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PERSONALIA

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In memory of Yuriĭ Sergeevich Sigov

Yuriĭ Sergeevich Sigov, a highly talented physicist, an authority on computational plasma physics, died on February 21, 1999. It was his fate to create this field of plasma physics from scratch, overcoming the difficulties that are tackled only by those who lead the way. He was able to make an important contribution to the progress in the theory of moderate turbulence in plasma, and has left a trace of indelible value in the Russian and world fundamental science by his research into self-organization of matter.

Yuriĭ Sergeevich Sigov was born on July 9, 1934 in the township of Krasnyĭ Luch of the Lugansk region. He was trained as nuclear physicist at Moscow State University; he lived in its student campus, was much loved by his fellow students, earned an honorary individual stipend, and graduated *cum laude* in 1958. It was a happy time for him, full of humor and intellectual give-and-take, and it shaped many outstanding sides of his character; it charged him with a good deal of optimism, with scientific daring and independence. Sigov's contemporaries, colleagues and disciples will remember Yuriĭ Sergeevich as a kind, luminous person, young at heart. He worked in the M V Keldysh Institute of Applied Mathematics, RAS for more than 40 years. He presented and brilliantly defended his thesis for Candidate of Physicomathematical Sciences in 1965 and thesis for Doctorate of Physicomathematical Sciences in 1980, becoming a professor in 1989 and finally the Chief Researcher of the Russian Academy of Sciences. Sigov had created around himself a scientific school that was not limited to the laboratory of 'Kinetic Models of Plasmas and Condensed Matters' which he headed for the last ten years. Yu S Sigov was a founder of the computational experiment in plasma physics both in Russia and in the world; using computers made in this country, which grew into powerful tools of modern research, he produced first-class results in space electrodynamics (1964 – 1967), controlled nuclear fusion (1972 – 1990) and synergetics.

As early as in 1960s Sigov discovered strata of charge density in the wake of the plasma flow around a satellite; this was a result of the formation of a standing ion-acoustic wave in outer space.

The development of complex kinetic codes based on the Vlasov – Maxwell equations made it possible to obtain results of a principal nature in the theory of parametric plasma heating and in numerical kinetic models of plasma turbulence. In the early 1970s, Yu S Sigov laid the foundation of discrete simulation of plasmas by macroscopic particles (1974); this was later applied to studying the strong Langmuir turbulence (SLT) by the techniques of kinetic theory (1975). Indeed, the theoretical predictions (1964 – 1972) on the importance of the modulation instability of plasma in the rise of electrostatic turbulence were confirmed by the numerical experiments on parametric plasma heating (1974 – 1977) run at the M V Keldysh Institute of Applied Mathematics.

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(09.07.1934 – 21.02.1999)

Furthermore, the mechanism of collisionless absorption of high-frequency energy by the plasma, based on the concept of the Langmuir collapse, and the phenomenon of short-wave plasmon transfer across the spectrum were first deciphered in the 1970s owing to Yu S Sigov's calculations; their analysis indicated the prevalence of Landau damping in this mechanism. The power-law behavior of the Langmuir spectra and the exponential shape of the tails of the electron distribution function also followed from his unique numerical experiments.

In his numerical experiments of 1976, Yu S Sigov obtained fundamental results, which were included to his DSc thesis: he discovered the generation of short-wave ion sound at the kinetic phase of collapse in nonisothermal plasma; this pointed to a possible additional channel of collisionless dissipation of wave energy in the SLT conversion of plasmons on short-wave fluctuations of ion density. Sigov

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simultaneously discovered the effect of forced collapse (quasi-collapse) of the one-dimensional ion cavity.

Investigations on counter plasma flows and current systems carried out in the 1980s allowed him to discover the generation of nonstationary double layers in 'open plasma systems'; the appearance of these layers is caused by the development of a nonlinear stage of the Buneman instability in plasmas. These results were soon confirmed in laboratory experiments by professor Y Takeda. The mechanism of electron thermalization in the flow mixing zone was deciphered. Yuriĭ Sergeevich regarded these results as extremely important and of principal significance. These findings remain quite relevant today for astrophysical and space research.

When studying moderate turbulence (1977 – 1997) in recent numerical experiments, Yu S Sigov discovered the correlation instability of high-temperature plasma, established that it is caused by coherent processes and studied the regularities of these processes. A number of effects of principal importance were found in the classical problem of collisionless relaxation of a nonrelativistic 'spread' electron beam which is steadily injected into a semispace occupied by an initially unperturbed plasma with a Maxwellian energy distribution of particles. A correct solution to this fundamental problem is closely related to the applicability of the quasi-linear theory to the description of nonequilibrium plasma systems, or rather, with its inapplicability to 'open systems'.

The numerical solution of the complete set of the Vlasov-Poisson equations allowed Sigov and co-workers to trace the essential differences between the self-consistent relaxation of beam particles and the plasma, on one hand, and the waves generated in the described 'open system' in the framework of the quasi-linear theory:

the correlation between field fluctuations and particle motion results in the shaping of wave packets that consist of correlated modes and form an ordered cellular structure on the phase surface, which is typical of moderate turbulence;

the trapping of beam particles by high-intensity coherent wave packets modifies the 'slow' diffusive regime of relaxation in the phase space to the 'fast' convective regime, in which the growth rates of the harmonics that form the packets are greater than the corresponding magnitudes in the quasi-linear theory;

the wave packets supply an important contribution to the plasma energy balance which is dictated by the capture and ballistic acceleration of the particles from the background plasma;

the coherence of the modes that make up the wave packet results in specific manifestations of modulation instability which occurs at a late stage of beam relaxation, leading to the formation and ensuing (forced) collapse of ion density cavities.

These results were awarded the Main Prize of MAIK Nauka, the publishing holding, as one of the best natural science publications in Russia in 1997.

Yu S Sigov arrived at the above conclusions, as he had arrived at many others, through the enormous physical intuition of a brilliant theoretician; it will be impossible to resign ourselves to this loss. A person with a very acute sense of human dignity, he was a true friend to those who had the good fortune of wining his respect. Let us keep our faith and gratitude remembering of this outstanding scientist and a noble man of our age.

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