

PERSONALIA

PACS number: **01.60. + q**

In memory of Vadim Alekseevich Kuzmin

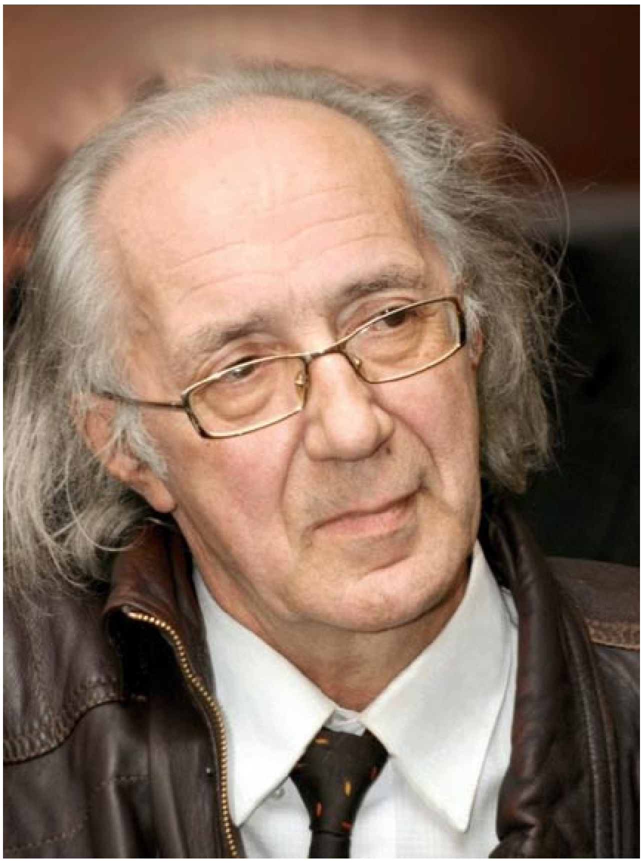
DOI: 10.3367/UFNe.0186.201604h.0447

Vadim Alekseevich Kuzmin, the outstanding theoretical physicist, world-renowned scientist, Corresponding Member of the Russian Academy of Sciences (RAS), and Principal Researcher at the Institute for Nuclear Research (INR) of RAS, passed away on 17 September 2015. V A Kuzmin made a fundamental contribution to cosmic ray physics, neutrino astrophysics, the theory of the early Universe, and the studies of the basic symmetry principles and conservation laws in elementary particle physics and quantum field theory.

Vadim Alekseevich was born on 16 April 1937 in Moscow. In 1955, on finishing secondary school he entered the Faculty of Physics of Lomonosov Moscow State University. Having graduated from the University in 1961, he admitted the postgraduate program at the Lebedev Physical Institute of RAS, and on completing it in 1964 he defended his Candidate of Sciences thesis under the guidance of G T Zatsepin. From 1964 to 1971, he was a Junior Researcher at the Lebedev Physical Institute of RAS. From 1971, he was taken on the staff in the Department of Theoretical Physics of the Institute for Nuclear Research (INR) of RAS.

The surname Kuzmin is primarily linked to the famous Greisen–Zatsepin–Kuzmin (GZK) effect. Soon after the discovery of cosmic microwave background, K Greisen, and independently Zatsepin and Kuzmin pointed out that when propagating through cosmological distances from a source to observer the highest-energy cosmic rays must catastrophically lose energy in threshold reactions of photopion production in interactions with this universal background radiation. As a consequence, the high-energy part of the cosmic ray spectrum has to be cut off, and the cosmic ray sources must be residing in the local neighborhood at distances of less than 100 Mpc from us. This discovery is based entirely on physical laws well checked in laboratory conditions. Thus, the question of whether the observed cosmic ray spectrum shows GZK suppression is fundamental, because its absence would be an unambiguous signal of new physics. On the other hand, the theoretical prediction by Greisen, and Zatsepin and Kuzmin initiated an enthraling search for cosmic ray sources and paved the way for charged particle astronomy. It is not surprising that the theoretical and experimental studies of the GZK effect determined the direction of the development of ultrahigh-energy cosmic ray physics for several decades. By now, the GZK suppression in the energy spectrum has been unambiguously established by specialized observatories, and the search for and identification of high-power cosmic accelerators is a priority task of high-energy astrophysics.

