Yuri L'vovich Klimontovich (28.09.1924–26.10.2002)

This issue is devoted to the memory of Professor Yu.L.Klimontovich, an outstanding theorist whose ideas and works have been a great contribution to modern kinetic theory and statistical mechanics. Without his fundamental papers and books it is impossible to imagine many fields of theoretical physics (such as statistical plasma theory, kinetic description of nonequilibrium processes in non-ideal gas and non-ideal plasmas, theory of turbulence, theory of open systems, fluctuations in quantum and relativistic systems, etc.).

Yu.L.Klimontovich was born on September 28, 1924, in Moscow. His parents belonged to noble families which fact has turned out to be a sufficient reason for his father to be subjected to repression in the 1930$^{\text{th}}$. Nevertheless, Yuri managed to enter the Lomonosov Moscow State University and to graduate from it in 1948. He performed his diploma work under the supervision of Prof. V.S.Fursov. The study concerned the retardation effects in the theory of light scattering by molecular systems. Later it was published as the first Klimontovich's paper in the Journal of Theoretical and Experimental Physics.

After graduating from the University, Yu.L.Klimontovich continued his scientific activity as a Ph.D. student of Prof. N.N.Bogolyubov, famous mathematician and theorist, one of the founders of the modern theory of kinetic processes. The outstanding Bogolyubov's ideas concerning the dynamical problems of statistical mechanics have made noticeable influence on Klimontovich and have been developed in his further activities. In 1951 Yu.L.Klimontovich successfully defended his candidate thesis

and started to work out his own scientific ideas concerning the microscopic description of many-particle systems, in particular, nonequilibrium plasmas. The key point of the theory proposed by Yu.L.Klimontovich is the description of a microscopic state of the system under consideration in terms of the microscopic phase density

$$N(X,t) = \sum_{i=1}^{N} \delta\left(X - X_i(t)\right), \qquad X \equiv (\mathbf{r}, \mathbf{p})$$

which satisfies the continuity equation in the phase space. Such an equation has the form of the well-known Vlasov equation, however, the physical as well as mathematical meaning of $N(X,t)$ is quite different from the distribution function $f(X,t)$ which is an averaged regular quantity while $N(X,t)$ is the random quantity described in terms of the generalized functions. The solution of the equation for the microscopic phase density requires the knowledge of phase trajectories. In this sense the problem is equivalent to the N-body problem. However, the formulation of the microscopic description in terms of $N(X,t)$ is much more convenient for the development of various approximate approaches. Yu.L.Klimontovich has shown how to use this advantage and gave a new treatment of the theory of nonequilibrium plasmas, fluctuation electrodynamics in particular. The proposed approach turned out to be especially useful for the derivation of the collision terms and various generalizations thereof (retardation, electromagnetic effects, etc.).

During this period Yu.L.Klimontovich fruitfully collaborated with V.P.Silin. This collaboration resulted in the theory of excitations in an electron gas and quantum microscopic description of the Coulomb systems.

In 1962 Yu.L.Klimontovich received his second scientific degree (doctor of physics and mathematics) from the Steklov Mathematical Institute. From 1964 and till his last days he occupied professorship in the Lomonosov Moscow State University. The same year 1964 he published his first book "Statistical Theory of Nonequilibrium Processes" (Moscow State University Publ. House, Moscow, 1964) which opened a new page in the kinetic description of nonequilibrium plasmas. After the publication of this book, the terms "Klimontovich-Silin approach", "Klimontovich distribution function" and "Klimontovich equation" became widely used in scientific literature.

One more advantage of the microscopic-phase-density formalism is the possibility to extend it to the case of non-ideal gas and non-ideal plasma, as well as to the description of large-scale (kinetic) fluctuations. With the microscopic equations being smoothened over a physically infinitesimal time (or spatial) scale, one obtains an equation for the smoothened microscopic phase density. This equation has the form of a kinetic equation with the collision term determined by the microscopic fluctuation spectra (microscopic fluctuations are the fluctuations with correlation times much smaller than the physically infinitesimal time that defines the level of kinetic description). However, the smoothened microscopic phase density still can be treated as a random quantity and thus the kinetic equation can be used as a basic equation to work out the theory of large-scale fluctuations (in the same way as the theory of microscopic fluctuations). Large-scale fluctuation spectra generate additional collision terms responsible for the relaxation of random perturbations of distribu-

