

IONOSPHERIC PHYSICS

INTERNATIONAL CONFERENCE AT PENN STATE

A conference on ionospheric physics was held at State College, Pennsylvania during the period July 24-27, 1950 under the joint sponsorship of the Geophysical Research Directorate, Air Force Cambridge Research Laboratories and the Department of Electrical Engineering, Pennsylvania State College. The purpose of the conference was the stimulation and encouragement of additional research in this very important aspect of upper atmospheric investigations. The total registration numbered over 230, with representation of leading researchers in the field from Alaska, Australia, Belgium, Canada, England, Germany, and India as well as the United States, thus making the conference truly international in character.

The conference was opened by two excellent papers on the characteristics and structure of the upper atmosphere. S. K. Mitra, University College of Science and Technology, Calcutta, India, presented a fundamental survey of current knowledge, regarding the composition, temperature, and structure of the atmosphere from relatively low altitudes to regions above the ionosphere. The distribution of ozone, the airglow, and the temperature-altitude function to the ionosphere were carefully surveyed, as were details on the dissociation of oxygen, heights and locations of the aurorae, and various ionization phenomena. The following speaker, L. Harang of the Norwegian Department of Defense, Oslo discussed the "Constitution of the Upper Atmosphere as Determined from Auroral Studies". Dr. Harang outlined the determination of an auroral luminosity curve as a function of altitude, the composition of the high atmosphere as indicated from auroral spectrograms and wind velocity determinations from movements of clouds in the aurora. In the latter instance, horizontal motions of yellow clouds were observed to range from about 220 to 360 km/hr at an altitude of 100 km.

T. R. Burnight, Naval Research Laboratory, Washington, D. C., presented a summary of recent direct observations on the upper atmosphere obtained by means of rockets. At 160 km, pressures were about 10^{-4} mb and temperatures between 80 and 160 km averaged about 250°K. The solar spectrum in the altitude range 69-115 km appeared to reach 2000 Å and the solar radiation curve between 200, 2000, and 3000 Å was best approximated by a black body of 4500°K although uncertainties may reduce the value to about 3800°K. Measurements on x-ray radiation (of about 10 Å), solar radiation below 1350 Å (as determined near 100 km), and possible ozone concentration to an altitude of 70 km were also presented.

An informative paper upon some of the objectives of the rocket program was delivered by E. Beth of the Air Force Cambridge Research Laboratories, Cambridge, Mass. In addition to discussing the special problems of interpretation of rocket data, Dr. Beth also described the experiments employed to determine electron densities in ionosphere, and pressures and temperatures in the region 40-100 km.

With respect to solar-terrestrial relationships, S. Chapman, Oxford University, Oxford, England, examined the geo-

physical consequences of solar ejecta. In his paper, "Corpuscular Influences upon the Upper Atmosphere", Dr. Chapman noted that the strong correlations often found between solar activity and magnetic storms and aurorae suggest a bombarding (corpuscular) agent, but admitted that the corpuscular theory is still not fully circumstantiated. The Doppler effect observed on the solar H and K lines during a magnetic storm was also mentioned. In a similar vein, R. v. d. R. Woolley, Commonwealth Observatory, Canberra, Australia, spoke on the connection between the solar corona and chromosphere and the ionosphere. After presenting evidence for believing that the effective surface temperature of the solar disc was only about 4830°K for radiation at a wavelength of about 1000 Å, Dr. Woolley pointed out that black body radiation at this temperature provides insufficient quanta for the formation of the terrestrial ionosphere. The agitation temperature of the corona is about 10^6 °K. Chromospheric temperatures are somewhat lower and are maintained by conduction. While most energy emitted by the sun lies in the range 11.1-12eV, a good proportion also lies in the region 13.6-50eV.

