insidious systematic error.

There is one way in which this difficulty may perhaps be overcome. The progression in mean parallactic velocity with absolute magnitude can be calculated by our method just as well as the progression in cross velocity. But this progression should be zero, and we must therefore assign to the absolute magnitudes that value of the probable error which will make the progression zero. This method of finding h was not thought of until the paper was in type, and we have not had time to test whether it is successful practically.

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The Commerceman

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SYMPOSIUM: THE QUALITIES OF AN EDUCATED PERSON

"What are the qualities of an educated person?" This question was asked of five members of the University teaching staff. The writers, representing various Departments, are: Dr. Douglas, Dean of Women; Professor Dorrance, of the Chemistry Department; Dr. Earl, Dean of the Faculty of Arts; Professor McDougall, of the School of Commerce; and Dr. Whalley, of the English Department.

The Qualities of an Educated Person

A. VIBERT DOUGLAS

Asked what I believe to be the qualities of an educated person, the first thing that comes to mind is a passage from T. H. Huxley's address to the South London Working Men's College in 1868 on A Liberal Education:

"That man, I think, has had a liberal education who has been so trained in youth that his body is the ready servant of his will, and does with ease and pleasure all the work that, as a mechanism, it is capable of; whose intellect is a clear, cold, logic engine, with all its parts of equal strength, and in smooth working order; ready, like a steam engine, to be turned to any kind of work, and spin the gossamers as well as forge the anchors of the mind; whose mind is stored with a knowledge of the great and fundamental truths of Nature and of the laws of her operations; one who, no stunted ascetic, is full of life and fire, but whose passions are trained to come to heel by a vigorous will, the servant of a tender conscience; who has learned to love all beauty, whether of Nature or of art, to hate all vileness, and to respect others as himself."

Education is, of course, a process which is never completed while life continues. Sincerity is an essential quality, for ability to discern truth, to differentiate truth from falsehood, is one mark of an educated man. He must have familiarity with our rich inheritance from the past and some appreciation of our debt as members of one nation to the great thinkers, the great artists, musicians, poets, craftsmen of many other nations in many ages. He does not need to be a creative research worker himself, bringing new intellectual wealth to mankind, but he must have sufficient knowledge, sufficient discipline of mind, sufficient sensitivity of feeling to recognize true scholarship when he sees it, to value it profoundly, and to respect and encourage the scholar.

One meets some undoubtedly learned people who are crude and boorish in manner, pompous, conceited, intolerant. One hesitates to call such persons 'educated', extensive though their knowledge may be. In addition to the trained, stored mind, and judgment made keen by experience and wisdom, the educated man should have an appreciation of the rights, feelings and sensibilities of his fellow beings and by practised self-control, if not by innate gentlemanliness, behave to his fellow men with courtesy, good sportsmanship and honour.

My thoughts go back to the winter of 1916 in London when I first read that essay of Huxley's while German bombs were falling over the dark city, and somewhere out in the cold deathridden muddy desolation of Flanders was the one who had given me the book. Two of the most highly educated nations of Europe were locked in desperate conflict—and it happened again twenty-four years later. Education which results from the striving for greatness in learning and leadership is not enough.

The 'educated' person will aspire not only towards greatness of learning and achievement, but to greatness he will add goodness because he will want to approach asymptotically to the ideal of true education which is the fullest development of the whole man for the whole experience of living in the actual world about him.

The educated man will recognize that in this actual world are two elements, the measurable experiences and the immeasurable, the material facts and the spiritual, the ephemeral and the eternal; and in the light of what he deems their relative value, he will live his life to the enrichment of his day and generation.

The Qualities of an Educated Man

R. L. DORRANCE

The dictionary gives the following meanings to *educate* and *education*:— To cultivate and train the mental powers of, to qualify for the business and duties of life: The act or art of developing and cultivating the various physical, intellectual, aesthetic and moral faculties. In my opinion the educated man is one who possesses the qualities implied in these definitions.

An educated man does not of necessity hold a university degree nor even have had a secondary school education. He may not be able to read the Aeneid in the original, nor know the trigonometrical functions, nor the Clausius-Clapyron equation; but he should be able to write and speak his own language without making too many serious grammatical errors and he should speak with a clear and pleasant voice.

An educated man should be familiar with the important problems at the international, national, provincial and municipal level and he should endeavour to acquaint himself with the facts so that he can form an opinion on these problems. Insofar as time permits he should take an active part in the life of the community. While he may have his own opinions and be prepared to support them he should be tolerant of those who hold opinions different from his. He should be free from racial and religious prejudice.

An educated man is courteous at all times; particularly to his elders and the very young, and those physically handicapped, always ready to lend a helping hand to those in need. He should be honest to his employer and fair with his employees. He should be most considerate of the feelings and comforts of others. He should be careful of his personal appearance, suitably dressed for the occasion but select his clothes so as not to attract undue attention.

In general an educated man is moderate in his general behaviour, courteous, considerate, well informed, a kind and thoughtful husband and father, an active force promoting those plans which tend to improve the life of his community and his country.

The Qualities of an Educated Man

R. O. EARL

Many people, when they are asked about education, will immediately think of the famous definition made by Thomas Henry Huxley. It is often quoted and may be found, among other places, in the little book, *Aphorisms and Reflections*. There are a number of almost equally valuable observations on education in this book. It is my opinion that has been requested, however, and I must give it in my own words.

I think that an educated person is one whose mind is trained and whose memory is stored. It would be well indeed if his intellect were as bright and clear as Huxley described it and his temperament equally good; but the capacities of everyone are determined by heredity; and these capacities are not a matter of praise or blame. We are concerned with improvement within limits and it is doubtless true that few achieve as much as they could.

To realize this one has only to consider the consequences of good teaching and example. There have been a few famous men whose effects on their students have been incalculable. By all means, let us praise them. There have also been many good and faithful teachers whose warm and stimulating influence has been felt, in the aggregate, by countless thousands, but who have no memorial. It may seem as if they had never been, yet this influence, though unrecognized perhaps, liveth forevermore in the lives of their pupils and descendants.

The educated man, therefore, has had at least one good teacher. Thus he has taken with pleasure to learning and through the accumulation of knowledge has acquired understanding. Narrow though his interests may have been at first, he will have found that all knowledge is his province and that glimpses of understanding of the most special and particular problems come from diverse sources.

Learning is a discipline involving logical processes of thought and complete respect for evidence. Since all problems are solved by these methods the educated person is not only efficient in his own pursuits but can also rapidly turn his mind to others. It is not unusual for a person, accomplished in a special field, to undertake a task in a broader one, which may be quite different, and to do well in it. A conspicuous example was the late Principal Wallace who had been a great geologist.

