



Flaming aurora photographed at College, Alaska, by V. P. Hessler. (From the book, *Physics of the Aurora and Airglow*.)

Physics of the Aurora and Airglow. By Joseph W. Chamberlain. Vol. 2 of Internat'l Geophysics Series, edited by J. Van Mieghem. 704 pp. Academic Press Inc., New York, 1961. \$16.50. *Reviewed by R. Landshoff, Lockheed Missiles and Space Division.*

AURORAS are very striking displays of light in the night sky which appear mainly in the zones near the geomagnetic poles. More precisely, one can define an aurora as a "sporadic electromagnetic radiation that is emitted from the atmosphere and induced by extra-atmospheric atomic or subatomic particles". Airglow is a much weaker radiation of the atmosphere which can only be detected by making careful measurements. It is not tied to the poles and is predominantly excited by sunlight and subsequent chemical reactions. In addition to the emission of radiation one observes a sporadic reflection of radio waves from regions of increased ionization. These regions are frequently associated with visual auroras and are called radio auroras.

These phenomena are exceedingly complex, and for their description and explanation one must apply quite varied experimental as well as theoretical methods. The most valuable clues concerning both auroras and airglow are obtained by identifying and by measuring the intensities of the observed spectral lines and band systems, and this book gives a thorough discussion of such aspects as line formation, radiative transfer, and spectroscopy. Other important features of a more qualitative nature are the influence of geographical location, of the time of day, and of solar activity on the appearance (arcs, draperies, etc.) and on the frequency and intensity of auroras.

The upper atmosphere, where auroras appear, is far from thermal equilibrium, and to understand what species are present and how the spectra are excited, one has to make a detailed examination of collisions and reaction rates. This leads to additional questions concerning the origin of the primary extraterrestrial particles and the manner in which their approach is influenced by the geomagnetic field. In explaining airglow, a distinction is made between the emissions oc-

curing during the day or in twilight and those occurring at night. After describing the data, the author presents various theories which have been proposed to explain airglow. This involves a detailed analysis of such processes as resonance scattering, fluorescence, photochemical reactions, excitation by recombination, etc.

The book is a well written and well documented presentation of our current knowledge and it should prove very useful to scientists engaged in allied fields as well as fields covered in the title.

Radio Waves in the Ionosphere. The Mathematical Theory of the Reflection of Radio Waves from Stratified Ionized Layers. By K. G. Budden. 542 pp. Cambridge U. Press, New York, 1961. \$18.50. *Reviewed by Howard Chang, Stanford Research Institute.*

THIS monograph, is an excellent summary of all research in this field up to the beginning of 1960. In this highly idealized model, the earth is assumed to be a plane of finite conductivity, and the ionosphere is assumed to be a very weakly ionized plasma whose number density varies only with altitude. The simplest example of such a medium is a three-component mixture of ions, electrons, and neutral molecules. From the stability of the layers of charged particles, it follows that the ionosphere must be almost electrically neutral, i.e., the number densities of the ions and electrons are equal to a very high degree of approximation. Furthermore, the simplifying assumptions are made that only the free electrons affect radio propagation, that the ions and neutrals are stationary, and that the collisions between the electrons and neutrals greatly outnumber electron-electron and electron-ion collisions. Upon taking into account the presence of the earth's magnetic field, plus the fact that the ionosphere does not have sharp boundaries, it will be appreciated that, using this simple model, the study of the propagation of radio waves in the ionosphere is not a trivial problem.

As Budden has indicated in the preface, his book is an expanded and up-to-date version of Ratcliffe's *The*