head of the Göttingen Institute of Mathematical Statistics, is at Columbia this year as visiting professor of mathematics. A course of training in mathematical statistics has been arranged by the coordination of courses in the departments of mathematics, economics and astronomy to dovetail together without overlapping. This work is designed for students familiar with calculus and higher algebra. It includes probability, taught by B. O. Koopman; statistical inference, by Harold Hotelling; mathematics of heredity and evolution, by Felix Bernstein; training in the use of card-tabulating and calculating machines, interpolation and finite differences, by W. J. Eckert; mathematical economics, by Harold Hotelling, and a seminar in advanced mathematical statistics. In addition there are at Columbia University numerous other courses in statistics designed for students in particular fields.

We learn from the Associated Press that the Haskell Laboratory of Industrial Toxicology has been established by E. I. du Pont de Nemours and Company. The laboratory was opened on January 22 on the grounds of the experimental station of the company near Wilmington. The new laboratory has been established because of the growth of the chemical industry in this country. It will be housed in a three-story building planned in thirty units, and has been named for Vice-President Harry G. Haskell. The function of the laboratory will be to study the effects of new products upon the health of employees during manufacture, and, prior to these new products being placed on the market, to study their possible effects on public health. Dedication of the laboratory took the form of a scientific meeting presided over by Frank C. Evans, director of the service department of the du Pont company.

DISCUSSION

UPTHRUST—A GEOLOGIC TERM

In a recent, discriminating review of "Geologic Structures,"[1] the reviewer unwittingly gave the senior author of that manual special satisfaction by singling out for commendation certain chapters written by the junior author, but he also criticized a lack of definition in the use of the term *upthrust,* for which the senior is responsible. Webster gives the definition: "Upthrust, n. An upward thrust; specif. Geol., an uplift of part of the earth's crust." That might be regarded as adequate, but the writer has allowed the word a certain freedom to be verb or adjective, as well as noun. He has designated an upthrust mountain, the Sierra Nevada of California, for instance, an upthrust. The fault which characterizes its eastern face he has called an upthrust fault or an upthrust in that connotation. He might refer to the movement itself as an upthrust or upthrusting. And he would defend each of these uses or any others in which the connection showed clearly in what sense the word was used. He holds that precise definitions deaden style and often obscure meaning; sometimes indeed they cloak ignorance. He would preserve for English words the freedom in which they have grown up. He opposes placing them in solitary confinement, in the narrow cell of a scientific strait-jacket; better that Greek or Latin supply the victims. However, the reviewer wants a definition. His question is: What is an upthrust fault? In response one may say: *An upthrust fault is a high-angle fault on which the displacement involved the demonstrable elevation of one side (or both) above its former position with reference to sea level.* The designation "high-angle" implies that the dip of the fault plane exceeds 45°. It is usually between 70° and 90°. *Upthrust* is thus distinguished from *overthrust,* which is the term applied to displacements on planes dipping less than 45°. It will be noted further that the definition does not include the direction of dip of the upthrust fault, whether toward the upthrow or the downthrow. In fact the dip may be toward either or in different parts of the same displacement, here toward one and there toward the other, for such fault surfaces are frequently curved. An upthrust fault may thus be either normal or reverse or may be a hybrid of both types. Considering the forces involved in such displacements it is clear that gravity is one and that an anti-gravity stress must also act. If the latter is the more effective there is upthrusting; if the former prevails there is subsidence, *i.e.,* gravity faulting, aided possibly by a downward directed stress. In large structures both effects may be represented, as for instance in the case of the Dead Sea Trough. There the Judean Peneplain or Matureland is elevated in the high plateaus and also depressed below sea level in the trough. The fault between the two segments is a high-angle fault, approaching 90°. With reference to the plateaus it is an upthrust or ramp; with reference to the trough it is a gravity fault or downthrust. It may be either normal or reverse, according to the direction of dip in any particular section. Upthrusts and upthrust faults are of common occurrence in mountain ranges and plateaus and they are also of many types. Let us keep the generic term free to serve us in the many

[1] Science, 80: 2085, 562, December 14, 1934.

useful relations in which it can serve adequately so long as it retains its fine old English meanings.