Finally, the educated person, because his mind is stored and his faculties trained, can recognize and appreciate the best in all walks of life, in all sorts and conditions of men and, of course, in nature. He can adapt himself to his circumstances, whatever they may be, and he can be a guide and helpful friend to others. Thus he exists in a state of lively awareness and has a satisfying and useful life.

Anyone writing on a subject should know a lot about it and should apply to it disinterested objective contemplation. The task is very difficult for one whose method of acquaintance was unusual and who is involved in it himself. Now my training at university was entirely in pure science except for one course in English; and I am, of course, deeply involved in the process of education. I would be the last to discount the value of self-education, particularly that which comes through reading; and I do belive that experience is useful for evaluation. Nevertheless I think I should say that what I have written is just my opinion. The readers of these words will have had, or be getting, a good, formal, general education, and will not, with rare exceptions, be teachers. They, therefore, should be well fitted to decide this matter for themselves. I hope that we would not find ourselves far apart.

The Qualities of an Educated Man

J. L. McDOUGALL

Many books have been written upon this topic; and anyone who dashes into this field to settle the question in five hundred words might well be asked where he got his warrant to blaze a trail for the angels. And yet—how can one hold oneself out as worthy to teach any subject if one has not thought on these things?

The essential word in this question is qualities. One may know many things. One may amass knowledge of facts, or wealth, or power, or all three, and still remain a boor. Qualities are not directly measurable, least of all the moral qualities which are implied in this question. No matter how many appeals are made to the opinions of authorities upon such matters, there must remain in every expression of opinion on them, some element of taste and judgment. One expresses such ideas as one has, and by so doing, lays oneself open to the judgment of those who differ from him.

An educated man is a bearer of the qualities of the civilization into which he was born. These qualities are not absorbed unconsciously only. The early contacts in the home, and, later through church and school are a beginning, but they become fully a part of the character of the man as they are consciously considered, and accepted. There must be an awareness of the full implications of the restraints which are imposed upon the mutually conflicting appetites of the natural man, and a desire to understand and honour the obligations which are imposed upon the man who hopes to bear the responsibility of being in some degree an interpreter of the best he has received to those who will follow him when his race is run.

It follows, therefore, that the educated man must have a sense of belonging to a civilization and that his own country is not the peculiar abode of virtue. Nor should he feel that his own time is the only one in which it is really worthwhile to live.

In brief, the educated man must have tried and at least partially succeeded in looking upon the culture into which he was born and whose influence he will show as long as he lives, against the perspective of its own historic change and with respect for the qualities of other civilizations whose qualities he acknowledges even though he knows that he will never understand their moving forces as well as he knows his own.

To this point, the argument has been put in very general terms. It might be accepted by a believing Christian, or by a follower of Confucius. Each had to achieve some kind of dynamic balance between the forces of stability and the forces of change within his own society; and nothing is in the end more destructive of the values of any civilization than the attempt to preserve blindly every aspect of society as our fathers knew it. Values cannot be mummified and then held up for perpetual veneration like the body of the late Mr. Lenin. They must be worked over afresh, and then accepted, or altered by each new generation. When that active process stops then the values wither and, ultimately, decay.

Canada is a part of Western civilization; and Western civilization is understandable only in the light of its Christian origins. It is true that for at least the last two centuries a major part of its intellectual energy has been given to a restatement of the Christian ethic in terms which are divorced from the Christian religion. The rights of man go straight back to the respect which is due to each of us as sons of God and objects of His loving concern. Without that basis it fails to make sense. It follows, therefore, that the educated man who is a member of Western civilization cannot understand the values of our culture or transmit them in full vigour without knowing whence they have sprung, and without realizing that no great civilization has ever developed without a great religion at its centre, or persisted after that religion disintegrated.

The Qualities of an Educated Person

A. G. C. WHALLEY

An educated person is not a past participle. He is a person who has plotted out the limits of his ignorance and has some idea how to find out what would be worth knowing. He will continue to search and to learn when left to his own devices, and will feel some need to mature in wisdom.

The essence of education is discipline: first a contagion—picked up (if one is lucky) from some vigorous and respected master—and then a self-imposed devotion. Discipline establishes those limits within which freedom can alone become vital and fruitful; for it enjoins respect for the integrity and mystery of other minds and lives, respect too for fact and for events that lie beyond the range of our personal desires, talent, and ambition. The "trained mind"—which is also a disciplined sensibility—is rooted in the recorded past of outstanding spirits, and is not so much a refined instrument of technical precision as a deft flair for grasping relevancies of any sort in any context. Recognising that everything is somehow related with everything else, and that every special aspect of knowledge invokes the whole universe of what can be known, the educated person will neither be paralysed by his own ignorance nor dangerously impressed by the little he happens to know. He will tend towards comprehensiveness and versatility; yet he will probe insistently towards the vital centre of things, rejecting whatever blurs discrimination or clouds vision. He will resist savagely all forms of apathy, narcotic superstition, and bland generality—even when these anaesthetics are respectably introduced under the titles of "social adjustment" and "good citizenship". For all attempts to produce the right answer without asking relevant questions are meretricious and dangerous, even when expedient. Sincerity and curiosity are not enough: the one declines too readily into sclerotic earnestness, the other into prurient acquisitiveness.

Respect for fact, an acute sense of relevance, a desire to embrace without destroying, a most undemocratic fascination with excellence; these are the marks of the educated person, virtues cultivated in the affectionate search for truth. But truth is not portable, and truth has many faces; and truth is so terribly simple, urgent, and elusive that a man may break his heart before he arrives at truth, and it can always slip easily away. It is humiliating to discover how little in a lifetime one can honestly grasp, understand, respect, remember. Often we hide that humiliation by acting before the world the part of monstrously adult quizz-kids. Yet at the centre of everything is one aching and overarching fact: that life is too short to grasp all its vividness and all its poignancy and all its mystery, and too short to let all of what little we *can* grasp tendril back into the immediacies of our actual living. I can think of nothing else that an educated person could properly be concerned to busy himself with.

REAL AND APPARENT RADIAL VELOCITIES.

By A. V. Douglas.

Monthly Notices of R.A.S., May 1924.

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REAL AND APPARENT RADIAL VELOCITIES.

