NOTES from ABROAD

PHYSICS IN CANADA

Canada has large natural resources but these have been only partially developed. The population is small and the area very large. Research is sponsored by a number of different administrative authorities. Consequently, organization assumes an even greater importance than usual if maximum success is to result. It is the intent of this article to give a brief survey of the nature of the work in Canadian physics and the method of its organization.

In most countries research is supported in three main ways: by government, the universities, and industry. Canada is no exception. To avoid wasteful duplication it is important that means be provided for a high degree of informal cooperation, and one very effective way of doing this has been to establish really active research committees. Some are quite national in character; others deal with relatively local problems. Sometimes two or more committees work in the same field under different administrative authorities and their coordination is accomplished either by interlocking memberships or joint sponsorship. Grants in aid of research also contribute to coordination since the majority of the grants are made by the larger administrative bodies who, though they may have no direct formal administrative connections, make it a point to be familiar with each other's activities and to take account of them when making awards.

The Federal Government gives most of its support to physical research through the National Research Council of Canada, the Defence Research Board, and the Department of Mines and Resources. Other branches of the Federal Government have laboratories doing a certain amount of physical research but the main interest of these laboratories is in some other field such as agriculture or health, and to these organizations physics is a tool rather than an end.

The National Research Council

Occupying a rather unique position, not only in physics, but in other branches of science, the National Research Council of Canada has proved so effective an organization that other research authorities in Canada have, to varying extents, followed its method of organization and operation. This Canadian body has the same name as one in the United States but the two are very dissimilar in many important ways. Relatively speaking, the responsibilities of the Canadian institution are broader and its functions more comprehensive.

The National Research Council is not a department of Government in the ordinary sense but a corporate body deriving its powers from the National Research Council Act of 1924, revised in 1946. This Act established a Committee of the Privy Council (the Federal Cabinet) of Canada on Scientific and Industrial Research consisting of certain Ministers of the Crown designated by the Governor-in-Council and under the chairmanship of one of them. The latter position is presently held by the Right Honourable C. D. Howe, Minister of Trade and Commerce. Under this committee is the Honorary Advisory Council on Scientific and Industrial Research. This body, usually called the Council, consists of a president, two vice presidents, one for administration and one for science, and not more than seventeen other members appointed from men distinguished in science and industry. Except for the president and vice presidents, they serve for a three-year term without emolument. They are really equivalent to a board of governors and as such are generally responsible for all the activities carried out under the National Research Council Act. The president is the chief executive officer and ranks as a Senior Deputy Minister. Dr. C. J. Mackenzie currently holds this position. The Act gives the Council very broad, general and specific powers to sponsor and promote scientific research and development in the public interest. It also confers to it responsibility for the maintenance of all primary physical standards. Thus some responsibilities parallel those of the National Bureau of Standards in Washington.

The activities of the Council can be placed under four general headings: maintenance of its own laboratories, awarding grants in aid of research, financial support of committees coordinating research in special fields, and the giving of scholarships. The main laboratories of the Council are located in Ottawa. These house the administrative offices and the divisions of physics, chemistry, applied biology, information services, and radio and electrical engineering. A few miles outside of Ottawa are two additional establishments, one devoted to mechanical engineering, aeronautical and building research, and the other to radio investigations mainly in the field of radar engineering. A regional Laboratory for the Prairies at Saskatoon is in active operation. This, as its name suggests, is devoted to special problems of the region and at the present time is mainly concerned with problems of applied biology such as the utilization of agricultural waste. A second regional Laboratory for the Maritimes, at Halifax, Nova Scotia, is in the planning stage. At Chalk River, about 135 miles up the Ottawa River from Ottawa, is a large atomic energy project which is devoted exclusively to fundamental research in nuclear physics and to peacetime applications of atomic energy.

Through a system of special committees, the Council makes an effective contribution to the financial support of research in special fields and to the general coordination of research throughout Canada. These committees, set up as associate committees of the National Research Council, bring together representatives of all groups interested in a particular field. Generally they comprise members of the Council's laboratory staff, the universities, industry, and other Government agencies. The researches, under the general guidance of a committee, may be located in

several widely separated laboratories under different administrative authorities. Some such committees provide an invaluable advisory body for work going on in the Council's own laboratories. It is thus ensured that the best talent within and without the Council organization participates in the direction of the work. On occasions the problems of a particular industry have been solved by the active cooperation through an Associate Committee of the National Research Council and firms dependent upon the industry. Under these circumstances all generally take their proportionate share of financing.

