Obituary

Professor Vladimir Semenov

1952 – 2017

Vladimir Evgenievich Semenov, leading research scientist of the Institute of Applied Physics of Russian Academy of Sciences, passed away on October 13, 2017 at an age of 64, after many years of struggling with cancer. He was a truly remarkable person and an outstanding scientist, one of the most brilliant representatives of the Nizhny Novgorod scientific school of radiophysics. He was committed to science to the very end, and continued research activity until his last days.

Vladimir Semenov was born on December 11, 1952 in the city of Gorky (now Nizhny Novgorod), Russia. He obtained his diploma in radiophysics with honors from Gorky State University in 1975. Upon graduation, he took his first research position at the Radiophysics research institute. Since 1977 he worked at the Institute of Applied Physics of Russian Academy of Sciences. At this institute he obtained his PhD (1983) and Doctor of Science (1997) degrees in plasma physics and chemistry. Since 2000 he had held the position of Head of the Plasma Physics Department at the institute.

Since his first scientific publications, V. E. Semenov was recognized as a highly qualified and ingenious researcher in the field of electrodynamics and plasma physics. His earlier studies focused on the dynamics and structures of gas discharge ignited by focused beams of high power microwave radiation in free space. The interest in this subject was associated with the ongoing development of high power microwave sources, gyrotrons, at the Institute of Applied Physics. Dr. Semenov developed theoretical models for a number of microwave discharge related phenomena in rarefied and dense gases, including ionization instabilities, stationary structures, breakdown threshold in non-uniform microwave field, propagation of ionization fronts towards the incident microwave radiation. His theoretical predictions were confirmed in many experiments.

Vladimir Semenov had a remarkably broad range of scientific interests. He is an author of more than 300 scientific publications in plasma physics, electrodynamics, hydrodynamics, continuous media mechanics, nonlinear dynamics, and materials science. He had collaborated with more than 30 research groups providing valuable advice, theoretical analysis and interpretation of experimental findings of very different nature. In particular, especially fruitful was his long-lasting collaboration with an international consortium Chalmers University of Technology (Sweden) – CNES (Centre National d'Études Spatiales, France) – Universitat Politècnica de València (Spain).

Listed below are some of the subjects and most important results of his publications:

- general study of non-linear waves: derivation of generalized adiabatic invariants and discovery of stable auto-solitons in systems with global nonlinearity;
- electromagnetic wave propagation in non-stationary media: a theory of frequency up-conversion of the electromagnetic wave propagating through an ionizing medium;
- plasma confinement and electron-cyclotron resonance (ECR) heating in magnetic mirror traps:
- development of a hydrodynamic approach to the plasma confinement problem which is used to optimize operation of ECR sources of highly charged ions;
- plasma expansion into vacuum: derivation of an analytical solution describing expansion of localized plasma bunch having arbitrary distribution functions of electrons and ions;
- gas breakdown phenomena in terahertz electromagnetic waves: a theory of the breakdown delay

and an explanation of the experimentally observed discharge structures depending on the field frequency and air pressure;
- nonlinear phenomena in optics: significant contribution into a development of the theory of propagation of partially incoherent light in nonlinear media;
- microwave breakdown in space-borne communication systems: theory of corona and multipactor discharge in non-uniform microwave fields which is used to predict the breakdown threshold in different microwave components.

The microwave heating community was lucky to have Vladimir Semenov participate for more than 25 years in the study of the electromagnetic field effects on high-temperature mass transport in solids and other fundamental aspects of microwave processing of materials. His most important seminal contributions into understanding microwave–material interactions include:
- theory of non-linear interaction of microwave electromagnetic field with charged defects in ionic crystalline solids;
- analysis of the influence of microwave-induced non-uniform temperature distribution on sintering within a framework of a viscoelastic model;
- models of effective dielectric and magnetic properties of consolidated dielectric and metal powder materials;
- advanced modeling of electromagnetic field distribution in multimode cavities;
- analysis of the global and local regimes of the superheating instability (thermal runaway) under microwave heating.

In the field of microwave processing of materials Vladimir Semenov collaborated intensely with a number of research teams, including those of the Institute of General Physics (Moscow, Russia), Institute for Problems in Materials Science (Kiev, Ukraine), Kyrgyz-Russian Slavic University (Bishkek, Kyrgyz Republic), Karlsruhe Institute of Technology and Universität Bayreuth (Germany), University of Nottingham (U.K.), University of Maryland and University of Wisconsin – Madison (U.S.A.).

Many colleagues recall their informal discussions with Vladimir who always aimed at obtaining in-depth understanding of the physics underlying the observed effects. He contributed to a number of comprehensive reviews of the physical aspects of microwave processing of materials.

Professor Semenov invested a vast amount of his talent, knowledge and passion into teaching. For over thirty years he had been teaching a number of theoretical physics courses to the students of the Advanced School of General and Applied Physics, a university department run by the Institute of Applied Physics. He developed original courses in thermodynamics and statistical physics, theoretical mechanics, continuous media mechanics, and physics of the gas discharge. He constantly strived to foster deep understanding and intelligent application of knowledge by his students. Many of his former students have built strong careers in science and technology, and they remember him as a teacher who gave them the most important skills in their professional life.

Vladimir's willingness to offer help, advice and encouragement not only in professional activity but also in everyday life was appreciated by all who knew him. A man of the highest moral principles, he possessed a keen sense of fairness and remained objective in any discussion. His encyclopedic knowledge combined with an unusually broad range of interests and an amazing sense of humor made him an excellent companion. He passionately loved nature, enjoyed walks in the autumn forest, skiing, canoeing, and summer fishing on the Volga.

Vladimir Semenov's sad demise is an irreparable loss for his friends, colleagues, and relatives. He will be missed by all who knew him.

Kirill Rybakov and Yury Bykov

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