BY

A. V. DOUGLAS.

(*Communicated by Professor Eddington, F.R.S.*)

The complete Doppler formula obtained by Silberstein * from de Sitter's spacetime theory, into which no limitation whatever is introduced, the observing station and star being treated as two free particles and the equations integrated in their full generality, is as follows :—

$$D = \gamma \left[1 \pm \sqrt{1 - \frac{\cos^2 \frac{r}{R}}{\gamma^2}} \right] - 1$$

where D = complete spectral displacement.

$\gamma = \frac{1}{\sqrt{1 - \frac{v_0{}^2}{c^2}}}$ always slightly greater than 1, not determinable theoretically, but only by observation of Nature.

r = distance to star from observer.

R = curvature invariant of spacetime.

This formula for the spectral shift resolves itself into two parts—(1) a term depending upon an individual characteristic of any star, v_0, its actual radial velocity at its nearest approach to the observer whether that occurred in the past or will occur in the future, (2) a term depending upon the ratio $\frac{r}{R}$ and thus due to the four dimensional nature of elliptical spacetime.

* *Nature*, 1924 March 8, p. 350.

Although these two terms are inseparably amalgamated, yet for stars near to the observer it is evident that the first term dominates the result, while for very remote celestial objects the second term completely outweighs the first.

Assuming Silberstein's value of R as 4×10^7 parsecs and r to lie between 100 and 1000 parsecs, then term (2) lies between 0·7 and 7 km. per sec., and may thus be not merely comparable to but even equal to or greater than the true v_0-velocity.

In the light of the above it seems advisable to reconsider the work which has been done with regard to the progression of velocity with absolute magnitude.

W. S. Adams * showed that for K and M giants the radial velocity and its progression with absolute magnitude were greater than the tangential velocity and its progression; while for the giants of all types (F to M) taken together, the reverse was the case, the radial velocity and its progression being the smaller.

Eddington † showed for the G_8 to K_2 giants, when due allowance was made for the systematic effect arising from accidental errors in the spectroscopic determinations of absolute magnitude and parallax, and when using the value $\pm 0^{m}\!\cdot\!3$ for the probable error of the absolute magnitudes, that the progression derived from the proper motion data became comparable with, though not quite as great as, that obtained by Adams for radial velocities. If, however, the value $\pm 0^{m}\!\cdot\!4$, given by Adams ‡ as the probable error, was used, the resulting progression for the tangential velocity was more than doubled.

The question which Silberstein's work suggests is that the progression derived from radial velocities is not a true progression. It is influenced by the unduly high velocities of the remote stars, due solely to their distances, which stars in the catalogue are for the most part of high luminosity. Since the true v_0-velocities of those stars, which are both very bright and very remote, should be less than the values assigned to them, it is evident that the progression for true radial velocities should be greater than that given.

The list of spectroscopic parallaxes § used in both the above-mentioned investigations is made up, to the extent of perhaps 20 per cent. of its total, of stars distant between 100 and 1000 parsecs, and as has been pointed out this distance may cause the r/R shift to equal or outweigh the shift due to true velocity. Thus 20 per cent. of the stars involved in the investigation—and these belonging chiefly to the most luminous groups—would have their velocities reduced to varying extents, and it seems probable that this would produce a considerable change in the factor b in Adams' formula $\log v = a + bm$.

It would be interesting if this brought b up to such a value that it represented a progression comparable with that given by Eddington's formula $v = a + bm$ for tangential velocity, when the probable error of absolute magnitudes is taken nearer the value $\pm 0^{m}\!\cdot\!4$ given by Adams.

* Adams, Strömberg, and Joy, *Ap. J.*, **54**, 1921 (Table III., p. 9).
† Eddington and Douglas, *M.N. R.A.S.*, 1923 January.
‡ Adams, Joy, Strömberg, and Burwell, *Ap. J.*, **53**, p. 15, 1921.
§ *Ap. J.*, **53**, 1921.

But it was pointed out by Eddington that there is little hope of determining this probable error precisely, and therefore no reliable progression can be obtained from proper motion data with which to compare the progression for radial velocity in an attempt to work backward to an average value of v_0. If a large number of values of v_0 were calculated, it seems as though they alone would provide the material from which the progression of velocity with absolute magnitude might be determined.

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REGIOMONTANUS, 1436–1476

By A. Vibert Douglas
Kingston Centre, R.A.S.C.

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

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

In 1463 he completed the *Epitome* left incomplete at the death of Purbach two years previously. This was published in Venice, but only in 1496. After five years in Italy, he went to Vienna and thence to Buda where he collated Greek manuscripts at the invitation of the King of Hungary.

Regiomontanus finally settled down in Nürnberg in 1471 to teach and pursue his own researches in astronomy and mathematics. One of his pupils was Bernhard Walther who became his patron. Together they constructed an astronomical observatory, furnishing it with greatly improved instruments which are described in the *Scripta*. This book, however, remained unpublished until 1544. His manual dexterity was not only evident in his instruments, for when the Emperor Maximilian I visited Nürnberg, he was requested to construct a large mechanical eagle to be mounted over the gate to the city. In 1472 a spectacular comet appeared and extensive observations were made of this. In the same year he set up a press in Walther's house and printed Purbach's planetary theory as well as some popular calendars. Two years later he published ephemerides for 1474–1506. This book contained also his method of using lunar distances for the determination of longitude at sea. The principle involved was far from new and is essentially valid but neither then nor throughout the succeeding two centuries were the practical results satisfactory for the simple reason that no accurate lunar tables existed. To remedy just this and other navigational problems the Royal Observatory at Greenwich was established by Royal Charter in 1675. The first Astronomer Royal, Dr. James Flamsteed, made the accurate determination of lunar positions over an extensive period his prime concern.

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

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

Report on UNESCO

—What will Canada do?—

by

A. Vibert Douglas

A Canadian delegate writes a first hand account of the Eighth General Assembly of UNESCO held in Montevideo. A study in tension, reconciliation and hope—and an appeal to the Canadian conscience.

A courageous vision of international cooperation in the things of the mind and the spirit brought UNESCO to birth in 1946. In these nine years it has developed into an organization which now brings together representatives of seventy-two nations for the purpose of discussing and planning educational, scientific and cultural collaboration. The record is a human record, not without its mistakes in policy and in methods of implementation, not without its hign-flown ideas which aftersight has clearly recognized as impractical; but in the main the record is one of much solid achievement in a wide range of endeavour.

The Eighth General Assembly of UNESCO was held in Montevideo from November 12 to December 11, 1954. The ninth is planned for New Delhi in the autumn of 1956 at the urgent request of India and all the countries of south-east Asia supported by all Latin America on grounds of the wide interest stimulated by the conferences in Mexico and Uruguay. After 1956 there will be strong pressure to have subsequent conferences meet at the new headquarters of UNESCO now under construction in Paris.