Each year the Council spends very substantial sums—of the order of a million dollars in the last fiscal year—on grants in aid of research to Canadian universities and some other organizations. These grants provide apparatus and trained assistants to researchers who might otherwise find it difficult to carry on their work. Funds are also dispensed for a very large number of scholarships, awarded by the Council to Canadian students studying for their doctorate. Recently a generous system of post-doctorate fellowships tenable in the Council's laboratories was established. These are open to applicants from abroad as well as in Canada and pay slightly under $3000 free of income tax. In this way techniques developed in other countries are brought to Canadian research in a direct and practical way. At the same time closer personal bonds will be established with workers in other countries.

Within the Council's laboratories, physical research is concentrated mainly in the Division of Physics at Ottawa and in the Atomic Energy Project at Chalk River. However, because physics has entered into so many other branches of science a fair amount of physics is done in other divisions of the Council's laboratories. In the Division of Physics at Ottawa a very well equipped laboratory for research in molecular spectroscopy and allied fields is nearing completion. Cosmic rays are studied by photographic plates, Geiger-Müller counters, and ionization chambers both at Ottawa and in the Canadian Arctic. An optics laboratory is pursuing research in such fields as high speed cinematography, photographic optics, air photography, colorimetry, photometry, photogrammetry, and spectro-chemical analysis. Other groups are studying the thermal conductivity of metals, the physics of housing problems, industrial radiology, acoustics, electricity, x-ray diffraction, electron microscopy, and nuclear physics.

At Chalk River the heavy water pile has a high neutron flux of 4.3×10^{12} neutrons per square centimetre per second which at the time of writing is still the highest flux obtainable anywhere. This makes possible many investigations which would otherwise not be feasible. For example, the lifetime of the neutron has been determined recently, its half-life being twenty minutes. In addition much other work in nuclear physics is going on. A five Mev Van de Graaff accelerator is nearing completion. Considerable attention is given to the production of radioactive isotopes. The usefulness of these to industry is studied as a cooperative investigation with the Industrial Radiology Laboratory of the Division of Physics.

Statistics do not always prove what is intended, but it is at least interesting to note as a measure of the physical development of the National Research Council's activities that the staff has increased from a few hundred at the outbreak of the war to just under three thousand at the time of writing.

Other Research Organizations

During the war the National Research Council acted as the research organization for the three armed services. At the close of the war it was decided, as a matter of policy, that the responsibility for defence research should be given to a separate body so that the Council would be left free to devote itself to its primary purposes. The Defence Research Board was therefore created and charged with the responsibility for all defence research. Although separated administratively, the two organizations work closely together and the President of the Council is a member of the Defence Research Board. The Defence Research Board maintains laboratories, makes grants in aid of research to other organizations, and awards scholarships. Much of its work is in the field of physics. Radio propagation, ballistics, marine physics, and Arctic research problems are among the more important studied in the Board's own laboratories at Valcartier, Ottawa, Churchill, and Esquimalt.

The Department of Mines and Resources has two important branches doing a considerable amount of physical research. The Dominion Observatory at Ottawa studies meteor physics, maintenance of time standards, seismology, geomagnetism, and similar problems, while the observatory at Victoria, British Columbia is devoted mainly to astrophysics. The Department also supports a metallurgy laboratory which is unsurpassed in Canada for the study of metals and alloys. Here physicists, in cooperation with metallurgists, are taking advantage of the excellent facilities to study the mechanical properties of metals and reconcile them with the concepts of modern quantum physics.

Most of the provincial governments of Canada either have already established or are considering the establishment of provincial councils, foundations, or boards intended to concern themselves specifically with research problems of peculiarly provincial concern. A goodly fraction of such work is in the physical sciences. In general, these provincial bodies are organized in a way that rather closely parallels the National Research Council of Canada. Under a governing board they maintain laboratories to varying degrees, make research grants, award scholarships, and sponsor committees in particular fields. These provincial organizations work in close cooperation with the National Research Council of Canada. One provincially supported organization somewhat different in character to the others because of the specialized nature of its work is the Manitoba Cancer Institute. This organization is very successfully coping with the problems of bringing physics to the service of medicine.

The Universities

The research work carried out in universities benefits to a large extent from the coordination effected through