Section 3.—Space Research in Canada*

Canadian scientific activities in space make no attempt to compete with activities in larger countries like the United States and the Union of Soviet Socialist Republics, but there are important things that can be done better in Northern Canada than elsewhere. Suppose space near the earth's surface is divided into various levels on a technological basis, that is, defining levels to be studied in terms of the vehicles that can be used to carry instruments. Instruments can be carried in aircraft or unmanned balloons up to heights of about 140,000 feet or 27 miles; the lowest practical satellite orbit is about 200 miles. In the interval between, many of the interesting upper atmosphere effects occur, such as the absorption of radio waves which causes communication blackouts. The aurora or northern lights and the lower conducting layers of the ionosphere also occur at these levels. At present, direct measurements in this interesting region of nearby space can be made only by the use of rockets. The rockets that carry instruments into this region need not be the large types used for launching satellites; very effective scientific results can be obtained using rockets of various sizes but having a maximum launching weight of approximately one ton, about 150 lb. of which is scientific instruments. Such a rocket will carry its load of 150 lb. to a height of 180 miles. Such a rocket has been developed in Canada by the Defence Research Board's Canadian Armament Research and Development Establishment.

The objectives of the scientific work are related to the physical and chemical nature of the rarefied gas in the upper atmosphere and the radiations and flux of particles which come in from the sun or outer space. It has become realized during the past few years that the solar atmosphere extends out to the earth's orbit and that there is an interesting region surrounding the earth where the earth's atmosphere merges with that of the sun. There is a flow of energy from the sun, not only in the form of electromagnetic radiation such as visible light, ultraviolet light, etc., but of gas and energetic particles which are often spoken of as the solar wind. This wind consists of clouds of moving gas and includes particles of quite high energy, in fact up to cosmic ray energies. This wind is very turbulent and its intensity varies greatly with observed activity on the surface of the sun. In fact, the intensity of ultraviolet light, X-rays and high energy particles coming from the sun is extremely variable. This is true even though the visible light from the sun is very steady. Radio waves from the sun also show turbulent bursts related to activity on the surface of the sun.

The earth's atmosphere is quite opaque to most of the wide spectrum of radiation and particles coming from the sun. There is a window covering a band of wavelengths represented by visible light and a few more narrow transmission bands in the infrared and at radio wavelengths. When one considers that the sun emits both electromagnetic radiation and particles with energies corresponding to all values from radio waves through the visible, ultraviolet, X-rays and cosmic rays, and only a small fraction of this range of the spectrum penetrates the atmosphere, it is apparent that measuring instruments must be taken outside the atmosphere to learn what is going on in this solar wind. Before the days of rockets and satellites only indirect measurements could be taken, such as by studying the reflection of radio waves from the ionosphere and spectroscopic measurements of the aurora.

The temperature of this solar wind is quite high—high enough that the gas is ionized and, therefore, electrically conducting. The turbulence is, therefore, not like the winds and storms in the lower more dense atmosphere but is subject to electromagnetic forces. The density of the solar wind is lower than the best vacuum that can be achieved in the laboratory and the motion of the particles represents a very high temperature. When this flow of gas moves within reach of the earth's magnetic field, its motion is profoundly influenced by the earth's magnetic field and the earth's magnetic field is, in turn, distorted by the flow of conducting gas from the sun. This flow occurs in bursts and the resulting

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