The importance of this subsidiary organization of the United Nations in the eyes of various governments may be judged, in part at least, by the quality and number of their delegates. The United Kingdom had a delegation of sixteen headed by Sir Ben Bowen Thomas and including Gen. Sir Ronald Adam, chairman of UNESCO's Executive Board, Sir John Simonson, a distinguished chemist, and Mr. Nivenson of the Ministry of Education. The French sent twenty; the U.S.S.R., twelve; the U.S.A., twenty. Many nations have had the wisdom to ensure continuity of representation and such delegates with the experience of a succession of conferences contributed more and spoke with greater authority and comprehension than was possible for a new delegate no matter how thoroughly briefed at the last moment. Canada's delegation of ten included only two men who had attended previous UNESCO Conferences. The leader of the delegation, the Ambassador of Canada to Brazil, had knowledge of the conference in Mexico, and the General Manager of the Chemical Institute of Canada, had been a delegate to several previous UNESCO Conferences. The Department of External Affairs was capably represented by a young member of the Department who had for several months familiarized himself with the UNESCO reports and in particular with the political implications involved actually or potentially in certain items of the agenda. Of the other members of the delegation two had had previous association with UNESCO, the one, as Executive Secretary of the Canadian Education Association, thoroughly versed in UNESCO's programme of primary and secondary education and responsible for passing such information to the Deputy Ministers of Education of the ten provinces and for coordinating information from them to External Affairs and UNESCO; the other, through the work of one of the International Scientific Unions and through an international non-governmental organization with active consultative status with UNESCO for seven years.

UNESCO is maintained by contributions from all the member states, the amounts being determined with a few exceptions in proportion to the contributions of each state to the United Nations Organization. Several sums were proposed for the total budget for the period 1955-56. After considerable debate in which the United Kingdom, the U.S.S.R., Canada and ten other countries urged the lowest figure, the Conference decided on a higher amount which is approximately $20,000,000.

If based solely on their economic position in the world today, as assessed by the U.N., the U.S.A. would be responsible for more than one third of the total budget; but in conformity with the policy of the United Nations, there is a 33 1/3 percent ceiling on contributions. At Montevideo the Committee on Contributions recommended reduction of the U.S.A. contribution to 30% in view of the fact that the entry into UNESCO of three more countries meant a wider sharing of the financial responsibilities and therefore for other nations a slight reduction of their allotted percentages. This led to a sharp division of the 51 delegations represented at this particular session. The United Kingdom, Canada and other Commonwealth countries and various very small countries urged the maintenance of the U.N. scale; while France, India, Egypt stressed some "principle of equity" to urge support of the proposed reduction of the American quota. The U.S.A. delegate spoke warningly of the danger of alienating the sympathy of the American Senate if this reduction were not authorized. A motion to retain the U.N. scale was lost by a vote of more than two to one.

The entry into UNESCO of the U.S.S.R. at this Conference was one of the most significant events. With them came also the Ukraine and Byelorussia, while Poland, Czechoslovakia and Hungary returned to the fold from which they had announced withdrawal a few years ago. The U.S.S.R. contribution is about 15% on the U.N. scale. They asked for reduction to the 10% which the I.L.O. has accepted, and for proportional reductions for Byelorussia and Ukraine, on the grounds of an unjustly high U.N. assessment in the light of their tremendous war damage and expenditures in war effort which was so largely responsible for the ultimate defeat of Germany. Brazil voiced the feeling of the majority that at least for the next two years the U.N. scale should be adhered to and the vote went against the proposal for reduction by 3 : 37.

Thus the U.S.A. and the U.S.S.R. together contribute 45% of UNESCO's present budget, with the U.K. giving about 8%, Canada 2.7% and the minimum contributors 0.04% each.

* * *

The most embarrassing situations arising in the entire month of the Conference centred around the Formosan Chinese delegation. It was an ironical situation and absurd in the extreme to see a small delegation from Formosa, augmented but not strengthened by an elderly Chinese sage now resident in Uruguay, claim to speak for

China. Opposing the recognition of this delegation and speaking with great moderation, the U.S.S.R. said with truth that the Chinese nation was not represented at this Conference. However, the inevitable happened and they were recognized. Later came the question of China's contribution to the budget, which on the U.N. scale would be over 5% or more than a million dollars. Obviously Formosan China cannot contribute more than a token payment and Japan brought forward a motion that she be assessed the percentage corresponding to her token payments of $14,000 per annum. China welcomed this suggestion since it would save face in that her full indebtedness to UNESCO for the next two years would be met by these payments and consequently no question of her voting privileges could arise. The U.K. strongly opposed such an arrangement; consistent with her stand on the U.S.A. and U.S.S.R. contributions, she advocated strict adherence to the U.N. scale. Poland called Japan's motion immoral, a result of supporting a "fictitious situation". India, Australia, New Zealand, Burma and the U.S.S.R. also opposed Japan's motion. The U.S.A., Egypt, Brazil, and Thailand spoke in support. A little humour crept in here because Japan, not having a slide-rule handy, kept referring to x percent until finally the Chairman said brusquely, "This committee cannot vote on x". The Representative of the Director General had by that time done the sum in long division and announced that x equalled 0.16% ! The vote on this motion was a tie and when a roll-call vote was taken at the next session the close decision of 22 :24 threw out Japan's motion and left the Chinese delegation to face the reality of their situation, namely assessment on their claim to represent China, temporary recognition on token payment, and the question of their vote in plenary session up for debate at a later session. They were subsequently granted voting rights, by a large majority, nine nations abstaining from casting a vote including the U.K. and Canada on the ground that only nations paying their full contributions to UNESCO should be entitled to vote. Later on three other countries with arrears in their contributions, Czechoslovakia, Poland and Hungary were also given voting rights but only after the adoption of a plan of instalment payments of their arrears.

