

Obituary

# Scientific Activities of Oleg Zatsarinny in the Ukraine

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**Abstract:** These memoirs about Oleg Ivanovich Zatsarinny (1953–2021) concentrate on his scientific activities in the Ukraine.

**Keywords:** Oleg Zatsarinny

On 2 March 2021, after a serious illness, a talented theoretical physicist, our colleague and good friend Oleg Ivanovich Zatsarinny (1953–2021), passed away. His extensive and fruitful scientific activity can be conditionally divided into two time periods: Ukrainian (1980–2000) and overseas (2000–2021). Since the latter is covered in the article by Bartschat et al. [1] in this issue, these memoirs about Oleg Zatsarinny deal in some detail with the Ukrainian period of his scientific activity.

Oleg was born and grew up in the city of Uzhhorod, Ukraine, where he attended and graduated from high school. After graduating from the Moscow Institute of Physics and Technology in 1977, he joined the theoretical group of the Department of Physical and Quantum Electronics at Uzhhorod University. Just about this time, pioneering investigations began on the electron-impact excitation of inner shells in metal atoms and ions. For the correct identification of the lines in the electronic and photonic spectra and for the analysis of the structures in the excitation functions, reliable calculated data on the excitation energies and cross sections of the levels were required. It is not surprising that Oleg Zatsarinny, a young theoretician with a high level of mathematical training and extraordinary skills, was invited to join this work. Originality in thinking and talent for physical modeling allowed Oleg to develop a method of superposition of configurations using the “frozen-core approximation” with a model polarization potential. Additionally, his attention was attracted by the method of non-orthogonal orbitals and its application to analyze the effects of core relaxation upon excitation of an electron from an outer subshell. In his Ph.D. Thesis, defended in 1985, he showed the effectiveness of these methods by the explicit example of calculating the excitation of outermost filled shells in alkali and alkaline-earth atoms [2].

Continuing to work on the problem of calculating the matrix elements for atomic structure, Oleg developed an effective method for reducing many-particle integrals to one-particle overlap integrals, in which the matrix elements were represented as relatively simple combinations of the overlap integrals of the radial parts of one-electron wave functions [3,4]. Further studies, together with Lyudmila Bandurina, were directed to establish the influence of relaxation effects of electron shells on spectroscopic characteristics of atoms when the inner shells are excited [5].

In the late 1980s, experimental studies of the excitation dynamics of autoionizing states in metal atoms were started at the Uzhhorod Branch of the Institute of Nuclear Physics of the National Academy of Sciences of the Ukraine (NANU). These works attracted the attention of Oleg Zatsarinny (already Head of the Theory Department), as well as Alexei Grum-Grzhimailo, another young theoretician from Moscow State University. The first results of a theoretical analysis of the experimental excitation cross section for the  $(3p^5 4s^2)^2 P_{3/2}$  state in potassium were reported in 1993 at the 18th ICPEAC [6]. Further



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improvement of the experimental technique made it possible to detect an intense resonance structure at near-threshold impact energies in excitation functions of autoionizing states. As shown by the theoretical analysis of these data carried out by Oleg and Alexei, it was not possible to explain the observed structure within the framework of distorted-wave theory. As a result, the question arose how to employ other approximations that are suitable at low interaction energies.

With his inherent talent for intuitive thinking, Oleg Zatsarinny settled on the *R*-matrix (close-coupling) method with pseudo-states. An important role in mastering this technique was played by his collaboration with Charlotte Froese Fischer, who introduced him to the *B*-spline method and helped him with the software needed for the calculations. His first work using *B*-splines was the analysis of experimental excitation functions of autoionizing states in lithium atoms [7]. Later, in close collaboration with Lyudmila Bandurina, results for the excitation cross sections of zinc [8] and cadmium [9] ions were obtained. It should be emphasized that [6–8] became the basis on which the *B*-spline technique was further developed by Oleg Zatsarinny in collaboration with Charlotte Froese Fischer (mostly for structure and photoionization) and Klaus Bartschat (mostly for electron collisions). Several software packages, including the BSR [10] and DBSR-HF [11] suites, were created. A review of BSR and its applications can be found in [12].

In 1997, Oleg began to collaborate intensively with leading experimental and theoretical groups in Germany and the United States, resulting in him emigrating to the United States in 2000. However, while working intensely in the United States, Oleg did not stop collaborating with Ukrainian theoreticians and experimentalists. During the period from 2005 to 2013, together with theoreticians Viktor Gedeon (See Figure 1) and Volodymyr Lazur from Uzhgorod National University, and the experimentalist Oleksandr Borovik from the Institute of Electron Physics NANU, he published a series of articles in peer-reviewed journals on the energy dependence of excitation cross sections in complex atoms (see [13–16], and references therein).



**Figure 1.** Oleg Zatsarinny (1953–2021) and Victor Gedeon (1955–2020) discuss their calculations at the Department of Theoretical Physics, Institute of Electron Physics NANU (2015). Photograph taken from private collection of Lyudmila Bandurina.

We conclude with a few words about Oleg Zatsarinny as a person. Oleg was extremely modest, decent, and charming in communication, a good family man, a loving husband, and a caring father. In his spare time, he liked to drink some good beer and talk about football (soccer). In work, he was exemplary—if he promised to make his contribution to a

particular project, this meant that everything would be done as agreed. It is a pity he left early in life. Physics has lost a talented scientist with great creative potential.

May you rest in peace, Oleg Ivanovich!

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