GURGEN A. ASKARYAN (1928 - 1997)

B. M. Bolotovskii

P.N.Lebedev Physical Institute, Russian Academy of Sciences,
Leninsky Prospect 53, 117924, Moscow, Russia

All his life Gurgen Ashotovich Askaryan lived and worked in Moscow. He spoke about himself: "I am an Armenian of the Moscow bottling". He very seldomly left Moscow, and if he left, always short term — several days, no more than a week. He never visited Armenia, despite numerous invitations of his friends and colleagues — physicists from Yerevan, the Armenian capital, where he was highly appreciated for his outstanding scientific achievements and for his numerous jokes.

Gurgen Askaryan was born in Moscow on December 14, 1928. His father, Ashot Askaryan, was a physician, a general practitioner. He was well known in Moscow. Gurgen's mother, Astrik Askaryan, was also a doctor and dentist. The parents were widely educated people, connoisseurs and judges of painting, music and fiction, and G. Askaryan inherited these qualities. Gurgen was the second child in the family. He had a sister, Goar, who was two years older. From early childhood Gurgen was taught to play the violin. He learned music willingly, and the parents expected that music would be his occupation in mature years.

In 1940, when Gurgen was 12, the head of the family, Ashot Askaryan, passed away. The family went into a grave condition. But in spite of all difficulties, Astrik alone raised the children although it was at the breakpoint of her forces and the family sometimes underwent severe hardships.

In 1946 Gurgen Askaryan completed his school education with a gold medal. In the school his favorite subjects were music and natural sciences, physics and mathematics. One event helped him to choose between his preferences. Not long before G. Askaryan left the school, a great violinist Yehudi Menukhin came to Moscow to give a concert. As a promising young violinist, Askaryan was allowed to attend Y. Menukhin's rehearsal. During that rehearsal G. Askaryan realized that he never would attain so high a level of performance. Therefore he decided to break his musical education and entered the Physical Faculty of Moscow State University.

Among the students, Gurgen Askaryan occupied his own place. He had sharp wit and sharp tongue. His knowledge in physics went beyond the frame of university programs. Usually he expressed his opinions in bright and aphoristic manner, and sometimes (not seldom) his remarks were caustic in form, though right in essence. Therefore, some students (and even lecturers) to whom his remarks referred, disliked him. On the other side, G. Askaryan had many friends, including those who never saw him but were informed of his numerous witty statements.

During the third year of his education G. Askaryan proposed a new method of registration of fast charged particles. His idea was the following. Suppose, there is an overheated transparent liquid. A very small amount of energy is sufficient to make it boil. Let a fast charged particle penetrate through this overheated liquid. The particle expends its energy on ionization of atoms located near its trajectory. This energy loss is transformed into heat in amount which is sufficient to induce boiling along particle's trajectory. Then the trajectory becomes observable because many bubbles are created along it.

G. Askaryan discussed this proposal with some of his teachers and fellow students. No one objected. However, no one supported him, no one helped to realize the idea. G. Askaryan then was inexperienced in forms and methods of scientific investigation. He even did not publish his proposal. Several years later, in 1952, the same idea was set forth independently by an American physicist Donald Arthur Glazer. He put the idea into practice having assembled the device known now as bubble chamber. This instrument proved to be so useful in high energy physics that D. A. Glazer was awarded with the Nobel Prize in 1960. This event gave rise to Askaryan's deep concern. Of course, he was shaken that Nobel Prize was so near and, so to say, he let it slip. On the other hand, this event helped him to get faith in himself.

After graduating from University, G. Askaryan occupied the vacancy of "aspirant" (post-graduate student) in Institute of Chemical Physics, Russian Academy of Sciences. His scientific supervisor was the outstanding physicist Ya. B. Zel'dovich. After several short conversations with G. Askaryan, Zel'dovich gave him full independence in the choice of problems to be investigated. Askaryan began to work on problems connected with registration of high energy particles. However, after a year, Ya. B. Zel'dovich left Institute of Chemical Physics and moved to a secret place where the hydrogen weapon was created. As a consequence, The vacancy occupied by Askaryan was cancelled.

In 1953 Askaryan passed to P. N. Lebedev Physical Institute in the position "aspirant", as in previous institute. His supervisor here was M. S. Rabinovich, at that time an outstanding expert in the theory of accelerators. Later, his investigations in plasma physics also brought fame to him.

