Physics – Uspekhi **49** (9) 987 – 989 (2006)

PERSONALIA

PACS number: **01.60.+q**

In memory of Yurii Lukich Sokolov

DOI: 10.1070/PU2006v049n09ABEH006182

Professor Yurii Lukich Sokolov, well-known Russian scientist, Chief Researcher of the Kurchatov Institute in Moscow, DSc in Physics and Mathematics, marvelous man, outstanding experimental physicist, and author of many unique experiments in atomic and nuclear physics, died on May 4, 2006 at 91 years of age. He was one of the very first scientists invited by Igor V Kurchatov in 1945 to work at the legendary Laboratory No. 2 that much later became the Russian Research Center 'Kurchatov Institute', where Yurii Lukich worked for over 60 years.

Yurii Lukich Sokolov was born on January 20, 1915 in the town of Aulie-Ata (currently Dzhambul in Kazakhstan). Among his ancestors we find architects whose names are inseparable from some unique buildings of 19th century Russia, mostly in Saint-Petersburg. His father, Luka Aleksandrovich Sokolov, was a well-known railroad engineer who not only built railroads but also surveyed the terrain, designing and erecting bridges, railway stations, and ancillary buildings. His mother, Elena Eduardovna (née Fratcher) had German roots with a trace of English blood and devoted her life to her husband and son.

The multifacetted talents of the young Sokolov were evident very early when he was engrossed in designing his own version of a photographic camera, wrote and published his first poetry, played musical instruments, and read voraciously. He was fluent in German and English and had a good ear for music and an enviable feel for words.

When he graduated from secondary school in 1932, his parents sent him to Leningrad to try to enrol in the Leningrad Industrial Institute (now the Petersburg Polytechnical Institute). Alas, as he lacked worker or peasant roots — a must in those times — he had to earn two years of worker's experience at the Leningrad Physical-Technical Institute (LFTI) before enrolling without any trouble at the Leningrad Industrial Institute. He found himself in the same class with A M Bonch-Bruevich and P P Feofilov, two physicists who rose to prominence later.

In speaking about the time before student days, when he worked at LFTI on D N Nasledov's and L M Nemenov's teams, we simply must mention the following fact, which is so very typical of his creative personality. Always taking the most active interest in various projects and research programs that ran at the Institute, Sokolov simply could not pass up the opportunity to satisfy his future scientist's curiosity, working at evening and night. As a result of his independent studies and after a lengthy and tormenting quest, he succeeded in growing extremely beautiful structures of liquid crystals that possessed most unusual properties and attracted the attention of I V Kurchatov at the time that the latter worked at LFTI. Subsequently, this contact grew into many years of collaboration at Kurchatov's Institute in Moscow.

Uspekhi Fizicheskikh Nauk **176** (9) 1015 – 1016 (2006)
Translated by V I Kisin

Yurii Lukich Sokolov
(20.01.1915 – 04.05.2006)

In 1939, Sokolov graduated from the educational institution and was sent to work at the Special Technical Bureau (Ostekhbyuro) as head of laboratory; here he began honing his skills as instrument designer. At the same time, he gained excellent experience — so invaluable for an experimental physicist — at the Leningrad Optical-Mechanical Works. With the help of top-notch technicians he mastered, among other skills, the profession of optics grinder and polisher. After a spell of training, he was given the very important task of high-precision polishing of a large lens for a telescope. In light of the fact that this lens later found its way to the works museum, he had clearly done a brilliant job. His virtuoso ability to create things with his own hands always distinguished Sokolov as a unique experimental physicist.

One of the most important results of his work at Ostekhbyuro was his invention and development of a gyroscopic sight of gun for an aircraft: its use made it possible for a pilot not to lose the target when the aircraft was bumpy. The sight passed with flying colors tests involving many hours of flights in which the inventor took part alongside the experienced and distinguished test pilots of the time; it was issued to the Air Force of the Soviet Army during the Great Patriotic war with Nazis.