Perhaps a partial list of the countries opposed to the Japanese resolution to place Formosan China on a special percentage basis is not without interest. That Canada appears in this list was due to our official policy of maintaining the U.N. scale of assessments; but it was also a matter of great satisfaction to the writer in whose eyes the presence of that delegation purporting to represent China was unrealistic and unjustifiable on any argument. Far better to have no representation of China for the time being than to continue to provoke China at this critical time in her new regime (whether good or bad is *not* the question under consideration). She is not at this stage of her history blessed with either Christian or non-Christian virtues of tolerance and patience. This continued policy of recognizing Formosan China as China appears to be simply goading China on to deeds of antagonism and ill-will. The following delegations were amongst those who for whatever reason voted against the Japanese motion which had it carried would undoubtedly have been interpreted by some nations as further provocation of China: Australia, Burma, Byelorussia, Canada, Egypt, Iraq, Iran, Israel, Indo-China, New Zealand, Norway, Pakistan, Saudi Arabia, South Africa, Sweden, Syria, Ukraine, U.K., U.S.S.R. Possibly a partial list of countries supporting Japan's motion is also of sufficient interest to record here: Argentine, Belgium, Brazil, Colombia, Costa Rica, Dominican Republic, France, Germany, Greece, Haiti, Italy, Japan, Netherlands, Philippines, Spain, U.S.A., Yugoslavia. Immediately after the roll-call the Yugoslav delegate rose to "explain his vote"—his delegation did not recognize Formosan China, but thought by their vote to facilitate the work of UNESCO.

On the second day of the Conference, the applications for the admission of Rumania and Bulgaria were submitted. These were dealt with individually and in both cases the U.K. moved an amendment to postpone decision for two years, that is until the IXth Conference. Canada supported the amendment as did the U.S.A., Italy and France on the ground that the U.N. had not admitted them because "human rights" were not respected in these countries and the International Court of Justice had condemned them. In favour of their admission were twelve countries, including the U.S.S.R. group, the

Scandinavian group and India, Indonesia and Argentine, whose arguments were expressed with fervour and sometimes with a sincerity that was almost convincing—UNESCO should be above politics, should hold open the door to every country that has something of culture to give and much to gain by free interchange of ideas and cooperation in the realms of education, science and culture, UNESCO should uphold the principle of "peaceful coexistence". But the vote was more than two to one against admission. Subsequently many references to this decision were made, including India's plea that UNESCO become truly global, that harsh criticism be abandoned since "some nations are lacking in material goods, some are lacking in human freedom and some are lacking in humanity" and Denmark's warning that failure to recognize China, plus rejection of Rumania and Bulgaria may have serious consequences for "when a nation is not accepted, its heart is hardened".

As a contrast to this unpleasant debate was the unanimous decision in favour of admitting to Associate membership (i.e. without voting rights) four non-self-governing territories of the British Commonwealth—the West Indies, the Gold Coast, Sierra Leone, and Malaya. A highly educated spokesman of each of these Territories addressed the Conference. For the four million people of Jamaica, Trinidad and the smaller British islands of the Caribbean sea, their representative thanked the Colonial Office for sponsoring them, and UNESCO for receiving them; recalled that a son of Italy sailing westward for the Queen of Spain discovered the islands; recalled their years under Spain, then under France, then under British domination, described their advance to compulsory free primary education, their secondary schools, tropical agricultural college and the newly established University College of the West Indies high up on a shelf in the Jamaican mountains overlooking the city of Kingston and the blue waters of the Caribbean. The representative of the Gold Coast with its four and a half millions spoke also with pride of the strides in free primary and middle education and the establishment of trade, technical and secondary schools, teachers' colleges and their University College with its growing extramural department. Sierra Leone's spokesman for two million people referred to Hannibal's visit to their coast in 500 B.C., to the iniquitous years of the slave trade, to the brighter years after abolition when the ideals of trusteeship of Edmund Burke began to take concrete form; and now from today as members of UNESCO, Sierra Leone would take its stand with the nations of the world working toward the fulfilment of Tagore's vision of the minds of men everywhere freed from the shackles of ignorance, fear or hatred.

Meetings of the Programme and Budget Committee occupied morning and afternoon sessions six days a week for two weeks. A long and detailed proposed programme had been drawn up by the Secretariat in Paris several months earlier and had been most thoroughly studied and adopted provisionally by the Executive Board whose chairman, Sir Ronald Adam, presented it to the Programme Committee for their approval or disapproval, their modifications, additions or excisions. The programme falls into sections on technical assistance closely coordinated with the U.N. efforts in this field; fundamental education and teacher training centres to combat the great problem of illiteracy in many lands; assistance in primary and secondary education to many countries; fellowships to aid scholars of science, the creative arts and the humanities; special projects such as the history of culture; coordination of international work on the geophysical year, arid zone research, oceanographic research; international computation centre; support of the international unions of science, medicine and humanistic studies; special seminars, study tours, and travelling exhibitions; sociological projects; bibliographic, translational and information centres; mass communications through films, publications, radio and television furthering the intellectual and cultural aims of UNESCO. It seems unnecessary to specify details of this vast programme with all its diverse ramifications—these are published by UNESCO for all to read who will.

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In the debates on item after item of this programme national characteristics became very obvious. To the practical mind of the Anglosaxon nations it was frustrating in the extreme to listen to high flown rhetoric which appealed to emotion and sentiment and swayed a majority of delegations to support some vague well-meaning, but in our view quite fantastic and impractical resolution. Very often before being voted upon, a rewording was accomplished which drew the teeth of the motion or an amendment to postpone implementation for two years was successfully introduced, thus somewhat soothing the ruffled spirits of the minority who felt that the proposition was thus rendered innocuous, though even so it did not add to the prestige of UNESCO. Some of these resolutions of dubious value had reference to a cheap stamp for encouraging children and young people to correspond thus forming friendships and bringing nearer the peace of the world, or the establishment of Friends of UNESCO clubs throughout the world, or Spain's resolution that an expert study be made of the possibility of setting up an International Fund to serve "the real needs of education, science and culture". In connection with Brazil's plea for this last named project which seemed to imply that UNESCO is not dealing with "real needs", the U.K. requested some clarification—from what sources was the fund to be established? government or private? who was to administer it? who might benefit from it? would it be used for loans? or capital expenditures by needy nations? how would it be integrated with UNESCO's present budget and programme?—to which reasonable request for information, Brazil replied with a dramatic gesture, "If I knew the answers to these questions I should not be supporting this resolution!" He deplored the attitude of the "have" nations "on whom Lady Fortune has smiled" but omitted to mention the record of these same nations for long years of sustained hard work and great initiative. Ceylon, Columbia and Chili spoke for Spain's motion, the U.S.A. wanted it deferred, but the English-speaking nations with a few others who thought similarly were defeated 30 : 10.

