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Kev Minullinovich Salikhov (on his 80th birthday)

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November 3, 2016 marks the 80th birthday of the prominent scientist, scientific supervisor of E K Zavoisky Kazan Physical-Technical Institute, Kazan Scientific Center of the Russian Academy of Sciences (KazSC RAS), Academician Kev Minullinovich Salikhov.

K M Salikhov is one of the leaders in theoretical chemical physics. He made a fundamental contribution to the formation and development of a new area of science, spin chemistry, to the creation of theoretical bases of magnetic effects in chemical reactions and the effects of hyperpolarization of electron and nuclear spins in the course of spin-dependent processes. For his results obtained in the theory of spin chemistry, he (on the team of authors) was awarded the Lenin Prize in 1986.

Kev Minullinovich laid the theoretical bases of the modern pulse methods of electron paramagnetic resonance (EPR) spectroscopy. He obtained fundamental results in the theory of spin coherence relaxation (phase relaxation) in paramagnets caused by dipole–dipole interactions between paramagnetic centers, and in the theory of spin-echo signal modulation due to hyperfine interactions between electrons and magnetic nuclei and to the spin–spin interaction between paramagnetic centers in spin clusters (pairs, triplets, etc.). KM's work on the theory of spin echo laid the theoretical basis for the study of the spatial distribution of paramagnetic centers formed during irradiation of substances and also for the development of nanometrology exploiting measurements of the magnitude of dipole–dipole interactions between paramagnetic centers (spin labels). At the present time, the pulse EPR methods are widely used in molecular biology to study the structure and molecular mobility through an address attachment of spin labels to checked molecules and to analyze electron spin echo signals.

KM made an outstanding contribution to the theory of electron spin coherence transfer and spin coherence relaxation caused by exchange interaction in the course of bimolecular collisions of paramagnetic particles (spin probes). He proposed kinetic equations for the spin matrix of paramagnetic particles with allowance for bimolecular collisions. The kinetic equations were derived for both neutral and charged particles. Electrolyte solutions were considered for the case of charged particles. The kinetic equations were obtained for the arbitrary kinematics of colliding particles passing through the region of their effective exchange interaction. These equations were utilized to calculate the rates of bimolecular spin exchange in collisions of free radicals, paramagnetic ion complexes of transition elements, triplet excitons, and positronium atoms. The spin exchange often serves as a model process for determining the frequency of bimolecular collisions in solutions. Therefore, the detailed spin exchange theory formulated by KM proved to be fairly claimed, especially in molecular biophysics and biochemistry, for instance, in examining the accessibility of ferment active regions for low-molecular substrates.

Kev Minullinovich Salikhov

One remarkable area of K M Salikhov's scientific activity covers the EPR study of spin-correlated Einstein–Podolsky–Rosen–Bohm (EPRB) type pair systems that can be exemplified by electron–hole pairs (ion–radical pairs) formed at the initial stage of solar energy assimilation in reaction centers of photosynthetic systems. These pairs of separated charges are born in the singlet spin state. KM predicted theoretically that during time-resolved experiments the EPR line intensities must oscillate and that the spin echo signals must possess an anomalous phase. These remarkable features of EPR spectra are due to spin coherence of the initial state of separated charges and to the subsequent spin dynamics. KM revealed another wonderful manifestation of spin coherence of EPRB type pairs in the experiment. In spin-correlated pairs, under the indirect observation of the EPR effect, e.g., in optical EPR detection, extremely narrow lines of two-quantum transitions

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can be registered even in the absence of interactions between the spins of the pair. KM's work demonstrated a considerable EPR potential in the study of coherent states of spin systems. These results are of great importance for quantum computations with the employment of unpaired electrons of paramagnetic centers as qubits.

K M Salikhov's scientific interest is currently focused on the development of new precise research methods and their application to systems that are promising for quantum informatics, spintronics, and optoelectronics. He pays great attention to the development of quantum computations using electron spins as qubits. K M Salikhov proposed a protocol of quantum teleportation in an electron spin system. The main peculiar property of this protocol is that the use of spin-dependent elementary chemicals acts as logical elements in the realization of an algorithm of quantum computing. A program of work on the practical application of quantum algorithms using spins is being developed under his guidance. He and colleagues were the first to propose a protocol for developing a quantum operation — a controlled NOT (CNOT) with the employment of electron spins as qubits. It was shown theoretically and experimentally that in EPR experiments using multipulse sequences the Zeno effect (paradox), well known in quantum informatics, appears.

The pioneering work of K M Salikhov brought him wide recognition. He was awarded the State Prize of the Republic of Tatarstan in the field of science and technology and a number of international prizes. He received the Order of Merits for the Fatherland, 4th degree, the Badge of Honor, and the Order of Merits for the Republic of Tatarstan. He was elected an Honorary Citizen of Kazan and an Honorary Member of the International EPR/ESR Society, 2014 and the International Society of Magnetic Resonance (ISMAR), 2015.

The breadth of K M Salikhov's creative thought, his startling creativity, endless optimism, and contagious enthusiasm invoke sincere admiration and inspire those who have been lucky enough to know him and to work with him. His youthful ardor is the foundation of new discoveries and developments.

Friends, colleagues, and disciples of Kev Minullinovich Salikhov heartily wish him sound health, happiness, and new achievements in science.

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