Physics – Uspekhi **56** (6) 633 – 634 (2013)

PERSONALIA

PACS number: **01.60.+q**

Lev Petrovich Pitaevskii (on his 80th birthday)

DOI: 10.3367/UFNe.0183.201306j.0665

Lev Petrovich Pitaevskii, outstanding physics theoretician and Academician of the Russian Academy of Sciences, celebrated his 80th birthday on 18 January 2013.

Lev Petrovich Pitaevskii belongs to the constellation of brilliant theoretical physicists who were the crop of the famous school created by Lev Landau already in the 1930s. The very style of Landau's work and his universalism demanded the same from his pupils: erudition, a wide scope of outlook on physics, solid mathematical training, and the ability to tackle any problem in any interesting field of physics. L P Pitaevskii was one of Landau's "youngest generation" of pupils; his stardom as a brilliant scientist began to shine under the Teacher's direct influence.

L P Pitaevskii's contribution to modern theoretical physics is enormous, living up to all expectations and demands that Landau anticipated from his pupils. L P Pitaevskii's range of interests covers a huge spectrum of physics problems: from his early work on liquid helium to fundamental problems of quantum statistics, from the physics of metals to quantum mechanics to plasma physics, from research in the physics of the ionosphere, and then again to the properties of quantum liquids at ultra-low temperatures. A great many of these results long ago found their way into textbooks and review papers.

Before making an attempt to give at least a brief overview of the most significant stages of L P Pitaevskii's life in theoretical physics, we need to say a few words about the subject of this note. His biography is fairly typical of many of Landau's students of the post-war Soviet period. L P Pitaevskii was born in Saratov. Having entered the University of Saratov, he became interested in physics and brilliantly passed the informal examinations of the famous "Landau's theor-minimum". In 1955, L D Landau invited him to post-graduate studies at the Institute for Physical Problems (now the P L Kapitza Institute for Physical Problems of the Russian Academy of Sciences — IPP); his official supervisor was E M Lifshitz. After graduating from the post-graduate program, he worked for a couple of years at the Institute of Terrestrial Magnetism, the Ionosphere, and Radio Wave Propagation of the USSR Academy of Sciences. From 1960 onwards, his life has been inextricably linked to the IPP. In 1976, L P Pitaevskii was elected to the Academy of Sciences of the USSR, as corresponding member and then in 1990 as full member.

Since early 1990s, L P Pitaevskii has spent most of his time in the Italian city of Trento. Without breaking his links with the IPP, he has worked at the University of Trento and in the Trento-based National Center for the Study of Bose–Einstein Condensation organized at Trento and headed by S Stringari.

Uspekhi Fizicheskikh Nauk **183** (6) 665 – 666 (2013)
DOI: 10.3367/UFNr.0183.201306j.0665
Translated by V I Kisin

Lev Petrovich Pitaevskii

With a high degree of simplification, L P Pitaevskii's scientific universe can be divided into the following segments:

I. Superfluidity of helium (^{4}He and ^{3}He); II. electromagnetic radiation in media (Van der Waals and Casimir–Polder forces); III. plasma physics; IV. quantum liquids and Bose–Einstein condensation of cold atoms. This list can be expanded by adding a number of papers of a mathematical nature, such as his contributions to the theory of solitons.

I. (a) Among his early results, the paper on the termination point of the excitation spectrum in superfluid helium (*Sov. Phys. JETP* **9** 830 (1959) [*Zh. Eksp. Teor. Fiz.* **36** 1168 (1959)]) impresses especially with its beauty and originality. The behavior implied by the processes of decay of excitations is such that the spectrum of quasiparticles cannot be extended beyond a certain value of momentum. The problem was solved by QFT techniques without introducing any assumptions on the weakness of the interaction.

I. (b) In his spectacular paper "On the superfluidity of liquid ^{3}He" (*Sov. Phys. JETP* **10** 1267 (1960) [*Zh. Eksp. Teor. Fiz.* **37** 1794 (1959)]), L P Pitaevskii was one of the first to turn to the superfluidity of ^{3}He. By analyzing the contribution of the singularity of Van der Waals interaction to the Cooper pair amplitude, he was able to predict the inevitability of transition to the superfluid phase for ^{3}He. In addition, the paper included a number of fundamental relations which he

never published separately; they are needed for a rigorous microscopic justification of the theory of the Landau Fermi liquid. These results typically form a separate chapter in textbooks on quantum statistics.

I. (c) We must also point out the equations describing vortices in non-ideal Bose gas (*Sov. Phys. JETP* **13** 451 (1961) [*Zh. Eksp. Teor. Fiz.* **40** 646 (1961)]). The classical result, also known as the ''Gross–Pitaevskii equations'', now plays the key role in the theory of ''cold atoms''. Three decades later, the work proved extremely important for research on cold gases in traps. In 1997, L P Pitaevskii's fundamental contributions to the theory of liquid helium and superfluid Bose liquids brought him the Eugene Feenberg Memorial Medal.