tion functions (for example, in the case of turbulent systems). Yu.L.Klimontovich has developed this general approach and, besides that, has shown how to introduce the physically-infinitesimal scales for various systems and thus has opened new possibilities for the description of kinetic fluctuations in both classical and quantum systems. Moreover, the introduction of appropriate physically-infinitesimal scales makes it possible to find the way of unifying the kinetic and hydrodynamical description. This was also done by Yu.L.Klimontovich.

Professor Klimontovich considerably contributed to the theory of plasma-molecular systems. In this theory, the contribution of a molecular subsystem (atoms and molecules) into electromagnetic fluctuations and structural properties of the system under consideration is treated on equal footing with the contribution of plasma particles. The kinetic theory of electromagnetic processes in molecular systems and plasmas that had been developed by Klimontovich earlier, has provided a natural basis for such unification. In this point it is extremely important that Klimontovich's approach (which is used as a basis in formulating the above mentioned kinetic theory) was developed for both classical and quantum models of particles and fields. This makes it possible to consistently describe electromagnetic field interaction with electrons, ions, and atoms, as well as the processes of ionization and recombination. Effects associated with radiation friction, finite line-widths of atom levels and collisions between plasma particles and atoms can be also taken into account. The fluctuation theory of bremsstrahlung in plasma-molecular systems could be regarded as an example of the efficiency of the proposed theory. During about 20 last years of his life Yu.L.Klimontovich dealt with the statistical theory of open systems. He was interested in the most fundamental questions of this field. What is a measure of stochasticity in an open system (in particular, under developed turbulence) and how to introduce such a measure? Which state is more regular – equilibrium or turbulent? What are the general principles of selforganization? Yu.L.Klimontovich gave special attention to the problems of open and dissipative quantum systems. In these fields he also managed to obtain excellent results. These include the proof of the S-theorem, derivation of the fluctuation-dissipation relations for quantum systems with dissipation (atoms in radiation fields included), fluctuation processes in lasers, nonequilibrium phase transitions in quantum systems. The basic problems of theoretical physics, such as superconductivity, superfluidity, flicker noise, quantum Hall-effect and many others also were among his scientific interests.

Yu.L.Klimontovich was a bright representative of Moscow professors possessing wide knowledge in various fields of science and culture. It was very interesting to discuss with him problems of physics, history, philosophy, literature and arts. Everybody who contacted him felt his friendly spirit.

The scientific activity of Yu.L.Klimontovich has been honored in many countries. He was the winner of the State Prize of Russia (1991), the Sinel'nikov Prize of the Ukrainian Academy of Sciences (1990), the Kapitsa golden medal of the Russian Academy of Natural Sciences (1997), and the Prize of the Humboldt Foundation (1994). He was honored by the degree "Doctor Philosophy Honoris Causa" from the Rostock University (1992), the Soros professorship (1995, 1997) and Senior Fellow-

ship of the Cariplo Foundation (Italy, 1997). However, probably the most important honor for Yu.L.Klimontovich is his wide recognition by the world scientific community.

A.Zagorodny

List of books by Yu.L.Klimontovich

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5. Klimontovich Yu.L. Statistical Physics. Nauka, Moscow, 1982; Harwood Academic Publishers, New York, 1986.

6. Ebeling W., Klimontovich Yu.L. Selforganization and turbulence in liquids. Teubner, Leipzig, 1984.

7. Ebeling W., Fortov V.E, Klimontovich Yu.L., Kovalenko N.P., Kraeft W.D., Krasny Yu.P., Kremp D., Kulik P.P., Riaby V.A., Ropke G., Rozanov E.E., Schlanges M. Transport properties of dense plasmas. Boston/Stuttgart, Birkhauser Basel, 1984.

8. Klimontovich Yu.L., Wilhelmson H., Yakimenko I.P., Zagorodny A.G. Statistical theory of plasma-molecular systems // Physics Reports, 1989, vol. 175, p. 263; Russ. transl. Izd. MGU, Moscow, 1990.

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