lem is a common faculty responsibility and that the final product is a Doctor of Medicine; hence, the ultimate test of any part of the teaching program is its relative contribution to this goal.

While discussing the content of various courses, one more comment may be offered. Since the student reaches his clinical years with an apparent lack of information about psychology, it is tentatively suggested that psychodynamics receive more attention. While it is true that this discipline is handicapped by its inherent difficulties in relation to research, much is known concerning the mechanisms of the emotions in man that could be taught if more time were offered. Moreover, the experimental neuroses in animals might provide a laboratory approach. It may be banal, but it is true, that the general practitioner or internist can help more people psychologically than he can somatically. Psychodynamics should constitute one of the important dynamic units.

A member of the surgical staff has contributed the following statement concerning the bearing of this memorandum on his department:

The chief function of undergraduate surgical teaching should be to assist in correlating the study of disease ordinarily seen and handled by surgeons with fundamental medical principles. The instruction given students by surgery should simplify their knowledge of and understanding of disease; it should not be concerned with the major techniques of therapy. The curriculum should encourage closer liaison between the surgical teacher and those in other clinical fields as well as in the basic medical sciences.

This memorandum has discussed in more or less general terms the structure, the purposes, and the content of the curriculum. To develop detailed schedules would require the thoughtful consideration of a group which should include representatives from all major departments. These men must be genuinely interested in pedagogic problems and willing to make the many concessions necessary if a workable program is to be developed. In fact, it might be wise to set up within the faculty a permanent Teaching Commission or Authority, to which would be delegated not only the future planning but the present management of the over-all teaching program. The purposes of this primary function of a medical school can be best defined and executed by a continuously functioning group independent of academic departments and routine university problems.

International Conference on Magnetism Strasbourg, 21-24 May 1939

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THIS CONFERENCE WAS ORGANIZED under the presidency of the eminent Pierre Weiss by the International Institute of Intellectual Cooperation and the French National Center of Scientific Research, in cooperation with the University of Strasbourg, whose Institute of Physics Prof. Weiss and his collaborators had made the world's chief center of magnetic research. Distribution of the proceedings[1] was long prevented by the German occupation and became possible only a short time ago.

The number of reports was restricted to 18, all dealing with important current work by the reporters and their collaborators, and some containing also authoritative and useful summaries of earlier work. The reports were mimeographed and distributed to the participants for reading in advance of the meeting. Thus, in general, only brief introductions on the part of reporters were necessary, and practically the whole time of the six scientific sessions of approximately three hours each was devoted to the discussions. In these, in addition to the reporters, an approximately equal number of other experts participated.

The complete proceedings constitute a most authoritative and useful guide to any who desire to undertake researches in this field.

After an informal gathering on 21 May, the formal meetings began on 22 May with a general session presided over by A. Terracher, the distinguished rector of the University and of the Academy of Strasbourg, who gave the address of welcome. There were also brief addresses by H. Bonnet, director of the International Institute; P. Montel, counselor of the National Center; H. Abraham, secretary-general of the International Union of Pure and Applied Physics; H. A. Kramers, scientific representative of the Inter-

[1] *Le magnétisme.* Vol. I: *Généralités et magnéto-optique* (pp. xxxviii + 184); Vol. II: *Ferromagnétisme* (pp. vi + 280); Vol. III: *Paramagnétisme* (pp. vi + 348). Paris: Collection Scientifique, Institut International de Coopération Intellectuelle, 1940. Handled in America by the Columbia University Press. Vol. I, \$2.00; Vols. II and III, \$2.50 each.

national Institute from Holland; and Prof. Weiss. The general session closed with an admirable address by E. Bauer on "Magnetism in the Last 50 Years." Prof. Bauer's role was to have been taken by Prof. Langevin, whose physical condition prevented his attendance.

