Physical research in Switzerland, while handicapped to some extent by the same financial problems that beset science in other European countries, is nevertheless being pressed vigorously in a number of directions. The following article reviews the activities of the main Swiss research centers.

physics in

By Hans H. Staub and H. Wäffler

As one of the few European countries which has been spared a direct and active participation in World War II, Switzerland has enjoyed a comparatively undisturbed decade of research in physics. Even during the war years, basic research progressed although difficulties in procurement of materials and the effects of the mobilization of the citizens' army hampered the work to a certain extent. Since the Swiss Physical Society has its own scientific journal, the *Helvetica Physica Acta*, where papers are published in any one of the three major national languages, the communications of Swiss physicists have often not come to the attention of as broad a readership as might be desirable, particularly in the Anglo-Saxon countries.

Since the end of the war, however, contact with England and the United States has become very close. A considerable number of Swiss physicists are at present working actively in the United States and conversely several British and American physicists hold research and teaching positions at Swiss institutions.

Basic research in physics in Switzerland is exclusively done at the laboratories of the seven State Universities operated by their respective cantonal governments in Zürich, Basel, Bern, Fribourg, Genève, Lausanne, and Neuchâtel and the laboratory of the Swiss Federal Institute of Technology (ETH) operated by the federal government in Zürich. The highly developed Swiss industry possesses a number of excellent research laboratories which are engaged primarily in research in applied physics. However, a very close and fruitful cooperation between industry and the institutions of higher learning is maintained.

One of the serious problems today confronting the Swiss physicist at the academic laboratories is that of financing his research. Since the Federal Institute of Technology and seven rather large universities represent a considerable financial burden for a small, however prosperous, country of four million inhabitants, the funds available for research are quite small compared to those put at the disposal of our colleagues in the Anglo-Saxon countries. On the other hand, Swiss laboratories enjoy an almost complete lack of direct government interference with respect to the type of research or the political attitude of their scientists, although various government agencies, as for instance the Swiss Atomic Energy Commission, sponsor various research projects. At present, plans are being formed for the establishment of a national science foundation which, as a private organization but subsidized by the Federal Government, should support basic research in all branches of the natural sciences and humanities.

Broadly speaking, the main fields of interest of the Swiss laboratories during the past decade have been nuclear physics and the physics of the solid state. The largest laboratory of the country is that of the Federal Institute of Technology headed by Professor Scherrer. It has at its disposal three accelerators for work in nuclear physics. A conventional cyclotron built during the war produces magnetically monochromatized protons with energies up to seven Mev and currents of about 10 amps. In a series of investigations, the excitation function of p-n reactions has been studied. In addition, the cyclotron produces active materials for the study of β processes which for quite some time have been major topics of research of this laboratory. Among the many interesting results it should be mentioned that recently an angular correlation between the electrons of two highly converted cascade γ-rays of Au^{198} has been discovered. A particular machine called the "tensator", which is essentially a cascade generator of ten sections, was developed by Swiss industry and produces voltages up to 700 Kv. It is primarily used as a neutron generator for the study of the scattering of neutrons on light nuclei. This problem has recently become of considerable interest in connection with the proposed shell model of nuclei. A third machine of the Cockroft-Walton type for 600 KV is equipped with an extremely powerful high voltage ion source of a modified Oliphant design. Using the Li^7-p-Be^8 reaction it represents an intense source of high energy γ-rays with which a large number of investigations of photo neutron, photo proton and photo α-reactions have been carried out. Of particular interest has been the discovery of the photo dissociation of C-12 into three α particles. In addition angular and energy distributions of the γ-rays of the above-mentioned reaction have been studied. At the same laboratory a second group is engaged in research on the solid state. Numerous investigations of the ferroelectric properties of Rochelle salt, the alkali phosphates, and barium titanate have been carried out. More recently another group under Professor Busch has worked on problems concerning the mechanism of conduction in semiconductors. The discovery that the grey modification of tin belongs to the group of semiconductors is particularly noteworthy.

The theoretical group at the ETH under the direction of

SWITZERLAND

Professor Pauli, Nobel prize laureate in physics of 1946, is occupied with meson theory and more recently with the theory of light nuclei.

