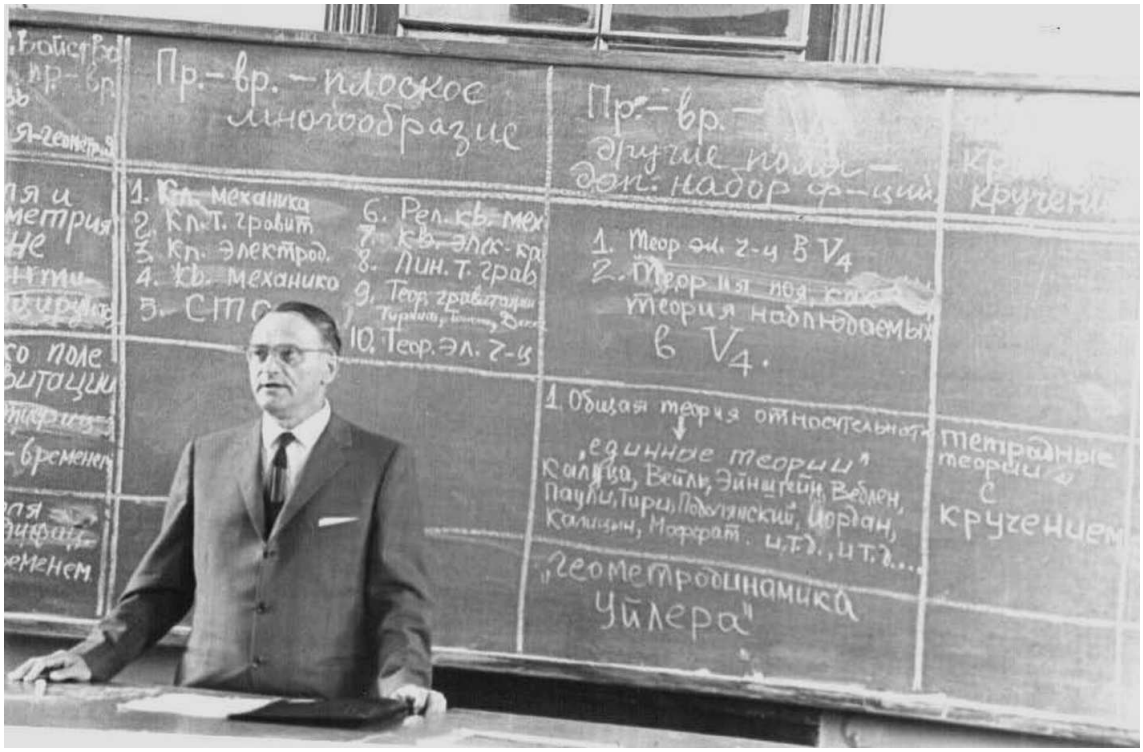
ALEXEI ZINOVIEVICH PETROV

Alexei (Alvian) Zinovievich Petrov[1] was born in the village of Koshki, the Samara province, on October 28 (15, according to the Old Style), 1910. A.Z. Petrov was the eleventh of twelve children in a large family of the village pastor Zina (Zenas or Zenon) Vasilievich Georgievskii. He was sickly and of a sedentary nature as a child. His father died of tuberculosis, when Alvian was only five years old. Shortly after this event, his own home caught fire, and the house with all its contents was completely destroyed. The disaster compelled his mother, Zoya Nikolaevna, to give over her two youngest sons, Alvian and Sevir, the former being a year older than the latter, to their paternal aunt, Ekaterina Vasilievna Petrova, a village teacher. It was she who adopted the boys. E.V. Petrova gave Alvian her surname Petrov and first name Alexei istead of Alvian. In the village of Koshki, Alexei Zinovievich received the elementary education and then, in 1926, he finished a seven-year-school education in the provincial town of Melex. He was very fond of reading and read many books. But he did not study well at school and was behind the class in mathematics. In fact, his mathematics teacher had to postpone the mathematics examination till the autumn. This hurt the boy's pride, and he got down to work. For the whole summer, he had been studying hard. In autumn when the teacher called on the hapless pupil to answer at the blackboard, everybody in the class expected nothing of him, but another failure. However, Alexei not only managed to solve the mathematical task put to him with lighting speed but also coped perfectly with all the other tasks that the astonished teacher offered to him. This episode hinted clearly at the mathematical future of Alexei Zinovievich and his main traits and character – strong will, propensity to work hard, and a remarkable persistence in attaining his goals.

