



SON of the Regiment

*"When the war began, we were evacuated from Moscow, and in March 1944 we returned. My mother fell seriously ill during the evacuation, so in Moscow she was put in a hospital. My sister (who was three years younger than me) and I were to go to an orphanage. I didn't want to and ran away to the front. I was barely 10 years old. The front was far away. I traveled across the whole of Ukraine, as best I could. All kinds of things happened to me on the way. In the south of Ukraine I ended up in a unit where the political officer was an Armenian. He settled me in.
"It was a base deployment region of aviation – our military unit 23326 serviced aircraft at front-line airfields. They sewed me a uniform and boots, and put on shoulder straps. So it was all done and dusted. I became the son of the regiment."*

In the army I had two functions. First, I was an orderly with the headquarters of the political department. Second, I played in a traveling amateur soldiers' band, where they staged all sorts of skits. That's where they tried to teach me music. But after three or five lessons, when I got bored of scales, I said: "Shoot me if you will, but I have no talent for music, and I'm not going to learn!" So when I left the army, I had the following trophies: a set of gramophone records, and for some reason I also took an accordion. In the year 1947 or so, I took the instrument and slowly began to pick music. Then I got a self-study guide and gradually learned to play. I still have that accordion.

With my military unit, I went through the Sandomierz bridgehead, Krakow, Czestochowa, and Breslau. We celebrated the victory not far from Berlin, about 80 kilometers away; our headquarters stood in the town of Sonnenwalde. Suddenly, we heard a noise; one was shooting in the air. This was in celebration of the Germans signing the capitulation. Then we were turned south. We marched through Prague and, as part of the occupation forces, found ourselves near Vienna. The place was called Kloisternaiburg, on the Danube. I swam in the Danube in the summer of 1945.

I returned to Moscow, to the same school I left when I was in the second grade. I came to my teacher in August 1946 – with shoulder straps, wearing a uniform of the air forces, with a medal. And I said that I wanted to study. She gave me individual lessons for a month, and I passed the external exam for the 3rd grade, and in September, I went to study in the 4th grade (from Marlen Topchiyan's memoirs).

On the way to the Golden Valley

Upon successful graduation in 1953, Marlen entered the Physics and Chemistry Department of the Moscow Institute of Physics and Technology (MIPT). When students completed their third year, they were assigned for practical training at the so-called "bases," most of which were large closed institutes related



to defense, aerospace, or electronics. These bases were located either in Moscow or the Moscow region. Topchiyan got in a group of students to specialize at Department 9, headed by Mikhail A. Lavrentiev. Since this department did not have a base of its own, the students completed their pre-graduation training in organic chemistry and explosives chemistry

at the Mendeleev Moscow Institute of Chemical Technology. A testing ground for explosions was set up in the woods near the village of Orevo, approximately 100 km from Moscow.

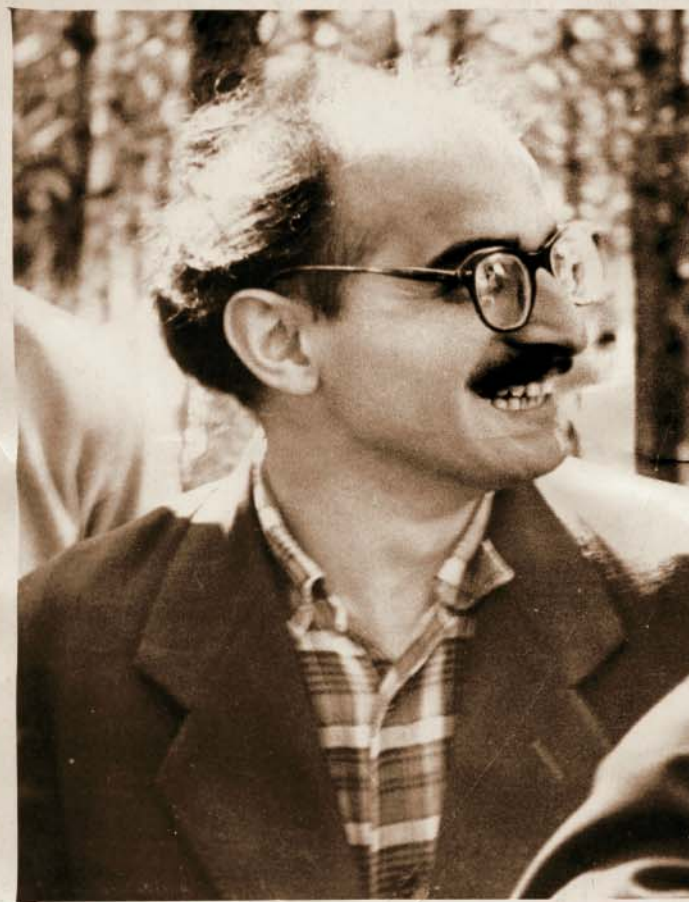
The specific feature of the training sessions at that testing ground was that the students themselves had to design and select equipment, assemble experimental stands, and then prepare their course and diploma papers using those stands. Among the students, there were many future inhabitants of the Golden Valley in Novosibirsk, and that experience would prove useful to them two years later, when they were setting up the first laboratories of the Institute of Hydrodynamics in Akademgorodok. The Orevo group lived a friendly life