At the laboratory of the University of Zürich, experimental research in nuclear physics is conducted under Professors Staub and Wäffler. A small pressure-type electrostatic generator for one and a half Mv is under construction. Experiments are planned on the energy levels of the lightest nuclei. Another group is working on problems related to the magnetic moments and quadrupole moments of nuclei. A series of measurements of nuclear moments by the method of nuclear induction is under way and experiments are planned to study the internal electric field of crystals from its interaction with the nuclear electric quadrupole moment. The medical school of the University has recently obtained a 30 Mv betatron built in Switzerland under the direction of Dr. Wideroe at the Brown, Boveri Company. This machine, although primarily intended for medical research, is made available to the physicists, and experiments with high energy γ-rays are in preparation. The laboratory also cooperates closely with the laboratory of physical chemistry where Professor Clusius has constructed several stable isotope separators working with his well-known method of thermal diffusion.

The theoretical group at the University of Zürich is engaged in research on meson field and radiation theory under the direction of Professor Heitler. In addition, Professor Heitler is presently writing a new edition of his famous book *Quantum Theory of Radiation*.

At the University of Basel, Professor Huber and his group have recently completed the construction of a one million volt cascade generator of the Cockroft-Walton type. This generator is also equipped with a high voltage ion source and represents a very intense source of neutrons, with which a large number of resonance scattering and disintegration processes have been investigated with respect to cross section, angular distribution, and energy dependence. At the Basel laboratory, Professor Baldinger has specialized particularly on electronics research for the needs of nuclear physics. Among other things he has developed coincidence circuits of very high resolution and a multichannel pulse analyzer. Baldinger and Huber also designed an interesting, simple, and quite accurate method for pulse analysis by a photographic technique. Also at Basel, optical research on molecular spectra is conducted by Professor Miescher. Theoretical physics is directed by Professor Fierz, whose contribution to field theory is well-known.

The laboratory of the University of Geneva headed by Professors Exterman and Weigle is equipped with a small accelerator. Work on isotope separation by means of a mass-spectrograph based on the time of flight method is also done. Another group is studying the relaxation phenomena of nuclear paramagnetism with the method of nuclear induction. Extensive research in biophysics is done by Professor Weigle.

Ferromagnetic phenomena have been under investigation for many years at the University of Lausanne under Professor Perrier, while Professor Haenny at this laboratory is working in the field of radiochemistry. At Neuchâtel, Professor Rossel is engaged primarily in theoretical and experimental research on slow neutrons.

Finally, it should be mentioned that Swiss physicists have at their disposal a well-equipped laboratory for research in the field of cosmic rays at the Jungfraujoch. This laboratory located at an altitude of 12,000 feet is conveniently reached by railroad. The excellent opportunities of this laboratory have mainly been used by British and French physicists and only a small amount of cosmic ray work has been done there by Swiss research groups. At present, however, Professors Heitler and Wäffler are planning experiments to be undertaken at Jungfraujoch in the near future.

The foregoing brief account shows the rather wide variety of interest at the Swiss laboratories. It is also noteworthy that for reasons of financing and of manpower no University laboratory has yet started work on a generator for ultra high energy particles. It is, however, quite commonly felt that, sooner or later, work in this direction should be started. Since such an enterprise is probably beyond the capacity of any single laboratory, it is likely that it will be done by a common effort of several organizations on a national or perhaps even broader basis. In this connection the proposal of Professor Rabi that a Central European laboratory for basic research in physics should be created under the auspices of Unesco, has found the general and enthusiastic approval of most Swiss physicists.

Both *Hans H. Staub* and *H. Wäffler* were born in Switzerland and studied at the Federal Institute of Technology at Zürich. Dr. Staub was an exchange fellow at Caltech in 1937, taught at Stanford and spent 3 years with the Manhattan District at Los Alamos before returning to Switzerland in 1949 to become professor of experimental physics and director of the Institute of Physics at the University of Zürich. Dr. Wäffler has been professor of experimental physics at the University of Zürich since 1950.