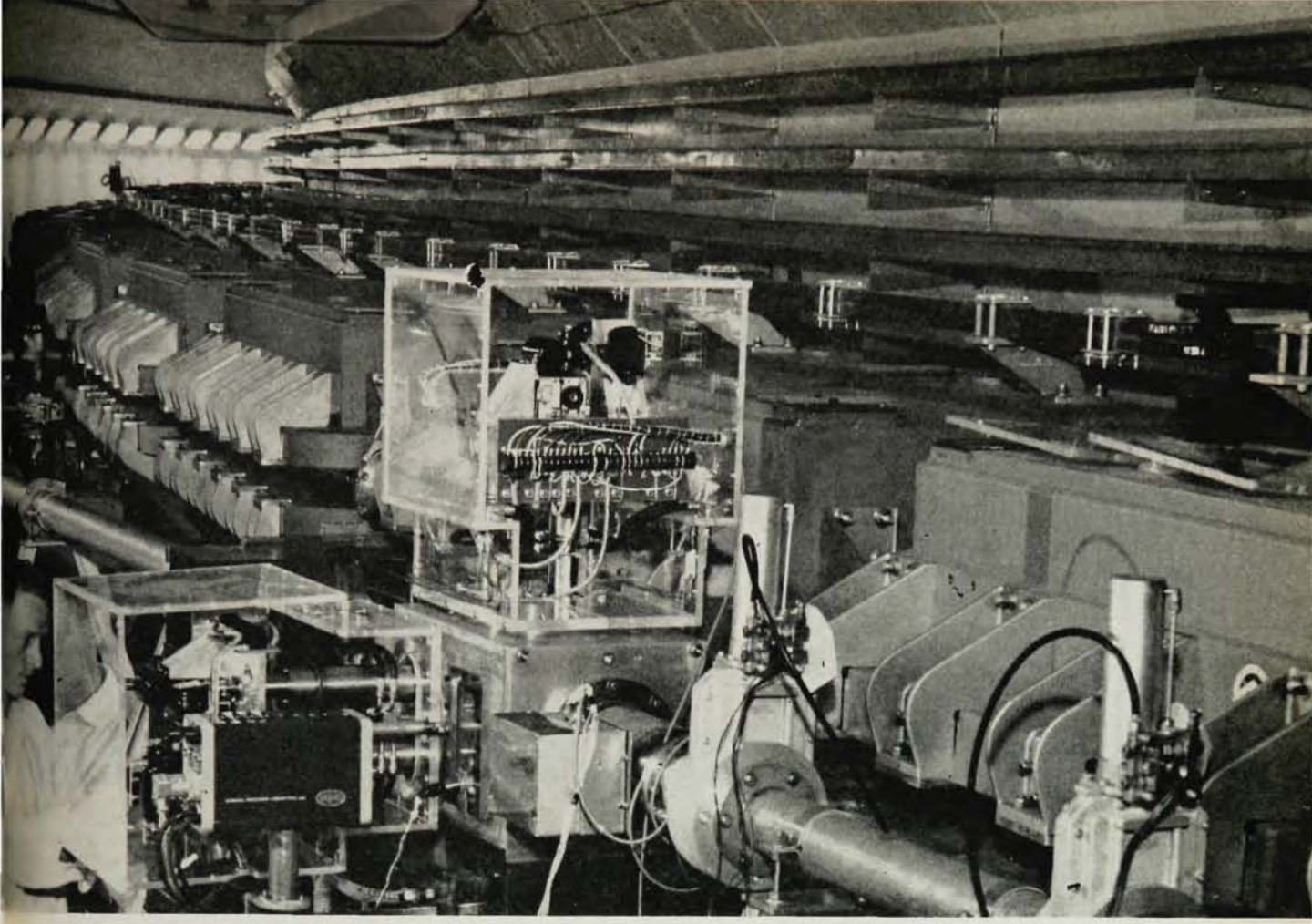

# Why High-Energy Physics?

*By* ***Maurice Goldhaber***

PHYSICS is an experimental science. Experiments are designed to ask questions of Nature, and the better they are designed, the clearer is Nature's answer. As the answers obtained through experiments become systematized, the theory of a subject develops. A theory is based on generalizations or idealizations from experiments and then permits us to make what are loosely called "predictions". Of course, used in this way, the word means no more than saying: If my assumptions (the generalizations or idealizations) are right, then my predictions follow. A new experiment, if it confirms these predictions, then strengthens our belief in the theory, and if it does not, it disproves it. But note, an experiment cannot by itself prove a theory. The same experimental results might have been obtained on the basis of other assumptions or idealizations. The more often a theoretical prediction is confirmed, the more we trust the assumptions of the theory, and finally we use it with as great confidence as if it were itself a fact of nature. Of course, this confidence is considerably greater if the theory is based on very general principles and if we use it only for interpolation rather than for extrapolation to regions of new experience.