Marlen with his uncle E. N. Topchiyan and his aunt E. N. Pavlova at the front. 1944

Top right: Marlen Topchiyan's "red" (honor) school certificate



Marlen Topchiyan, a student at MIPT



Marlen E. Topchiyan at the opening of a pioneer camp in Zolotaya Dolina. Novosibirsk, 1960s

as a commune: food was brought in for everyone; all the students cooked in turns; they played football with local youth; in the evening they went to dances in the village club.

Marlen Topchiyan: “At my first practical training, Bogdan Vyacheslavovich [Voitsehovskiy] instructed me to use improvised means to measure the impulse of a shock wave during the detonation of a spherical gas charge. To this end, a standard spherical aerological cylinder was filled with a mixture of acetylene and oxygen and detonated using a spark from an automobile ignition coil. Bricks were used as impulse meters. The bricks were placed on a flat surface ‘on end’ at different distances from the explosion site. Knowing the mass of the brick and its dimensions and having solved the problem to calculate the impulse of the force that overturns the brick, it was possible to judge from the inrush about the magnitude of the impulse acting on the obstacle and about its dependence on the distance.

“To conduct the experiments, we had to solve the problem of obtaining acetylene. We had neither appropriate cylinders nor a ready-made generator, but calcium carbide was available in the immediate vicinity. It was

necessary to make an acetylene generator. To this end, we had to sacrifice a galvanized tank for drinking water. We inserted into the tank lid a pipe for loading carbide, which was protruding above the lid by about half a meter and not reaching the bottom by about 30 millimeters, and put a gas valve for releasing acetylene. The entire structure was thoroughly soldered. First, to displace the air, this “generator” was filled with water up to the lid level; then, carbide was loaded into the pipe so that it would move downwards and gas bubbles would float upward to the side of the pipe. The water was displaced by the released acetylene, and the excess was drained. When the ball was filled, the gas valve was opened, while the water level was maintained above the lower cut of the pipe so that the gas remained locked under pressure corresponding to the difference in the water levels in the tank and the pipe. The ratio of the components was found using ordinary gas meters.

“This generator appears to have been one of the first experimental facilities made at the Orevo testing ground. The results of this work were presented in the form of a course paper.”

During the winter holidays at the beginning of 1957, Lavrentiev organized a trip for his students to the base of the Black Sea Branch of the Marine Hydrophysical Institute. At that time, scientists were preparing an experiment in Balaklava Bay on the focusing of a converging surface wave excited by a cord charge. Lavrentiev wanted his students to take part in this experiment as observers. In addition, he wanted them to familiarize themselves with the Simeiz Observatory and the so-called “wavetron,” i.e., a facility built to study waves excited by wind on the water surface, which Lavrentiev believed to be an example of an ill-considered decision and a useless waste of money.

While on the trip, Lavrentiev told his students about the founding of the Siberian Branch of the USSR Academy of Sciences and about his intention to move to Novosibirsk. As early as that summer, students from his department got employed to work part-time at the Institute of Hydrodynamics, which was just being created.

Marlen Topchiyan: “At the end of summer – beginning of autumn 1958, all of our team began moving to Novosibirsk, and my fellow students were preparing and defending their diploma theses in Zolotaya Dolina (‘Golden Valley’).

However, I could not yet leave Moscow due to family circumstances.

“The aim of my diploma thesis was to experimentally verify the acoustic theory of the spin detonation plume, which was put forward in 1946 by Numa Manson. To measure the frequency, the plume image was scanned through a slit perpendicular to the tube axis. To ensure a large number of periods and high measurement accuracy, a bundle of medical tubing was wound tightly around the glass tube so that the latter would not deteriorate too quickly. Experiments with different diameters of the tube and with the acoustic characteristics of the volume, which were changed by means of a concentric insert, showed that Manson’s theory described with very good accuracy both the rotation frequency and the inclination of the plume and the spiral described by the ‘head’ to the tube’s generatrix. The acoustic nature of the spin detonation plume was finally confirmed.