In 1945, Kurchatov invited Sokolov to move to Moscow where he worked for some time in Nemenov's sector. However, Kurchatov soon transferred Sokolov to the cyclotron sector and began to formulate interesting physical

problems for him. This set of investigations during his early period in Moscow resulted in the discovery of the diffraction of fast charged particles by nuclei of various chemical elements — beryllium, carbon, and aluminium. He also conducted an experimental test of the Bohr – Frenkel droplet model of the nucleus and studied the structure of energy levels in aluminium and silicon nuclei. Later on, Sokolov also worked with G N Flerov and I I Gurevich. At this time, he was spending much time recording elementary particles passing through photoemulsions on glass plates. This was a field where his talents as designer and experimenter found full expression as he was building novel special photographic equipment, imaginatively using parts of instruments brought from defeated Germany as war booty. However, when very special lenses and photoemulsions were required, he went several times in the 1950s to the then East Germany, to the Carl Zeiss and Agfa works.

Sokolov worked for a large part of his life, after the death of Kurchatov in 1960, in the Ogra sector created by Igor Nikolaevich Golovin. It was here, at Ogra, that Sokolov found, after long deliberations, his own path in physics to which he devoted the last 40 years of his life.

Sokolov concentrated his efforts on the interference of quantum states of the atom; this phenomenon belongs to conceptually the most important properties of the quantum world. To study it, Sokolov pioneered an elegant scheme of the atomic interferometer. The essential idea was that the amplitude measured at the output of a specific internal state of an atom is determined by the interference of phase-shifted contributions that evolve at the preceding instants of time along different 'paths'. The idea of such an instrument and the rich promise it held for studying subtle physical effects immediately drew attention and became the subject of detailed discussions with I N Golovin, V M Galitsky, E K Zavoisky, and A I Baz'. Sokolov first implemented this idea experimentally on the verge of 1960s – 1970s using a beam of metastable hydrogen atoms that fly across a region of space with constant electric field and where the Stark states of the atom play the role of distinct 'paths'. The name Sokolov gave to his setup was Pamir, in honor of those majestic mountain ranges to which, as he used to say, his heart truly belonged. On the suggestion of Anton Zeilinger [see, e.g., *Atom Interferometry*, Ed. by P R Berman (Academic Press, 1997) p. 100] Sokolov's atomic interferometer became known in world literature as the atomic states interferometer, because we have to do with the internal states of the atom.

The choice of the hydrogen atom for the object of observation in Sokolov's experiments is based on the principal argument that both the theoretical and the experimental study of this simplest system continue to offer the most important low-energy tests of modern quantum mechanics and quantum electrodynamics. This factor dictates the importance of maximum-precision measurements of fine and hyperfine structure intervals, including the Lamb shift of atomic energy levels. Using a specially developed design of the so-called 'double' atomic interferometer, Sokolov measured the Lamb shift in hydrogen with an accuracy that remains unsurpassed even today; this allowed researchers not only to carry out a comparative analysis against the results of the latest theoretical calculations (a matter of principle, of course) but also to evaluate the rms proton radius with a very small error. It is worth mentioning the following interesting fact: the combined use of the magnitudes of the Lamb shift measured at Harvard University (USA) and at the Kurchatov Institute yield the most accurate experimental value of the excited-state lifetime known to atomic physics.

The measurement results obtained by Sokolov for the Lamb shift in hydrogen are widely known in Russia and abroad, having been published in collective monographs and in review and original papers. Some components of the unique equipment of his making are being successfully used in the leading laboratories in the West (e.g., at the Technical University in Berlin). From the metrological standpoint, the reason that Sokolov's high-precision experiments on measuring the Lamb shift by atomic interferometric techniques were exceptionally important, was because they opened new perspectives for alternative checking on measurement results obtained by very different techniques for a number of atomic systems, including deuterium and hydrogen-like ions.

The initially 'metrological' nature of Sokolov's research into the interference of atomic states has gradually acquired increasingly more general conceptual weight as the deeper insight into profound ties between quantum and classical physics emerged; we can refer here to the famous Bohr – Einstein discussion in 1935 on what we know as the Einstein – Podolsky – Rozen paradox [EPR, see, e.g., *Usp. Fiz. Nauk* **16** (4) 436 (1936)]. Correspondingly, Sokolov's thoughts on the physical aspects and potentials of his new method manifest a recurrent theme of 'prescience' that the "interference pattern observed in a wide range of phase shifts may reveal certain unusual (and probably yet unknown) properties of the interfering states of quantum systems". We will mention in this context the very first experiments with the atomic interferometer that were motivated by the hypothesis, advanced by Galitsky, for the possibility of a fundamental connection between the quantum spreading of the wave packet and the 'true' corpuscular nature of atomic particles. These experiments, which for a number of reasons remained unfinished, were described by Sokolov in a review paper published in *Physics-Uspekhi* in 1999 [*Phys. Usp.* **42** (5) 481 (1999)].