We believe in the classical mechanics of Newton at low velocities, in the relativistic mechanics of Einstein at higher velocities. These theories, together with the

Prior to his appointment last summer as director of the Brookhaven National Laboratory, Dr. Goldhaber served as chairman of the Laboratory's Department of Physics.

electromagnetic theory of Maxwell and Lorentz, were used with great trust in building the Alternating Gradient Synchrotron which we are today dedicating. They have not let us down. Thus we have an endless chain from experiments to theory, with theory becoming a helpful tool in the design of new experimental equipment which in turn permits us to ask new questions of Nature; the answers lead to new theories, and so on. The momentum of this process is very great. But the intellectual challenge is of a different nature in different parts of this chain, which is, of course, not a linear chain but rather many-dimensional. It is fortunate that scientists have different interests. They fall in love with different puzzles and then live for their solution. Some puzzles (those, for instance, connected with the structure of protein molecules) are of such a nature that they can be successfully solved only after the fundamental physical principles underlying their complexities are already understood. We believe that this situation has been reached in this case, and that the solutions of questions concerning protein structure will be within the framework of the known physical principles. Other fields, such as low-temperature physics and space science, also belong to this category, though one must always be prepared for surprises. The great intellectual challenge of working in a field where certain bounds to the imagination are given, attracts certain types of intellect: analytical, thorough, and patient. But there are others, perhaps of a more adventurous temperament, who are happy only if they can work on the border between light and dark, where no complete set of guiding principles is as yet established. They constantly weigh the fundamental principles and are perhaps a little impatient in their desire to find something new. They like the most direct attack on a problem, the crucial experiments. They always remember that in science, as elsewhere, true is only what remains true. It is to such intellects that we owe much of the progress of science. The new fundamental principles they find penetrate scientific endeavor not only throughout all fields of research but also in the teaching of science.

My answer to the question posed in the title of my talk, "Why High-Energy Physics?", is therefore briefly this: We need high-energy physics because it works on the border between light and dark. It is in the direct line of progress in physics which goes back to such epoch-making discoveries as the discovery of x rays, of radioactivity, of the nucleus, of the structure of the atom, and of cosmic rays. Today the border between light and dark has moved to questions of nuclear structure, of the structure of elementary particles, and of the forces between them. High-energy physics has led to such exciting and fundamental discoveries as the lack of mirror symmetry in weak interactions and the existence of antimatter with its great implications for cosmology. These discoveries are full of import for all human thought.

High-energy machines have become so large and complicated that they have given rise to new procedures in physics. A physicist who thinks of an experiment would normally proceed to design and build an apparatus which should give him an answer to a particular question. But human nature being what it is, you can hardly imagine an experimenter proceeding to build a machine of the size we are dedicating today because he wants to know an answer some ten years later. The facts of life have led to a different procedure. People who are interested in producing high-energy machines invent new methods and convince others that such or such a machine should be built. They have to convince the machine builders, the experimental and theoretical physicists, and, last but not least, those who foot the bill. What criteria should we use in judging such proposals? The competence of those who want to build the machine, the enthusiasm of the scientific community supporting them, the availability of manpower and of suitable sites, the total expense, and many other considerations enter into the final decisions. Research with these machines is a great adventure; it leads us nearer to the heart of the particles of which we all are built. To think of something more exciting is difficult. Also, in high-energy physics we have established a tradition of peaceful international cooperation and may thus contribute to more sanity in a world which can use it.

Ceremonies for the dedication of the Brookhaven alternating-gradient synchrotron took place in the large (over one acre) addition to the AGS target building. Commissioner Haworth is shown delivering the main dedication address. Others on the platform are, left to right: G. K. Green, chairman of the BNL Accelerator Department; E. L. Van Horn, manager of the AEC's Brookhaven Office; I. I. Rabi, president of Associated Universities, Inc.; and M. Goldhaber, director of the Laboratory.