

A note on the history of experimental and theoretical research into molecular attractive forces between solids

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Abstract. From the Editorial Board. In a brief followup to the talk by E I Kats on “Van der Waals, Casimir, and Lifshitz forces in soft matter” (see pp. 892–896 of this issue) at the E M Lifshitz centennial session of the Physical Sciences Division of the Russian Academy of Sciences, an interesting and instructive story was told by Nina Petrovna Danilova (Department of Low Temperature Physics and Superconductivity, Faculty of Physics, Moscow State University) of how E M Lifshitz was enlisted to explain I I Abrikosova’s and B V Derjaguin’s experimental results. The Editorial Board of *Uspekhi Fizicheskikh Nauk (UFN)* [*Physics – Uspekhi*] journal found the story appropriate to be published in the “Letters to the Editor” section of *UFN* in a jubilee selection of works marking the centennial of E M Lifshitz’ birth.

Keywords: from the history of physics, molecular attraction, molecular forces, long-range forces, fluctuation forces, dispersion interactions

The first to appear were in fact the results of experimental study [1–3]. Lifshitz’s paper [4] was published later, in a sense owing to that experimental work.

In 1949, I I Abrikosova¹ started the experimental work on direct measurement of molecular attractive forces between solids as a function of their mutual separation. Experimentation was proceeding at the Institute of Physical Chemistry (IPC) of the USSR Academy of Sciences at the Laboratory of

Surface Phenomena headed at that time by Corresponding Member of the USSR Academy of Sciences B V Derjaguin. These kinds of experiments had not been described by that time even qualitatively. The corresponding measurements encountered exceptional experimental difficulties, and the success of the work depended to a great extent on the correct choice of both the method of measurements and the subjects of research. It was only after approximately five years of experimentation that clear and well reproducible dependences of the interaction forces on micron distances between two quartz surfaces were obtained.

I I Abrikosova showed the results to A I Shal’nikov, who often helped her with his advice, clues, and various details for the experimental setup. Aleksandr Iosifovich evaluated the results and advised her to write a dissertation. But Irina Igorevna complained of the lack of a rigorous modern theory which would be substantial proof of the molecular nature of the experimentally examined attraction effect between solids. Then A I Shal’nikov immediately addressed L D Landau, asking him to listen to I I Abrikosova, and she told Lev Davidovich about her experiment the same day. L D Landau became interested in the results and engaged E M Lifshitz in this work [7, 8]. In no more than ten days, B V Derjaguin and I I Abrikosova were invited to a theoretical seminar at the Institute of Physical Problems (IPP) of the USSR Academy of Sciences to a talk by E M Lifshitz.

This was how the theory of molecular attractive forces between solids was first reported by E M Lifshitz in 1954. The calculations based on this theory were closely coincident with the observed data—the experimental points for different samples in various series of experiment agreed well with the theoretical curve. This consistency of the theory and experiment confirmed the hypothesis of the electromagnetic nature of molecular forces advanced by P N Lebedev as far back as 1894.

In 1955, Irina Igorevna successfully defended her thesis for Candidate of Sciences (Phys.-Math.) (the Academic Council of IPC of the USSR Academy of Sciences even found her to be worthily of the degree of Doctor of Physics and Mathematics). Soon after that, I I Abrikosova gave a talk at P L Kapitza’s seminar (‘Kapishnik’), which was always held on Wednesdays at IPP.

In 1957, the work by E M Lifshitz, I I Abrikosova, and B V Derjaguin was nominated for a Lenin Prize. But that year the Lenin Prize was rightfully given to E K Zavoiskii for his brilliant work on the discovery and study of paramagnetic resonance.

