Mikhail Konstantinovich Polivanov (Obituary)

O. I. Zav'yalov, D. N. Zubarev, B. V. Medvedev, S. P. Novikov, V. P. Pavlov, A. K. Pogrebkov, A. A. Slavnov, A. D. Sukhanov, L. D. Faddeyev, S. S. Khoruzhiy, and D. V. Shirkov

Usp. Fiz. Nauk **162**, 183–186 (July 1992)

On 23 January 1992 Mikhail Konstantinovich Polivanov died suddenly. He was 62 years old. Polivanov was a well-known scientist, a specialist in quantum field theory and mathematical physics. He headed a department at the V. A. Steklov Mathematical Institute.

Polivanov was born on 19 September 1930 in Moscow to a family with a long history of public service as military men and teachers, doctors and scientists, one of the families that had created and preserved for centuries the best traditions of the Russian intelligentsia. His father, K. M. Polivanov, was a prominent scientist and electrical engineer. His maternal grandfather, the outstanding Russian philosopher G. G. Shpet, was the first to introduce the idea of philosophical phenomenology to our science, an extremely important direction in twentieth century philosophy. The signs of exact and keen thinking for which G. G. Shpet was praised were clearly discernible in the scientific style of M. K. Polivanov.

When M. K. Polivanov graduated from the physics department of Moscow State University in 1954, he was doubly lucky. First, he met the remarkable teacher N. N. Bogolyubov (later he became one of the brightest representatives of the Bogolyubov school). Second, he fortunately entered science at a critical time for quantum field theory. After the first intoxicating, brilliant successes of the renormalization technique in quantum electrodynamics, it was found that it apparently had no further use. In meson theory, the main model of the time was the model of strong interactions, and the results of calculations, whether due to difficulties in the calculations or a significant defect in the theory itself, were not yielding anything related to reality. Landau and Pomeranchuk's statement of the "null-charge" which was formulated in these same years had cast doubt upon the possibility of constructing a theory along the Hamiltonian path. Attempts were made to obtain specific results without resorting to equations of motion, proceeding only from basic physical principles. Dispersion relations were formulated.

Deducing these relations, however, required physicists to turn to a level of mathematical rigorousness, which was completely uncustomary for them at the time. They also had to use the vehicle of the theory of generalized functions and the theory of functions of many complex variables. This was practically how the scientific career of M. K. Polivanov began. Together with N. N. Bogolyubov (and B. V. Medvedev) Polivanov wrote the well-known book on dispersion relations in which they were first proved for the scattering of π mesons by nucleons, and in which the limits within which this conclusion was valid were established.

MIKHAIL KONSTANTINOVICH POLIVANOV
1930–1992

These activities determined the future scientific interests of Polivanov for a long time. His candidate's dissertation in 1958 was devoted to dispersion relations for the scattering of K mesons by nucleons. He found that the technique which had been developed for π mesons could not be transferred directly to other cases, and that a rigorous derivation of dispersion relations can be carried out only for a limited number of processes.

The methods developed to derive dispersion relations became the foundation for a new approach to the construction of a complete theory along the path which came to be called the axiomatic path. However, before moving along this path Polivanov contributed to the then stylish enthusiasm for nontraditional variants of the theory. In 1958 he studied the opportunity which seemed to be presented by the introduction of an indefinite metric having determined the close relation of such theories with nonlocal ones. In the early 1960s Polivanov developed a variant of the theory in which the main object was a sequence of radiation operators linked with variational derivatives of an extended S matrix. He established a chronological representation for them through quasi-local current-like operators which completely fixed the dynamics; their number is finite for renormalizable theories. He constructed infinite sets of linked equations for the c-number functions which defined these operators. This study led to the important conclusion that, even outside

 0038-5670/92/070623-03$03.00

the framework of perturbation theory, the renormalizable theories are the only polynomially limited theories, and the renormalizing counterterms are inhomogeneities which insure the very existence of nontrivial solutions.

The inclusion of Heisenberg fields in this scheme allowed Polivanov to elucidate that the S matrix in the scheme can always be formally represented in the form of a Wick T exponential function of a Lagrangian. "Formally" because the properites of the Lagrangian being hermitian and local are supplemental rather than coinciding with the unitarity and causality of the scattering matrix. Polivanov constructed several models to illustrate this situation.

In 1963 Polivanov undertook a study of the analytical properties of the amplitude in the quasipotential approach having discovered that for a quasipotential in the form of a superposition of Yukawa potentials, additional singularities appear which destroy the Mandelstam representation and which are simply linked with the anomalous singularities of the triangular diagram.

In the late 1960s Polivanov studied the mechanism of renormalization of Heisenberg operators and of the free ends of Feynman graphs. Their formal description required the invention of an algorithm with such exotic objects as nonassociatively multiplying operators.

