The Cavendish Laboratory, Cambridge University, England, has a world-wide reputation for its scientific accomplishments. An outline of its current programs of research has been given in this article.

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By W. L. Bragg

THE FIRST BUILDING of the Cavendish Laboratory at Cambridge University, England, was opened in 1874 and its first professors were James Clark Maxwell, Lord Rayleigh, and J. J. Thomson. It was in this Laboratory that C. T. R. Wilson constructed the cloud chamber, an apparatus which has perhaps had more influence on the development of atomic physics than any other single piece of equipment; it was here that F. W. Aston developed his mass spectrograph, Lord Rutherford confirmed the disintegration of nitrogen by alpha particles, Sir James Chadwick discovered the neutron, and Sir John Cockroft and E. T. S. Walton first achieved the disintegration of atomic nuclei by artificially accelerated particles.

When Lord Rutherford died in 1937 the main effort of the Laboratory was directed towards nuclear research, although pioneer work was also being done in the radio section under Sir Edward Appleton and in the Mond low-temperature laboratory under Sir John Cockroft. These groups have continued to be three of the Laboratory's principal sections, although other lines of research have also developed.

Staff, Fellows, and students doing research work now number one hundred and fifty, about one-third of them from overseas. As far as research work is concerned, the various sections are in effect independent units, though all take part in normal undergraduate teaching, which is centrally organized.

The basic aim of nuclear physics is to discover what forces hold the nucleus together, and how the particles are arranged. Research at Cambridge is carried out into those light nuclei where the particles are not very tightly held together and whose binding energies, of several million electron volts, are rated as low. Other subjects of research are the breakdown of deuterons and other nuclei by means of gamma rays, the spin of the nucleus, and such nuclear disintegrations as give rise to beta rays. Full details of the energy involved in the binding process of the nucleus are being determined in the case of such unstable nuclei as sodium 24 by the atomic beam resonance method.

Nuclear detecting instruments are being developed which record each nuclear particle as an electrical pulse of height proportional to the energy of the particle detected. New associated electronic equipment includes a form of analyzer which divides electrical pulses into 60 to 120 channels at counting rates of one thousand per second and is proving particularly useful.

Accelerators in use at the Laboratory are a small cyclotron, two Philips rectifier sets, and a Van de Graaff machine; in addition, a linear accelerator is under construction with which it is hoped to reach 300 million electron volts. This will make possible investigations at high-energy levels.

In the radio section of the Laboratory the ionosphere is being studied by a series of different methods for the purpose of understanding its constitution and the nature of the ionizing process. A recent development is the study of the horizontal structure of the ionosphere as contrasted with its vertical structure. A comparison of the fading of echoes at spaced receivers gives information about winds and turbulence at one hundred kilometers and higher.

The other main field in the radio section is that of radio astronomy, the study of radiation from extraterrestrial sources, the sun and stars. The positions of some fifty radio stars not visible through any telescope have been plotted, and it is hoped to increase the number to one thousand by increased sensitivity and resolving power.

The accuracy with which radio stars can be located has greatly increased, and since there is no apparent change in their position at different times of the year they are probably further away than one-and-one-half light years. Fluctuations in amplitude, or twinkling, are being observed at spaced receivers and measurements of radio brightness across the sun's disc at different wave lengths are being made.

In the realm of low temperature physics, research is concentrated on problems arising below 4.2 degrees Kelvin, such as the magnetic properties of metals at such low temperatures, the behavior of liquid helium, and the reasons for certain materials becoming superconductors. As far as superconductivity is concerned, much recent work has been carried out into the depth at which the electrical currents flow which keep the magnetic field out of a superconductor at different temperatures and at high frequencies.

The behavior of liquid helium at temperatures below 2.19 degrees Kelvin is also an interesting subject for research, since a fraction of the liquid then behaves as if it were superfluid—its viscosity appearing to be almost immeasurably small. This problem is being studied by measuring the inertia of the liquid in an oscillating system (comparing the drag on a disc oscillating in liquid helium with one oscillating in a

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liquid of known properties), by the flow in capillaries, and by what are known as second-sound oscillations. These last are variations in the temperature and physical state of the helium which can be transmitted in a way very similar to the transmission of sound waves.

For achieving temperatures very close to absolute zero adiabatic demagnetization methods are used, and a machine is being built to maintain continuously temperatures of the order of 0.1 degree Kelvin.

The exploration of atomic arrangements in matter is an important part of the work of the Cavendish Laboratory. X-ray methods are being perfected there so that finer details of structure—such as the positions of the light hydrogen atoms and concentrations of electron density representing chemical bonds—can be revealed. A microbeam technique is used to study crystalline structures in cold-worked metals, and x-ray diffractions from crystals having a volume of only 10^{-11}cc are being detected.

The complex molecules which form living matter—proteins—are also being studied, and powerful x-ray tubes have been developed for getting diffraction effects from their minute crystals; these tubes are some forty times as effective as the normal sealed-off tube.

Meteorological physics is also studied in the Laboratory. It is known that polyatomic gases in the atmosphere are present only in small concentrations; but owing to the way in which they absorb infrared rays they largely control the thermal equilibrium of the lower stratosphere. As a contribution to the study of this subject the infrared solar spectrum is being recorded up to forty thousand feet by an instrument mounted in an aircraft.

Other researches in the field of meteorological physics being carried out at the Cavendish Laboratory include the examination of cloud structures by radar and the measuring of electric charges on individual raindrops in an attempt to understand their origin. The wave forms of atmospherics from lightning discharges up to distances of a few thousand kilometers are also recorded so that the methods by which such atmospherics are transmitted from the source of disturbance to the receiving point may be examined.

It is the concern of that section in the Laboratory dealing with electron microscopy to improve the resolving limit of the electron microscope. It is also its function to take photographs for all scientific departments of Cambridge University.

Sir (William) Lawrence Bragg, professor of experimental physics at the Cavendish Laboratory at Cambridge University, is perhaps best known for his contributions (which were made together with his father, the late W. H. Bragg) to x-ray spectroscopy and crystal structure—contributions for which they jointly received the Nobel prize in Physics in 1915. A Fellow of the Royal Society, a past president of the British Institute of Physics, and a member of numerous other professional scientific societies, he was knighted in 1941.

Electron microscope techniques have been used in the field of radiography: the section has developed a point-focus x-ray source of about 0.2 micron in diameter. Small objects such as insects can be put as near as one millimeter to the focal spot and enlarged shadows cast on a photographic plate. A stereoscopic effect, and a resolution equivalent to that of an optical microscope, may be obtained, with the added advantages of detail at all depths in sharp focus. The possible biological applications of radiography on such a small scale are extensive.

In its study of glaciology the Laboratory measures each year the distortion, by an instrument known as an inclinometer, of a tube sunk from the top to the bottom of the Jungfraujoch Glacier in Switzerland. Findings are correlated with laboratory measurements on the plasticity of ice and mathematical investigation of the flow of ice over the glacier bed.