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PERSONALIA

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In memory of Yurii Efremovich Lozovik

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An outstanding theoretical physicist, world-class scientist, head of the Nanostructure Spectroscopy Laboratory at the Institute of Spectroscopy of the Russian Academy of Sciences (ISAN), Yurii Efremovich Lozovik, passed away on June 24, 2024 at the age of 86.

Yu E Lozovik was born on November 1, 1937 in Tashkent. In 1960, he graduated from Tashkent State University (formerly Central Asian State University) with a degree in physics and received the classification of Secondary School Physics Teacher. He completed his postgraduate studies at the P N Lebedev Physical Institute of the USSR Academy of Sciences (FIAN) with a degree in theoretical and mathematical physics and defended his candidate thesis in 1974 at FIAN. He worked at the Institute of Spectroscopy beginning in 1968, and concurrently taught at the Moscow Institute of Physics and Technology (MIPT) and the Moscow Institute of Electronics and Mathematics (MIEM) of the Higher School of Economics (HSE). He was also an employee at the N L Dukhov All-Russian Research Institute of Automation (VNIIA).

Yu E Lozovik's scientific activity was quite multifaceted: his interests included solid state physics, the physics of nanostructures, clusters, and low-dimensional electron systems, nanoplasmonics, spectroscopy, photonics, photon crystal optics and quantum optics, quantum electrodynamics in a cavity, quantum calculations, superconductivity and superfluidity, collective effects in systems of excitons, magnetoexcitons, and polaritons, the theory of particles with fractional statistics, computer simulations of classical and quantum systems, graphene and carbon nanotubes, topological insulators, and other quantum materials.

In these fields, he obtained generally recognized scientific results. In particular, together with V I Yudson, he predicted the formation of a uniform coherent phase with Cooper pairing of spatially separated electrons and holes in bilayer systems leading to dipolar superfluidity and anomalies in drag effects. This effect has recently been experimentally confirmed in heterostructures based on two-dimensional materials — graphene and dichalcogenides of transition metals.

Together with I V Lerner, he formulated a magnetoexciton theory in quasi-two-dimensional systems in strong magnetic fields, including the theory of collective magnetoexciton effects: phase transitions, Bose condensation, and strongly correlated states. Proposed was a way of scanning dispersions of dipole excitons and magnetoexcitons by a parallel magnetic field in experiments on their luminescence, further realized by L V Butov's group.

Yu E Lozovik predicted Wigner crystallization of electrons in quasi-two-dimensional systems in strong magnetic fields and obtained fundamental results in the theory of

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Yurii Efremovich Lozovik
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composite fermions occurring in the regime of the fractional quantum Hall effect. He proposed the method of creating a rapidly moving 'plasma mirror' in a semiconductor using a femtosecond laser pulse, later realized experimentally and allowing observation of the dynamic Casimir effect — photon production from a vacuum in an electromagnetic resonator as a result of a sharp change in boundary conditions. A self-consistent crystal melting theory was formulated and the effect of orientational cluster melting was predicted. Also predicted was the dynamic Lamb effect — parametric atom excitation through shaking of its virtual 'photon coat' or Lamb shift modulation due to a rapid variation in the properties of the resonator surrounding the atom.

Among the recent results obtained by Yu E Lozovik together with his students, one can note a new method of increasing the lifetime of two-dimensional direct excitons using photon state engineering, allowing the possibility of observing exciton condensation at high temperatures; the prediction of many new collective effects in graphene and in other Dirac materials; and the development of the spaser theory on the basis of new nanomaterials. The Keldysh

Yurii Efremovich Lozovik was a regular and very active participant in famous All-Moscow Seminar on Theoretical Physics (better known as Ginzburg's Seminar) held from 1956 to 2001 at P N Lebedev Physical Institute of Russian Academy of Sciences (FIAN) directed by Vitaly Lazarevich Ginzburg (later, the 2003 Nobel Prize laureate in physics). Photograph shows one of 1700 sessions of seminar in FIAN assembly hall (photo taken no later than January 1980).

technique was used to develop a consistent microscopic theory of an open system of polariton condensate in a reservoir; a Hall spin effect for polaritons in two-dimensional dichalcogenides of transition metals was predicted.

Yu E Lozovik formulated a theory and predicted the properties of collective excitations in an electron liquid in a chiral two-dimensional electron liquid on the surface of a three-dimensional topological insulator and predicted a resonant amplification of the magnetoelectric effect and of the related Faraday effect in topological insulators due to chiral excitons. The theory was developed of the condensation of polaritons as two coupled condensates — an exciton condensate and a photon condensate having different spatial profiles due to different 'healing' lengths; the vibrational dynamics of this exciton–photon system was studied under detuning of cavity exciton and photon resonance, and it was predicted that, along with Rabi oscillations, oscillations of the relative phase between the condensates arise in the system — the internal Josephson effect.

Yu E Lozovik published over 700 papers, including 18 reviews (15 of them were published in the journal *Uspekhi Fizicheskikh Nauk* (*UFN*), see https://ufn.ru/ru/authors/731/lozovik-yurii-e/) and collective monographs. The new physical effects predicted by him (equilibrium condensation of spatially indirect electron–hole pairs, Wigner crystallization of two-dimensional electron gas induced by a magnetic field, the dynamic Casimir effect in a system with a plasma mirror, the formation of magnetoexcitons in quasi-two-dimensional systems, and some others) were confirmed experimentally and are widely cited.

Yu E Lozovik was a member of the Academic Council of the Institute of Spectroscopy of the Russian Academy of Sciences and a full member of the European Academy of Sciences. He was a member of the editorial board of the international scientific journal *Solid State Communications*. He collaborated with several universities in Germany, the USA, and Spain. He was the principal investigator of grants from the Russian Foundation for Basic Research (RFBR), the Russian Science Foundation (RSF), and the RF Ministry of Education and Science, joint grants with foreign countries, and grants from the Samsung and General Electric companies. In 1998–2000 and 2001–2004, he was a recipient of grants for outstanding scientists. In 2002, he received the prize for the best publication in Russian scientific journals. He was awarded the Certificate of Honor of the Russian Academy of Sciences. He was awarded the title of Person of the Year 2011 in the science category in the city of Troitsk. He received the Letter of Gratitude and the 1918 Moscow Mayor's Prize.

Under the supervision of Yu E Lozovik, more than 40 candidate theses were defended. Many of his students are now professors in Russia, the USA, England, Germany, the Netherlands, Spain, and Australia.

The blessed memory of Yurii Efremovich will forever remain in our hearts, and his scientific results and ideas will foster further theoretical and experimental studies of new generations of scientists.

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L A Surin, A M Shalagin, V I Yudson