tory, Fort Wainwright, Alaska) who presented a modified wind-chill chart describing the wind-chill indices as equivalent temperatures under calm conditions. The chart has proved more useful and understandable than previously used environmental cooling power charts; it has been distributed in pocket-card form to all military personnel within U.S. Army Alaska. R. G. Possenti (Arctic Aeromedical Laboratory) concluded by reviewing his work on small group performance at remote military sites.

This symposium brought together many scientists and interested military observers from Alaska and from the other states. The variety of subjects discussed indicates the considerable scope of scientific talent required to resolve the problems of military operations in cold regions. Research specialities represented included biology, civil engineering, geography, geology, geophysics, hydrology, materials engineering, physiology, and psychology. Even with such a multidisciplinary representation it was recognized that only a fraction of the military problems and research needs for cold regions could be summarized. A welcome interest was shown in the symposium by military representatives stationed in Alaska. Such symposiums tend to strengthen the ties between the scientific and military communities and to narrow the gap between research effort and military needs.

This conference was held under the auspices of the Alaska Division, AAAS. The papers presented at this symposium are scheduled for publication as part of the *Proceedings of the 15th Alaska Science Conference* about 1 January 1965.

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Magnetism: A Decade of Conferences

The Tenth Annual Conference on Magnetism and Magnetic Materials, held in Minneapolis 16–19 November, completes a decade of unprecedented activity in magnetism in the United States. This is shown by comparison with two conferences that preceded this series. A "Ferromagnetic Symposium and Conference" was held in 1931 in Schenectady; volume 39 of the *Physical Review* contained the full text of the two symposium papers, abstracts of the seven conference papers, and summaries of the discussion. The "Washington Conference on Magnetism" was held in 1952; the 67 papers, with discussion, were published in *Reviews of Modern Physics* in 1953. The program of the 1964 conference listed 22 invited and 149 contributed papers, as well as an evening symposium. This report will therefore deal not with individual papers but with the following topics: fields attained, materials studied, measurement techniques, and theory.

An impressive forward step during this period was the upward extension of available steady magnetic fields. In 1931, it was usual to produce a few hundred gauss with solenoids or a few thousands with electromagnets; in 1952, attainment of 35 kilogauss was reported; in 1964, fields to 80 or even 100 kilogauss "are now economically within the reach of most research budgets." This accomplishment is the result of development of new superconducting materials. Fields as high as 255 kilogauss are available at the M.I.T. National Magnet Laboratory. Research applications of these high fields are still few; but there has been great expansion of the range of materials studied and of the measurement methods applied to them.

The 1931 conference dealt with ferromagnetic metals (iron, nickel, and cobalt) and alloys. The 1952 conference devoted much attention to new high-resistivity ferromagnetic compounds (ferrites) and antiferromagnetic compounds. The basic principle in both is that the coupling between nearest-neighbor spins tends to orient them antiparallel (rather than parallel, as in iron), so that the spins form two sub-lattices with opposite spontaneous magnetizations. In antiferromagnets these sub-lattice magnetizations, in the absence of a field, cancel one another; in ferrites they cancel one another only incompletely because, though opposite in direction, they are not equal in magnitude. Since 1957, still another group of compounds has been investigated: those in which the sub-lattice magnetizations fail to cancel one another because, though equal in magnitude, they are not quite opposite in direction (hematite is an example). The theory that explained this "weak ferromagnetism" led also to predictions of other interesting properties, such as magnetoelectric interactions, in certain compounds. Like the ferrites, but more complicated (having more than two sub-lattices), are the ferromagnetic garnets first studied in 1956. All these materials—metals, alloys, ferrites, garnets, weak ferromagnets, antiferromagnets, and magnetoelectric materials—received attention at the 1964 conference. In addition to composition, size and geometry are important. In 1931, only material in bulk was studied; in 1952, there was great attention to fine particles; in 1964, the interest has shifted to thin films. This interest has been generated by the need for faster magnetic memory elements for computers; the microsecond switching time is the chief limitation of the ferrite cores now being produced in great quantity.

In 1931, measurement of magnetic properties usually consisted of fluxmeter observations of static hysteresis curves. By 1952, ferromagnetic resonance (resonance of the precession of spins about a d-c field in response to a transverse microwave field) had been discovered, had been used to get information about ratios of magnetic moment to angular momentum, and had been applied in the development of microwave devices such as "gyrators." Now, in 1964, the garnets have provided narrower resonance-line widths, and thin films have permitted observation of spatially nonuniform resonance modes; "microwave devices and magneto-optics" provided material for one session of the latest conference. A technique new in 1952, but the topic of an entire session in 1964, was direct study of ordered spin structures (as in an antiferromagnet) by neutron diffraction. A technique still new in 1964 is use of the Mössbauer effect to measure microscopic effective magnetic fields.

In 1931 spontaneous magnetization was explained with the Weiss molecular-field theory, reinterpreted on the basis of elementary ideas about exchange forces. In 1952 exchange itself was the topic of a symposium, and the statistical mechanics of the Ising model was the subject of a 37-page review. The 1964 papers show considerably more progress in the statistical mechanics of such localized-spin models than in the quantitative theory of exchange forces in metals. Several new theoretical techniques have been developed. They have been applied both to the Ising model and to the more realistic Heisenberg model, to ferromagnetic, antiferromagnetic, and spiral spin structures, and to transitions between these structures.