After finishing the school, Alexei entered the pedagogical college of Melex. However, after one year, he had to leave and find employment due to the retirement of his foster-mother and the consequent financial hardship this implied. He worked in the town of Saratov as a carpenter. In 1931, he together with his brother Sevir found work in the town of Kazan at the building of a thermal electric power station.

The brothers' lives were hard but still Alexei studied avidly, stubbornly, and hard. He was preparing himself for the entrance examinations to the University. Once when he was searching for books at a bookstall, Alexei came across a university textbook on higher mathematics and began to read it. This finally decided his fate. The choice was made, and, in 1932, he passed the external secondary school final examination and entered the Faculty of Physics and Mathematics at the University of Kazan. That was the time of the first of the five-year plans, the time of great aims and high hopes and everyone's enthusiasm.

[1] We follow a biography of A.Z. Petrov presented on WebPage of Kazan State University.



Together with the young Soviet Union, the University of Kazan was at the height of the remarkable uplift. On returning from Göttingen, Professor N.G. Chetaev, full of plans and youthful enthusiasm, set to work on his famous "Kazan program." N.G. Chebotarev, Corresponding member of the Academy of Sciences of the USSR, who had moved to Kazan shortly before, united the talented youth round himself to found an algebra school in Kazan. Profound investigations carried on in the theory of Riemann and generalized spaces by Professor P.A. Shirokov once again put the University of Kazan in the foreground in the development of non-Euclidean geometry.

These people, who had a common desire in their hearts to serve the cause of science, an exalted understanding of its meaning, and strong moral principles, became mentors for Alexei Petrov. He had been true to his ideals all his life.

The first-year students of the Faculty of Physics and Mathematics at once took notice of this clever student A.Z. Petrov who had a reputation for being able "to solve any problem straight off" and for being "very good at mathematics". "And how he studied!" – recalls his fellow-mate, Assistant Professor V.G. Kopp, who was in the same year as Petrov. Students would often drop in to see him while he was working and try to talk to him, but Alexei answered all the questions with an inaudible mumble, characteristic of him at work. If you heard such a mumble you ought to leave – it was impossible to tear him away from his work.

The gifted persistent student drew the attention of Professor P.A. Shirokov. The work under guidance of Professor P.A. Shirokov determined, in many respects, the fate of A.Z. Petrov in science. At that time, P.A. Shirokov was one of the most prominent and erudite geometers in the Soviet Union. He was intimately acquainted not only with N.I. Lobachevsky's ideas about the influence of matter upon the properties of space (and which became a forerunner of the gravitation theory by A. Einstein) but also with the applications of the Lobachevskian geometry and its generalization to theoretical physics. At the time when Einstein's theory was in its infancy and many physicists considered it as being hard to understand due to the complexity of the mathematical techniques used and to its esoteric nature, P.A. Shirokov foresaw the enormous potential of the theory and the new challenge and opportunities it posed to his research students. The theme he offered to A. Petrov would become afterward the theme of Petrov Doctor's thesis, and its name would become the title of Petrov's classic monograph "Einstein Spaces".

After graduating from the University, A.Z. Petrov worked as a teacher in many Kazan institutes and, at the same time, did his PhD work under under guidance of Professor P.A. Shirokov, working hard day and night. Sometimes, he lived just with a piece of bread and a glass of water.

His studies were interrupted by the war. In December, 1941, in a bitter forty-degree frost, Alexei Zinovievich was sent to the front near Moscow to command a mortar detachment. As a result, he did not have the time to defend his dissertation.

The defense of his dissertation successfully passed off in January, 1943 when battery commander A.Z. Petrov received a short leave of absence for it. But in August of that year, he was badly wounded and returned home as a disabled soldier of the Great Patriotic War and was placed in the second highest group of disablement. He became ill and irritable. The disability status would be cancelled far later and after a long treatment. After his demobilization, Alexei Zinovievich worked as an Assistant Professor in the Kazan Aviation Institute where he joined the Communist Party in 1945. He was very proud of it, writing enthusiastic letters to his brothers about this event, and having high regard for the title of communist. He was loyal to it all his life. Later that year, he transferred to the Geometry section of the University.