II. In papers published jointly with I E Dzyaloshinsky and E M Lifshitz, L P Pitaevskii used the methods of quantum field theory to construct the general theory of fluctuations of long wavelength radiation in absorbing media (see, e.g., [*Sov. Phys. Usp.* **4** 153 (1961) [*Usp. Fiz. Nauk* **73** 381 (1961)]). This includes the calculation of Van der Waals interactions, Van der Waals and Casimir–Polder forces, and the properties of thin films of helium. The results have been experimentally verified on a number of occasions, for instance by Deryagin's group in the 1960s. L P Pitaevskii has recently returned to these problems (in 2008) by constructing the theory of interaction between an atom and a metal surface with low carrier numbers; it generalized Lifshitz's theory developed for a dielectric with zero spatial dispersion.

III. The physics of plasmas occupies an important place in L P Pitaevskii's research world. In addition to studies driven by needs of applications, a number of the latest papers are very innovative both in questions of formulation and in the nature of the results. We are essentially speaking here about solving ''hydrodynamic'' challenges for low-density plasmas. The work initiated by Ya L Alpert and carried out by L P Pitaevskii together with A V Gurevich gave rise to a whole new avenue of research: ionospheric aerodynamics, including the question of streamlining of bodies (such as artificial satellites or natural space objects) moving through rarefied ionospheric plasma. In the course of this work, an efficient method was built for construction of multi-soliton solutions of nonlinear equations. The team obtained solutions that described collisionless shock waves and investigated the structure of its borders. The works on these issues are presented in a review (*Sov. Phys. Usp.* **6** 13 (1963) [*Usp. Fiz. Nauk* **79** 80 (1963)]) and later in a monograph [''Artificial satellites in low-density plasmas'' (Moscow: Nauka, 1963)], which was very soon translated into English under the title ''Space Physics with Artificial Satellites'' (New York: Consultants Bureau, 1965). The effort was further extended in a number of papers of a mathematical nature. For this brilliant piece of plasma physics research, L P Pitaevskii and A V Gurevich received in 1980 the L D Landau Prize of the USSR Academy of Sciences.

IV. In the 1990s, immediately after experimental implementation of the Bose–Einstein condensation of alkali atoms in traps became a reality, intense experimental studies of supercold atomic gases were launched. Even heavy gases acquire quantum properties at micro-kelvin temperatures. Gross–Pitaevskii equations proved to be one of the most important tools of the theory, which allowed L P Pitaevskii to immediately become the center of the research efforts. His work, carried out together with Italian colleagues, studied the novel properties of gases in traps; the properties were very different from those found in Fermi and Bose systems. First of all, this is true for the work with the Fermi-gas theory in the unitary limit where atoms interact with infinite scattering length. Also, owing to the possibility of controlling the intensity of forces of interaction among atoms under the Feshbach resonance, one of the principal questions of modern physics dealing with pairing in the BCS and Bose condensation theories became open for experimental study.

Work on soliton dynamics in condensates of Bose and Fermi gases is of great interest. L P Pitaevskii also investigated soliton dynamics in the Fermi case and in the case of the transition from the Bose–Einstein condensation regime of molecules to the regime of Cooper pairing. His papers of this period support current experiments and point to new ones. Some of the papers proposed measuring the temperature dependence of the Casimir–Polder force and of the collective oscillations modes of the unitary Fermi-gas; these were conducted jointly with experimenters.

L P Pitaevskii possesses extraordinary pedagogical talent. Together with E M Lifshitz, he was able to complete what Landau regarded as the job of his life — the famous multivolume ''Course of Theoretical Physics''. In addition, he has written numerous review papers, published both in the *Uspekhi Fizicheskikh Nauk* [*Physics – Uspekhi*] journal and in journals abroad. For example, his review, ''Theory of Bose–Einstein condensation in trapped gases'' [in collaboration with F Dalfovo, S Giorgini, and S Stringari and published in *Rev. Mod. Phys.* **71** 463 (1999)], is one of the most cited reviews in *Reviews of Modern Physics*.

In 2008, L P Pitaevskii won the L D Landau Gold Medal of the Russian Academy of Sciences for his outstanding contribution to modern theoretical physics.

L P Pitaevskii's contribution to the work of the journal *Uspekhi Fizicheskikh Nauk* [*Physics – Uspekhi*] is invaluable: for many years now he has occupied the position of the Associate Editor of the journal and continues to be a regular contributor.

L P Pitaevskii's scientific activity in the last ten-to-fifteen years has been nothing short of remarkable! Within only the 10 years since his 70th birthday, he has published more than 60 papers in the most vital fields of physics. L P Pitaevskii continues to be at the top of his powers and talent.

We wish Lev Petrovich good health, inexhaustible creative energy, and success in all his undertakings.

A A Abrikosov, A F Andreev, V F Gantmakher,
L P Gor'kov, A V Gurevich, I E Dzyaloshinskii,
V E Zakharov, L V Keldysh, L A Prozorova,
S Stringari, I A Fomin, I M Khalatnikov