Evgeniĭ Mikhaĭlovich Lifshitz (on his sixtieth birthday)

I. E. Dzyaloshinskiĭ and L. P. Pitaevskiĭ

Usp. Fiz. Nauk **115**, 333–334 (February 1975)

Lifshitz embarked on his scientific career at a very early age. While only nineteen years old, he collaborated with Landau in publishing a paper on the formation of electron-positron pairs in heavy-particle collisions[1]. To understand fully how nontrivial this paper was at the time, it is sufficient to note that it was printed in 1934, only two years after the discovery of the positron. At the same time, an effect as subtle as the delay of electromagnetic interaction, for example, is essential for solution of this problem. A unique method that is closely similar in its essentials to the present-day relativistic-invariant method was used to take these effects into account. It would be literally sufficient to change only a few words to "translate" this paper into the contemporary theoretical language.

The next year, 1935, saw the publication of one of the most monumental studies in the theory of magnetism—the Landau-Lifshitz paper "Toward a Theory of the Dispersion of the Magnetic Permeability of Ferromagnetic Bodies"[2]. This modest academic title tells the present-day reader very little until, with astonishment, he find that the paper contains simultaneously a complete theory of domains in ferromagnets, an equation of motion of magnetic moments that takes account of external fields and exchange and spin-orbital interactions (the Landau-Lifshitz equation), and a theory of ferromagnetic resonance.

The paper in which Lifshitz derived an expression for the Coulomb collision integral of a plasma in a strong magnetic field dates from 1937[3]. This paper was perhaps far ahead of its time. For example, it contains the first use of the well-known drift approximation to simplify the kinetic equation—a problem that was subsequently the subject of numerous papers.

Even in those years, Lifshitz's interests were far-ranging. In 1939, he published a paper in nuclear physics—a calculation of deuteron dissociation on collision with a charged particle[4]. In virtue of its use of a highly general quasiclassical calculation method, this paper has not lost its significance even today.

Lifshitz's 1941 paper[5] had a major role in the development of present-day phase-transition theory. Here the question as to which phase transitions can be brought about as second-order transitions was fully resolved. In fact, Landau's original paper had indicated only one reason for which a transition can cease to be continuous —the presence of third-order terms in the expansion of the thermodynamic potential. The phase transition then becomes a first-order transition, but an infinite set of types of second-order transitions remains. Lifshitz showed that only a finite number of types is in fact possible, in accordance with the finite number of space groups. He established the properties of the possible transitions—"the Lifshitz criterion"—and listed all possible crystallographic-changes that could accompany the transitions.

The 1944 paper[6] was of decisive importance for experimental observation of an extremely important physical phenomenon: second sound in superfluid helium. The existence of a special type of sound in superfluid helium had been predicted by Landau in 1941. However, attempts to excite this sound by conventional acoustic methods had invariably failed. Lifshitz showed that since second sound constitutes a kind of thermal wave, it should be excited by a heater with oscillating temperature. It was precisely in this way that second sound was detected in V. P. Peshkov's famous 1946 experiments.

What was perhaps Lifshitz' most elegant paper appeared in 1954 to construct a theory of the molecular forces operating between condensed bodies[7]. Before it, these forces had been evaluated only in a very rough approximation, by adding the forces of interaction between individual atoms. Lifshitz' ingenious suggestion was that these forces are in fact a manifestation of the pressure of a fluctuating electromagnetic field occupying the spaces between the bodies. The formulas obtained in this way express the forces solely in terms of the electrodynamic characteristics of the bodies, namely in terms of their dielectric constants. Lifshitz's formulas automatically take account not only of the effects of nonadditivity of the molecular forces, but also of various delay effects. His paper gave impetus to many theoretical and experimental studies in this field.

During the last twenty years, Lifshitz has been consistently concerned with one of the most fundamental problems of contemporary physics—the theory of gravitation and cosmology. His very first paper in this field (1946) investigated the question as to the stability of Friedman's cosmological solutions of the equations of general relativity theory[8]. However, he obtained his most important results in the years that followed (jointly with I. M. Khalatnikov and E. A. Belinskiĭ[9]. These papers presented the complete answer to the question as to the nature of the singularities in cosmological solutions of Einstein's gravitation equations. Roughly speaking, it was shown that the "condensed" state that preceded the "present" rarefied state of the Universe had quite singular properties. Space was strongly anisotropic near the singular point of the solution and contracted without limit on two of the coordinate axes, while simultaneously expanding on the third, with the directions of contraction and expansion varying with time. The picture that emerges is mathematically so complex that it is practically impossible to describe it with a single formula.

In the mind of the contemporary physicists, the name of E. M. Lifshitz is inseparably associated with the Landau-Lifshitz "Textbook of Theoretical Physics." Lifshitz was one of the first students, friends, and colleagues of Landau. This textbook is the basic result of their collaboration. The amount of labor that the authors invested in this volume would be difficult to measure. It can only be stated with conviction that the result was a book that expresses the very spirit of theoretical physics. Worldwide, it is no longer the first generation of theoreticians who study their science "from to Landau and Lifshitz." The enormous number of editions of the book in various countries and in various languages, together with the award of the Lenin Prize to its authors in 1962, stand as symbols of its universal recognition. Since Landau's tragic accident, Lifshitz has hardly set aside his work on the book for a single day, regarding it as his life's labor.

Lifshitz' personal influence on the development of Soviet physics has also been associated with his many years of work on the Zhurnal Eksperimental'noĭ i Teoreticheskoĭ Fiziki (Sov. Phys.-JETP) as its Deputy Editor-in-Chief. His erudition, fundamentalism, and benevolence are well known to every one who has been published even once in that journal. There is no doubt that the JETP owes no small part of its high reputation to these qualities.

We take this opportunity to congratulate Evgeniĭ Mikhaĭlovich on his birthday and wish him new scientific results, new books, good health and success.

[1] L. D. Landau and E. M. Lifshitz, Phys. Zs. Sowjetunion 6, 244 (1934).
[2] L. D. Landau and E. M. Lifshitz, ibid. 8, 153 (1935).
[3] E. M. Lifshitz, ibid. 7, 390 (1937).
[4] E. M. Lifshitz, ibid. 8, 930 (1938).
[5] E. M. Lifshitz, ibid. 11, 255, 269 (1941).
[6] E. M. Lifshitz, J. Phys. USSR 8, 110 (1944).
[7] E. M. Lifshitz, Zh. Eksp. Teor. Fiz. 29, 94 (1955) [Sov. Phys.-JETP 2, 73 (1956)].
[8] E. M. Lifshitz, ibid. 16, 587 (1946).
[9] E. M. Lifshitz and I. M. Khalatnikov, ibid. 39, 149, 800 (1960) [Sov. Phys.-JETP 12, 108, 558 (1961)]; E. A. Belinskiĭ, E. M. Lifshitz, and I. M. Khalatnikov, ibid. 62, 1606 (1972) [35, 838 (1972)].

Translated by R. W. Bowers