Polivanov's interest in various axiomatic field theories appeared in his 1973 publication devoted to algebraic axiomatics. Here Polivanov analyzed the superselective structure of the theory and the link of the very concept of a field with interlaced operators.

In 1973-74 Polivanov constructed a simple and elegant proof of the Bogolyubov–Parasyuk theorem which guarantees the existence of a perturbative quantum field theory. Later, in 1977, Polivanov developed an effective "counterterm technique" which makes it possible to use a renormalized series of perturbation theory "as a whole." This technique later made it possible to justify the so-called nonlocal conical expansion of current products, which found a number of applications in high-energy phenomenological physics.

Finally, in the late 1970s to 80s Polivanov occupied himself with the problem of the analytical properties of multiparticle amplitudes, which was posed already in 1961 by H. Araki and D. Ruelle. The main problem consisted of proving that amplitudes with a fixed number of external lines are limit values of a single analytical function of invariant variables. For fifteen years, a number of authors proposed various ways of proving this theorem; however, these proofs were not only very cumbersome, but they also contained substantial gaps in logic. Polivanov succeeded in constructing an exhaustive and relatively simple proof which uses as its starting point the system of axioms of N. N. Bogolyubov.

At that time Polivanov also became interested in the theory of completely integrable equations. A theory of scattering by singular potentials was developed, and on the basis of this theory Polivanov investigated the singular solutions of the well-known Liouville equation. Later he also studied other equations, and was the first to introduce the concept of singular solitons, the particle-like properties of which were so clearly expressed that they prompted people to recall Einstein's idea of particles as singularities of fields.

From the late 1980s to his last moments, Polivanov worked actively on the theory of $(2+1)$-dimensional integrable equations. Several ideas and methods of the theory of dispersion relations found a new application in the resolvent approach to the problems of multi-dimensional scattering developed in these studies.

Speaking of Polivanov, one cannot help but think of two things which occupied a very important place in his life, namely his work on the board of editors of the journal Teoreticheskaya i Matematicheskaya Fizika [translated as Theoretical and Mathematical Physics (USSR)] and his work as head of the department of quantum field theory at the V. A. Steklov Mathematical Institute of the Academy of Sciences. From the very foundation of the TMF journal Polivanov was first the chief secretary of the editorial board, then the deputy editor-in-chief. And all these years he took on an enormous amount of work, from purely technical and organizational work to the constant battle to preserve and maintain the scientific level of the journal.

Virtually the entire scientific life of V. K. Polivanov was spent at the V. A. Steklov Mathematical Institute. His good nature and thoughtfulness led to a situation where worries and burdens far beyond the circle of his immediate responsibilities at the institute were frequently brought to him. More than 20 years ago he was unanimously chosen by his colleagues to take the post of the head of the quantum field theory department. He remained in this post to the end (he gave his last seminar on the eve of his death), and maintained, cultivated, and preserved the amazingly good and peaceful interrelations among colleagues and the high level of authority of the department in the scientific world.

Polivanov had many students. It was characteristic of him that he in no way tried to steer their work into a particular scientific course, for example, Bogolyubov axiomatics, of which he himself was one of the creators. Instead, he aimed at a broad and completely modern range of interests, focusing attention on new directions in science which have appeared only recently. His constant role with respect to students has been the role of a good-natured patron who "noted and praised," rendering the most effective and most constructive support.

It is surprising how many people who were very different in their views and positions valued the opinion and advice of Polivanov and sought his support. One frequently noted that even people who did not know him before listened to him with interest and attention. When a democratic movement—the Council of Scientists—arose in the scientific milieu, he naturally entered it and became quite prominent in it. The Independent Moscow University was created mainly due to his enthusiasm and authority, and he was chosen to be the rector. It is characteristic that, in contrast to many such institutions appearing now, this university, although it has not yet received official status, is already teaching students.

Polivanov is indebted to his family for many of his qualities. In his upbringing, world view, and deepest roots, he was a devout Christian, and the main features of his character were his innate internal decency and his sense of duty. Polivanov is obligated also for his literary creativity to the humanitarian traditions of his family, its broad literary ties and interests (more than one generation of the Polivanov family has been friends with the families of Pasternak and Voloshin). Polivanov had a long and friendly relation with A. I. Solzhenitsyn, who highly valued his literary taste and

judgment. Polivanov helped Solzhenitsyn in his literary work (this also was a reflection of Polivanov's civil position) and became one of the participants in Solzhenitsyn's published collection *From Under the Rubble* under the pseudonym "A. B." Polivanov was the author of remarkable reminiscences of his friend N. Ya. Mandel'shtam. He prepared, but did not manage to publish in its entirety, a biographical essay on his grandfather, G. G. Shpet.

Polivanov had a special charm, an amazing good nature, and a desire to help and simply knew how to listen to another human being. People here and far from our country knew and loved him. May he always be remembered.

Translated by C. Gallant