P. Millman, Dominion Observatory, Ottawa, Canada, speaking on "Meteoric Ionization", noted that the kinetic energy of a meteor lies between 10^8 and 10^{15} ergs, and that the brightest meteor trains usually have the greatest duration of luminosity. A most striking spectrogram was presented of a meteor and its train; the recombination spectrum of Mg, Ca, and Fe being plainly visible in the train. Mean heights of the Perseid and Geminid meteor showers, determined from the ionization trails, were 61 km/sec at 103 km, and 35 km/sec at 97 km, respectively. A logical basis for the classification of meteoric ionization trails was given.

W. Pfister, Air Force Cambridge Research Laboratories, discussed his research in a paper entitled "Studies of Ionospheric Region E". Dr. Pfister showed that the E ionospheric region may be represented by a simple Chapman layer only at altitudes above the D (absorption) region. The E layer is produced by photoionization of molecular oxygen above the altitude of dissociation. A linear increase in value of the scale height was considered. Dr. Pfister mentioned that the height of the region may be influenced by wind motions in the atmosphere, and pointed out that appreciable errors may arise in the scale height from a neglect of the terrestrial magnetic field. A companion paper, "Effects of Scale Height Gradient on the Variation of Ionization and Absorption," was offered by M. Nicolet, Royal Meteorological Institute of Belgium, Uccle, Belgium. Dr. Nicolet indicated the expected absorption of radiation in a region of variable scale height, and developed equations for ion production under these conditions. A method of determining the upper atmospheric temperature gradient, based upon the preceding work, was then evolved. In his work, Dr. Nicolet noted the very long lifetime of atomic nitrogen which may be formed in the region 200-300 km.

Two papers were presented on an examination of the ionosphere by means of the scattering of incident radio waves. H. G. Booker, Cornell University, in "Scattering of Radio Waves with an Application to Radio Astronomy", developed a theory for scatter from the E and F ionospheric regions as well as from the aurora. In applying this theory to sporadic E reflections, the "critical frequency" of the probing electromagnetic wave is determined more by the patchiness and fine structure than by the electron density. Scatter in the ionospheric regions would result in a fading or "ionospheric twinkling" of galactic noise sources (at

microwave frequencies) when received at the earth's surface. W. Dieminger, Institut für Ionosphärenforschung, Lindau, Germany, discussed the "Origin of Ionospheric Scattering". Several types of scattered signal may be distinguished: E, single-hop F, double-hop F, and G. Under proper conditions strong multiple ionospheric echoes are obtained which may be attributed to back scatter from the ground. Back scatter from distant locations, such as remote mountains, may easily be observed.

With respect to motions of ions in the atmosphere at ionospheric altitudes, K. Weekes, Cambridge University, Cambridge, England, presented "Ionospheric Winds". From an analysis of fading phenomena found at appropriately spaced receivers, Dr. Weekes found wind velocities of about 210 km/hr with a maximum speed of about 288 km/hr. A diurnal variation in direction was found, which during June indicated a west wind (in the meteorological sense—from the west) from 06 to 18 local mean time, and an east wind from 18 to 06 LMT. Such daily variations are to be expected from the theory on geomagnetism. During a magnetic storm an apparent speed of 1800 km/hr was estimated for the wind. In discussing "Diffusion Processes in the Ionosphere", M. H. Johnson, Naval Research Laboratory, Washington, D. C., noted that the results of his theory indicate that the scale height near 250 km is greater than 100 km and that the number density at 250 km is about $10^6/\text{cm}^3$. A marked change of the atmospheric state between the altitudes of 200 and 250 km is indicated. In a strong magnetic field, no pressure diffusion is possible. Analyzing data for Huancayo, Peru, Dr. Johnson found that the virtual height of the F ionospheric region fell rapidly during the darkness period.

D. F. Martyn, Australian Council for Scientific and Industrial Research, Canberra, discussed his recent work in "Traveling Disturbances in the Ionosphere". He found electron clouds which show vertical movement and, over both England and Australia, distinct horizontal motions. Vertical motions of the electrons indicated speeds of about 250 km/hr. Average F region electron velocities, observed over Australia during the interval 06–18 local mean time, revealed winds from the south and southwest during August and from the northwest and north during November. August speeds were about 480 km/hr. During April an abrupt change in wind direction from the southwest to the northwest was observed; the reverse effect was noticed during October.

