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The International Conference "Petrov 2010 Anniversary Symposium on general relativity and gravitation", held under the auspices of the Petrov School, was dedicated to the centenary of the birth of an outstanding Soviet scientist – geometer and physicist, laureate of the Lenin Prize of the USSR, Academician Alexei Zinovievich Petrov (1910–1972), founder of the first and only in the Soviet Union Department of the theory of relativity and gravitation of Kazan University (1960).

Born in Volost village of Koshki, the Samara guberniya, on October 28 (15, according to the Old Style), 1910, Alexei Zinovievich Petrov was the eleventh of twelve children in a large family of the village pastor. He was sickly and of a sedentary nature as a child. His father died of tuberculosis when Alyosha (the diminutive of Alexei) 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, Alyosha 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 and gave them her surname.

In the village of Koshki, Alexei Zinovievich received elementary education and then, in 1926, he finished a seven-year school education in the provincial town of Melekes. He was very fond of reading and read many books. But at school he did not study well and was behind the class in mathematics. In fact his mathematics teacher had to postpone his mathematics examination until the autumn. This hurt the boy's pride and he got down to work. For the whole summer he had been studying hard and 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. He not only managed to solve the mathematical problem put to him with lightning 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 gaining his ends.

After finishing the school Alexei entered the pedagogical college of Melekes. 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 Saratov as a carpenter. In 1931 he, together with his brother Sevir, found work in Kazan in 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 department 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.

Together with the young Soviet Union the University of Kazan was at the height of the remarkable uplift. On returning from Gottingen, Professor Nikolai Gurievich Chetaev, full of plans and youthful enthusiasm, set to work on his famous "Kazan program", which he successfully carried out afterwards. Nikolai Grigorievich Chebotarev, a 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 Petr Alexeyevich Shirokov once again put the University of Kazan in the foreground in the development of non-Euclidean geometry in according with glories traditions founded by great Lobachevsky*<sup>1</sup>".

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 department 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 Veniamin Grigorievich Kopp, who was in the same year as Petrov. "You 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 and persistent student drew the attention of Professor P.A. Shirokov. His working under 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 Soviet geometers.

Studying and promoting the heritage of Lobachevsky, holding international competitions which reflect the latest advances in non-Euclidean geometry<sup>2</sup>. 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 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 Petrov would become afterwards 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 Yoshkar-Ola and Kazan institutes and at the same time did his PhD work under Professor P.A. Shirokov, working hard day and night. Sometimes he existed on just a piece of bread and a glass of water. The first research works of A.Z. Petrov were devoted to solving the classical geodesic problem about geodesic mappings of Riemannian spaces with indefinite metrics which was proposed by his advisor Professor Petr Alekseevich Shirokov. In his paper published after the World War II (1949) Petrov gives canonical forms of geodesically corresponding three-dimensional Riemannian metrics and gives a sketch of solution to the problem for onetype of  $n$ -dimensional Riemannian spaces<sup>3</sup>. His studies were interrupted by the war. In December, 1941, in a bitter forty-degree frost, Alexei Zinovievich was sent to the front at Moscow to command a mortar detachment. As a result he did not have the time to defend his dissertation.

The defence 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 that year he was badly wounded and

<sup>1</sup>From the Preface of B. L. Lapev to the book by P. A. Shirokov "Izbrannye raboti po geometrii" ("Selected works on geometry"), Kazan, 1966.

<sup>2</sup>The list of laureates of these competitions is a constellation of brilliant names: S. Lie, D. Hilbert, H. Weyl, E. Cartan, W. Killing, V.A. Fock and others. Present works were referred by Klein, H. Poincare and others including P.A. Shirokov. See P.A. Shirokov "Izbrannye raboti po geometrii" ("Selected works on geometry"), Kazan, 1966.

<sup>3</sup>A solution to a similar problem for two-dimensional spaces was done by P. A. Shirokov in the paper which was published only in 1966, many years after his death. General solution to the problem of geodesic mappings which allows for an uncountable set for basic types (comprising infinite variety) of Riemannian spaces of arbitrary signature and any dimension (unlike previous results which are all restricted to the three basic types) was done by A.V. Aminova in 1987.

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 at the Kazan Aviation Institute where in 1945 he joined the Communist Party. 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. Work in 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 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 in 1952–54 proved a remarkable theorem that afterwards brought him world fame. The theorem stated the existence of three types of Einstein spaces (called Petrov types in the present world literature). This “Petrov Classification” as it is now known has proved immensely useful in the description and 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 at 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 selection committee. But the overwrought heart could not put up with the new anxiety. With the diagnosis of cardiac 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 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, 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 Physical Faculty<sup>4</sup> of the University of Kazan (and which was the first and up to now the only one in the Soviet Union and Russia). Without interrupting his scientific investigations at that time, Petrov expended much effort on 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 variety of special courses read at it)<sup>5</sup>. He devoted much time to work with students,

<sup>4</sup>In 1960 the department of physics and mathematics was divided into two faculties – physical and mechanical-mathematical.

<sup>5</sup>The number of these special courses and the list of their titles impress by their depth an broad educational goals of the chair: 1) Special relativity; 2) General relativity; 3) Riemannian geometry; 4) Theory of Lie groups with with applications in Physics; 5) Theory of spinors; 6) Quantum field theory; 7) Relativistical astrophysics and cosmology; 8) Experimental basis of General relativity; 9) Classical theory of potential. Also, additional courses such as basics theory of differentiable manifolds, topology and theory of fiber spaces were taught. The chair still remains unique due to the number and variety of courses given, the number of which got even bigger after the formation of magistracy in 90’s. Moreover, from the very beginning of existence the chair is responsible for all the mathematical education of the department of physics (now

postgraduates 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 whole galaxy of talented followers and created a scientific school that became famous far outside Kazan.

In 1960 Alexei Zinovievich Petrov was elected the Chairman of the section in the scientific council of the USSR devoted to gravitational investigations and the Chairman of the Soviet commission in the International committee for gravitation and the relativity theory. Petrov occupied these posts till the end of his life and played a significant role in the organization and 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" 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 special place in the world literature on the general theory of relativity and were translated into foreign languages.

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 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 A. Shirokov and A. Einstein on the wall and the windows looking out on to the busy junction of Kirov (now Moscow) and Chernyshevsky Streets.

He managed to find time somehow to read and would sometimes surprise you with a thorough familiarity of 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 an Academician of the Ukrainian Academy of Sciences (UAS) and in July 1970 he became the Head of the department of relativity theory and gravitation in the Institute of Theoretical Physics of UAS. 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 postgraduate students and department workers and directed and consulted them.

In April 1972 A.Z. Petrov was awarded The Lenin award for the series of works "invariant group methods for investigations in the relativity theory". On May 9 that year he died in the hospital following an operation when a blood clot came into his heart.

Not long before his death, late in the year 1971, Alexei Zinovievich came to Kazan. He was taciturn and estranged, as if he had been secluded from the rest of the world by an invisible wall. During his conversation with V.G. Kopp he said "I live now in a beautiful room looking onto a garden. There is silence all around. That's the place where it is so wonderful to work in". These words reveal completely A.Z. Petrov's character as a man whose aspiration to knowledge was irrepressible and graceful like a flying arrow, sent from a tautly drawn bow, precisely hitting the target.

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