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***PERSONALIA***

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# Aleksandr Viktorovich Gurevich (on his seventieth birthday)

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The outstanding talent of A V Gurevich — the physics theorist whose 70th anniversary came on 19 September 2000 — has shone in such fields of physics as plasma physics, radiophysics, astrophysics, cosmology and mathematical physics. The span of this list reminds us more of theoreticians from generations separated from us by several decades, not of the current era of pragmatic specialization. Another unusual aspect lies in the fact that in all these fields A V Gurevich produced not merely a number of high-caliber results but that he wrote papers that grew into fully-fledged branches of not only theoretical but also experimental research.

We begin our brief outline of select papers of A V Gurevich with that on the theory of runaway electrons. Even the first experiments on plasma confinement in the 1950s pointed to a considerable excess of high-energy electrons as compared with the numbers expected in the case of an equilibrium velocity distribution. A V Gurevich considered the problem of motion of a group of fast electrons placed in permanent electric field, taking into account that their scattering cross section on thermal electrons and plasma ions decreases as the particle energy increases. A consistently constructed theory of this effect provided a quantitative description of the flux of fast particles from the thermal-energy to the high-energy range. One unexpected result of this study was that a non-equilibrium state with a non-Maxwellian distribution function arises in the plasma in any, even arbitrarily low electric field. This is the principally important distinction of a plasma from a gas.

This work of A V Gurevich was at the time the second important step, after L D Landau's theory of damping, to the construction of the kinetic theory. In contrast to the traditional application of the kinetic equation method, of deriving hydrodynamic equations and calculating transfer coefficients in them which traces back to S Chapman and D Enskog, this work discovered essentially non-hydrodynamic solutions. The kinetic theory thus ceased to be an auxiliary tool of hydrodynamics and was shown to describe essential features of a physical phenomenon.

Using the concept of runaway electrons, in the 1990s A V Gurevich suggested a new mechanism of electric breakdown in gases. The idea was that in the electric field, a bare 'runaway' electron ionizes the neutral gas by collisions, generating, together with a large number of low-energy electrons, a certain number of electrons with energies sufficient to overcome ionization losses. These newly generated fast electrons are in their turn accelerated by the electric field and ionize the gas. The avalanche of fast electron will thus rapidly grow. The kinetic theory of this phenomenon, created by A V Gurevich and K P Zybin and their co-authors, demonstrated that the threshold electric field for this phenomenon is about one tenth of the value in conventional breakdown while the spatial scale of avalanche growth at atmospheric pressure is only about a hundred meters. This work was greeted by experts on atmospheric electricity who observed the emission of X-rays during electric storms and whose measurements of electric fields in storm clouds invariably yielded values that in terms of the conventional mechanism were deemed insufficient for electric breakdown of the gas. On A V Gurevich's initiative, experimental studies and observational work were started on breakdown due to escaping electrons.

Aleksandr Viktorovich Gurevich

The subject that stimulates greatest enthusiasm in A V Gurevich is the physics of nonlinear phenomena. Beginning with the work on ionospheric dynamics, i.e. the theory of flow around body by rarefied plasma (1957) and the paper on nonlinear waves in plasmas together with V L Ginzburg (1960), A V Gurevich is still excited today by the rich variety of problems and possibilities in the field.

The analysis of ionospheric and space plasmas is important for A V Gurevich not only because plasma is the main state of matter beyond the bounds of terrestrial atmosphere but also because it is in space that the plasma manifests its properties in a 'cleaner manner' than in terrestrial set-ups, and thus opens ways to developing novel theoretical concepts. A string of consecutive papers were devoted to the theory of nonlinear modification of the ionosphere subjected to intense

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radio waves. It was predicted that such waves could produce instabilities in the ionospheric plasmas, resulting in nonlinear absorption of the radio wave, its demodulation and self-focusing. Various plasma waves are generated in the zone of the perturbed radiowave, which results in a nonlinear plasma turbulence. This manifests itself in the acceleration of electrons and in the generation of radio emission from stable plasma structures. In response to the stimulating ideas emanating from A V Gurevich, special high-power radio units were erected in the USSR, USA and in Northern Europe to probe and locally modify the ionosphere.