By that time, Alexei Zinovievich had already married and had a little son Alyosha. The family had to leave their comfortable institute flat and move to a room without modern conveniences in a university hostel. The work at the University promised a vast opportunity for pursuing science, and material comforts were of little importance to Alexei Zinovievich. He never valued them. Early in the post-war years, A.Z. Petrov completely formed his scientific predilections: the application of mathematical methods (geometry, group theory, algebra) to physical field theory.

In 1946, he began research in the theory of Einstein spaces and proved a remarkable theorem in 1952-54 that brought him afterward the world fame. In the paper written in 1954, Alexei Petrov describes his famous classification of spaces according to the algebraic structure of the curvature tensor that determines the classes of the gravitational fields permitted therein. Now this classification of spaces (and, respectively, of the gravitational fields) is known as Petrov's classification. This paper was originally published in Russian in Scientific Transactions of Kazan State University (A.Z. Petrov, Klassifikatsiya prostranstv opredelyayushchikh polya tyagoteniya, *Uchenye Zapiski Kazanskogo Gosudarstvennogo Universiteta*, 1954, vol. 114, book 8, pages 55-69). The theorem

stated the existence of three Petrov's types of Einstein spaces. The "Petrov Clasification," as it is now known, has proved immensely useful in the description and the finding of exact solutions of Einstein's field equations and in the study of gravitational radiation.

Thus, it became possible to shed light on one of the most complex and intricate questions of the general theory of relativity. The classification of Einstein spaces according to the three types became the basis of Petrov's doctoral thesis and was defended with huge success in 1957 in the State University of Moscow (MSU).

In Moscow, he had been working very hard as usual, never sparing himself, and upon returning to Kazan after the completion of his doctoral research, he headed the University's selection committee. But the overwrought heart could not put up with the new anxiety. With the diagnosis of myocardial infarction, Alexei Zinovievich was placed in the old hospital just opposite the University, under the observation of Professor Z.I. Malkin. Hardly was the first danger past, when he demanded that he should be discharged from the hospital. His appeal was refused. Then he persuaded his wife to bring him pen and paper and began to work in the hospital. The doctors were indignant about it and threatened him with heavy consequences, but were unable to overcome his stubbornness.

This was all to recur in five years time and again, despite all prohibitions and persuasions, he stubbornly carried out research, met with and consulted post-graduate students and insisted on his early discharge from the hospital to his home, where his research would not be impeded. This attitude of A.Z. (as his friends referred to him) to his disease was not bravado or levity of mind

– to him, the disease was nothing more than a disappointing obstacle which he had to get rid of as soon as possible.

In October of 1956, A.Z. Petrov became Professor at the Geometry Chair of the University of Kazan, and, in 1960, he headed the Chair of Relativity Theory and Gravitation, which he helped to found at the University of Kazan (and which was the first and the only one in the Soviet Union for a long time). Without interrupting his scientific investigations at that time, Petrov expended much effort on the organizational and methodical work. He was a brilliant lecturer. With immense energy and an outstanding ability to work hard, he delivered a large number of special courses on gravitation, relativity theory, and related disciplines (and even now the Chair remains unique for the number and the variety of special courses read at it). He devoted much time to work with students, post-graduates and Chair's assistants, headed several regular seminars, and was an editor of the periodic collection of works "Gravitation and the Relativity Theory" published by the University of Kazan. For a short time, he managed to bring up a lot of talented followers and created a scientific school that became famous far outside Kazan.

In 1960, Alexei Zinovievich Petrov was elected Chairman of the section in the scientific council of the USSR devoted to gravitational investigations and Chairman of the Soviet commission in the International committee for gravitation and relativity theory. Petrov occupied these posts till the end of his life and played a significant role in the organization and the development of investigations in the field of gravitation in the Soviet Union and abroad.

In the 1960s, two monographs by A.Z. Petrov "Einstein Spaces"[2] and "New Methods in the General Theory of Relativity" were published, summing up the results of his investigations for many years. These monographs occupy a particular place in the world scientific literature on general relativity theory. They obtained rapidly the common recognition and were translated into many foreign languages.

