PHYSICS RESEARCH

The present article deals with New York University's department of physics at the University Heights center, which is administered by the NYU College of Engineering. The University has several divisions, including the University College of Arts and Pure Science and the College of Engineering, both at University Heights, and the Washington Square College of Arts and Science at Washington Square.

AT the present time, the Physics Department of New York University's College of Engineering at University Heights is conducting an active research program in various branches of physics. Under Professor Yardley Beers a program of microwave research is in progress, Professor Leon Fisher is investigating the fundamental properties and phenomena in electrical discharges in gases, Professors Fritz Reiche, Sidney Borowitz and George Hudson are conducting investigations in theoretical physics, Professor Yale K. Roots is working on a spectroscopic problem, and Professor Serge A. Korff is conducting a program in cosmic rays and counters. A brief description of most of these projects follows, largely in the words of the faculty member concerned.

The basic problem in the field of cosmic rays is a determination of the origin of this radiation, of the role the radiation plays in the universe, and of the effects which the radiation produces when it impinges upon the earth.

Among the effects produced by cosmic radiation, the production of cosmic ray neutrons has had several interesting corollaries. In order to study the number of neutrons and their processes of production and interaction, a series of balloon flights has been conducted, in which the numbers of neutrons at various altitudes and latitudes were measured. This work has led to two quite unanticipated results, first the use of the neutron-produced carbon 14 as a dating-tool by archaeologists, and second to a realization that fluctuations in the neutron intensity are a more sensitive indicator of such astrophysical phenomena as solar activity than are fluctuations in the total intensity. The present program consists in a continuation of the series of balloon flights and observations on mountains, for the purpose of ascertaining the number of neutrons, their rates of production in various substances, their energy distribution and the effect on this of the surrounding substances, the life history of the neutrons and the rates of production and life histories of the isotopes produced by the eventual capture of these neutrons.

In order to improve the neutron observations, it has been found necessary to study the properties of many different types of counters as well. This has led to a series of investigations of counters, including a study of the quenching mechanism, a study of the factors controlling the slopes of the plateaus and other operating characteristics, the possibility of securing self-regenerating mixtures in the counters, the physical chemistry of the progressive decomposition of the gases, the rates of decomposition and synthesis of various molecules and finally the problem of time lags. The progressive effects of counting on the gases in the counters can be studied by filling a large number of counters at the same time on the same manifold to the same pressure, then running them for various periods, and finally subjecting the gas to mass-spectrographic analysis after the conclusion of the runs. The time lags are exceedingly important, for these govern the speed with which reliable counting can be achieved. The time lag is by definition the time interval between the instant that the entity to be detected passes through the counter and the instant at which an observable voltage swing of the central wire takes place. The problem is then to determine the factors controlling the lags. This work required the development of some microsecond timing circuits, and the lags were found to depend on such factors as negative ion formation, a complex subject in itself, and one in which much remains to be done. It has also been found necessary to measure the ionization potentials and other critical potentials of gases used in counters, some of which had not hitherto been determined.

In connection with the upper atmosphere cosmic ray studies, development of radiosonding and of ballooning techniques has been undertaken. A considerable amount of new instrumentation has been devised, and a number of new techniques greatly facilitating ballooning operations have been worked out. These programs have also been supported by the joint program of the Office of Naval Research and the Atomic Energy Commission. The initial work immediately following the end of the war was stimulated by grants from the Research Corporation and the Carnegie Institution of Washington.

Professor Reiche was working, under NACA contract together with Dr. H. Ludloff of the NYU Dept. of Aeronautical Engineering and other co-workers, on an

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aerodynamical problem briefly described as follows. A two-dimensional or axially symmetric slender body rests in a *non*uniform, two-dimensional supersonic, basic flow, which thus shows a pressure gradient. This case is of importance for wind tunnel experiments. By the method of linearization (power-series expansion with respect to thickness-parameter and a second parameter characteristic of the pressure gradient), one can find the influence of the pressure gradient on drag, lift, and pitching moment, exerted on the body. Professor Reiche plans to continue some older work on absorption in spectral lines which R. Ladenburg and he started 40 years ago and which, in the meantime, has been amplified by W. Elsasser, F. Matassi, and others, for the use of astrophysical and meteorological problems.

Professor Yale K. Roots, who is a specialist in optics, reports that the Spectroscopic Laboratory of the College of Engineering is equipped for standard procedures in spectroscopy and related fields. The instrumentation includes several Hilger spectrographs, among them the small, medium, and large ultraviolet instruments. The latter, which is a very large Littrow, possesses glass and grating optics in addition to quartz. A small grating spectrograph and a Hilger constant deviation spectroscope are also available, as well as much supplementary optical, photographic, photometric and sensitometric equipment and source material.

A laboratory course in spectroscopy and allied techniques is given in this laboratory. Beyond this certain research projects are under way. A study of the absorption spectra of certain gases used in Geiger counters has been initiated, and investigations are now under way in the high speed Schlieren photography of acoustical phenomena and of high speed photography of a periodic event. An optical problem involving one of the many government projects has been in progress for some time, as well as a photometric investigation in which this laboratory has cooperated with personnel of the New York Zoological Society.

