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PERSONALIA

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Yurii Moiseevich Kagan (on his 80th birthday)

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Professor Yurii Moiseevich Kagan, a Full Member of the Russian Academy of Sciences (RAS), an outstanding Russian physics theoretician, a scientist with an exceptionally broad range of interests in science, and with the brilliant mind and erudition of a physicist, celebrated his 80th birthday on July 6, 2008.

Yu M Kagan's pioneering papers, which preceded the advent of new fields in condensed matter physics and initiated a large amount of experimental and theoretical work, brought him widespread recognition. He won the Lenin and State Prizes, the M V Lomonosov Prize of the USSR Academy of Sciences, the A P Karpinsky Prize, and the Humboldt Research Award (Germany). He has recently received the RF Triumph Prize. Yu M Kagan was made DSc *honoris causa* by the University of Münich and Uppsala University, and was elected the Van der Waals Honorary Professor of Amsterdam University, a Member of the European Academy, and a foreign Member of the Hungarian Academy of Sciences.

Yu M Kagan was born in Moscow in 1928. His father Moisei Aleksandrovich Kagan was a qualified lawyer, who graduated from St.-Petersburg University before the 1917 revolution. His mother Rakhil Semenovna obtained a doctor of medicine diploma from Advanced Women's Courses. Both were born in Vitebsk.

Yu M Kagan's youth saw the difficult years of the Great Patriotic War and the post-war recovery. In 1943, at the peak of the war, he started working in the war industry. He was also attending evening classes for working youngsters. At 16 years of age he enrolled in the Moscow Aviation Institute. In February 1946 he transferred to the second year of the just created Department of Engineering Physics of the Moscow Institute of Mechanics (now the Moscow Engineering Physics Institute, MIFI) and graduated from there in 1950. His teachers in this department, created specially for training specialists for the Soviet Atomic Project, were such brilliant theoretical physicists as I E Tamm, M A Leontovich, I Ya Pomeranchuk, and A B Migdal. Even before graduation he successfully passed L D Landau's famous Theoretical Minimum exams, after which his whole life in physics was closely tied to the Landau school.

After graduation, instead of proceeding to the postgraduate program to which L D Landau had invited him, Yu M Kagan started independent research work at one of the secret 'objects' of the Soviet Atomic Project in Urals. There he authored the general theory of separation of isotopic gas mixtures in porous media. The original idea of replacing a porous medium with a heavy gas made it possible to obtain a unified solution for the entire pressure range from the Knudsen to the hydrodynamic regime. The results he obtained were used efficiently for finding the optimal operating parameters of the gas-diffusion plant separating uranium isotopes.

Yurii Moiseevich Kagan

In 1956, Yu M Kagan was invited to transfer to the Institute of Atomic Energy in Moscow (now the Russian Research Centre 'Kurchatov Institute'). His work in molecular physics was now extended by elaborating the kinetic theory of molecular gases with the rotational degrees of freedom. The introduction of the rotational angular momentum (in addition to the velocity of particles) changed radically the entire structure of the classical theory of gases and made it possible to develop the theory of transport phenomena in neutral gases in magnetic and electric fields. It became possible for the first time to explain the Sentfleben effect, known from the 1930s (changing kinetic coefficients of a neutral molecular gas in a magnetic field). The theory stimulated a considerable number of experimental studies in the homeland and abroad. Its results, which in fact became classical, moved to monographs and textbooks. The vector that plays the principal role in the theory, composed of the velocity vector and rotational angular momentum, is known as the 'Kagan vector'.

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In the 1960s, Yu M Kagan started an intense program of studies that covered various research areas in solid-state physics. Most of all, we need to point here to his important contribution to progress in the microscopic theory of metals, especially in revealing the role of electron liquid in the formation of the static and dynamic properties of metals, including their phonon spectra. A whole range of the results of principal importance are associated with his name in this field. Thus, the nature of unpaired forces in nontransition metals was understood, the problem of the equivalence between the dynamic and static compressibilities was resolved, and the specific features of multiparticle type phonon spectra of metals and the logarithmic singularity well-known now in a quasi-one-dimensional metal were predicted. It was proved for the first time that there is no upper bound on the magnitude of the electron – phonon interaction constant, which was extremely important for the quantitative analysis of superconductivity. The results of the theory were confirmed in numerous experimental studies. In 1975, the series of papers with these theoretical results was awarded the M V Lomonosov Prize of the USSR Academy of Sciences.

This series is closely related to Yu M Kagan's widely known papers on the theory of metallic hydrogen. They gave for the first time an exhaustive analysis of the crystal structure, the equation of state, and the vibrational spectrum of the metallic phase of hydrogen in metastable and stable states. A gloriously nontrivial result of this work, predicting that the highly anisotropic structures alone can be stable, was supported by the subsequent calculations by other authors who applied to it the entire power of modern computers.

Yu M Kagan's work played a significant role in improving our understanding of imperfect crystals. His prediction of the presence of quasilocal levels in the phonon spectrum of crystals with defects and the attendant sharp anomalies in thermodynamic, kinetic, and spectral properties stimulated a large number of experimental studies. One of the central series of projects he is still pursuing today deals with the theory of the amorphous state. Yu M Kagan and his disciples have proposed an original concept of the origin of universal low-temperature properties of amorphous bodies of a most different nature. It was demonstrated for the first time that there exist collective low-frequency excitations in glasses due to the interaction between tunneling centers; this made it possible to explain anomalous behavior in the propagation of sound and electromagnetic radiation at ultralow temperatures.