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ALTERATIONS IN THE FOUNDATIONS OF THE EXACT SCIENCES IN MODERN TIMES

IN an article appearing in the October 5 issue of *Die Naturwissenschaften* under the title, "Wandlung der Grundlagen der Exacten Naturwissenschaften in jungster Zeit," Professor W. Heisenberg, theoretical physicist of the University of Leipzig and recent Nobel prize winner, has presented his views on the effects induced in the general scheme of exact sciences by the revolutionary physical discoveries of the past thirty-five years. This presentation is a particularly inviting one, coming as it does from one of the young leaders in theoretical physics, for to such a man, who will undoubtedly be a prominent figure for many years to come, it must be considered an urgent necessity that the importance of the field of science in which he has worked is clearly understood and appreciated. For this reason Heisenberg is careful to point out the various links between the exact sciences themselves and between these and the affairs of everyday life. The manner in which this is done is probably best illustrated by a survey of the text of the article. Such a survey is given in the following paragraphs.

The two major additions to the fields of physics which have been made in the past thirty-five years are those summed up in the expressions, "Relativity Theory" and "Quantum Theory," and were heralded by the discovery of the quantum of action by Planck and the propounding of the special theory of relativity by Einstein. Previous to this, in the period of so-called classical physics, all fields were underlain by a set of basic conceptions which were taken as unquestioned facts and which were the guiding principles of all investigations. In the words of Heisenberg:

> . . . Physics dealt with the behavior of real entities in space and their variation in time. Although merely the character of experiences underlying physics was specified by this, a number of conclusions were drawn concerning the properties of such entities at the same time. One was led to the unexpressed viewpoint that the occurrence of events in time and space is independent of observation, and moreover, that space and time constitute mutually independent classifying categories of events and in this rôle represent an objective reality that is common to all men.

The underlying assumptions of classical physics were contested by the special theory of relativity which found its experimental basis in the well-known work of Michelson and Morley that yielded results contradicting the classical concepts. From the new view-point the classical concepts of an absolute past and future, separated by an instantaneous present that is the same for all observers, were abolished and supplanted by the view that the absolute past and future of two observers is separated by a finite stretch of time which depends upon the relative conditions of observers. These newer views have since received abundant enough experimental verifications that they may now be taken as definite facts of the exact sciences in the same sense as that in which the principles of classical mechanics and thermodynamics are accepted.

In order to emphasize the fundamental importance of this change in attitude Heisenberg states:

> The extraordinary significance of these facts lies, in the first place, in the completely unexpected realization that the natural result of following the route indicated by classical physics compels a change in the foundations of this field. . . . Modern theories do not arise out of revolutionary ideas that are, so to speak, brought in from the outside of exact sciences; they are the results of investigations undertaken with the desire to carry out the program of classical physics. Therefore, at this point one can not compare the beginnings of modern physics with the great revolutions of the past, that is, for example with the work of Copernicus; the ideas of Copernicus were, to a great extent, introduced into the conceptual scheme of contemporary physics from the outside. . . .

The general theory of relativity has revised the concepts of the geometrical properties of space-time and has established a connection between the geometry of the world and the distribution of matter in it. Its experimental justification is not as firmly established as that of special relativity, but it has met no contradiction. The principal conviction of its truth lies in the fact that it presents many stimulating view-points that were previously overlooked. The fact that the fundamental postulate that the geometry of the world depends upon the distribution of matter does lead to a completely self-consistent picturization of gravitational phenomena causes one to anticipate that additional progress will be made on the basis of this theory rather than from a wholly new one, even if experimental contradictions do appear in the future.

The foundations of quantum theory, like those of relativity, arise out of the attempt to extend the classical domain rather than from the introduction of radically new ideas. On the basis of Planck's discovery, the investigations of Lenard and Einstein necessarily led to the adoption of a corpuscular view-point, that is, the classical wave theory was contradicted in performing an experiment suggested by classical reasoning. In exactly the same way, each stage of development of quantum theory up to the present time has been required by contradictions in the previously