Professor Leon Fisher, who did his thesis work under Professor Loeb, has continued his study of electrical discharges in gases. The work concerns itself primarily with the mechanism of various forms of breakdown. The principal experiments have been designed to measure the length of time required by the physical processes responsible for breakdown. These so-called formative time lags are being measured extremely close to the breakdown threshold, and for this reason the work is radically different from any other previous measurements. The experiments require extraordinarily delicate voltage stabilization, and have yielded experimental results which have enriched and extended our understanding of the breakdown mechanism. Data have been reported for formative time lags in uniform fields for air, oxygen, nitrogen, and argon; theoretical discussions of the experimental results have been given. Work is in progress to determine similar experimental parameters in the positive point-to-plane corona pre-onset pulses, as well as for the glow discharge. A number of other fundamental studies are in progress. These experiments are shedding new light on the half-century-old problem of breakdown. There are at present six graduate students involved in this work, and the program is being supported by the Office of Naval Research and the Research Corporation.

The field of nonlinear physics is an extensive and active one. It encompasses, insofar as the work of Professor George E. Hudson is concerned, problems in aerothermodynamics with applications to jet propulsion, research in the recently proposed unified field theory of relativity, and the timely study of the phenomena attendant upon the explosions of shaped charges.

Although the equations of motion of compressible, viscous fluid flow in one or more dimensions have long been known, and have been investigated extensively by mathematical physicists, their forbidding nonlinear character has foiled almost all attempts at direct application to useful problems—and when the complications of heat addition by combustion of fuels or otherwise are included—! The development of high-speed calculators probably cannot materially alter this difficult situation, since these more fundamental problems are studied themselves because of the general light they should throw

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on basic mathematical theory and general physical situations. Hence attempts are being made in the direction of invention of new approximate or exact methods.

The unified relativity theory naturally offers a virgin field for scientific exploration. Combined with the circumstance that the mathematical problems posed are extremely complicated, is the factor of an elegant generalized geometrical interpretation. This presents a definite challenge for the mathematically minded. On the other hand the physicist finds it appealing in the remarkable resemblance of certain concepts in the theory to the "ether strain" of Maxwell and Faraday, as well as in the universal nature of its goal, to describe all physical phenomena by a nonlinear field theory.

Once one passes beyond the realm of applicability of the elementary theory of shaped charge jet formation and penetration, the experimental and theoretical studies become extraordinarily difficult. This is due not only to extreme difficulties in observation but also to the presence of large, as yet unexplained, fluctuations in some of the phenomena. From the theoretical side it is due partly to the fact that the processes involved can but rarely be regarded as steady state ones. For these reasons, and for certain practical applications, it is handy to be able to summarize the formulation of the elementary theory in as concise a form as possible. Theoretical calculations along these lines are in progress.

The theoretical work of Professor Borowitz is mainly concerned with investigations in the field of fundamental processes of the ionosphere. The principal long-range concern is to investigate the collision and recombination cross sections of electrons with atoms and molecules and ions. At the moment the simplest three body scattering processes are being considered.

The elementary processes are of the utmost importance in determining electron, ion, and radiation densities in the upper atmosphere. Inasmuch as the physical situation existing in the ionosphere cannot be duplicated in the laboratory at the present time, the theoretical calculations offer the best hope of obtaining information.

Many of these problems have been examined in the past, but their complexity has prevented any but the crudest approximations to the answers from being made. In recent years, improved analytical techniques coupled with computational machines have made the outlook for better results promising.

The work is being performed by Assistant Professor Borowitz and Visiting Associate Professor Gerjouy under contract with the Geophysical Research Directorate, Air Force Cambridge Laboratories.

Professor Beers has initiated some spectroscopy in the longer microwave region where there is promise of obtaining interesting information concerning the structure of molecules although the number of lines is smaller and intensities are considerably weaker than in the "K" band and millimeter regions which are popular fields for research elsewhere. At the time of writing Professor Beers and two graduate students have just completed a spectrometer and results should be forthcoming in a short time.

Books

Operations Research

Methods of Operations Research (First Edition Revised). By Philip M. Morse and George E. Kimball. 158 pp. The Technology Press of Massachusetts Institute of Technology and John Wiley & Sons, Inc., New York, 1951. $4.00.

Professors Philip Morse and George Kimball have produced the most impressive account of wartime operational research that has appeared, so far as the reviewer knows, in either the United States or the United Kingdom. The origin of the book is clearly indicated by the first paragraph of the authors' Preface, which reads:

"In a sense, this book should have no authors' names or else several pages of names. Parts of the book were written by various persons during and at the end of World War II. What the undersigned have done is to collect the material, rewrite some in the light of later knowledge, expand some to make it more generally intelligible, add chapters on organization and general procedures, and cement the mosaic into what is hoped to be a fairly logical structure.

"Since the undersigned were members of the Operations Research Group, U. S. Navy, it is perhaps not surprising that the examples given are drawn chiefly from the work of this group, though an effort has been made to include examples from the work of other groups. Many persons have helped by discussions and editorial criticism, including members of other operations research groups in this country and in England. To mention a few would slight many others, so none will be named."

The perusal of the various chapters bears out this account of the book's origin. Much of the material has been taken directly from previously secret service reports. Naturally detailed references to these reports cannot be given. In a bibliography at the end of the book a comprehensive review of published work on operational research is given, and it would perhaps have been expected that where such published work is quoted verbatim detailed references would have been given. It is perhaps a pity that this was not done, as it is somewhat disconcerting to find in the book paragraphs taken almost verbatim, and without inverted commas, from one's own writings on the subject! This criticism is, however, rather trivial, and in no way detracts from the value of this excellent compilation of wartime results and experience.

As one who was closely associated with several of the