Auroral Research

THE aurora, revered since the time of the first arctic nomads, has been discussed for millennia. Even such vivid descriptions as that of Weyprecht—"Waves of light drive violently from East to West, the edges assume a deep red and green color and dance up and down. Rays mount rapidly towards the zenith. The sky is in flames . . ."—scarcely recapture the splendor of the violent displays so common in the North. Yet little scientific investigation of this phenomenon occurred prior to 1900. Fritz constructed his map showing isopleths of equal auroral intensity in 1881; no serious revision has ever been found necessary.

A theory regarding the formation of the aurora was first advanced by Goldstein (1881). His view—that these excitations arise from the bombardment of the atmospheric gases by charged particles ejected from the sun—was subsequently supported by Birkeland and Störmer. Lindeman (1919) introduced, and Chapman and Ferraro (1931) developed, the view that the polar aurorae are caused by a *neutral* ionized stream of solar particles. Alfven believes that the energy necessary for the penetration of the particles to an altitude of 100 km is provided by an electric field in the vicinity of the earth. This field may result from the motion of charged particles in a magnetic field. Greatest weight, however, is generally given to the views of Chapman and Ferraro, who postulated a ring current (about five earth radii outward from the earth) from which the solar particles bombard the ionosphere, mesosphere, and exosphere. These atmospheric shells are, at latitude 45° N, located, respectively, in the altitude range 80–400 km, 400–1000 km, and greater than 1000 km.

Several international cooperative attempts have been made to study the aurora and other polar phenomena. During the Polar Year of 1932–33 the intimate relationship between the aurora and irregularities of the E ionospheric region was established. Magnetic storms of various intensities produced marked increases in the ionic concentration of the ionosphere and rapid changes in its structure. Radio wave absorption during intense phases of magnetic storms results in "radio blackouts," some of them lasting for periods as long as 24 hours. A few types of radio communication systems in the Arctic are subject to severe limitations and even drastic failure.

The alleviation of these deficiencies has stimulated examination of the polar aurora in all its phases, and a new tool has been given to the auroral researcher in the form of radar. Radio wave probings of the aurora (at radio frequencies from 30 mc/sec to about 30,000 mc/sec) are being conducted at various localities. Attempts to determine its reflective properties (insofar as radio communications are concerned) have been progressing, with splendid cooperation from the amateur radio fraternity.

The various observational techniques provide an integrated investigation, to allow a better understanding of the aurora and the processes of its formation, as well as a better basis for the prediction of its normal and abnormal occurrences, its influence on communications, etc.

Studies of the aurora have revealed spectra thus far unobtained in the laboratory—e.g., the OH band systems and the Meinel system of molecular nitrogen. From examination of the band sequences, important information may be deduced regarding the excitation and ionization produced in the ionospheric and mesospheric regions. Although only protons have thus far been observed entering the terrestrial atmosphere, it is conceivable that heavier particles are also present.

In spite of the promising start made in auroral research, much remains to be done. An adequate treatment of the magneto-hydrodynamical equations describing the deflection of the solar, ionized particles by the geomagnetic field has never been successfully accomplished. The mechanics of ejection of these particles from the sun is unknown. The excitation and ionization which they produce as they invade the mesosphere and the ionosphere have not been fully clarified. All these unsolved problems offer an exciting challenge.

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