The head of the laboratory where Askaryan worked was V. J. Veksler, world known for his investigations of cosmic rays and discovery of the phase stability principle. Askaryan's supervisor, M. S. Rabinovich, was Veksler's deputy in laboratory, and after Veksler's passage to Joint Institute for Nuclear Research (Dubna), Rabinovich became the head. Here, as well as in Institute of Chemical Physics, Askaryan was given full freedom in his work. In this very laboratory Askaryan worked during all his subsequent life. In 45 years of fruitful work he obtained many important results.

Soon after his arrival in the laboratory, G. Askaryan began to work in close collaboration with V. J. Veksler. The latter was interested in all possible processes where strong electric fields might be obtained in order to use these fields for acceleration of charged particles. Askaryan studied different radiation effects such as transition radiation, Cherenkov radiation etc. Most detailed was his investigation of transition radiation at radio frequencies. Askaryan formulated conditions necessary for coherent radiation. He also found (together with M. L. Levin) a combination of auxiliary high-frequency fields which could secure stability of electron bunch during acceleration.

It is very difficult to enumerate Askaryan's achievements in different branches of physical sciences. Below, we mention several of his important contributions.

G. Askaryan discovered and investigated in details various effects accompanying passage of high energy particles through dense matter (liquids or solids). It was shown that hadron-electron-photon showers and even single fast particles may produce sound pulses. Ionization losses are quickly converted into heat, and the small region adjacent to trajectory undergoes quick thermal expansion thus generating sound waves. These results gave a new approach to the study of cosmic rays. Before, investigations of cosmic rays were based on direct interaction of cosmic ray particle with a detector. Askaryan's results made it possible to detect showers and single particles using sound receivers situated at some distance from the event. Later G. Askaryan showed that intense laser beam passing through matter also generates sound waves This effect may be used for processing and for destruction of matter. As a result of this series of investigations, a new branch of physics was created, radiation acoustics, and G. Askaryan was the founder. Several years ago, the registration of energetic particles and showers with sound detectors in sea water was planned as an important part of global monitoring.

G. Askaryan also showed that cosmic ray showers emit electromagnetic radiation, thus giving yet another way for their registration. Before Askaryan went after this problem, it was commonly assumed that electron-photon showers do not emit any electromagnetic radiation because electrons and positrons are created in pairs. As a consequence, it was accepted that shower had zero total charge and zero total current. G. Askaryan analyzed the problem and came to the conclusion that in an electron-photon shower there must be excess of negative charge (in other words, excess of electrons). The excess electrons are knocked out from atoms either by shower photons (photoeffect), or by shower electrons and positrons (ionization).

At the same time the number of positrons decreases because of the annihilation process. Therefore, an electric current is associated with shower, a current formed by excess electrons. The duration of the current is the same as the duration of the shower, and current varies along with development of shower. Variable current is the source of radiation. Therefore, every shower is the source of electromagnetic radiation. G. Askaryan estimated intensity of the radiation and showed that its field is well above the proper noise of the receiver. These investigations paved the way for distant registration of cosmic ray showers. Now many radio-astronomical stations are conducting observations on cosmic ray showers.

After discovery of lasers, G. Askaryan began to investigate interaction of laser beam with different substances. At that time physicists who worked with lasers, used to break through thin metal specimens (usually, razor blades) with laser beam. It was something like a game. G. Askaryan also rendered tribute to this game. He noticed that holes made by laser beam were of two kinds. When he used laser of moderate power, the edges of aperture were smooth, as if the aperture was melted through (indeed, it was melted). However, the hole made by powerful laser had rough uneven edges, as if the hole was broken through, not melted. At first G. Askaryan supposed that it was the light pressure which knocked out the part of razor blade in the light spot. However, simple estimates showed that the assumption was wrong. Light pressure was too weak to break through even a thin metal specimen. So, the different appearance of the holes made by lasers of different power remained obscure.

The problem was cleared up by G. A. Askaryan and E. M. Moroz. The explanation was the following. The beam from a powerful laser heats metallic surface so intensely that surface layer turns into a vapor before the heat penetrates into next layers. The vapor is ejected from the surface. Thereby, a force arises which acts on the part of surface within the spot. This force is numerically equal to the momentum of vapor ejected during a unit of time. Such is the reaction of vapor on the surface. And in the case of powerful laser this reaction is so strong that the metal within the spot is torn out. The reaction of the vapor gives pressure that is many orders greater than the light pressure. Vaporizing ablation is now used for compressing the nuclear fuel in the problem of laser induced controlled thermonuclear reactions.

