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GERSH ITSKOVICH BUDKER

(In Honor of his 50th Birthday)

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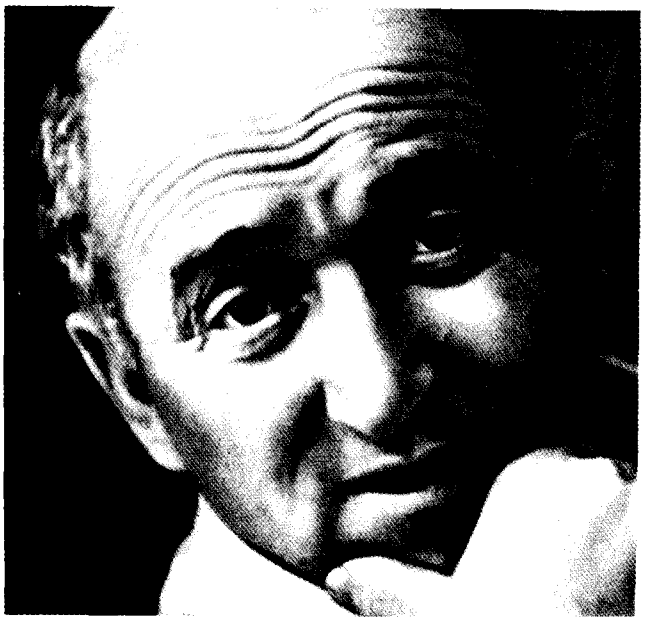
ON 1 May, 1968 the organizer and director of the Institute of Nuclear Physics of the Siberian Department of the USSR Academy of Sciences, founder of a new orientation in experimental high-energy physics—the colliding-beam method—Academician G. I. Budker celebrated his 50th birthday. His friends and acquaintances usually refer to the birthday celebrant as Andreĭ Mikhaĭlovich and therefore we take the liberty of referring hereinafter to him by this name, by which he is known to the majority.



Budker was born in the family of a farm laborer at the very zenith of the Civil War, literally on the front line. On that very day the White Guards killed his father. His childhood was spent in Vinnitsa, where he was graduated from the secondary school in 1936. In the same year he enrolled at the Physics Department of the Moscow University.

Budker carried out his first scientific project while still a student, under the direction of I. E. Tamm. It was devoted to the problem of finding the energy-momentum tensor of the electromagnetic field in moving media.

He was graduated from the university in 1941. He passed his last State examination on 24 June, and on 27 June he donned an army uniform. While in a field antiaircraft unit, he made his first invention, pertaining to an improvement in the flak fire control system. In 1945 Budker joined the Division of Theoretical Physics at the Laboratory Number 2—the celebrated "Two" (now the Institute of Atomic Energy, USSR Academy of Sciences) headed by I. V. Kurchatov. That was an heroic era of Soviet physics. The young Budker found himself at the very center of work on the solution of the atomic problem. He had the good fortune to work from the very beginning directly with I. V. Kurchatov, A. B. Migdal, I. Ya. Pomeranchuk, L. A. Artsimovich, and other eminent Soviet physicists.

The first professional work of Budker was devoted to the theory of the finite uranium-graphite lattice. This was followed by a series of studies of the principles of the kinetics and control of atomic reactors. All these studies did not require as yet considerable experience and erudition, but Budker's resourcefulness and initiative proved to be highly useful.

The next series of studies by Budker pertained to the theory of cyclic accelerators. It was carried out in connection with the construction of the giant—for that time—accelerator in Bol'shaya Volga (now the city of Dubna). The results of these studies were summed up in his Candidate dissertation and he was awarded the State Prize for them.

Therewith ended the first stage of Budker's scientific activity, which generally dealt with more or less well-known and commonly recognized ideas. Thereafter he became an experienced theoretical physicist and began to put forward his own radical ideas which essentially predetermined his further scientific activity. It was exactly at that time that his talent as researcher and inventor began to bloom.