The first exclusively scientific session was devoted to the discussion of four reports on magneto-optics, chiefly in its relation to paramagnetism. The first, by Rabinovitch, includes the description of successful work on the feeble magnetic double refraction (Cotton-Mouton effect) of gases and certain organic compounds, and that of certain metallic salts and salts of rare earths. The second, by Bizette, shows that the magnetic double refraction of the paramagnetic gas, NO, its magnetic rotatory power (Faraday effect), and its magnetization, as well as their variations with temperature, can be explained on the basis of the spectroscopic states of this gas and the new quantum-mechanical theory. Both these investigations came from the Laboratory of the Great Electromagnet at Bellevue, presided over by Prof. Cotton, who took an active part in the discussions.

The third report, by J. Becquerel (Paris), is divided into two parts. The first part gives an account of his extensive researches, made in collaboration with the Leyden physicists—especially, in recent years, Van den Handel and Kramers—on the absorption spectra and the paramagnetism of crystals containing rare earths, especially at low temperatures. The paramagnetism was studied by the rotation of the plane of polarization of light (Faraday effect). This method has the great advantage over purely magnetic methods that smaller specimens can be used and thus much stronger magnetic fields employed. Especially striking among the more recent results are the curves showing complete magnetic saturation of a number of compounds. The phenomena are complicated by the presence of crystalline electric fields and magnetic interaction, but are in large measure explained by the spectroscopic quantum theory as developed by Kramers, Van Vleck, and Ladenburg. The second part discusses researches made in the same manner on what may apparently be described as incipient ferromagnetic effects in strong fields at very low temperatures in substances purely paramagnetic at ordinary temperatures and is designated as *metamagnetism,* after a suggestion by Kramers. The results are closely related to those previously obtained by purely magnetic methods at Leyden and elsewhere. They bear striking resemblances, as pointed out by Foëx, to those obtained with very hard ferromagnetic substances at ordinary temperatures.

The fourth report, by Ollivier (Strasbourg), is devoted especially to the thermal variation of the magnetic rotation of the plane of polarization of light by paramagnetic solutions. In very precise experiments he finds, optically, for many solutions, a close parallelism with the results obtained magnetically, including both cases of paramagnetism obeying the Curie-Weiss temperature law and cases of paramagnetism with temperature independence.

The fifth, sixth and seventh reports, by Kramers (Leyden), Mott (Bristol), and Néel (Strasbourg), deal principally with the very special conditions which give rise to ferromagnetism and to the transition between ferromagnetic and paramagnetic substances as related to position in the periodic table. Kramers gives a rigorous quantum-mechanical treatment of the various kinds of action upon the magnetic elements in a crystal and devotes himself especially to the problem of rigorously proving the existence of points of transition, such as the Curie temperature; but he concludes that no model of interaction hitherto proposed is sufficient to give such a proof. Mott's report deals with recent progress (with which he is much dissatisfied) and difficulties in the theory of metals based on the energy band hypothesis of electron distribution. The theory is applied to the problem of specific heat at low temperatures, the Curie-Weiss law, ferromagnetic moments, paramagnetism of free electrons, and the general question of the origin of ferromagnetism. The report of Néel is largely a resumé of his profound and extensive original work. Its problem is to discuss the nature of the elementary carrier of the magnetic moment and the statistics which are applicable to it for the so-called elements of transition in the periodic table and especially iron, nickel, cobalt, and their alloys. All the numerous aspects of the subjects are critically examined, and the various theories are discussed and compared with the results of experiment.

The eighth report, by the writer, deals with the gyromagnetic ratios of ferromagnetic substances and discusses briefly the general methods of measurement, the errors involved, and recent results. The gyromagnetic ratio, ρ, for a substance is the ratio of the angular momentum of its magnetic element to its magnetic moment. This is equal to m/e (electron mass/electron charge) for a spinning electron and to 2 m/e for an electron moving in an orbit. Experimentally, in the cases of the usual ferromagnetic substances, ρ is found to range from m/e for Heusler alloy to 8 or 9 per cent more for cobalt. Thus, for most of these substances the spinning electron is responsible for nearly all of the ferromagnetism, but the orbital motion in general contributes a part. This excess of ρ over m/e is to be expected from theory, as pointed out by Kramers and Van Vleck, but the actual calculations are exceedingly difficult and have not yet been made.[2] For pyrrhotite, the observed gyromagnetic ratio is approximately $3.2 \times m/e$, the orbital motion thus apparently playing a great part. But there is as yet no adequate explanation of this result.