“At the Graduate Assignment Commission, I had to fight so that they sent me to Novosibirsk. Many graduates had already been assigned to institutes of the recently founded Siberian Branch, so the rector of the MIPT, Lieutenant General of Aviation Ivan F. Petrov, would in no way meet my desire. The situation was saved by a telegram signed by Lavrentiev, which was placed on the rector’s desk.

“One way or another, on March 8, 1959, I boarded an express train from Moscow to Novosibirsk, which 72 hours later brought me to the Main Railway Station in Novosibirsk. We safely arrived at the ravine on the Zyryanka River, which had already received the name of the Golden Valley.”

“Peaceful” explosions

The first project in which the young scientist took part as a staff member of the institute was assigned to him and supervised directly by Lavrentiev. The aim was to study gunpowder detonation. It was necessary to check the suggestion put forward in 1944 by Nikolai M. Sytyi regarding the possibility of using water-soaked substandard gunpowder as a standard explosive for rock blasting operations on the surface. Small experiments were conducted in the Zyryanka ravine, and large-scale ones were carried out on the then deserted Taivan’ island in the Ob Sea, opposite the current central beach of Akademgorodok.

In a very short time, scientists tested about 30 types of smoke and smokeless gunpowder to confirm the expediency of Sytyi’s proposal. The consequence of this work was a huge national economic effect from utilizing tens of thousands of tons of gunpowder left over from the war. Substandard gunpowder began to be used as a regular

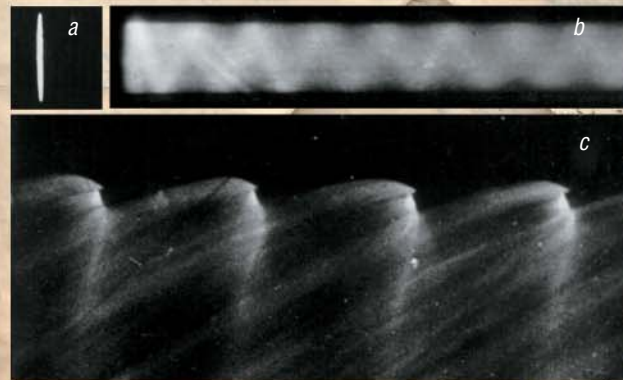
SPIN DETONATION

Marlen Topchiyan: “Starting from their fourth year, MIPT students spent ever more time training at ‘bases.’ I was assigned to the ‘base’ of MIPT Laboratory 9, which was headed by Voitsekhovskiy.

“He said it was Lavrentiev who drew his attention to the structure of the ‘head’ of spin detonation, a yet unsolved problem. A huge amount of experimental material was accumulated both in our country and abroad; luminaries of science, like Kirill I. Shchelkin and Yakov B. Zeldovich, were developing its gas dynamic model. Nevertheless, we were far from understanding the phenomenon.

“The situation was complicated by the fact that conventional instantaneous frame-by-frame shooting methods could not yield an undistorted image of the spin head. The latter had a relatively weak luminosity; a short exposure was required to avoid image blurring (when shooting on a stationary film of an object that was moving at a speed of about 2 km/s); and the then used mirror-scan cameras with an opaque metal drum had a low light intensity. In view of those circumstances, the sensitivity of the available photographic materials was insufficient.

“When studying detonation and measuring the velocity, every researcher, starting with the photorecorder inventors Mallard and Le Chatelier, set the scanning direction perpendicular to that of the wave. In the same formulation, the phenomenon was discovered in 1926 by the English scientist Campbell in the form of a periodic structure observed in the photo scans of detonation for some mixtures. In the early 1930s, Bon, Frazer, and Wheeler proved that the inhomogeneities of self-luminescence were caused by a special structural inhomogeneity localized near the tube wall; moving with the front of the wave guiding the detonation, the structural inhomogeneity was rotating around the tube axis. The sum of the movements yielded a spiral trajectory with a spiral angle of about 45° to the generating tube. The phenomenon was called spin detonation, and the structural entity was named the spin head. The nature of the phenomenon remained a mystery. “In an attempt to obtain an image of the head, Yakov K. Troshin and Shchelkin used a method of compensating for the longitudinal velocity of the detonation wave, with scanning parallel to the tube axis, which increased the exposure time by about an order of magnitude but did not give a correct picture of self-luminescence. When discussing methods for obtaining an undistorted image with me and the laboratory assistant B. E. Kotov, Voitsekhovskiy came up with the idea of turning the photorecorder axis at about 45° to the tube axis, perpendicular to the direction of the spiral movement of the head when it was passing the slit of the photorecorder. This unconventional setup made it possible to fully (in magnitude and direction) compensate for the image movement and



a – detonation wave front in the classical representation
b – spin detonation phenomenon, discovered in 1926.
The photo shows a brightly glowing spin head rotating in a spiral
c – photo taken by Voitsekhovskiy during his studies of spin detonation in 1957–1958