Almost immediately following the first proposal by A. D. Sakharov and I. E. Tamm concerning the implementation of controlled thermonuclear reactions, Budker evolve his own approach to this problem (the so-called magnetic-mirror trap), which has subsequently gained wide currency. In this connection, Budker carried out a number of studies of plasma physics encompassing a broad range of problems. Instead of confining himself to "conventional" plasma which was, incidentally, a quite unusual subject of physics at that time, Budker switched to relativistic plasma. In that domain he succeeded in discovering a theoretically amazingly exquisite formation of relativistic electrons and ions which he termed the stabilized electron beam. This formation displays a number of remarkable properties which can be utilized in accelerator engineering, the thermonuclear problem, and industry. In that field also he carried out a number of elegant studies of the theory of relativistic plasma and kinetic equations in the antidiffusion approximation (for rare collisions). This series of studies represented the substance of the doctoral dissertation which Budker defended in 1954.

After the communication concerning Budker's work on the stabilized electron beam was presented at the 1956 Geneva Conference, his name became widely known and his ideas aroused great interest among

physicists from many countries.

However, it was not so easy to convince experimenters and engineers to engage in translating into reality these almost fantastic ideas. True, there was no shortage of young enthusiasts, but the further development of this work required attracting the interest of an entire institute and all the institutes already had their own problems. In such a situation Budker made a decision that was perhaps the most important in his life and that has determined its further course. He abandoned "pure" theory and decided to himself head a team of experimenters and engineers working to implement his ideas. Despite the unusual nature of such a step and its unexpectedness to his acquaintances, this decision was actually quite logical of Budker, since one of his characteristic traits running like a red thread through his entire scientific life, is the constant striving to combine the most abstruse scientific ideas with convincing experiment as well as, insofar as possible, with practical applications to the cardinal problems of the national economy. This trait was pithily defined by L. D. Landau when he half-jokingly called Budker "a relativistic engineer," a title of which the latter is very proud.

Budker approached the new problem as a theoretician, basing the establishment of an experimental laboratory on his own original ideas on the organization of a creative collective of scientists. Such an approach, combined with lack of organizing experience, at first caused Budker's actions to appear somewhat stumbling but despite this or, more exactly, precisely because of this the collective of young scientists rapidly developed, being unfettered by ancient traditions. Budker's group, which in 1953 had consisted of only eight persons, as early as in 1957 evolved into one of the largest laboratories (Laboratory of New Methods of Acceleration) of the Institute of Atomic Energy, and in 1958, with the active support of I. V. Kurchatov and M. A. Lavrent'ev, it was transformed into the autonomous Institute of Nuclear Physics of the new Siberian Department of the USSR Academy of Sciencies. The move to Novosibirsk played an important role in the Institute's development, because the conditions and atmosphere at the new science center were optimally conducive to the implementation of Budker's original ideas.

Budker was elected Corresponding Member of the USSR Academy of Sciences in 1958 and Academician in 1964.

The current scientific activity of the Institute of Nuclear Physics is characterized by several orientations, including thermonuclear research and industrial electron accelerators. However, the principal focus of interest at the Institute is the work on colliding beams, which was initiated as far back as 1956 in Moscow. Although the idea of colliding-beams is itself not new, it proved feasible to implement it only on the basis of the considerable experience that has been gained by the Institute in strong-current accelerators as well as owing to the extraordinary inventiveness of Budker himself.

This work began with experiments to verify quantum electrodynamics in electron-electron collisions with considerable momentum transfer (VÉP-1 colliding-beam installation). However, more interesting experimental possibilities were revealed after Budker devised a method for accumulating a high positron current, such as to enable construction of installation with electron-positron colliding beams (VÉPP-2 installation). The difficulties encountered in carrying out this program require no comment, considering how exotic are the conditions under which positrons are encountered in nature. It took great experimental audacity, if one may say so, to decide to implement such a project. The scale of the resulting success is characterized by a positron current of 80 mA, which has currently been achieved in the VÉPP-2 installation, and by the use of this current to conduct the first experiments in elementary particle physics. For this work Budker was awarded the 1967 Lenin Prize.

At present the VÉPP-2 installation is used to implement a series of experiments on so-called vector mesons. The point is that high-energy interactions between the electron and positrons are the sole means of producing these mesons in the absence of any other strongly interacting particles which might distort the picture of the process. The first project in this series of experiments dealt with ρ-meson resonance; at present the properties of the φ meson are already being investigated.

