Lev Landau: a View from the West

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Lev Davidovich Landau

(1908 -1968)

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L. D. LANDAU

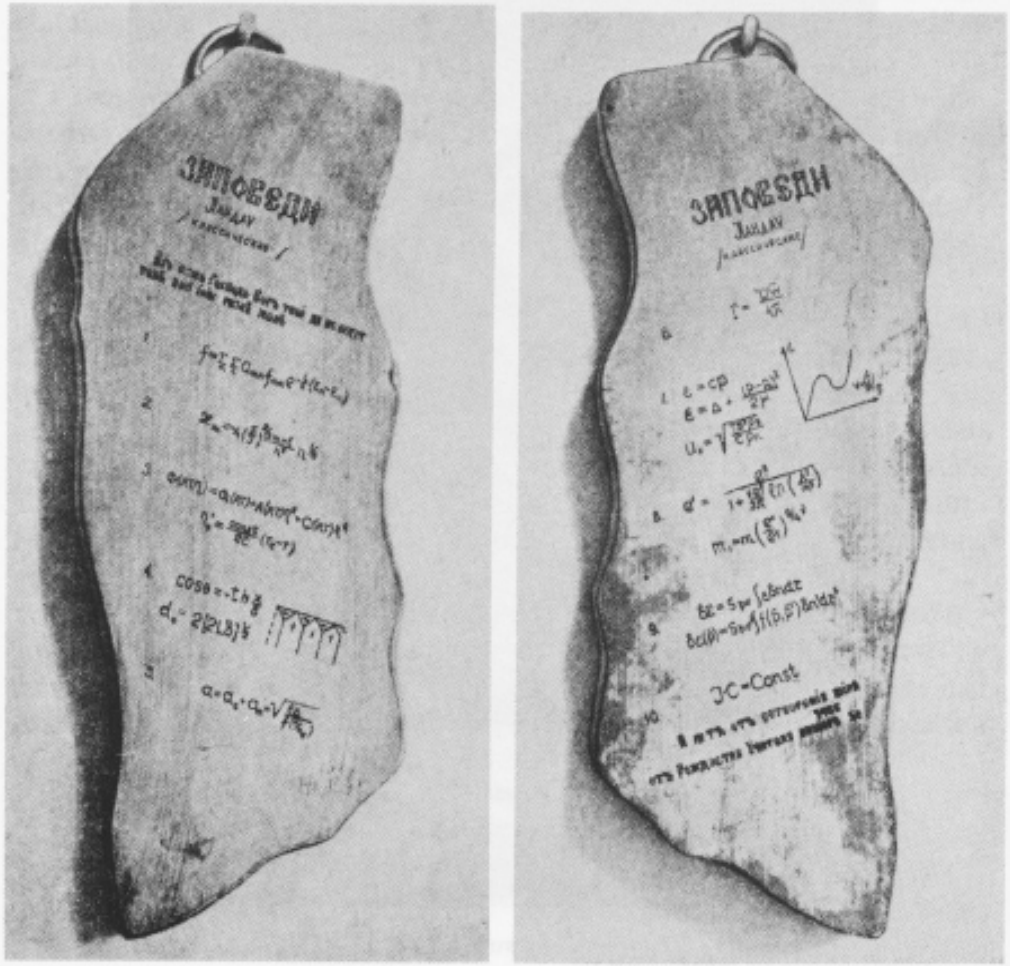
Lev Davidovich Landau

- 1908 Born in Baku, Azerbaijan
- 1921-1927 University (Baku, Leningrad)
- 1928- 1932 Leningrad (Physicotechnical Institute)
- 1929-1931 Travels to Copenhagen, Zurich, Germany, UK
- 1932-1937 Kharkov (Physicotechnical Institute, University)
- 1937-1962 Moscow (Institute for Physical Problems)
- 1938 Imprisoned for 12-13 months
- 1962 Automobile accident (January)
- 1968 Dies in Moscow

The Main Scientific Achievements

Landau wrote a total of 100 papers. For his 50th birthday he was presented with tablets with the 'Ten Commandments', to signify his 10 greatest papers:

1. Density Matrix (1927)
2. Landau Diamagnetism (1930)
3. Dynamics of Ferromagnets (1935; with E M Lifshitz)
4. Theory of Phase Transitions (1937)
5. Intermediate State of Superconductors (1937)
6. Statistical Theory of Nuclei (1937)
7. Theory of Superfluidity (1941)
8. Renormalization of Electron Charge in QED (1954, with Abrikosov and Khalatnikov)
9. Theory of Fermi Liquid (1956)
10. Two-component neutrino (1957)



The Ten Commandments.