Yu M Kagan's widely known work on the coherent phenomena that accompany the resonance interaction of nuclear radiation (γ-quanta, neutrons) with crystals occupies a special place in his program. The effect he predicted — the suppression of a nuclear reaction in perfect crystals — has been discovered experimentally and studied in detail by a number of researchers. In his papers, Yu M Kagan introduced the concept of nuclear excitons delocalized over a crystal, and predicted changes in the lifetime of excited nuclear states; this effect was later discovered experimentally. The ideas developed in this study served as a basis for elaborating the general theory of excitation of nuclear isomeric states and of resonance nuclear diffraction in the field of synchrotron radiation. All the results of this theory were experimentally confirmed and are widely used at the world-leading sources of synchrotron radiation. It must be remarked that closely tied to this line of research is an important series of Yu M Kagan's papers on the theory of practically every solid-state aspect of the Mössbauer effect; they helped substantially in advancing the studies based on this effect in the homeland. Yu M Kagan made an important contribution to research in other fields of radiation interaction with matter as well. He developed the quantum theory of charged particle channeling and completed the building of the dynamic theory of X-ray diffraction taking atomic vibrations and temperature into account. Yu M Kagan advanced the idea of a bound state of the neutron inside matter; this neutron state was later found experimentally.

The study of low-temperature quantum kinetics in condensed media is undoubtedly a brilliant field of research in Yu M Kagan's scientific activities. This avenue opens with by now a classical paper by Yu M Kagan and I M Lifshits with a pioneering prediction that the kinetics of phase transition at temperatures close to absolute zero will be governed by the underbarrier tunneling of a growing nucleus of the new phase. A large portion of studies in this area is devoted to the theory of quantum diffusion of particles in insulators, metals, and superconductors. Analyzing this phenomenon demanded the development of the theory of underbarrier tunneling of particles under the strong interaction with electron and phonon excitations of the medium. Novel concepts were formed of the electron polaron effect, coherent and noncoherent diffusion, and the dynamic destruction of coherent correlations. Quantum diffusion and localization in irregular crystals were the subjects of special detailed study and an unexpected effect of self-localization in the process of the diffusion of interacting particles in ideal crystals was predicted. This effect was discovered experimentally when diffusion of ^{3}He atoms in the crystalline matrix of ^{4}He was investigated. Numerous experiments, some of them examining diffusion of muons and muonium in crystals, are still pursued today; all predictions of the theory were confirmed. That series of studies won the Lenin Prize (1986).

In recent years, Yu M Kagan's main scientific interests have concentrated on the problem of Bose condensation and superfluidity in the macroscopic quantum systems formed by ultracold gases. Yu M Kagan and his disciples made a considerable contribution to the coming of age of this field of research, which is vigorously expanding in many countries. The first stage of exhaustive analysis of the attainment of Bose condensation in spin-polarized atomic hydrogen, of the kinetics of condensate formation, and simultaneously of the stability problem for this metastable system was instrumental in the development of the fundamental concepts in this field. The prediction of the existence of a decay channel unavoidable in principle — the three-particle dipole recombination — and confirmed experimentally by all leading laboratories, played a significant role in changing the direction of research. Instead of increasing the gas density and achieving a substantial transition temperature, a tendency grew to drastically reduce gas density and switch to ultralow temperatures. That series of papers made a remarkable prediction: the effect of suppression of inelastic processes when the Bose condensate is formed. The experimental examination of this effect in alkali metal gas made it possible to use it for proving the formation of coherent correlations in the condensate.

A large series of papers was devoted to the kinetics of the formation of Bose condensate and superfluidity in an initially purely classical gas — one of the most interesting problems in this area. Of special interest is the work on the theory of the formation of a quasicondensate with the local correlation properties of a true condensate in the low-dimensional systems.

In the last several years, Yu M Kagan has been developing a theory explaining the nature of the loss of coherence, phase memory, and, consequently, of oscillation damping in a condensate at zero temperature. Another line of research led to predicting the surprising effect of anomalous transparency of the potential barrier separating two Bose condensates. Today the focus of his interest is the problem of Bose condensation in a gas of excitations in a stationary thermodynamically nonequilibrium system. The first publications on the subject appeared in 2007.

As head of laboratory and later of the Theoretical Division at the Kurchatov Institute, he brought up the 'Kagan school' — a pleiad of talented students having grown to CandScs, DScs, and corresponding members of the RAS. He is in fact an informal scientific supervisor of all experimental laboratories at the Kurchatov Institute connected with the physics of condensed media. The theoretical seminar led by Yu M Kagan is famous, and deservedly so. For many physicists (theoreticians and experimentalists alike) a successful presentation at this seminar is equivalent to getting a badge of high ranking. Yu M Kagan is a brilliant lecturer who at MIFI has delivered lectures in his course on 'Modern Solid State Theory' for nearly 40 years. These lectures nurtured, and continue to nurture, many generations of young physicists. His son Maxim Kagan, now a Corresponding Member of the RAS, was among the students who were attracted to the physics of the condensed state by these lectures.

One can only envy the vigor of Yu M Kagan's creative and social activities. He is essentially young at heart and strikes everyone by his passionate interest in new problems, his reactions to social phenomena, his undiminishing love of art.

Yurii Moiseevich's colleagues, friends, and disciples wish him happy birthday, along with good health, much happiness, and new brilliant achievements in science.

A F Andreev, S T Belyaev, E P Velikhov,
L P Gor'kov, M V Koval'chuk, L A Maksimov,
Yu A Osip'yan, L P Pitaevskii, A Yu Rumyantsev,
V B Timofeev, N A Chernoplekov, G M Eliashberg