One of Askaryan's brilliant achievements is discovery of self-focusing. It is well known that light beam in homogenous medium (and in vacuum) is always divergent —- its cross section grows with distance. It turned out that this rule is valid only for comparatively weak electromagnetic waves, when linear electrodynamics is applicable. G.Askaryan investigated propagation of a strong electromagnetic beam in a refractive medium. A strong field changes the electromagnetic properties of the medium. For instance in so called Kerr effect a strong electromagnetic field produces an increase of the dielectric constant (or, which is the same, an increase of refractive index). The addition to the dielectric constant is proportional to E^2, where E is electric field. This property is called Kerr non-linearity. Let us suppose that a strong electromagnetic beam propagates in a medium with Kerr non-linearity. Then the refractive index of the medium inside the beam is greater than the refractive index outside. If the field E is strong enough then the beam creates a dielectric waveguide in the medium, a waveguide for itself. This waveguide reduces or fully eliminates divergence of the beam. Askaryan called this effect self-focusing. Discovery of self-focusing opened a new chapter in non-linear electrodynamics.

G.Askaryan belonged to the category of physicists which one can now meet very seldomly: he was not only an outstanding theoretician, he was a skilled experimentalist. As a rule, he verified his ideas by carrying out a convincing experiment. In particular, he conducted a series of experiments on self-focusing of electromagnetic and acoustic waves and showed that for both types of wave field, self-focusing takes place.

The list of Askaryan's achievements given above is far from complete. However, here we are limited in space and cannot give more detailed information. In Russia a book was issued entitled "In memory of G. Askaryan" in which his selected papers were collected. The book contains about 70 of Askaryan's papers, less than one third of his scientific heritage. The selection was made in accordance with the author's opinion. He said once that just these papers brought him the most pleasure and most misfortune.

It is appropriate to add several words about G. Askaryan as a person. He was very sociable and many his colleagues were his friends. In turn, he was a constant and careful friend. On the other side, whenever G.Askaryan got to know about any violation of ethic in science or in everyday life, undeserved blame, or undeserved praise, he always started a battle in defence of justice. As a consequence, he had not only friends. Some people disliked him, and among them there were men of influence.

G. Askaryan was also very inventive in playing various tricks on his friends and colleagues. He was inexhaustible in playing tricks as well as in producing brilliant scientific ideas. I shall give below two examples of his numerous jokes.

The head of Askaryan's laboratory, Professor M. S. Rabinovich every day came to Institute with big and heavy portfolio. Every evening, when Rabinovich went home, he carried the portfolio away with him. Once, in a talk with colleagues, G. Askaryan expressed his opinion that M. S. Rabinovich never opens the portfolio. Listeners did not agree with his supposition. G. Askaryan laid a bet with opponents. One day, when M. S. Rabinovich went out of his office, Askaryan came in with several colleagues whom he called to witness. He opened Rabinovich's portfolio and laid there a brick wrapped in a newspaper. During two weeks M. S. Rabinovich transported the brick in his portfolio there and back. He did not notice anything. After two weeks Askaryan removed the brick, again, in the presence of several witnesses. So he won. M. S. Rabinovich was informed by Askaryan about all details of this adventure, and he laughed together with colleagues. At that time M. S. Rabinovich was overloaded with numerous duties. He carried the portfolio and hoped to find time, to open the bag and to begin the work on his papers. However, his numerous duties gave him no time for it.

During several years G. Askaryan shared his room in the Institute with Dr. Igor Danilkin. Every midday Danilkin went out for lunch in Institute canteen. After lunch he returned, sat down at his writing-table, opened central drawer where he kept his cigarettes, smoked out a cigarette, and thereafter resumed his work. One day, after I.Danilkin went out for lunch, G. Askaryan came to Danilkin's writing-table and removed handle of central drawer and door-knobs of pedestals. Then he turned the writing-table back to front and mounted handles on its rear side. Danilkin returned, sat down at his table and tried to open central drawer. He pulled the handle but the drawer did not open. Then he pulled stronger, again without success. At last I. Danilkin applied all his force, and then the writing table drifted toward him. Danilkin was confused, and some time passed before he came to understanding.

G. Askaryan was never married. He lived with his mother and sister. They both were in poor health and Askaryan spent much efforts to look after them. Usually in lunchtime he went home to feed (sometimes, to spoon-feed) his women. Then he returned to Institute and remained in the laboratory until late in the evening.

G. Askaryan received many invitations to participate in various conferences. However, he never left Moscow, never came abroad because he could not abandon mother and sister. Gurgen was 12 when his father Ashot Askaryan passed away. On his deathbed, the father asked him to take care of his mother and sister. Gurgen vowed to fulfill father's will. And he kept his vow. He was an excellent son and excellent brother.

