

introduced by high-altitude nuclear explosions. Data are transmitted from the satellite to the ground stations in several countries around the world and the magnetic tape records are sent to Ottawa for analysis. Scientific results to date have been most gratifying and the satellite measurements have added greatly to knowledge of the earth's upper atmosphere.

The over-all design and construction of the spacecraft were carried out by the Defence Research Telecommunications Establishment. Some components were made by Canadian industry and the cosmic ray instruments were the responsibility of the National Research Council. The cost of the launching vehicle, the actual launching and much of the data recovery were undertaken by the NASA as part of its international co-operative program. This joint Canadian-United States program is continuing. The launching of *Alouette B*, successor to the present satellite, is scheduled for late 1965. *Alouette B* is the first of four satellites to be built in Canada for the International Satellites for Ionospheric Studies (ISIS) series. These vehicles, to be launched at intervals during the next five years, will carry more sophisticated instruments and orbit at greater heights than *Alouette I*.

The rocket-launching facility at Fort Churchill, Man., located almost under the belt of maximum auroral activity, has been a centre of activity during the past year. A total of 103 rockets and 41 high-altitude balloons were launched in 1964. Four launchers are in use and a variety of rockets, including *Arcas*, *Nike*, *Cajun*, *Nike Apache*, *Astrobee*, *Aerobee*, *Argo D-4* (*Javelin*) and the *Black Brant* series. The range is operated by the United States Air Force for joint United States and Canadian scientific purposes. Early transfer of its operation to the National Research Council of Canada is planned.

Rockets have a special role in the space programs because there is an important region of the upper atmosphere that is too low for satellite orbits and too high to be reached by balloons or aircraft. This is the region between heights of about 25 and 200 miles. Here are found the absorbing layers in the lower ionosphere which cause radio blackouts and here are detected the complex atmospheric processes which produce the visible aurora. Because the axis of the earth's magnetic field is tilted, the auroral zone sweeps down across Canada, and Churchill lies almost in the middle of this zone. This region of the atmosphere is therefore of great interest and importance to Canadian scientists. For many years investigations were limited to ground-based radio and optical measurements but now rockets are being used to carry instruments right into the aurora. These measurements, *in situ*, of electron density, temperature and charged particles will ultimately lead to a proper understanding of the aurora and high-latitude disturbances.

Many of the rockets fired at Churchill are of Canadian design and development. These are the *Black Brant* rockets which were pioneered by the Defence Research Board and are now produced commercially in Winnipeg. The first in the series, the *Black Brant I*, was an experimental vehicle and is now obsolete. *Black Brant II* is a 17-inch diameter vehicle capable of carrying 150 lb. of payload to over 100 miles. *Black Brant III* is a smaller rocket, 10 inches in diameter which will lift 40 lb. to about 100 miles. *Black Brant IV* is a combination of *II* and *III* and will go to a height of about 600 miles. *Black Brant V* is an optimum design of the *II*. Most of the flights have been made with the *II*'s but the *III*'s and *IV*'s have been successfully flown and will be used to carry scientific instruments in the immediate future.

Along with the increased activity in Canadian space programs there has been a general broadening of interests. The Meteorological Branch of the Department of Transport (DOT) Meteorological Satellite Data Laboratory is conducting a program to produce applications of satellite observations to the problems of meteorology and ice reconnaissance. In the field of communications satellites, the DOT has a joint program with NASA in which Canada participates in the testing of such spacecraft as *Telstar*, *Relay* and *Syncom* and a new experimental ground station will provide information for the development and use of communication satellite systems.

Canadian universities have continued to be very active in the field of space research. Nine university groups have programs involving the instrumenting of rockets, balloons