Photos provided by A.A. Vasiliev

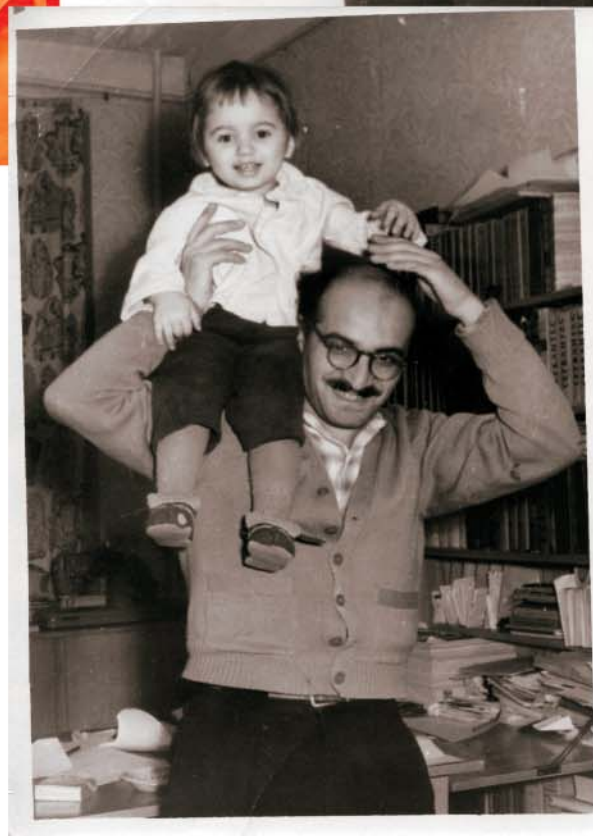
obtain clear, undistorted images, which, in turn, allowed us to construct a qualitatively new structure of the head with a transverse wave. A simple and very effective ‘do-it-yourself’ design of a photorecorder with a transparent drum based on a vacuum cleaner motor, which was applied (and, apparently, invented) by Voitsekhovskiy himself, enabled the maximum possible luminosity of the device and ensured the success of the experiments. Photorecorders of this design are still in use at the institute. The corresponding article was submitted to the journal Doklady Akademii Nauk (Proc. USSR Acad. Sci.) on February 12, 1957.

“All through 1957–1958, the entire time before moving to Novosibirsk, Voitsekhovskiy had been studying gas detonation far from the limits in channels of different configurations. He studied self-luminescence of transverse wave tracks in flat channels using a photo camera with an open shutter and in round pipes at an angle to the axis with compensation for the longitudinal velocity of movement. Kotov and V. V. Mitrofanov participated in these experiments, and some of the results formed the content of the latter’s diploma thesis. The experiments revealed that the cellular structure of the front far from the limits remains an invariable companion of gas detonation; it appears and disappears along with the detonation process. The size of the cell far from the limits depends only on the physical and chemical properties of the mixture and the initial pressure. Experiments conducted by Mitrofanov confirmed that in round pipes, the cellular structure extended over the entire cross-section and was not a consequence of the interaction of the detonation wave with the walls. The results were published as early as September 1958.”



Marlen E. Topchiyan (top, far right) with colleagues from the Institute of Hydrodynamics, Siberian Branch, USSR Academy of Sciences, Novosibirsk Akademgorodok, 1970s

On the right is Topchiyan with his daughter Elena



explosive in rock blasting operations, e.g., during the construction of the dam in Medeo and the destruction of the Kazachinsky rapids on the Yenisei River.

Throughout his long and immensely fruitful scientific life, Topchiyan – first a candidate and then a doctor of physics and mathematics – focused on solving problems with direct practical applications. One of his accomplishments was the study of the electrical properties and sensitivity of nitroglycerin to electric discharge, which resulted in recommendations that ensured the prevention

of accidental explosions during nitroglycerin production. Topchiyan became, in fact, the founder of a new research area, i.e., physical substantiation, development, and practical use of gas sources for obtaining dense hypersonic flows. Within this area, new facilities were designed, which, in many respects, remain unsurpassed to this day.

