Although data from Arctic placentae show a dramatic increase in ^{210}Po levels over those in other tissues from non-Arctic residents, the actual increase in dose at natural levels is small (about 10 per cent), based on the assumptions that the normal level is 100 mrem/yr, that 0·01 pc. ^{210}Po/g wet tissue produces a dose of 1 mrad/yr, and that the relative biological effectiveness for α-particles is 4. (With the usually assumed relative biological effectiveness of 10, the dose would be increased to about 130 mrem.) However, these numbers may be significant relative to the much larger values in bone because, for instance, the radiation effects to soft tissue may be greater than to bone, or the relative biological effectiveness at low dose rates may be much different than that used here.

Conclusion

Further investigations of this type, together with the epidemiology, would provide information of value in assessing the effects of low-level radiation on human and animal populations. (The reindeer and caribou are exposed to skeletal doses of 1–10 rems/yr (relative biological effectiveness = 4) which is fifty times that of cattle and 500 times that of humans.) Natural 'fall-out' is also of particular use in tracing food chains and in studying the metabolic properties of the nuclides and elements involved. Moreover, similar studies of this type appear to be feasible elsewhere, as the high levels of natural (and artificial) 'fall-out' are, with our present knowledge, only by chance characteristic of the Arctic, that is, the lichen is a slow-growing plant eaten only by reindeer and caribou which, in turn, form a substantial part of the human diet. Similar conditions might obtain in other regions, such as deserts, where vegetation, for lack of water, may grow only slowly. This phenomenon is indicated in Hill's data on camel bone[8] and in DiFerrante's ox bone[14], in which the specimens with the higher activities came from the more arid regions.

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OBITUARIES

Prof. R. O. Kapp

Reginald Otto Kapp, professor emeritus of electrical engineering in the University of London, died suddenly on February 20 at the age of 80, four days after the death of his wife.

Kapp was born at Brentwood in 1885. After early education in Germany, he graduated in electrical engineering at the University of Birmingham, where his father, Prof. Gisbert Kapp, was head of the department. He then spent four years with Messrs. Brown Boveri in Baden, Switzerland, working on the development of electric traction. In 1913 he returned to Britain to join the staff of Messrs. Kennedy and Donkin, engineering consultants, but his new work was soon interrupted by the outbreak of the First World War in which he served with the Royal Engineers in Salonika and elsewhere.

After the War, Kapp returned to consultancy and, under Sir John Kennedy, began detailed studies of electrical power supplies and demands in Britain. These studies provided load forecasts and financial estimates which formed the technical basis of the Electricity Act, 1926, the legal instrument which established the grid system. The grid encouraged an increase in the size of generators, and Kapp worked on the associated design and switching problems. The integration of power generating systems also aroused an early interest in the economic and technical advantages of standardization.

In 1935 Kapp was appointed to the Pender chair of electrical engineering at University College, London. At the beginning of the Second World War, the College departments were evacuated to other universities, and Kapp, as Dean of the Faculty of Engineering, went with the engineering departments to Swansea. On their return to London, he was mainly concerned with the post-war rehabilitation of his department.

In 1950 Kapp reached the academic retiring age of sixty-five but, still full of vitality, returned to part-time consultancy with his former employers. He was chairman of a committee appointed by British Railways to reduce inductive interference between railway tele-communications and power lines. He also worked on energy storage by compressed air and on tidal systems as sources of power. As he had taken advantage of his early training on the Continent to equip himself as a linguist—his German, Italian and French were impeccable—he was much in demand as a chairman at international conferences. His linguistic abilities combined with his interest in standardization, of terminology as well as of equipment, led him to the chairmanship of committees of the International Standards Organization and the International Electrotechnical Commission as well as of the British Standards Institution. Consultancy work

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requiring the critical assessment of proposed systems of generation and distribution of electrical power took him in this later period to Egypt and to Argentina. He enjoyed his travels immensely, making many friends abroad, taking great delight in trying exotic foods and in solving new problems of linguistic communication.

But, full as it was, his career as a professional engineer was only part of his public life. For many years he had pondered two fundamental problems, one philosophical—the relation of 'mind' to 'matter', and one cosmological—the creation and evolution of the universe. His approaches to these problems, adumbrated in *Science versus Materialism* (1940), were developed with characteristic tenacity in later works. The philosophical problem was further discussed in *Mind, Life and Body* (1951) and in his Riddell Memorial Lectures on *Facts and Faith: the Dual Nature of Reality* (1955). He then returned to cosmology. By the ruthless application of Occam's Razor, which Kapp later elevated to 'The Principle of Minimum Assumption', he disposed of the 'big bang' and other contemporary theories of the origin of the universe and, in 1940, concluded that creation is continuous: matter is continuously being created at random throughout existing space and is continuously being destroyed at random throughout existing matter. Inferences from this hypothesis, including the idea that the continuous destruction of matter is the cause of gravitation and the prediction that lunar rock will be found to be micro-porous and mechanically weak, are worked out in *Towards a Unified Cosmology* (1959). This book, his final work, is about to be published in a German edition. Kapp was disappointed by the reception of his cosmological theories and regretted that he lacked the mathematical skill to exploit fully the implications of his physical insights.

