COSMIC RAY RESEARCH UNIT

INDIAN INSTITUTE OF SCIENCE

THERE is no doubt that the ultimate aim of all scientific activity is the discovery of the laws governing the behaviour of both the inanimate and animate world in order that the forces and properties of nature may be used for the benefit of humanity. The research work which has to be done before the forces of nature in any field can be used for human ends can be divided roughly into three stages. The first stage is one of pure research where the laws governing the phenomena in that field are still being investigated. The second stage is one where sufficient knowledge of the laws has been acquired to enable one to think of ways and means of applying them for human ends. The third stage is one in which our knowledge of nature in the particular field concerned has already been put to practical application, and research consists mainly in perfecting the existing appliances and methods by technical improvements. It is clear that of the three stages the first is the one which is most pregnant with possibilities for the future, and, indeed, without it the two subsequent stages could not exist. This type of research is usually described as 'pure' research for the simple reason that its applications are still too remote to be foreseen even by those actually engaged in the research. The third stage is called 'applied' or technical research, and industrialists are most easily induced to finance this stage since no particular vision is required to see the immediate benefits which result to mankind in general and their own pockets in particular from this type of activity. But it is obvious that technical or applied research can never open up entirely new fields for the service of humanity.

The history of wireless provides an excellent example of the process of development outlined above. The electromagnetic nature of light had been put into evidence by the researches of Faraday, and the laws of electricity and magnetism were put into their present mathematical form and expressed as a set of equations for the first time by Maxwell at about the middle of the last century. Maxwell realised that his equations required that electromagnetic disturbances should also be propagated through space with the velocity of light, and deduced that electromagnetic waves must exist in nature. It was left to Hertz to actually establish in 1887 that such waves are in fact sent out when a condenser is discharged. The second stage set in when following this result scientists tried to produce such electromagnetic waves artificially and to devise suitable apparatus for their detection. Then a student, Lord Rutherford was one of the first to make a detector to detect such waves which had passed through several brick walls over a distance of a hundred yards. This was in 1895, before Marconi had taken up the subject. The practical importance of these waves was immediately recognised, and several inventors including Marconi, began the attempts to improve the apparatus so as to make the transmission of signals more reliable and to extend it to increasingly greater distances. The third stage began when wireless telegraphy had become a fact and it was only a matter of improving the instruments and technical devices to bring radio to its present stage of perfection. This history brings out very clearly that wireless as we know it could not have existed without the pure researches of Faraday and Maxwell, and that at the time when Faraday and Maxwell did their work they could not even have foreseen the possibility of wireless communication and television.

In the case of Nuclear Physics we have the example of a field in which the first stage of pure research has been almost completed, and we are entering the second stage of attempts at application, with important successes in certain directions. Nuclear physics has already found a remarkable application as an instrument for the investigation of biological and physiological phenomena and allows us to tackle the problems of intermediary metabolism in a direct way which would be extremely difficult otherwise. The possibilities of its use in the treatment of hitherto incurable diseases also cannot be overestimated. On the theoretical side, our present knowledge of nuclear physics has already enabled us to understand the process of stellar evolution for the first time. Finally, nuclear physics has opened up the possibility of extracting from a gram of matter a million times more energy than we extract at present by the process of chemical combustion, and there is no doubt that the practical application of nuclear physics to power production will put the most immense sources of power in human hands in the future. The problem is only one of doing on a practical scale what can already be done in the laboratory. Under the stimulus of war, money is being lavishly spent in America and Europe to find methods of using nuclear energy in a practical way and we may look forward to a successful application of nuclear physics to power production within the next few years. In nuclear physics, therefore, we have the example of a field in which the first stage has been largely traversed and we are entering the second.

In the case of cosmic rays we are still very much in the first stage. The great importance of cosmic rays is that on a single particle of cosmic radiation there is sometimes concentrated more than a million times the energy concentrated on any particle produced in nuclear phenomena, which in its turn is several hundred thousand times more than the energies involved per atom in the ordinary chemical and physical processes on which our life depends. Cosmic rays, therefore, provide us with the only means of studying matter in realms far beyond those studied by nuclear physics. The study of cosmic rays has already revealed certain absolutely fundamental processes of nature which have led to a revolution in our ideas of the physical world. The creation and the annihilation of matter has been established and effected in the laboratory and the existence of a new fundamental particle in nature, the meson, responsible for the stability of nuclei, and in consequence of matter in general, has been revealed. The laws governing one entire side of the cosmic ray phenomena are now completely known and expressed in mathematical form in the cascade theory first put forward by Bhabha and Heitler. But the behaviour of the more penetrating component of cosmic rays is still only partially investigated and there is every reason to believe that a complete understanding of the behaviour of the penetrating component will lead to a vital extension of our knowledge of the physical world.

The Sir Dorabjee Tata Trust, whose management consists of the foremost industrial interests in this country and whose far-sighted and generous munificence has been supporting many a scheme of fundamental research in this country, has now financed the setting up of a Cosmic Ray Research Unit at the Indian Institute of Science, under the direction of Dr. H. J. Bhabha, F.R.S. It is hoped that it will be possible to fill in some of the more vital gaps in our knowledge of the penetrating component mentioned above by experiments carried out in the laboratory of the Unit and by high altitude balloon flights as well as by mathematical investigations. It would be pointless to ask a cosmic ray physicist to-day of the possible applications of his work, for he is still in the stage in which Maxwell found himself when he formulated his equations., Nevertheless it can be confidently said that a complete understanding of the phenomena of cosmic rays will have the most far-reaching effects in our understanding of some of the most remote problems of the structure of the universe on the one hand, and open up realms at present undreamt-of for the benefit of humanity on the other. Indeed, it is held by some scientists that the mutations upon which all biological evolution depends are stimulated by cosmic rays, so that it is not beyond the realm of possibility that the very process of animal and human evolution may depend on the existence of cosmic rays. At the present rapid rate at which science progresses, we may hope that in another ten or fifteen years the entire field of the purely scientific aspects of cosmic rays will have been investigated and that we will be in a position to think of the application of the knowledge so obtained to practical purposes.