Title

Igor Ekhielʹevich Dzyaloshinskii

Journal

Physics Today, 74(10)

ISSN

0031-9228

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Publication Date

2021-10-01

DOI

10.1063/pt.3.4863

Igor Ekhiel'evich Dzyaloshinskii

Igor Ekhiel'evich Dzyaloshinskii, who made groundbreaking contributions that span the field of theoretical condensed-matter physics, died on 14 July 2021 in Irvine, California. His scientific legacy in the areas of magnetism, multiferroics, one-dimensional conductors, liquid crystals, van der Waals forces, and applications of methods of quantum field theory has already been assured.

Igor was born on 1 February 1931 in Moscow. He was the first in his family to attend a university. At age 21, while still a student, he passed Lev Landau's infamous "theoretical minimum" exams and became a member of the "Landau school." He graduated from Moscow State University in 1953. Later Igor became one of the founding members and intellectual leaders of the Landau Institute for Theoretical Physics, which was established in 1964.

At Igor's PhD defense at the Institute for Physical Problems in 1957, Landau, in a rare show of praise, called Igor "one of the most talented young theoreticians whom I had met." Indeed, the traits that are emblematic of Landau's school as a whole—a formidable technical rigor with an intimate interest in real-world phenomena—are also the ones that best represent Igor's lifelong approach to physics. He was never interested in equations for their own sake but was in search of the world's internal beauty.

In one of his first publications, in 1957, as part of his PhD thesis work, Igor outlined a set of elegant symmetry arguments for the existence of an antisymmetric exchange interaction that explained the puzzling phenomenon of "weak ferromagnetism"—the occurrence of a small net magnetization in select antiferromagnets. Later, Toru Moriya identified spin–orbit coupling as the microscopic mechanism of such an exchange, which became known as the Dzyaloshinskii–Moriya interaction and is omnipresent in real magnets. The symmetry approach Igor pioneered still permeates the field of magnetism. The modern fields of vortex-like skyrmion spin structures, topological magnon-band Berry curvatures, and anisotropic-exchange magnets are all descendants of Igor's earlier works.

With his remarkable insight, and as part of the same PhD thesis, Igor suggested a mechanism of the magnetoelectric effect and predicted piezomagnetism: magnetization induced by stress and deformation caused by a magnetic field. Those conceptual results are the cornerstones of the field of multiferroics—the study of materials with coexisting magnetism and ferroelectricity—which has blossomed since the 2000s, nearly half a century after Igor published his foundational works.

A long-lasting result from the same era was the novel use of the methods of quantum field theory. Igor, together with Lev Gor'kov and Alexei Abrikosov, helped to develop and popularize the temperature-diagram technique—a universal method in theoretical condensed-matter physics. A groundbreaking monograph, *Methods of Quantum Field Theory in Statistical Physics*, written while Igor was still in his late twenties, was published in Russian in 1962 and in English in 1963. An immediate bestseller, it became known simply as AGD, after the authors' initials. Generations of theoretical physicists have been brought up on that masterpiece. Many owe their craft and the research directions that define their careers to the methods learned from the book.

It is impossible for us to express sufficient amazement at the fertility of that period of Igor's life because it was also marked by his seminal contributions to the theories of van der Waals forces and 1D conductors. With one of us (Pitaevskii), he solved the problem of the van der Waals forces between bodies separated by an absorbing liquid, and with Yury Bychkov and Gor'kov, he addressed the problem of superconducting and charge-density-wave instabilities in 1D conductors. Both analyses had profound impacts on their respective fields. In the 1970s Igor and Anatoly Larkin also offered a solution to the Luttinger-liquid problem that is central to the theory of 1D Fermi systems and to the bosonization technique.

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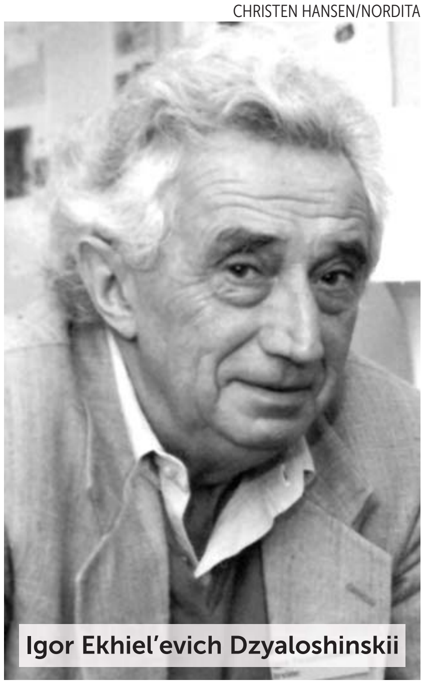

Igor Ekhiel'evich Dzyaloshinskii

The following decades in Igor's scientific trajectory were again marked by an impressive variety of studies: phase transitions, quantum crystals, spin glasses, topological defects, and liquid crystals. He was also an editor of the flagship Soviet physics journals *Journal of Experimental and Theoretical Physics* and *JETP Letters* and a professor at the Moscow Institute of Physics and Technology and at Moscow State University.

In 1991 Igor left the Soviet Union for the US and became a professor at the University of California, Irvine (UCI) in 1992, where he continued teaching and working well into his retirement. Almost symbolically, in his last publication, in 2014, Igor suggested a novel effect in magnetoelectrics—one of his lifelong interests—that was soon confirmed experimentally. Life coming full circle.

A very private man, and a resident of the campus faculty housing since his arrival at UCI, Igor could be found hiking surrounding hills or walking his dog in the early hours of the morning.

Igor had a rare combination of brilliance, integrity, modesty, generosity, and erudition, both in physics and far beyond. He was approachable and enjoyed a good joke. His colleagues, friends, and former students miss his warm, if mischievous, smile.

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