In the ninth report Forrer (Strasbourg) gives a new discussion, and one not in conformity with generally accepted quantum theory, of the parts played by the orbital motion and the electron spin in the magnetic elements of iron, nickel, etc. The main contribution to the moment of the element comes from the resultant electron spin in the 3d shell (as usually believed), but, according to Forrer, a supplementary part comes from a rotation of this shell complete with an angular velocity, $l=1$. This orbital part is variable from material to material, its ratio to the first ranging from 0 to 1/5, *i.e.* the ratio of the Weiss magneton to the Bohr magneton. This makes the maximum ratio of the orbital moment to the total moment equal to 1/6, and gives to the possible gyromagnetic ratios, if measured at saturation, the range from m/e to $1\ 1/6 \times m/e$. The experimental values all lie within these limits and are of the right order of magnitude, but smaller—a fact attributed to the measurements being made in relatively weak fields. The relation between moments and Curie temperatures is also discussed. A linear relation between the orbital part of the moment and the square of the Curie temperature is found to hold in a number of cases, whereas there is no apparent relation between the total moments and this temperature.

Becker (Goettingen), in the tenth report, without the necessity of considering the nature of the magnetic elements or the nature of the forces acting upon them, assumes the Weiss theory of the spontaneous magnetization of ferromagnetic substances practically to saturation in favored crystalline directions in minute domains, and the Bloch theory of the thin transition "walls" between them. Restricting himself to phenomena at ordinary temperatures in weak and moderate fields and making use of the principle that for equilibrium the sum of the crystalline energy, the energy of elastic deformation, and the magnetic energy must be a minimum, and considering the transition phenomena in the Bloch walls when necessary, he is able to give quantitative, but not exact, treatments of many phenomena and to show that the results are consistent with experiments.

In the eleventh report Sucksmith (Bristol) describes a new method for comparing the saturation magnetizations of ferromagnetic substances which permits measurements of precision at any temperature on specimens with volumes of only a few cubic millimeters. As a part of a program involving the detailed study of alloys with special characteristics, he has already applied the method to the system Fe-Ni-Al at temperatures up to the Curie points and has shown that the changes of phase may, in general, be followed by means of determinations of the saturation magnetization alone.

In the twelfth report Simon (Oxford) gives a thorough discussion of the possibilities and limits of the method of magnetic cooling described in the next report. By using suitable salts and either very intense fields or the "method of cascade" which he has devised, and by increasing the thermal insulation it should be possible to obtain temperatures lower than 10^{-4} degree K. And by making use of the paramagnetism of the atomic nuclei, as suggested by Gorter and by Kürti and Simon, it may be possible to go down even much farther toward the absolute zero.

Casimir (Leyden), in the thirteenth report, first gives a brief account of the history of the method of producing extremely low temperatures by the demagnetization of paramagnetic substances previously magnetized to approximate saturation in strong magnetic fields at temperatures already low, with special reference to the work done at Leyden by de Haas and his collaborators. He then discusses the theory of the measurement of specific heat at low temperatures, describes results obtained at Leyden and elsewhere at exceedingly low temperatures, and gives evidence indicating that the kind of apparent ferromagnetism observed in several paramagnetic salts at very low temperatures is due rather to paramagnetic relaxation.

In the fourteenth report Gorter (Groningen) and Kronig (Delft) give a theory of the effect known as paramagnetic relaxation, discovered by Gorter in 1936, and describe extensive experiments on numerous substances. The effect is analogous to the electric relaxation effect in dielectrics, studied by Debye and others, and has to do with the time lag of the magnetization behind the applied magnetic intensity. The effects vary with the temperature, with the strength of a strong magnetic field in which the specimen is placed, and with the frequency and strength of an applied alternating field. The whole theory of paramagnetic relaxation, however, is still in quite an unsatisfactory state.

