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30 Years of the Landau Institute

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30 Years of the Landau Institute (Selected papers)

Eds I M Khalatnikov, V P Mineev (World Scientific Series in 20th Century Physics, Vol. 11) (Singapore: World Scientific, 1996) 774 pp.

The foundation and flourishing of the L D Landau Institute of Theoretical Physics can be considered, without any exaggeration, as an important event in the theoretical physics of the 60s – 90s. It is to this very event that the publication of a book of selected papers of the Landau Institute (Singapore: World Scientific, 1996) is dedicated. It is significant that this book is not a traditional academic collection covering all the fundamental papers. In fact, this could not be realized within one volume. The editors of the collection (I M Khalatnikov and V P Mineev) have had to restrict themselves to no more than 5% of the basic works done in the Landau Institute over 30 years.

To read this book is not only useful but gives genuine pleasure. Being excellently written, many papers of the collection have become classics which could be included into university courses of physics without any changes. Reading these papers, you familiarize yourself with the history of contemporary physics and realize its place in modern science.

The book is subdivided into four parts in accordance with subject fields. The first part (which presents the main line of investigations of the Landau Institute, especially at the opening stage of research in 1965 – 1975) deals with condensed matter physics. It starts with a paper by three authors (Yu A Bychkov, L P Gor'kov, and I E Dzyaloshinskiĭ) which was published in *JETP* in 1966 (incidentally, this work was the first to be submitted for publication from the Landau Institute). The paper abounds in so many ideas that only its discussion is worthy of separate methodological note.

Firstly, a theory of one-dimensional (or actually, quasi-one-dimensional) systems was developed there. It caused a real sensation in theoretical and experimental condensed matter physics.

Secondly, the paper correlated superconducting, magnetic and dielectric properties of such systems.

Thirdly, an extremely powerful and fruitful 'parquet' approach (so named from the shape of diagrams used in the approximation) was tested and applied to problems of condensed matter physics. Subsequently this method was used in many other areas of theoretical physics.

Essentially, all the papers from this part of the collection deserve to be discussed in no fewer words. However, if I did so my review would many-fold exceed the volume typical for bibliographic reviews in *Physics – Uspekhi*.

There can be no doubt that the paper by Abrikosov and Beneslavskiĭ (*JETP*, 1971), which dealt with a wholly new type of substance (neither metal nor semiconductor nor insulator), namely a system with a zero gap in the energy spectrum, also merits above-mentioned methodological considerations. The fine and powerful results of the paper exerted a great impact on the subsequent development of theoretical physics. No less interesting is the paper by Azbel and Privorotskiĭ (*JETP*, 1969) where diamagnetic domains were predicted and studied, or the paper by Larkin and Khmel'nitskiĭ (*JETP*, 1969) where the ideas of describing phase transitions in terms of the so-called ε-expansion were foreseen and understood. (Later, the american physicist K Wilson was awarded the Nobel prize for this method). Also noteworthy is the paper by Berezinskiĭ (*JETP*, 1974) on the kinetics of a quantum particle in a one-dimensional system†. All these outstanding papers unveiled (to use the bureaucratic, but apt, language of the High Certifying Commission) new directions in theoretical physics.

But even against this background I would like to single out two brilliant papers from the first part of the collection.

First of all, the paper by Aslamazov and Larkin (*Sov. Phys. Solid State*, 1968) on fluctuations in superconductors (or so-called paraconductivity). The authors used rather simple mathematical tools, but arrived at extraordinary results in physics of the problem. This paper can serve as an example of Einstein's witty formula of how discoveries are made. Needless to say that in 1968 everybody knew about the existence of fluctuations, but everybody (including the reviewer who did not accept this paper for publication in *JETP*) also knew that they were 'not observed' in superconductors due to a small parameter (the ratio of the transition temperature to the Fermi energy). So then, Aslamazov and Larkin decided to test this opinion and made their epochal discovery.

The other work that I would like to mention is, in a sense, the exact opposite of the previous. This is the paper by P Vigman (*Physics Letters A*, 1980) devoted to the exact solution of the Kondo problem. In my opinion this work is the height of theoretical treatment and elegance inherent in modern methods of theoretical physics.

I cannot dwell upon all the papers of the collection for reasons of space. Frankly speaking, there is one more reason: I have not read them all. Some of them require the mastery complicated tools of modern theoretical physics. However there are simple and evident criteria for the significance of many papers presented in other parts of the collection. For example, we can list numerous notions and terms which were introduced in these papers and have come into general use. To mention just a few: Polyakov's monopole, the instanton of

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† Incidentally, an even more famous paper by V L Berezinskiĭ on two-dimensional systems, which is not included in the collection, since it was not submitted for publication from the Landau Institute, was actually approved and revised at a seminar in the Landau Institute (see, for example, the list of acknowledgments at the end of the paper).

Belavin and Polyakov, Zamolodchikov's equations, Sinai's billiard, and Zakharov's collapse. All these papers are presented in the collection, as well as many others, which really are classic.

In conclusion I would like to bring your attention to the astrophysical part of the collection, which although containing few papers, has represented (and represents) a significant place in the investigations of the Landau Institute. In particular, mention should be made of the paper by Belinskiĭ, Lifshitz and Khalatnikov (*JETP*, 1971) on oscillating solutions of Einstein's equations which had a great resonance in the scientific world.

It is common practice to conclude bibliographic papers of this type by calling the reader to buy the book under review. However, in view of the present-day economic situation one can hardly recommend this rather expensive edition published in Singapore to Russian scientists (not to mention undergraduate and postgraduate students). It might be worthwhile to advise the editors to prepare a Russian variant of the book. Furthermore, the Singapore edition can be found at the library of the L D Landau Institute of Theoretical Physics (Chernogolovka, Moscow region).