The young doctor of sciences became a coauthor of two discoveries that were put on the USSR State Register of Discoveries: “Instability of the detonation wave in gases” (1972) and “The phenomenon of splitting of the spin detonation wave (fine structure)” (1973). The first discovery seriously changed previous ideas about the real structure of detonation waves in gases. Previously, it was believed that when far from the detonation limits, detonation waves have a smooth shock front, behind which the chemical reaction develops synchronously in all gas particles; i.e., the combustion process in the wave was considered to be one-dimensional. However, Novosibirsk scientists found that the detonation front had a bumpy

**FROM AN INTERVIEW WITH MARLEN TOPCHYAN
FOR A STUDENT ALMANAC (JULY 1999):**

– Do you think it is necessary to influence a student's civic stance? To shape his or her worldview?
– Absolutely! But there is no point in giving special lectures or moralizing. It's useless. I teach a course in general physics, but when I talk about a new phenomenon, about a discovery, I say it was our scientists who did it. There were great achievements in Russian science, in physics. Great names, too, from Lebedev, Mendeleev, Popov to Tsiolkovsky, Kurchatov, Zeldovich, Sakharov, Landau, and others. We need to use these examples to cultivate personality rather than drone on about civic duty. This is a difficult question, in fact, and a very painful one.
– In your opinion, what period in the life of our university was the best one?
– The best one was the last four to five years of Spartak T. Belyaev's rectorship. I think that the decline began when Valentin A. Koptug left. Still I think that NSU remains at a fairly high level to this day. What fears me most? Our laboratories are deteriorating, and there is no money to support them.

– The university used to live an eventful life. There were international weeks, student construction brigades, and so on. Were these activities forced upon students?
– No, I disagree absolutely. The very first impulse might have been imposed artificially, a long time ago, at the very beginning. But then it all went on quite naturally. The Komsomol facilitated all these activities. By the way, all the party and Komsomol life at our university was quite loyal.
– Do you consider it interesting to work with students?
– Of course. Even though you get terribly tired during lectures. It's hard work really. Standing at the board for two hours with chalk in your hand, watching the audience so that no one falls asleep, attracting attention in time, saying right thing in the right time to relieve fatigue or, on the contrary, present the material more in a stricter form... You need to respond to the audience all the time, and this is hard. But still, you get satisfaction. As long as I have the strength, I will try not to break with students because they give me some kind of reverse charge

structure and the chemical transformation zone had a complex three-dimensional basis. An analogy was also established between the instability of combustion in the detonation wave and in a liquid rocket engine (LRE). The practical value of the second discovery was the possibility of using transverse detonation waves in technical devices (e.g., LREs or chemical reactors) to intensify the combustion of a gaseous fuel or a fuel sputtered in a gaseous environment. Another area of application is the new methods for obtaining information on the rates of chemical ignition reactions at high temperatures.

For many years, Topchiyan headed the department of high-speed processes at the Institute of Hydrodynamics, and until 2007, he headed the gas detonation laboratory. The scope of his scientific interests was expansive: modeling and experimental studies of gas detonation; development of new technological processes and production of new substances in chemical industry under gas detonation conditions; explosiveness of gases, combustible dusts, and gas-droplet systems; physical substantiation and principles of using ultrahigh

gas pressures to obtain dense hypersonic flows, which allow for simulating aerospace flights in ground conditions, etc. For instance, he led the research group that took part in 2000 in the development of the AT-303 wind tunnel, which is indispensable for testing various types of aerospace models.

Throughout his scientific life (over 40 years!), the former "son of the regiment" was connected with Novosibirsk State University (NSU). As early as in 1963, the 29-year-old candidate of sciences began teaching at the Chair of Physical Hydrodynamics (Physics Department, NSU), organized by Voitsehovsky; subsequently, he became a professor at the Chair of General Physics.

The publication uses photos from Marlen E. Topchiyan's family archive, which were provided by L.I. Topchiyan

The author of the idea and text is N.N. Bogunenko

Victory Day in Novosibirsk Akademgorodok. Marlen E. Topchiyan (far right) with Rear Admiral Georgiy S. Migirenko, Deputy Director of the Institute of Hydrodynamics, Siberian Branch, USSR Academy of Sciences (in the center). Mid-1960s



Professor M.E. Topchiyan gives a lecture to biology students at NSU. Late 1990s