He immensely enjoyed tackling new huge problems, technological or administrative, obscured by detail and complicated by conflicting interests or economic constraints. His invariable technique was, first, patiently to seek the relevant guiding principles and then, having established them, to apply the principles rigorously and without fear or favour; Kapp abhorred the *ad hoc*. He also enjoyed writing, especially as a means of solving intellectual problems: successive drafts on a given thesis were for him a means of self-communication, each new draft being not merely a polishing but a significant development of its predecessor—a process which continued until a solution, usually of a problem much more fundamental than the one he began with, was obtained. His interest in writing, and his long experience of the inadequacies of the working papers on which his consultancy work depended, led him to establish a lectureship in the presentation of technical information at University College and to found a Group, of which he was the very active president for seventeen years, and, more recently, a Research and Education Trust, all concerned with aspects of scientific and technical writing. He also led the British Society for the Philosophy of Science to its present autonomy and founded the Occam Society.

He served on the governing bodies of Middlesex Hospital Medical School and of Northampton College of Advanced Technology where, as chairman of the academic council, he recently devoted much thought to the transition of the College to university status. His committee work, always thoroughly prepared, gave the impression to those who shared any one committee with him that that particular committee had commanded his whole attention since the previous meeting. But at one time in the 1950's he was an active member, if not chairman, of fifty assorted committees.

Yet he found time also to enjoy the arts—the ballet, the theatre and music especially—and to publish occasional compositions for the piano.

He died of a heart attack, physically tired by the long illness and death of his wife, but in full possession and control of his formidable faculties to the last, and leaving, as his friends would have expected, all his affairs and papers in perfect order. A son and daughter, both married, survive him.

B. C. BROOKES

Prof. A. Fraenkel

PROF. ADOLF ABRAHAM HALEVI FRAENKEL, emeritus professor of mathematics at the Hebrew University of Jerusalem, died on October 15, 1965, at the age of 74, after a short illness.

Prof. Fraenkel was born in Munich in 1891, of an illustrious Jewish family. He studied mathematics at the Universities of Munich, Marburg, Berlin and Breslau. In 1922, he started teaching at the University of Marburg, later obtaining there the chair of the renowned German algebraist, Hensel. In 1928, he was called to the University of Kiel. Three years later, he received an invitation from Dr. Chaim Weizmann, who was to become the first president of the State of Israel, to join the recently created Hebrew University of Jerusalem. Having been an ardent Zionist since his youth, Fraenkel accepted this invitation and, alternating with Prof. Fekete, became chairman of the Mathematical Institute of the Hebrew University. It was mostly due to him that the Institute quickly achieved a world-wide reputation. Almost all the present professors there are his former students, while other students occupy important positions in other scientific institutions.

During the years 1938–40, Fraenkel served as rector of the Hebrew University. For many years, he headed its Institute of Adult Education, spending on it much time and fruitful effort. He was a member of the National Council of the Jewish community in (then) Palestine and was active in the establishment of the State of Israel in 1948. He became one of the founding members of the Israel Academy of Sciences and Humanities.

Fraenkel started as an algebraist and was one of the first to study the theory of abstract groups, thereby paving the way for the investigation of abstract algebraic structures in general. His main contribution, however, was in the field of abstract set theory, a contribution which is still very much alive and finds its external expression in the fact that one of the major axiom systems of set theory is known as 'ZF', the Zermelo–Fraenkel system. Zermelo was the first to publish, in 1908, a workable axiom system for set theory in order to fortify the foundations of that discipline which had become shattered through the discovery of paradoxes at the turn of the century. Fraenkel, in 1921, just a few months before a similar accomplishment by the late Norwegian mathematician, Th. Skolem, was able to increase decisively the logical rigour in the formulation of one of the axioms, the so-called axiom of subsets (or *Aussonderungsaxiom*), and to add considerable strength to the system by the addition of another axiom, the axiom of replacement. As a result of the life-long interest in the axiom of choice, an interest which was of combined mathematical and philosophical origin, he made significant contributions towards the final proof of independency of this axiom, achieved only three years ago by P. J. Cohen and hailed as one of the major achievements of this century.

Fraenkel's philosophy of mathematics was an unabashed Platonism, and he stuck to this view even when it was no longer fashionable. But his deep convictions in this respect did not hinder him from becoming one of the main interpreters of intuitionism in his text-books, which have long since become classics in their fields.

Fraenkel was deeply religious but of extraordinary tolerance and liberalism towards his environment. He combined his religious and mathematical interests in a thorough investigation of the Jewish calendar.

For many of his students Fraenkel was the decisive factor in shaping their lives, and they will never forget this man who combined ice-cold scientific rigour with the warmest interest in their scientific and other progress,

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