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In memory of Sergeĭ Aronovich Fayans

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Fayans Sergeeĭ Aronovich, a well-known physics theorist, outstanding expert in theory of nuclei and the physics of weak interactions, DSc in physics and mathematics, died on May 16, 2001 after a severe illness.

In 1961, having completed his military service, S A Fayans enrolled in the Moscow Engineering Physics Institute, from which he graduated *cum laude* in 1967. The next year he entered the postgraduate course of the I V Kurchatov Institute of Atomic Energy and joined a group of young researchers guided by A B Migdal, his science adviser; at the time the group was vigorously advancing a new approach to the theory of the nucleus: the theory of finite Fermi systems (TFFS).

S A Fayans chose the aspect of nuclear β-decay. Even his first publications manifested the characteristic features that are typical of his entire contribution to physics. First, it was a profoundly detailed analysis of a problem, an effort to reach the core of the matter, and second, it was the reliability and extremely high measure of acceptability of the results obtained. Not a single paper out of more than a hundred published by S A Fayans was found to be in error.

Among the results obtained during this first period we will single out the explanation of the 'RaE paradox', widely discussed at the time. This term, in the parlance of the scientific community, stood for the considerable discrepancy between the experimental probability of the β-decay of the ^{210}Bi nucleus (denoted by RaE in an obsolete classification) and the existing theoretical calculations. S A Fayans conducted a detailed study of this process in the TFFS framework taking into account numerous correction terms, and the paradox was essentially resolved.

At approximately the same time S A Fayans carried out another research project of fundamental importance: an analysis of electromagnetic corrections to the superallowed nuclear β-transitions $0^+ \to 0^+$ which are important for precision evaluation of the constant G_V of the vector weak interaction of hadrons. The problem is still regarded as important in our times and Fayans' work of thirty years ago is still quoted as the most reliable and thorough analysis of the problem. In 1970 S A Fayans presented and defended his PhD thesis on the basis of this and several more publications on weak interactions in nuclei.

Having completed his postgraduate course, S A Fayans headed a small team of theorists in the experimental laboratory of L A Mikaelyan who at the time was drawing plans and later implemented experiments with reactor neutrinos. Here Fayans worked until the end of his life first as a junior and then as a senior research scientist, and from 1990 on — as leading research scientist. S A Fayans greatly contributed to the theoretical foundation of the experiments run at the laboratory and in general to the physics of low-energy neutrino interactions with matter. S A Fayans combined this work with a profound study of the structure of atomic nuclei. His most significant results were obtained in this field. His work on a self-consistency relation in finite Fermi systems between the one-particle Green's function and the effective two-particle interaction proved to be especially important; it was done in 1973 together with V A Khodel. It provided a basis for developing a new approach to the nuclear theory, later known as the self-consistent TFFS.

Sergeeĭ Aronovich Fayans
(12.11.1938 – 16.05.2001)

An important role was also played by a technique, developed during the same years, for an exact calculation of the continuum contribution to equations of the many-body theory for the linear response function. The idea of this method was generated in A B Migdal's group at the beginning of the 1970s; however, enormous efforts were needed to practically implement this idea with the computers available at the time, and the decisive contribution to the practical implementation of the method was made by S A Fayans.

A series of papers written by S A Fayans together with É E Sapershteĭn, S V Tolokonnikov and V A Khodel used this method to calculate the characteristics of low-lying collective vibrations of magic nuclei. This method also proved very efficient for a correct description of pion degrees of freedom

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in finite nuclei. In a number of papers devoted to this field, S A Fayans, É E Sapershteĭn and S V Tolokonnikov obtained the most reliable evaluations of the degree of softening of the pion mode in nuclear matter.

A collaboration of S A Fayans with a team of theoreticians at the Joint Institute of Nuclear Research (JINR, Dubna) led by N I Pyatov and F A Gareev proved to be very fruitful. A combination of the earlier-developed method of exact account of continuum with the now suggested simplified but sufficiently realistic form of the effective interaction of nucleons in nuclei made it possible not only to carry out massive computations of nuclear structure but also to extend the approach to describing nuclear reactions. Maximum attention was paid to the simplest charge transfer reactions producing the analogue resonance and the Gamov – Teller resonance; more complicated reactions, including the heavy ion interaction, were also considered. In this situation a natural merger occurred with the team led by A A Ogloblin, which carried out experimental investigation of nuclear reactions induced by light ions. Several joint papers were published as a result. Work completed in this decade formed the basis for the DSc thesis presented and defended by S A Fayans in 1989.

A paper published in collaboration with S T Belyaev, A V Smirnov and S V Tolokonnikov, "Pairing in nuclei in the coordinate representation" was later considerably extended; the paper developed a method for the exact solution of Gor'kov equations for spherical nuclei. It served as a basis for a novel version of self-consistent TFFS, the method of an energy functional with pairing in the coordinate representation. This method was vigorously elaborated by S A Fayans until his very last days. It was found to be very fruitful for explaining the odd-even staggering effect in the dependence of the radius of a nucleus on the mass number. This was a difficult hurdle for all theoretical approaches. At the beginning of the 1990s Professor D Zawischa of Hanover University hypothesized that the odd-even effect could be explained by the density dependence of the nuclear pairing. The Fayans functional was perfectly suited to describe this dependence. A detailed analysis of isotopic shifts in long chains of isotopes, carried out by S A Fayans and D Zawischa and their collaborators, made it possible to give an excellent description of the odd even effect over the entire range and to deduce from this analysis some subtle details of the density dependence of nuclear pairing. The nuclear masses were thereby calculated with a record precision for a microscopic computation. This work has already generated considerable response among colleagues but the well-deserved recognition will come later. S A Fayans' work is well known in the world of the physics community. In the last ten years he was an active member of the international cooperation and took part in many international conferences on nuclear physics. He was a profoundly intelligent, extremely communicative and wonderfully charming person. Owing to his extensive erudition in various fields of physics and his good intuition, he was a useful participant in discussing problems which were not even very close to his fields of work. A professional of very high caliber, he would need very little time to master a related field, bringing to it his own unique experience. Various research centers in Europe and the USA welcomed him for joint projects.

S A Fayans was full of promising plans. He began to apply his method to describing the properties of nuclei close to the nucleon stability line, which has been a field of intensive experimental studies in recent years; he thought of applying the methods to matter in neutron stars. He battled courageously against his illness and kept working relentlessly until his last day. Sergeĭ Aronovich Fayans was a true knight in science, engrossed in the creative process and paying little attention to personal success and fame. This is how he will be remembered by all those who had the good fortune of knowing him well and working with him. Many of his more than a hundred publications will outlive their author by many years.

S T Belyaev, F A Gareev, V P Martem'yanov,
L A Mikaelyan, N N Nikolaev, A A Ogloblin,
É E Sapershteĭn, S V Tolokonnikov, V A Khodel'