Vadim Alekseevich made a considerable contribution to neutrino astrophysics. Neither the chlorine–argon neutrino detector in the Davis experiment nor the electron detector in the Kamiokande experiment could answer the question of whether the revealed deficit of solar neutrinos results from inaccurate modeling of processes in the Sun or is a sign of a new physics. To answer this question, one needed recording techniques sensitive to the low-energy part of the solar neutrino spectrum. As far back as 1965, V A Kuzmin proposed the gallium–germanium radiochemical method which allowed registration of practically the total solar neutrino flux. The idea was realized 25 years later in the underground experiments SAGE at the Baksan Neutrino Laboratory of INR RAS and GALLEX in the Gran Sasso National Laboratory. And we know today that the key to the solar neutrino problem lies in the new physics, the neutrino mass, and neutrino oscillations.



Vadim Alekseevich Kuzmin
(16.04.1937 – 17.09.2015)

Kuzmin's contribution to the early Universe cosmology is also versatile and fundamental. The physical formation model of the baryon asymmetry in the Universe in CP noninvariant decays of heavy particles at the nonequilibrium stage of cosmological expansion, which was proposed by V A Kuzmin, served, together with A D Sakharov's work, as the basis of the modern theory of the occurrence of baryon asymmetry in the Universe. In that same year of 1970, Vadim

Uspekhi Fizicheskikh Nauk **186** (4) 447 – 448 (2016)
DOI: 10.3367/UFNr.0186.201604h.0447
Translated by M V Tsaplina

Alekseevich pointed out that the necessary violation of the baryon number can be observed as neutron–antineutron oscillations. He developed the theory and put forward the idea of conducting an experiment to seek this phenomenon. Such experiments are now being planned and carried out in some laboratories in the world. V A Kuzmin took an active part in the discussion of future experiments.

Together with V A Berezin and I I Tkachev (1983), he obtained pioneering results describing the dynamics of vacuum bubbles in the General Relativity, which are important for a number of applications. They are applied, in particular, in explorations of cosmological phase transitions, black hole physics, and the cosmology of multidimensional models of the physics of particles localized on a bran.

In one of his most well-known publications, Vadim Alekseevich discovered [together with V A Rubakov and M E Shaposhnikov (1985)] that the necessary condition of baryogenesis, i.e., the existence of fast transitions with nonconservation of the baryon number, has already been realized in the Standard Model of particle physics and requires no new hypothetical interactions. These anomalous processes, unexpected at first glance, play a crucial role at high temperatures in many models and mechanisms proposed for an explanation of baryon asymmetry of the Universe.

Vadim Alekseevich's scientific style can briefly be characterized as follows: a technical problem whose solution was obvious did not interest him. He generated new and often revolutionary ideas. In particular, he substantiated in the late 1980s the possibility of weak violation of the Pauli principle in the framework of quantum mechanics.

In his last years, V A Kuzmin was working on the enigmas of dark energy and dark matter in the Universe. In 1996, he suggested the hypothesis implying that dark matter and baryon asymmetry can appear jointly in one process. Such a model might explain the enigmatic balance, as well as an approximate equality of contributions of dark and visible matter to the energy density in the Universe. In 1998–2000, V A Kuzmin (together with V A Rubakov and I I Tkachev) introduced a new and, in a sense, natural candidate for the role of dark matter particles, namely, superheavy particles, and revealed that the study of ultrahigh-energy cosmic rays opens the door to the superearly post-inflationary Universe.

V A Kuzmin brought up a whole generation of disciples, of which many became world-renowned scientists. He was awarded the Medal of Honor (1978) and was a laureate of numerous scientific prizes.

Vadim Alekseevich was an exceptionally bright man. He selflessly loved science, loved life, and had a refined sense of humor. His friends often became trustful and appreciative victims of his innocent jests. To his last days, he spent his vacation in Karelia in a tent, canoeing, fishing, and gathering dead branches for handmade craps and mushrooms. He was an extraordinary and very interesting artist.

The vivid memory of Vadim Alekseevich Kuzmin will forever remain in the hearts of his relatives, friends, and colleagues.

V A Berezin, V S Berezinskii, V N Gavrin,
A D Dolgov, G V Domogatskii, L V Kravchuk,
N V Krasnikov, V A Matveev, V A Rubakov,
O G Ryazhskaya, I I Tkachev, M E Shaposhnikov