In a second paper, Dr. Martyn presented "The Mechanism of Magnetic Storms and Aurorae". Idealized current systems found in the upper atmosphere were presented after the fashion of Chapman and Ferraro; on the basis of these currents, magnetic effects and the aurorae could be explained. Extending these theories, Dr. Martyn visualized the stream of particles flowing from the ring current to the upper atmosphere and then leaving at the opposite side a small circle forming the aurora. Thus the aurora is visualized as being formed by particles which are first trapped or forced to remain for a short time in the ring current, then join the auroral current, and then leave the aurora.

In two papers, "The Motions of Very Slow Electrons in Air" and "Ionospheric Cross Modulation", L. G. H. Huxley, Adelaide University, Adelaide, South Australia, developed the theory and presented results of experiments dealing with the Luxembourg Effect. Dr. Huxley noted the rise in temperature in an electric field and from considerations of the drift velocity and relaxation time, obtained the theoretical basis for interpreting this cross-modulation experiment.

Two papers dealt with ion reactions and mechanisms in the ionosphere. The first paper dealing with this vitally important subject, "Evidence on Recombination Processes from Laboratory Measurements of Ionized Gases", was presented by J. Sayers, The University, Birmingham, England. Employing an electrode discharge in high purity Argon, a recombination coefficient of the order of $10^{-30} \text{ cm}^3/\text{sec}$ was obtained. This value, of the same order of magnitude as that found in the F² ionospheric region, is pressure independent. However, some doubt exists regarding the actual recombination process involved and the effect of contaminants. D. R. Bates, University College, London, England discussed "Ionization and Recombination Processes in the Ionosphere". The possibility of resonance scattering of sunlight by N_2^+ atoms in the high atmosphere was mentioned. Cross sections for various photoionization processes possible in the ionosphere were examined. The probability of such mechanisms as predissociation of molecular oxygen and photodetachment of electrons from atomic and molecular oxygen was discussed. Radiative and neutralization recombination processes possible in the high atmosphere were investigated. Dissociative recombination, attachment, detachment and charge transfer mechanisms among the important atmospheric constituents were examined to determine most probable reactions. It was concluded that the main reaction in the E ionospheric region involved dissociative recombination of an electron with molecular oxygen; for the F regions the probable reaction is yet in doubt.

A most important aspect of the conference was the three symposia held during the afternoon or evening. The first symposium, moderated by S. K. Mitra, dealt with "The Physical Characteristics of the Upper Atmosphere". The second, presided over by D. R. Bates, encompassed "The Characteristics of and Processes in Ionized Media". The third, under the direction of D. F. Martyn, considered "The Dynamic Characteristics of the Ionosphere". In each symposium a lively discussion ensued with the audience vigorously participating.

The conference was very fortunate in having as an after-dinner speaker, L. V. Berkner, Carnegie Institution of Washington, Washington, D. C. Dr. Berkner addressed the group on "Signposts to the Future of Ionospheric Research" and in his enthusiastic fashion portrayed the growth of the science. Important milestones in past progress of ionospheric research were outlined, as well as the importance of determining, for example, such factors as coupling between the lower and upper atmospheric regions. The utility of such sciences as paleontology in estimating past atmospheric conditions and the possible suddenness of changing atmospheric composition and subsequent effects on life were vividly presented.

N. C. Gerson

Air Force Cambridge Research Laboratories

MEETINGS TO BE HELD

AAAS SESSION ON SOCIAL PHYSICS

Four papers falling under the general category of "social physics" will be presented during a special session of the Cleveland meeting of the American Association for the Advancement of Science in December. The program is being sponsored jointly by the sections on engineering and social science and will include the following papers: "What is Social Physics?" by John Q. Stewart of Princeton University; "Dynamics of Economic Growth" by W. F. Sutherland of the Toronto Hydro-Electric System; "Dimensional Analysis in Social Physics" by Stuart Carter Dodd of the University of Washington; and "The American Chemical