A regular feature of these conferences is the exhibits, in which manufacturers of materials and apparatus display and explain their offerings. Another feature is the distribution of the *Magnetic Materials Digest*; the current issue summarizes, in connected and organized sequence, the publications in magnetism—1777 in all—for 1963 (M. W. Lads Co., 46 South 40 Street, Philadelphia, $6). The proceedings of the conference itself will be published in a separate issue of the *Journal of Applied Physics* in the spring of 1965 (American Institute of Physics, $5). The A.I.P. and the Institute of Electrical and Electronics Engineers are the joint sponsors of these conferences.

The number of registrants was 747, with at least six foreign countries represented—despite the recency of the International Conference on Magnetism at Nottingham in September. Having been abroad during the preparations for this conference, I can without immodesty commend the excellent work of the local committee, headed by R. J. Prosen. This was a very successful decennial. The first conference of the second decade is scheduled for 15–18 November 1965, in San Francisco.

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Space Vehicles in an Ionized Medium

An exciting set of problems which do not usually receive much public attention were discussed at a symposium on the interaction of space vehicles in an ionized medium which was organized as part of the 15th International Astronautical Congress held in Warsaw during the week of 6 September 1964.

In his introduction, S. F. Singer, chairman of the symposium, considered the interactions between bodies and ionized gases. On the one hand, the body itself will acquire an electric charge by the accretion of ions and electrons from the plasma. This phenomenon is further complicated by the presence of a magnetic field and by the environment of solar ultraviolet photons and high-energy charged particles. Because of its electric charge, the body will undergo momentum exchanges with the plasma particles, the summation of which produces a drag force which may be termed a coulomb drag. Such drag forces may have important dynamical effects on the trajectories of small bodies, such as cosmic dust particles.

On the other hand, the plasma is disturbed by the passage of the body, which produces wakes whose character depends on the characteristics of the plasma and the presence of the magnetic field; magnetohydrodynamic effects may occur with wave propagation initiated by the interaction. Such effects are of great interest, as is their detection by direct measurements or by indirect radio propagation studies.

The phenomena involved in the interaction between a charged body and the plasma are of interest both for pure science and for engineering. The local disturbance of the plasma affects the usefulness of a satellite for making measurements on the ambient plasma; it affects the operation of various types of plasma probes, langmuir probes, and impedance probes, the operation of antennas at certain frequencies, and the propagation of radio waves generally. The coulomb drag may affect the orbit and the lifetime of a satellite, and the coulomb interaction can also give rise to torques which can change the orientation of a body operating in the space environment. As another application of electric charging, in the operation of ion propulsion engines, great care must be taken that the potential of the body does not rise to too high a level. Finally, Singer mentioned a whole range of effects which relate to the production of plasma clouds by a charged body moving through the outer ionosphere.

The first paper, presented by Marcel Nicolet (Space Research Center, Belgium), reviewed the ionized gas environment of the earth. The problem is closely linked to the problem of neutral particles in the upper atmosphere. The ion production depends, in normal conditions, upon the solar ultraviolet radiation. The photoelectrons produced have energies clearly greater than those of the atmospheric surroundings, and the distribution of ions with altitude depends at the same time upon the ionic temperature and the electronic temperature.

It must be pointed out that it is not possible to consider only one model of ionospheric distribution, because the solar conditions are extremely variable in the course of an 11-year cycle. Solar activity considerably modifies the distribution of ions, of oxygen, helium, and hydrogen; temperature variations from 2500°K to 750°K occur in the outer ionosphere. At the lowest temperature hydrogen becomes almost immediately the most important constituent in the exosphere, while at the highest temperature oxygen prevails up to considerable altitudes. Because of these variations it is not always possible to consider conditions of equilibrium. This is particularly true during rapid changes of temperature which are associated with perturbations of the earth's magnetic field.

A paper closely related but restricted more narrowly to the topic of the distribution of neutral hydrogen in the exosphere was presented by W. G. Kurt (Sternberg Astronomical Observatory, Moscow). Kurt described a new set of observations taken from a Soviet space probe by means of a Lyman alpha scattering experiment with a photometer. He has been able to deduce the altitude variation of neutral hydrogen. This paper, which showed a rather slow fall-off of the hydrogen density at a distance of four to five earth radii, provoked a great deal of discussion relating to the experiment itself and to the model calculations which were carried out to explain the observed results. No final determination was reached, however, and full publication of the results must be awaited.

A detailed account of the electric charging process which determines the potential of a body moving in a space environment was presented by K. P. Chopra (Melpar, Falls Church, Va.). Chopra also was concerned with the thermionic and photoelectric screening of electric charge on a metallic object moving in an ionized medium. He described (i) the estimate of the electric charge established on the object's surface through the processes of accretion of electrons and ions from the ionized medium and emission of electrons (thermionic and photoelectric) from the object's surface; (ii) the determination of the resulting screening electron density distribution; and (iii) the electric field distribution in the vicinity of the object. The analysis was based on the dynamical laws of the motion of electrons and ions in the electric field of the object. Analytical expressions were presented for the case of a spherical object of any radius R for the steady-state conditions established