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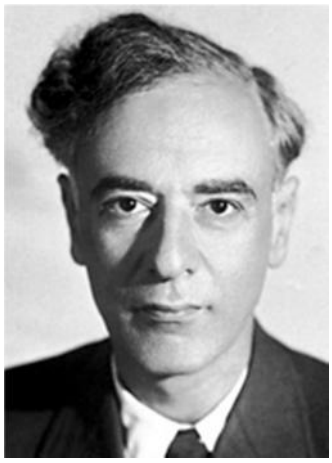
Nobel Prize in Physics 1962



Lev Davidovich Landau

The Nobel Prize in Physics 1962 was awarded to Lev Landau *"for his pioneering theories for condensed matter, especially liquid helium"*.

RESEARCH INFORMATION:

The winner of this year's Nobel Prize in Physics, Professor Lev Davidovic Landau at Moscow University, was born in Baku, 1908. His mathematical talents appeared at a very early age and at the age of 14 he began his studies at the University of Leningrad. After finishing them he spent one and a half years abroad, in particular with the well-known atomic physicist Niels Bohr in Copenhagen. He made a strong impression during this time thanks to his brilliant intellect and great outspokenness.

In 1930 Landau published a quantum theoretical investigation concerning the behaviour of free electrons in a magnetic field which immediately gave him international fame. This work turned out to be essential for the understanding of the properties of metals. Starting from new fruitful ideas Landau found after his return home, often in collaboration with his pupils, important results concerning the structure of magnetic substances and supraconductors and advanced fundamental theories for phase transformations and thermodynamical fluctuations.

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Landau's ability to see the core of a problem and his unique physical intuition appear clearly in his investigations on liquid helium which he started after having been attached in 1937 to the Institute for Physical Problems in Moscow. The head of this institute was the famous physicist Kapitsa who then performed interesting experiments on liquid helium. The natural helium gas had earlier been liquefied by cooling to about four degrees above the absolute zero of temperature and subsequent research had shown that this fluid when further cooled about two degrees was transformed to a new state which has quite strange properties. According to a term introduced by Kapitsa it is superfluid which means that it can easily flow through very fine capillaries and slits which almost completely prevent the flow of all other liquids.

The originality in Landau's attack on the problem of explaining these phenomena was that he considered the quantized states of motion of the whole liquid instead of the states of the single atoms as other scientists had done earlier. Landau started by considering the state of the fluid at the absolute zero temperature which is its ground state. He described the excited states of the liquid by the motion of certain fictive particles called quasiparticles. Landau combined experimental results with his calculations and deduced in this way the mechanical properties of the quasi-particles. These results, from which the properties of the fluid could be calculated, were later directly confirmed by investigations on the scattering of neutrons in liquid helium. Such experiments were first performed at Atomic Energy Ltd. in Stockholm in 1957. Landau further found that there exists in liquid helium besides ordinary sound waves also waves of a "second sound". He inspired thereby a Russian scientist to confirm this phenomenon experimentally.

Natural helium consists of an isotope of atomic weight 4 apart from about one millionth of another isotope of atomic weight 3. The lighter isotope has been studied in the liquid state since about 1950. This kind of liquid helium has properties which are quite different from those of the heavier isotope because the helium nuclei of atomic weights 3 and 4 are essentially different. A satisfactory theory for the lighter helium liquid was first given by Landau in 1956 - 1958 and has many formal similarities with his above-

mentioned theory for the heavier isotope. The new theory is valid only at very low temperatures, less than one tenth of a degree above absolute zero. This is, however, the most interesting temperature range. Due to the difficulty of making measurements at these low temperatures the theory was not experimentally tested until very recently. These tests have been the more favourable for the theory the more the measuring technique has been refined. Landau has also predicted a new kind of wave propagation for this liquid and has called it zero sound. He has thereby stimulated experimental scientists to great efforts aiming to detect zero sound.

The importance of Landau's investigations are apparent when one considers that an important goal of physics research is to explain the properties of liquids as completely as it has been possible to explain the properties of crystals and of rarefied gases. In their efforts to attain this goal the scientists have in general met with insurmountable difficulties. An essential exception is Landau's theories of liquid helium which therefore are an achievement of great and profound importance.

Besides his investigations on condensed matter, i.e. matter in the solid and liquid state for which he is now awarded the Nobel Prize, Landau has also made contributions of the utmost importance to other parts of physics, in particular to the theories of quantized fields and of elementary particles. He has by his original ideas and masterly investigations exercised far-reaching influence on the evolution of the atomic science of our time.

Professor Landau has unfortunately not yet fully recovered from the severe accident which he sustained at the beginning of this year. He is therefore not here to receive his Nobel Prize which is instead handed to him today by the Ambassador of Sweden in Moscow. On behalf of the Swedish Academy of Sciences I wish to express the hope that Professor Landau will soon completely recover.

For more details please visit:

http://www.nobelprize.org/nobel_prizes/physics/laureates/1962/press.html