Three times debate waxed hot and oratorical over the proposal that UNESCO should enter the field of cancer research. Here again the international cleavage was very marked. All the anglo-saxon delegations, joined only by Chili from the Latin countries, were opposed to UNESCO moving into a field in which active research is already highly organized and coordinated and supported by millions of dollars. But the appeals to heart and conscience, to the cry of suffering humanity, were vehemently expressed by France and Switzerland with Italy, U.S.S.R., Poland, Lebanon (who said he spoke not as a scientist but with common sense!), Ukraine, Pakistan, India and Brazil supporting, and they carried the vote 25 : 13. Thus $17,000 of UNESCO's small budget will go to a study of how UNESCO can best aid in furthering and coordinating research on what all delegations agreed to call Basic Research on Cellular Growth.

Several resolutions which were to come forward towards the end of the Conference occasioned some apprehension and no small amount of behind the scenes activity in the earlier weeks. One of these was India's resolution on the peaceful uses of atomic energy, with which might be coupled Japan's plea for research and information on the harmful effects of radiation. Since atomic energy was under consideration in the U.N. and President Eisenhower's proposals appeared to be receiving sympathetic consideration from all quarters, it was imperative that no resolution which would make the U.N. task more difficult should be allowed to evolve out of the debate on India's proposal, whether by intent or by accident. A further resolution was therefore drafted which could only strengthen and in no way embarrass the U.N., a resolution sponsored by France, India and Japan which "invites all Member States to join together in devoting their efforts and resources in an increasing measure for the utilization of atomic energy for education, science and culture and other peaceful purposes with a view to raising the standard of life of the people in all parts of the world and especially in underdeveloped areas; and instructs the Director-General to extend full cooperation on behalf of UNESCO to the United Nations and its Specialized Agencies in the fulfilment of this task, including the urgent study of technical questions such as those involved in the effects of radio-activity on life in general as well as for the diffusion of objective information concerning all aspects of the peaceful utilization of atomic energy." This was supported by the U.S.A., Denmark and Poland and it was carried unanimously.

Taking firm hold of a very prickly nettle, the Americans introduced a motion which called upon all Member States "to eradicate or to help others to eradicate the evil of racial discrimination" and authorized the Director-General "to initiate a world-wide campaign against this evil as an integral part of UNESCO's programme." This gained unanimous support except for South Africa's abstension from voting.

Another matter which caused concern was a Russian resolution to the effect that since mass communications were being used by some nations to spread mistrust of other nations and breed animosity, UNESCO should require its Member States to restrain all such activities. A new resolution was worded positively, calling upon all Member States to encourage the use of all their mass communications "for the promotion of better relations among peoples and thus to counteract any attempts, wherever they may occur, to use these means of mass communication for purposes of propaganda either designed or likely to provoke or encourage any threat to the peace, breach of the peace or act of aggression; and inviting all Member States to take the necessary measures to assure freedom of expression and to remove barriers to the free flow of undistorted information between Member States and to promote the use of the means of mass communication in the interest of increasing mutual confidence and understanding among the peoples of the world . . . ". This was agreed upon by the American and Russian delegates meeting together one evening for the definite purpose of finding a wording which both could accept—an achievement which was itself significant. The U.S.S.R. supporting the motion explained their attitude, called for unanimous approval and urged that the resolution be backed up by law and action ! The U.K. voiced its support, but stressed freedom of the press, and remarked that any interjection of hatred into UNESCO's deliberations was to be deplored, adding that sometimes a resolution could in itself be a bitter document. The U.S.A. commented on their interpretation of "undistorted information", information is the story of the day and no government authority should be intrusted with the decision as to what is news. The American delegate closed his speech with the Pauline words, Ye shall know the truth and the truth shall make you free.

Twelve countries supported this resolution and it was carried without a dissenting vote. Will it make any difference in the world at large or was it no more than a pleasant ripple on the surface of the Montevideo Conference? At least one American, the rapporteur

of the Programme and Budget Committee, was not cynical about its significance when he described this resolution as "one of the most important actions of the Committee, and doubtless of this Conference."

The future holds the answer. These and the other affirmations of lofty ideals and worthy intentions are never of no significance—whether they prove of negative or positive value remains to be seen. Impatient critics must learn "to think in centuries" and Voltaire was surely not wrong in placing HOPE as God's greatest gift to man. Certain it is that the multi-facetted action programme of UNESCO gives small scope to the carping criticism of the cynics and pessimists of this world. In its main outlines and purposes it is an honest effort to meet some of the problems of our world of today in the spirit of Carlyle's sound active advice to "do the next thing".

How much do Canadians know about UNESCO? To its support the tax-payers contribute $277,000 per annum. Until our government sees its way to the establishment of a National Commission for UNESCO, closely cooperating with a Canada Council for the Arts, Letters and Science, no machinery exists in Canada to bring the importance of the UNESCO programme home to our citizens or to transmit enlightened opinion about UNESCO to the government. The need for a National Commission was discussed in the House of Commons on January 27, 1955 by the Vice-chairman of the Canadian delegation to Montevideo, the member of parliament for Bonaventure. Of the seventy-two member nations of UNESCO, Canada has the distinction of standing with Korea, Czechoslovakia and Saudi Arabia as the only four countries of the seventy-two members of UNESCO to have set up no National Commission. Will the government take the necessary step, "do the next thing", and give us a National Commission before the Ninth Conference of UNESCO meets in 1956?

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The Responsibilities of a University

by A. Vibert Douglas, *Dean of Women, Queen's University.*

THE first responsibility of a University to its students is to provide teachers who have spiritual as well as intellectual qualities and who have a contagious enthusiasm for their subjects. No one can measure the influence of an inspiring teacher, a man or woman who has "a sincere and kind familiarity with wisdom." Nor can one over-estimate the influence of the scholar who is wringing forth the secrets of his chosen field, without narrowing down his sympathies, losing his perspective and stultifying his humanity.

There is, of course, the responsibility to provide library, laboratory, class room and club room facilities. Students need to be encouraged to delve among books, and whether in a central or in a departmental library, there should be shelves of books open to them in attractive and accessible surroundings. They also need space where they can get together to discuss things, work and argue together, and chase ideas far into the night, when so inclined. This is where student residence life can be very helpful.

"Truth is a diamond with many facets," and one mark of education is the ability to discern truth and to see through the facade of half-truth that so often masks falsehood. This means that our schools and colleges must provide a mental discipline, a training in basic logic, a suspicion of vague generalities. Bacon's requirements for the man of science are worth holding before students in every faculty, "the desire to seek, patience to doubt, fondness to meditate, slowness to assert, readiness to reconsider, carefulness to dispose and set in order . . . a man that hates every kind of imposture." every separate phrase in this quotation might be elaborated at some length from the spirit of seeking to the concern for truth. These are amongst the highest characteristics of mankind and as part of the data of observation and experience, they call as loudly for inclusion in a student's philosophy of life as do the measurable facts of the physical universe. The university has a responsibility to encourage its students to formulate a philosophy of life, a working hypothesis for living, which will stand four-square to the winds of ignorance, indifference, cynicism and sentimentality.