At the end of the 1980s — beginning of the 1990s, Sokolov discovered a new effect: long-range interaction between metastable hydrogen atoms and electrically conducting surfaces; B B Kadomtsev proposed giving the effect the name of its discoverer, Sokolov (see *Phys. Usp.* **37** 425 (1994)]. To study the effect in detail a number of experimental approaches were developed that make use of the interaction to be studied as a component of the atomic interferometer. The most astonishing feature of these experiments is not the fact that interaction takes place at all but that it was observable within the sensitivity of the equipment used at macroscopic distances between an atom and a metal surface. The explanation of the nature of the discovered phenomenon suggested by Kadomtsev is based on the fact that the observed effect results from the entanglement, traceable back to the EPR paradox, of the states of the moving atom and of the microscopic particles in the thin surface layer of the metal [see B B Kadomtsev's monograph *Dynamics and Information* (Moscow: UFN Editorial Board, 1999) and *Phys.-Usp.* **46** 1183 (2003)]. A different approach formulated by S T Belyaev reduces to representing an atom as a wave packet whose 'wings', i.e., its diffraction halo that forms as a result of passage through a narrow collimator, interact with the edges of the entrance slit of the interferometer [see *Eur. Phys. J.* **D 25** 247 (2003)]. Even after a number of years of intense discussions and thorough experimental

testing of the two theories, no conclusive proof was found to uphold either of them. The nature of the Sokolov effect thus remains mystifying and not really understood.

Sokolov was a scientist with a very large span of interests. He uniquely contributed to the biological sciences as well. In fact, he made a discovery of the phenomenon of photoreactivation in higher plants growing in alpine conditions by measuring the solar radiation spectrum in a wide range by a unique field spectrometer that he himself designed and built. The phenomenon is that, under irradiation with light combining the ultraviolet and visible parts of the spectrum, a fraction of plants survive even after lethal doses of ultraviolet radiation; some individual plants arise among them with completely new shapes and productivities. In the opinion of B L Astaurov, one of the foremost experts in cytogenetics, the radical growth in plant productivity caused by photoreactivation may be triggered by polyploidy, i.e., by a multiple increase in the number of chromosome sets.

The literary gift of Sokolov is a very special topic. Possessing a truly phenomenal memory, he would retell superbly various episodes of his life, beginning with his teenage and student years. He knew by heart passages from the best prose and an infinite number of poems in different languages, and until the very last days of his life he would often recite them to grateful listeners. At the beginning of the 1960s he published literary essays that described his individual perception of the Central Asia mountains that he loved so much. Then his reminiscences turned to his great and unforgettable colleagues and mentors — Ya I Frenkel and Kurchatov. After that, he started publishing purely literary pieces as well as journalistic work; a special place in the latter group is occupied by his article on the role of the human factor in the Chernobyl disaster. As in his experimental physics research, he addressed his writing with the same utter responsibility and meticulousness. It is a sad fact that he wrote many more pieces of prose than were ever published. The level of his literary talent was much appreciated by such highly respected writers as Konstantin Paustovsky and Nikolai Tikhonov. In the last years of his life, his truly outstanding memory and rare gift of storytelling began to attract TV journalists. For instance, he was one of those who, on the occasions of jubilee anniversaries, shared with TV audiences his memories of Kurchatov and Abram Fedorovich Ioffe.

When we think of the long and fruitful life of Yurii Lukich Sokolov, we cannot but admire how fate combined in one person the talent of a most skilful experimenter and theoretical physicist with precision mechanical engineer, master turner, miller, metal worker, and polisher, plus inventor, designer, writer, and journalist: on the whole, a man of enormous knowledge and skills, of high culture and huge personal charm.

We cannot allow our memory to fade about his plans and his ideas, his magical creative hands, his soaring intellect and culture, and finally, his virtuoso experiments inviting the physics of the future. These were his words: "The memory lets nothing disappear".

S T Belyaev, E P Velikhov, A A Zamyatnin,
M B Kadomtsev, V I Kogan, V M Kulygin,
G von Oppen, V G Pal'chikov, V P Smirnov,
A Zeilinger, V D Shafranov, V P Yakovlev