

series. On Jan. 1, 1966, the National Research Council assumed responsibility for the management of the Churchill Research Range. This arrangement was formalized by a Canadian-United States governmental agreement of June 14, 1965, which provided for joint funding and use of the range and designated the National Research Council and the National Aeronautics and Space Administration as the responsible Canadian and American agencies. Operations at the range are carried out by a civilian contractor.

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 two experimental ground stations for the development and use of communication satellite systems are nearing completion at Halifax and Toronto.

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 or satellites for upper atmospheric studies. The McGill University program of gun-launched vehicles in the Barbados known as HARP (High Altitude Research Program) has been carried on with considerable success. About 100 launchings were made in 1965. Improvements have been made to both the gun and the vehicles and successful measurements have been made of wind shears and atmospheric constituents in the 100-km. region. A gun and test range has been set up near Highwater, Que. This program is carried on in collaboration with the U.S. Army.

Much of the foregoing work is shared with Canadian industry. Civilian contractors are producing instruments and space vehicles for both Canadian and foreign experimenters. In some programs, such as the *Alouette* satellite and the development of *Black Brant* rockets, industry is playing a major role. Other work of great importance for the space programs, such as fundamental research on materials and in plasma physics, is also being carried on in industrial laboratories.