The University should foster an atmosphere conducive to stirring and stretching the imaginative faculty in every student. Imagination is fundamental to the appreciation of what has been achieved in literature, in art, in music, in every form of science, in economics, in philosophy; and creative imagination is the mysterious force, the trigger action, which impels the mind of man across the frontier of knowledge and achievement into new realms of thought and new modes of expression. Let the universities plan their curricular and special extra-curricular programmes to jog the mind out of pedestrian paths so that there may be more and more students whose imaginations "go forth in uncurbed glory".

More and more demands are being made on university graduates to play a part in local community affairs and international affairs. It is the duty of the university to encourage recognition of this fact and to provide some training for such service. This can be done through student self-government, public affairs clubs, visiting lecturers, and in other ways. It is

(Continued on page 91)

(*Continued from page 82*)

not enough today to be a specialist in some one line—a first class engineer, physician, homemaker, business executive, teacher, farmer, lawyer or anything else—one must also be an active working citizen, an intelligent student of conditions in the world, capable of playing a part in moulding a healthy, honest, far-visioned public opinion. More and more, too, university men and women must be willing to run for public office, to serve on school boards, town councils and in parliament. In preparation for such service the universities must teach their men and women students to pull together as citizens, irrespective of sex, co-workers equally concerned in knowing the facts, righting injustices, seeking solutions to the problems of mankind and combatting intolerence and apathy.

The Universities have a responsibility to teach internationalism. This becomes more urgent than ever before as weapons of destruction become more appalling and far-reaching in their dire consequences upon the human race, born and unborn. Selfish isolationism and intolerance can only be overcome by knowledge and a realization of the indebtedness of any one nation to many other nations. Not only through history, economics, political science, and religion stressing the brotherhood of man, can students be made more world minded. By proper emphasis on the development of every subject taught within the halls of a university, students should be constantly reminded of their debt to the great thinkers of other nations. The growth of knowledge in every field of endeavour is a record of international effort. This should be pointed out to children by parents and teachers from the earlist years. It is not enough to begin thinking in such terms at the university level. But it is at the universities that this realization must be consciously directed to the challenge of world citizenshp. Without far-seeing, courageous, honest leadership and dynamic, enlightened public opinion, it is not beyond possibility that dire calamity may overtake the human race.

The Universities must strive to give their students the wisdom and perspective which come from a study of the past, the courage and vision to foresee a great and good future, and the knowledge and skills to enable them to use the present—each instant as it comes—so that their highest ideals, as individuals in their homes and communities and as world citizens, may be brought nearer and nearer to realization.

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With compliments
AVD

Rosa Garibaldi

– Brief Encounter in Rome –

by

A. Vibert Douglas

The granddaughter of the great Liberator died in April, 1958, at the age of ~~75~~ 81. In a charming vignette drawn from personal reminiscence Miss Douglas gives a moving account of a chance meeting with this "restless questing spirit".

I saw her standing by the Campidoglio on the Capitoline Hill on a hot morning in early September 1952. Under the archway to the inner courtyard people, speaking wide variety of languages, were passing, pausing to show their cards of admission to a uniformed official. Police were keeping the entrance way open and a uniformed mace bearer awaited the arrival of the Mayor. Some of the dignitaries were already arriving, representatives of government and of the City. In no hurry to make my way into the auditorium, I was lingering in the brilliant sunshine of this beautiful square which Michelangelo designed. Looking about me at everything and everybody, I noticed this lady of perhaps nearly seventy years, of average height, spare, with intense observant eyes. She crossed the entrance way to where I stood and said "I am Rosa Garibaldi, can you tell me what gathering this is?" I replied "This is the opening ceremony of the meetings of the International Astronomical Union . . . and did you say your name was Garibaldi?" "Rosa Garibaldi". "A descendant of the great Liberator?" "I am the granddaughter of Giuseppe Garibaldi".

I put out my hand and grasped hers and said how greatly I had revered her grandfather's name since childhood, when I had read and reread a sermon preached by my grandfather in the 1880's in which a passage ran like this: "Tribulation is the law or condition of all noble achievements . . . When Garibaldi raised the standard of revolt against existing despotism, when multitudes flocked to that

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standard and asked 'What shall we have if we follow you?' 'Have?' cried Garibaldi, 'you shall have cold and hunger; you shall have long marches and the terror of night-watches; you shall have battles and wounds, disease and death – but Italy shall be free'." Had these words, perchance years ago, rung in the ears of Mr. Churchill? Often have I wondered if this were so.

This unexpected tribute to her grandfather greatly pleased Miss Garibaldi and seemed to draw us together with a bond forged long years ago. I told her that my ticket admitted two and asked if she would care to accompany me. To my great delight she accepted and together we passed into the court with its many fragments of sculptures of antiquity, and on into the great hall rich with marble and murals. Several dignitaries recognized and greeted my companion; she was quite obviously a citizen of Rome, known and honoured.

When the ceremonies were over and we stood together at the head of Michelangelo's steps which lead down to the level of the Piazza de Venezia, I asked Miss Garibaldi if she would lunch with me at any one of the several small restaurants in the neighbourhood. Thus it came to pass that for two hours and a half as we lunched in a quiet Trattoria, then walked over the Tiber and up the right bank of the river to the Via Pompei Magno, and there in the apartment which she and her sister shared, she poured out to me her memories of her grandfather; the heroic story of his campaigns, his defeats, retreats and victories; the pathetic story of the death of her grandmother – the brave, once beautiful Anita; the romance and wanderings of her own parents; the military careers of her brothers; her own ideals, prejudices and philosophy of life.

Rosa Garibaldi was the oldest of ten children. Her father, the second son of Giuseppe Garibaldi and Anita, had gone as a young man to England, where he fell in love with an English lady who married him in spite of her parents' disapproval and went with him to Australia where their family were born. This explained Rosa's excellent English. All her brothers, except the youngest, were dead. With pride she told how Giuseppe's sons, and their sons and grandsons had fought for the ideals of liberty in Italy, in Greece, in Mexico,

in France. Wherever a struggle for freedom was taking place, there a Garibaldi wanted to be.

