

and American agencies. Operations at the range are carried out by a civilian contractor. At present about 70 large sounding rockets are launched each year together with about 200 small meteorological rockets.

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. The measurement *in situ* of electron density, temperature and charged particles will ultimately lead to a proper understanding of the aurora and high-latitude disturbances.

Another zone of particular scientific interest is that in the vicinity of the magnetic dip pole. Because its geographic location at the present time is well outside the cover of the Van Allen radiation belts, which terminate in the auroral zones, the magnetic polar region is particularly suitable for the study of radiation from outer space. In 1966, two *Black Brant III* rockets carrying instrumentation for the measurement of galactic X-rays were launched from a quickly prepared site at Resolute Bay, N.W.T. The operation was very successful and the results were of considerable scientific interest. In 1967 the installation was improved and expanded to cater for meteorological rockets. Launches are planned for late 1967 for the NRC, the University of Calgary, NASA and the Meteorological Branch of the Department of Transport.

Many of the rockets fired at Churchill are of Canadian design and development; the *Black Brant* rockets were pioneered by the Defence Research Board and are now produced commercially in Winnipeg. *Black Brant IIA* is a 17-inch diameter vehicle capable of carrying 150 lb. of payload to over 100 miles. *Black Brant III*, 10 inches in diameter, will lift 40 lb. to about 100 miles. *Black Brant IV* is a two-stage rocket, combining the *IIA* and *III*, and will go to a height of about 600 miles. *Black Brant VA* and *VB* are both 17-inch vehicles, the former with the same motor as the *IIA* but with a rather higher performance, and the latter with a motor giving slightly less thrust for double the time which results in an ability to carry 250 lb. of payload to over 240 miles.

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 applying satellite observations to the problems of meteorology and ice reconnaissance. Two experimental ground stations for the development and use of meteorological satellite systems have been completed at Halifax and Toronto. In the field of communications satellites, DOT has a joint program with NASA in which Canada participates in the testing of satellites in the Applications Technology Satellite (ATS) Program using the experimental communications satellite ground station at Mill Village, N.S.

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, known as HARP (High Altitude Research Program), has been continued with success, although Canadian financial support for the project has terminated.

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.