Even more interesting experimental vistas will be opened after the proton-antiproton beam installation now under construction is put into operation. It will enable the Institute of Nuclear Physics to undertake a broad program of research into strongly interacting particles at an energy equivalent to more than 1000 GeV for conventional accelerators (antiprotons). Although part of the experiments performed on conventional accelerators cannot be carried out with colliding beams, the remaining part is more than sufficient to keep busy even such a large and rapidly growing staff as that of the Institute of Nuclear Physics.

The work on colliding beams was first reported at the 1963 International Conference on Accelerators in Dubna and it aroused great interest. Immediately after that conference the Institute of Nuclear Physics was visited by the first group of well-known physicists from several countries. This initiated close and fruitful international collaboration (and highly useful competition) between Soviet, West European and American physicists working on the colliding-beam problem.

Although so far the center of gravity of this problem has pertained to the development of equipment itself, Budker has always regarded this activity as merely the first step forward toward the cherished goal of conducting unique experiments in the physics of elementary particles. In this sense, most of the work still remains to be accomplished. In general Budker has to constantly combat the tendency (both within and without the Institute) to regard the Institute as being entirely devoted to accelerators. He never tires of repeating that accelerators are not an end in themselves but only a means, only "small" experimental apparatus of the modern physics of elementary particles.

A few words about the principles of the organization and work of the Institute of Nuclear Research, that favorite child of Budker. Of these principles, the paramount one perhaps is originality of the program which,

as a rule, is conceived within the institute; moreover, the overwhelming majority of the new ideas originate from Budker himself. This enables the young institute, which this year is celebrating only its 10th anniversary, to successfully compete with great old physics centers in this country and abroad. Budker enjoys repeating that in science there exist many possible paths, except that which has already been traveled by others. This makes it clear why one of his favorite slogans is "Overtake, don't come abreast!"

Another important principle is the constant endeavor to focus all effort on the solution of a small number of large problems without frittering it away on secondary projects. This is closely associated with the task of preserving the scientific unity of the Institute's staff, preventing its break-up into individual groups and thus assuring the possibility of rapid redeployment of forces, which is so desirable in scientific work. Even now that there are more than 1500 people at the Institute and it is the largest within the Siberian Department of the USSR Academy of Sciences, it operates as a single whole, just like the Budker's old tiny laboratory did 15 years ago. And it is highly important that this has been accomplished in ways other than administrative. Budker has so far succeeded in avoiding the quite common attendant danger of turning into a major, honored and esteemed administrator. Above all, he remains a physicist, an acolyte of his beloved science, which he understands so subtly and profoundly. The only method used at the Institute to solve scientific-organizational problems is the method of discussion and persuasion. It appears that ever since the founding of the Institute no single official order regulating these questions has been issued. On the other hand, so far as persuasion is concerned, Budker's patience and persistence are boundless. He asks questions directly, penetratingly and passionately without any trace of indifference. He can talk for hours persuading his associates and particularly the Institute's Scientific Council of the correctness of his ideas regardless of whether the subject is a new major project, a minor but interesting experiment, or the architectural style of a new Institute building. But he is particularly insistent and adamant in observing what is probably the most important principle of operation of the Institute, namely the principle that the Scientific Council presided over by the Director is the genuine supervisor of all of the Institute's everyday activities.

Now, as 15 years ago when the strenuous development of Budker's ideas had been commenced, he is bursting with energy which refuses to recognize any obstacles except perhaps the laws of nature, proliferating with an inexhaustible supply of new ideas that are sometimes so fantastic that they can be discussed only within a narrow circle of friends, and he still displays an amazing ability to convince his associates to undertake the implementation of the most improbable projects. And at the same time his thoughts and desires already run somewhere far ahead again. Quite recently electron-positron colliding beams seemed unreal, yet now they already are used to conduct experiments and Budker already is engrossed in the new proton-antiproton beam project. The basic parameters of this project have been barely determined and the construction of the installation has merely started, but Budker is already talking at the "round table," entranced, about a new and still more grandiose project.

Translated by E. Bergman