A few more papers

2a. Antiferromagnetism (1933)

2b. Polarons (1933)

2c. Rayleigh Scattering in Fluids (1934, with Placzek)

6a. Cascade Theory of Electron Showers (1938, with Rumer)

7a. Theory of Turbulence (1944)

7b. Damping of Plasma Waves (1946)

7c. Phenomenological Theory of Superconductivity (1950, with Ginzburg)

7d. Hydrodynamic Theory of Multiple Particle Production (1953)

10a. Analytic Properties of Vertex in Quantum Field Theory (1959)

10b. Fundamental Properties (1960)

The Course of Theoretical Physics
L D Landau and E M Lifshitz
After 1962 with L P Pitaevskii and V B Berestetskii

1. Mechanics - 1958
2. Field Theory - 1941
3. Quantum Mechanics (Non Relativistic Theory) - 1948
4. Quantum Electrodynamics - 1968 (EML, VBB, LPP)
5. Statistical Physics Part I – 1938
6. Fluid Mechanics – 1944
7. Theory of Elasticity – 1965
8. Electrodynamics of Continuous Media – 1958
9. Statistical Physics Part II – 1978 (EML, LPP)
10. Physical Kinetics – 1979 (EML, LPP)

The Landau School

The following physicists are said to have passed the “theoretical minimum”:

1. Kompaneets	16. Sudakov	31. Falkovskii
2. E. Lifshitz	17. Kagan	32. Andreev
3. Akhiezer	18. Gershtein	33. Kondratenko
4. Pomeranchuk	19. Gorkov	34. Rusinov
5. Tisza	20. Dzyaloshinksii	35. Marinov
6. Levich	21. Arkhipov	36. Berkov
7. Berestetskii	22. Balashov	37. Melik-Barkhudarov
8. Smorodinskii	23. Vedenov	38. Moskalenko
9. Khalatnikov	24. Maksimov	39. Ignatovich
10. Khutsishvili	25. Pitaevskii	40. Bud'ko
11. Ter-Martirosyan	26. Sagdeev	41. Man'ko
12. Abrikosov	27. Bekarevich	42. Malkin
13. Ioffe	28. Ivanchik	43. Kolabasov
14. Zharkov	29. Bychkov	
15. Lapidus	30. Shapoval	

●There are also “adopted sons”:
Ginzburg, I. Lifshitz, Migdal, Gribov, Pokrovskii, Azbel, Larkin and many more.

● In his trips to the west in the thirties Landau met Bohr, Peierls, Dirac, Pauli and many of the great physicists of the day, including Einstein.

● Due to the isolation of Soviet society thereafter, Landau had only limited contact with western scientists. Apart from Tisza and Shoenberg who spent time in the Soviet Union, Landau’s meetings with western scientists were very limited, on the occasion of their brief visits to Moscow.

● Landau never met Fermi, Feynman and Onsager, whom he admired greatly.

● My own experience:
In the period September 1962 – July 1963 I held a postdoctoral fellowship at the Institute for Physical Problems under the auspices of an exchange agreement between the US National Academy of Sciences and the Soviet Academy of Sciences (I was the first appointee).

Although the community was still attempting to adjust to the tragedy of Landau’s accident I had the privilege of meeting most of the members of the Landau School and interacting with many of them. I worked on superconductivity with L P Gor’kov and A A Abrikosov.

The Scientific Legacy

- The history of condensed matter physics (and to some extent of particle physics) of the past half century since Landau's tragic accident can be thought of as building upon, and in many cases modifying, the foundations laid down by Landau's work.
- In each case it is interesting to ask to what extent these more recent developments were foreshadowed, either explicitly or implicitly, by Landau himself.
- The questions I ask are not expected to have precise answers. Instead, they are opportunities to reflect on "what might have been" and on the immense influence that Landau has had on contemporary physics.
- It is my hope that the subsequent speakers, who are eminent representatives of the Landau School, might shed some light on these questions.

- Why did Landau resist London's and Tisza's views regarding the superfluidity of ^{4}He, which invoked the analogy with Bose condensation? Did his attitude change after Bogoliubov's 1947 paper? In what way?
- What were Landau's ideas regarding strongly interacting Fermi systems (e.g. magnetism or metal-insulator transitions in electronic systems) and the departures from Fermi liquid theory which have so dominated discussions since the discovery of high-T_c superconductivity?
- Did Landau notice Anderson's 1958 paper on localization? What were his ideas on disordered electronic systems?
- What were Landau's ideas about one- and two-dimensional many-body systems, whose theoretical and experimental study have so enriched physics in the past 50 years?
- To what extent did Landau anticipate the modern theory of scaling, universality and the renormalization group which represent breakdowns of his theory of phase transitions? Did he connect these issues with the problems in quantum field theory he worked on in the 1950s?

As beneficiaries of the great papers, the Course of Theoretical Physics and the Landau legacy, it can be said that we are all members of the Landau School.