In the fifteenth report Van Vleck (Cambridge, Massachusetts) describes the present state of the quantum-mechanical theory of paramagnetism, for whose development he has been chiefly responsible, together with Kramers and Stoner, both of whom took important parts in the discussions. This work played

[2] See, however, Gorter and Kahn. *Physica,* 1940, **7**, 753; and C. J. Gorter. *Phys. Rev.,* 1941, **60**, 836.

a prominent part in the proceedings; and indeed much of the material presented in the reports was directly suggested by Van Vleck's theory and verified it in a remarkable manner. It is impossible to abstract the report here.

The sixteenth report, by Krishnan (Calcutta), gives an account of the very extensive and precise results obtained at Calcutta by a magnetic study of the anisotropy of (paramagnetic) inorganic crystals and (diamagnetic) organic crystals. The principal results, on paramagnetic crystals, give many striking confirmations of the quantum theory. The results obtained on organic substances are in accord with what would be expected from work on magnetic double-refraction, or the Cotton-Mouton effect, and X-ray analysis. The wide applicability of the results is pointed out. There is also described a study of the remarkable diamagnetic asymmetry of graphite crystals.

In the seventeenth report Cabrera (Madrid) gives a thorough account of recent and precise experimental results on the paramagnetism of the rare earths and the families of palladium and platinum and discusses their relations to the laws of Curie and Weiss. Again the new quantum theory is of the greatest importance in the interpretation of the results, but many phenomena are still obscure.

In the eighteenth report Foëx (Strasbourg) gives an elaborate statement of the general facts of paramagnetism as they are known from recent and precise experiments, of the laws derived from them, and of numerous cases which are still partially or wholly unexplained. The first chapter is devoted to paramagnetism independent of the temperature, of which three kinds are treated; the second, to the law of Weiss and the two constants which are involved in it: the Curie constant C and the constant of the molecular field; the third, to a thorough discussion of the moments of the magnetic elements of the paramagnetic substances, with the exception of the rare earths, treated by Cabrera. In general, the quantum theory gives an excellent account of the phenomena, especially the variation of the moment with the number of electrons in the ion; but there are numerous important facts which are unexplained.

The discussions, to which, as indicated above, the scientific sessions were almost entirely devoted, were recorded verbatim. After revision by the authors and slight rearrangement they occupy in the printed text about one-quarter as much space as that taken by the reports. The president of the Conference contributed a special discussion of the present position of the Weiss (or empirical) magneton relative to the Bohr magneton, long recognized as a fundamental unit. While the evidence for the existence of the former as a physical reality is not now so great as it formerly seemed to be, he concludes, from facts presented in some of these reports, that it has a distinct place in the description of well-established, but incompletely explained, ferromagnetic and paramagnetic phenomena, and that attention should still be devoted to it, as to these phenomena themselves. Whatever view may be taken of the physical reality of this magneton, there can be no doubt in the mind of anyone acquainted with the recent history of magnetism that the idea has been most productive in originating and stimulating a vast amount of highly important work at Zürich, Strasbourg, and elsewhere —leading, in fact, to much of the work presented in these volumes.

At the end of the publication Prof. Weiss gives an extensive and clear review of all the reports.

Prof. Weiss died in Lyon near the time at which the proceedings of this Conference were published. Two of his colleagues in the magnetic laboratory were deported to Germany for forced labor, and the rest were scattered elsewhere. Most of the laboratory's scientific equipment was stolen, and only a small part of it has been recovered. But Foëx, Forrer, Ollivier, Sadron, and Yvon are now back, and are most assiduously and courageously working toward the restoration.

Scanning Science—

The seventh session of the International Geological Congress will be held in St. Petersburg toward the end of the month of August, 1897, and will continue about one week. Before the opening of the Congress there will be an excursion to the Ural Mountains lasting some 25 days, and after the close of the Congress there will be an excursion into the Crimea and the Caucasians lasting about a month. The Czar of Russia has ordered that geologists attending the Congress be allowed free transit (first class) on all the railways in Russia, before and after the Congress and including the excursions.

—17 July 1896