The apartment was a veritable museum. Both Rosa and her mother were artistic, and paintings of historic scenes and portraits filled the walls, busts stood on mantles, tables and on the floor, cases of medals, coats, caps, weapons, letters, maps, documents were everywhere. Record books of two charities started by her mother, Costanza, filled shelves. Objects of special concern to Rosa were these hospitals at Caprera near Sardinia and in the Sabine hills. Her grandfather had purchased a small estate at Caprera and from this his beloved island he had embarked on his military campaigns from 1854 to 1870. There it was that he died and there he is buried. Rosa felt deeply the family responsibility for this hospital as a memorial. The other hospital was situated near her family home in the mountains where she and her brothers and sisters spent much of their childhood. In the grounds of their house was a swimming place where the children would gather and Rosa clearly remembered a few occasions when her grandfather – old, worn and crippled with rheumatism in his last years of life – was helped down to the pool where he would sit in his wheel chair and happily watch his grandchildren at play.

So Rosa Garibaldi was 75 years of age! A little mental arithmetic told me that – but it was hard to believe it of this vigorous woman so proud of her family heritage, passionately devoted to the cause of freedom, interested in everything in the current world, strong in her likes and her hatreds – a word which hardly seems too forceful, for her opinions were definite and vehemently expressed. She was that striking combination of an avowed atheist and a champion of the ideals of truth, honesty and courage, courage to speak out against hypocrisy in whatever form it appeared. Though tolerant of those who believed in religion as a purely spiritual experience, she was bitterly opposed to any ecclesiastical activity in the realm of politics. For this reason she fulminated against Mussolini's compromise with the Pope in creating the Vatican City; she deeply resented and deplored the growing political power of certain religious orders in Italy; and she bitterly criticised a younger Garibaldi whom she felt to be an unworthy bearer of a great name, first because he had associated himself with a church-sponsored political party in Rome and secondly because, in his choice of a wife, he had been false to the memory of the many Garibaldis who had died fighting against German tyranny in the wars of 1914 and 1939. Her own father at the age of 23 had fought under his father against the Prussians at Châtillon and at the defense of Dijon in 1870, and in 1914 when he was 67 he enlisted in the French army – and two of his sons, her brothers Bruno and Constante, had given their lives fighting for France, the one in 1914, the other in the Argonne in 1915.

Her pride in the family name was tremendously deep and episodes of the family history over more than a hundred years were poured out to me with all the vivid detail of an eye witness. She relived episodes of her grandfather's early exploits in South America – fighting for the freedom of Montevideo – when he first met and loved at sight the dark Brazilian girl of Portuguese ancestry, Anita. She told me of his indomitable spirit, his resourcefulness and daring in eluding capture when surprised and surrounded by enemies, his passion for justice and for consistency in policy; his tender solicitude for mothers whose sons had died in his campaigns; his pride that his own son, Menotti was fighting with him for the freedom of Italy in 1859-60 and both his sons in 1866 and the following year in the victorious expedition against Rome. She spoke of his fine tenor voice appealing whether in speech or in song, never quickened with excitement, but on occasion charged with the intensity of controlled emotion.

Of Mussolini Rosa had only two good things to say – he revered the memory of her grandfather and respected her father, and he conceived and carried out the idea of bringing the ashes of the devoted Anita from Nice to an honoured grave on the Janicula Hill where stand the monuments to her husband and his generals. Poor Anita, in life she knew little of peace and nothing of tranquility and even in death she was not left undisturbed. Anxious about her husband in 1848 she unwisely left their home in Nizza (still at that time an Italian city, birthplace of Giuseppe), and joined him in Rome. When his bid for victory failed Garbaldi with Anita and the faithful remnant of his followers retreated eastward, eventually making the coast

and boarding a fleet of small ships for Venice. Intercepted by the Austrian fleet, he beached his little ship and on foot he and Anita fled inland and northward. But she was stricken with the fever of the coastal swamps and in a farmhouse a dozen miles south of Ravenna she died. Garibaldi was overwhelmed with grief, but the Austrian pursuers were so close on his heels that he could only beg careful burial and speed off northward a hunted lonely man. Her body was given crude burial under a heap of sand, was found later by the local authorities, identified, cremated and the ashes were buried in a wayside church near Ravenna. In 1859 Garibaldi himself brought Anita's ashes from Ravenna to Nizza, little dreaming how soon his natal city would be known to the world as the French city of Nice. But even there near the grave of Giuseppe's gentle, devout mother (the Rosa after whom Anita's first granddaughter was called) the ashes found no lasting repose. Perhaps on the Janicula Hill they will be left in peace to mingle ultimately with the Italian soil.

But it was to her grandfather that Miss Garibaldi kept returning, attempting to analyse that elusive quality of the man which might explain the amazing confidence which he inspired in his followers. That his name is still one to conjure with in Italy today was obvious to anyone who was in Italy in 1948 just before the first free general election after the downfall of the Mussolini régime. I told Miss Garibaldi of the many striking posters which I had seen that spring in Milan, Bologna and Florence and how obvious it was that both the pro-communist and the anti-communist parties strove to claim the great Garibaldi as their own symbol of leadership. The noble head of Giuseppe, complete with velvet cap above the broad shoulders and loose red shirt, appeared on many a poster. He gazed down from walls plastered with communist posters. Adjacent would be rival posters displaying the same noble face but in the form of a mask covering the hard sinister features of Stalin, with a reminder that a vote for the Communist party was a vote for enslavement, not for a free Italy.

I did not leave Miss Garibaldi's apartment that memorable afternoon until she had promised to come with me to the evening reception which the City of Rome was giving for astronomers a few days later.

Thus I saw her once again, but the occasion permitted less connected talk, since it offered so many opportunities to introduce to this distinguished Italian citizen astronomers who I knew would appreciate the privilege of meeting her, astronomers from Canada, from the United States, from Japan and from Great Britain. We strolled on the Campidoglio terrace, we ate ices and sipped vermouth, we listened to the orchestra, we walked and talked with various scientists in the gardens below the marble terrace where fountains and flowering shrubs and graceful trees were softly floodlit; and then we walked through the rich rooms, galleries, and corridors, through the courtyard and out onto Michelangelo's square, where many a time her grandfather had come to address the Assembly. A Scottish astronomer and I put her on the tram which would take her almost to her door and then we boarded one going to our hotel on the opposite side of the city.

Our paths never crossed again and a letter and a card brought no reply. But when I read in the spring of her death in a Rome hospital, my thoughts took wing as I followed her spirit to the edge of the unknown, and the words of Walt Whitman alone seemed appropriate to her restless questing spirit:

> Sail forth – steer for the deep waters only,
> Reckless, O soul, exploring . . . .
> O daring joy, but safe: are they not all the seas of God?
> O farther, farther, farther sail.

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