Intensive scientific activity and arduous family duties gradually ruined Askaryan's health. He suffered heart disease. At the end of February, 1997, G. Askaryan said to his colleagues that he would work at home during one week. He asked to not disturb him during the next week. However, after the week passed, G. Askaryan did not come to the institute. His friends and colleagues came to him, ringed and knocked at the door, but Askaryan did not respond. On the 7-th of March several Askaryan's colleagues entered his flat. Askaryan was dead. He was sitting in the kitchen with a note-pad before him. He worked till last moment. According to the experts' decision, he died on the 2-nd of March, 1997, of ischemia. He was then 68.

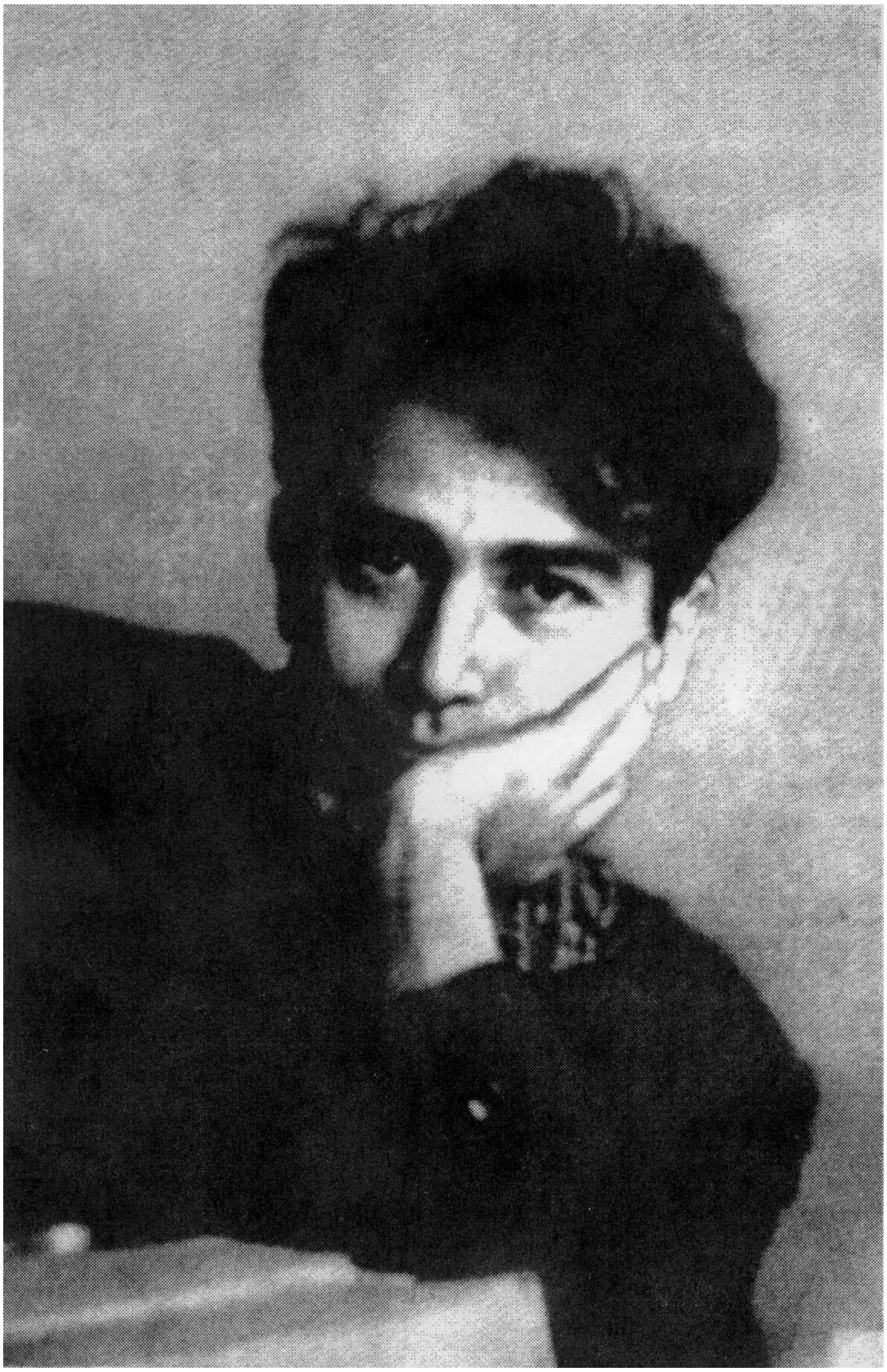

FIGURE 1. Gurgen Ashotovich Askaryan