[2] In differential geometry and mathematical physics, an Einstein manifold is a Riemannian or pseudo-Riemannian manifold, whose Ricci tensor is proportional to the metric. They are named after Albert Einstein, because this condition is equivalent to saying that the metric is a solution of the vacuum Einstein equations (with the cosmological constant), although the dimension, as well as the signature, of the metric can be arbitrary, unlike the four-dimensional Lorentzian manifolds usually studied in general relativity.

A.Z. Petrov carried out the studies in the field of mathematical physics, general relativity theory, and philosophical questions of physics; performed a cycle of works on the group invariance methods in the theory of gravitation; proposed new methods to study the gravitation radiation and the energy of a gravitation field and to model the gravitation field; proved the existence of three types of gravitation (Petrov's types); constructed the classification of gravitation fields by the groups of motion (the conformal, affine, and projective groups). He developed the general theory of modeling of gravitation fields and advanced the idea to describe the Einstein's theory of gravitation in terms of a plane space. Alexei Zinovievich also showed keen interest in questions concerning the experimental confirmation of the general theory of relativity. For that purpose he organized an experimental laboratory at the Chair of the theory of relativity and gravitation and later, during his work in the Institute of Theoretical Physics of the Ukrainian Academy of Sciences, he led together with Professor V.B. Braginsky (MSU) a series of experiments on the experimental observation of gravitational radiation. He was an active popularizer of the relativity theory, and his brochure "Space, Time, and Matter" written in 1961 is characterized by a clear style easily understandable by the ordinary reader. This brochure ran into several editions and was translated into Japanese.

Meanwhile, A.Z. Petrov had been working as hard as ever, not less than twenty hours a day. As a rule, he worked at a coffee table, sitting in a settee in his study – a large room, one corner of which had been cut off, with portraits of P.A. Shirokov and A. Einstein on the wall and the windows looking out on to the busy junction of Kirov and Chernyshevskii Streets.

He managed to find time somehow to read and would sometimes surprise you with a thorough familiarity with the works of some little-known poet or writer. He was interesting to talk to if occasionally his manners were a little on the sarcastic side and witty. He spoke little and slowly, subduing the listeners with sparing, imperious, exact words. He wrote in a similar way omitting the unnecessary and getting to the point quickly. His vivacious keen phrases devoid of stereotypes were easily retained in the memory. He demanded the same of his students, derisively correcting the "vile jargon" of their first articles.

On December, 26, 1969, A.Z. Petrov was elected Academician of the National Academy of Sciences of Ukraine (NASU), and, in July 1970, he became Head of the Department of Relativity Theory and Gravitation at the Institute for Theoretical Physics of the NASU. At the time

of his departure to Kiev, his final illness had begun. In Kiev, although he had been ill for a long time, he continued to work in hospital. Every day, according to a special schedule, he met in his ward with post-graduate students and department's workers and directed and consulted them.

In April 1972, A.Z. Petrov was awarded The Lenin Prize for the series of works "Invariant Group Methods for Investigations in Relativity Theory". On May, 9 that year, he died in the hospital after the operation, when a blood clot came into his heart.

In passing, it should also be mentioned that Prof. A.Z. Petrov was a person of high culture and a leader in humanity. His international cooperation with Western European scientific institutions had effect of a clearly transgressing scientific policy: it helped to establish contacts of Institute for Theoretical Physics of the National Academy of Sciences of Ukraine with Western scientific institutions. A.Z. Petrov also had the pleasure to find excellent collaborators centered around the his famous scientific school in Kiev (Ukraine). This international cooperation in the frame of Bogolyubov–Petrov scientific school has helped to guarantee a stimulating atmosphere which continues till now to attract the bright students which the community of physicists in Europe needs to accomplish its further scientific goals.

The community of physicists at the Bogolyubov Institute for Theoretical Physics of the National Academy of Sciences of Ukraine regrets to have lost someone who not only was an eminent physicist, but also a teacher, friend, and colleague to many of us. All Ukrainian scientists will always keep the memory of Alexei Zinovievich Petrov in the highest esteem.