In the 1970s A V Gurevich and L P Pitaevskiĭ formulated and solved the problem of the structure of the dissipationless shock wave in a dispersive medium. The perturbation of a dissipationless medium with zero dispersion is known to generate a singularity in a finite time. A V Gurevich and L P Pitaevskiĭ were able to show that with non-zero dispersion, an expanding zone of oscillation forms instead of a singularity. The solution was constructed by averaging the Korteweg – de Vries equation by the Witham technique. The authors demonstrated the advantages of this method for the construction of multi-soliton solutions as compared with the inverse problem method for scattering. This feature attracted many theorists and grew into a new field of analysis of exactly integrable equations.

In recent years A V Gurevich embraced the problem of describing turbulence in dissipationless medium with non-zero dispersion. Together with his co-authors, he was able to show that in such a medium, a rich class of deterministically prescribed initial perturbations will evolve to a chaotic state whose statistical characteristics are calculated from the initial perturbation.

In the 1980s A V Gurevich, V S Beskin and Ya N Istomin constructed the theory of pulsar magnetospheres and radio emission from pulsars. This series of papers is very typical of A V Gurevich's style in physics. He loves concrete physics, that is physics based on experiments and observations, but he regards it first and foremost as a source of new theoretical problems, not as a field of application of previously developed models. This always drives him to what he himself calls a 'closed formulation of a problem'. He invariably emphasizes: "One has always to strive to build a coherent self-consistent theoretical model that stems from the 'relevant physics'. The observable characteristics of a phenomenon must only then be generated as natural consequences of the theory". To be accordingly specific, the authors have constructed a theory of physical phenomena that take place in the neighborhood of a strongly magnetized rotating conducting sphere. It was discovered that the principal feature of this system is the spatial structure of currents that flow in the magnetosphere and close the circuit on the surface of the sphere. Thus it is the ponderomotive action of surface currents that causes the slowdown of the rotation rate of pulsars (which we known to manifest itself in the reducing repetition rate of their radio emission pulses). This statement sounds trivial nowadays but about 15 years ago astrophysicists were up in arms against it. Having supplemented this picture with the pioneering consistent kinetic theory of creation of a relativistic electron-positron pair close to the magnetic poles of the neutron star and the theory of generation of coherent radio emission, the authors obtained another 'first': a closed physical model of a pulsar magnetosphere that was found to agree well with observational data.

A V Gurevich has given the last nearly forty five years to working in the Theoretical Physics Division of the P N Lebedev Institute of Physics of the Academy of Sciences. Having risen to chairmanship of this Division, he strives to maintain the spirit of devotion to science, kindness and impeccably clear conscience as planted in his time by Igor Tamm; this spirit formed him as a scientist and shaped his personality. This hard work can only be appreciated by someone who had to manage five dozen theoretical physicists. There is no doubt that one of the levers that Aleksandr Viktorovich uses is his beaming smile which broadcasts genuine welcome and kindness.

Aleksandr Viktorovich has managed to live through the problems of growing into the post-Soviet era. He is happy to be able to gather an actively working group of students and colleagues around him but still sighs sometimes: "A grant would never be enough to build a 'Bomb' (or in other English words "It is impossible to create a 'Bomb' on a grant")". And follows it with a reflection in his inimitable style: "I do not mean a hidden something here but rather a conditional something". Among his other aphorisms, we will mention his formulation of the impossibility of guiding and advising his group by e-mail while on a long visit abroad: "If you are not there — you are *not there*!" ("You *do not exist* being absent.") A summary of a research effort is sometimes put into this format: "We suspected something but it proved to be a *real something*".

Even having reached his seventieth anniversary, A V Gurevich still generates more working ideas than he has hours in a day to devote to implementing them. We wish Aleksandr Viktorovich's contagious optimism to keep propelling him through the barriers that life inevitably erects.

*V S Beskin, A V Gaponov-Grekhov, V L Ginzburg, K P Zybin, Ya N Istomin, L V Keldysh, O N Krokhin, L P Pitaevskiĭ, M O Ptitsyn, V I Ritus, V Ya Faĭnberg, E L Feĭnberg*