¹ Irina Igorevna Abrikosova, an experimental physicist, was a disciple of Academician Aleksandr Iosifovich Shal’nikov. In 1945, she graduated from Moscow State University (the Department of Low-Temperature Physics of the Faculty of Physics). It should be noted that in 1943–1955 the Department resided in the Institute of Physical Problems (IPP) of the USSR Academy of Sciences, and lectures to the students were delivered by research workers of IPP. In 1945–1948, I I Abrikosova worked at Laboratory No. 2 of the USSR Academy of Sciences under the guidance of I V Kurchatov, in 1949–1960, at the Institute of Physical Chemistry (IPC) of the USSR Academy of Sciences with B V Derjaguin, and in 1961–1977, she continued her work at the Department of Low-Temperature Physics at the Faculty of Physics, MSU.

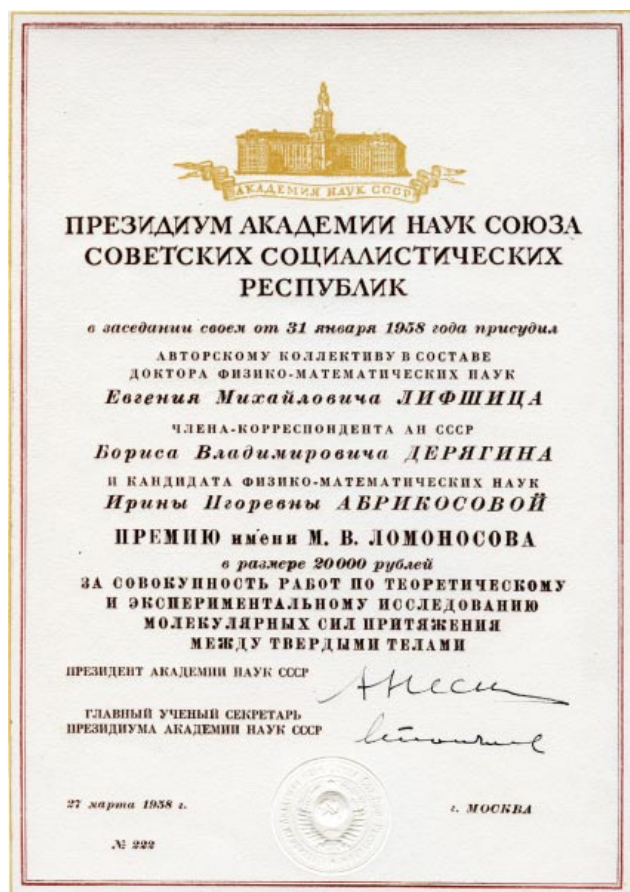
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**PRESIDIUM
OF THE ACADEMY OF SCIENCES
OF THE UNION OF SOVIET SOCIALIST
REPUBLICS**

at the meeting of 31 January 1958 awarded

the collective of authors consisting
of the Doctor of Physics and Mathematics sciences
Evgenii Mikhailovich LIFSHITZ,
the Corresponding Member of the USSR
Academy of Sciences
Boris Vladimirovich DERJAGUIN,
and the Candidate of Physics and Mathematics sciences
Irina Igorevna ABRIKOSOVA
the **M V LOMONOSOV PRIZE** (20,000 rub)
for “a collection of works on the theoretical
and experimental research
into molecular attractive forces between solids”

President of the USSR Academy of Sciences

Chief scientific secretary
of the Presidium of the USSR Academy of Sciences

March 27, 1958

MOSCOW

No. 222

Figure 1. 27 March 1958 awarding the team of authors consisting of E M Lifshitz, B V Derjaguin, and I I Abrikosova, the M V Lomonosov Prize for a collection of works on the theoretical and experimental research into molecular attractive forces between solids.

But already in 1958, the Presidium of the USSR Academy of Sciences awarded the team of authors (consisting of the Doctor of Physics and Mathematics sciences E M Lifshitz, the Corresponding Member of the USSR Academy of Sciences B V Derjaguin, and the Candidate of Physics and Mathematics sciences I I Abrikosova) the M V Lomonosov Prize for “a collection of works on the theoretical and experimental research into molecular attractive forces between solids” (Fig. 1).

Thus, this work was immediately highly rated by the scientific community.

References

- Derjaguin B V, Abrikosova I I *Zh. Eksp. Teor. Fiz.* **21** 945 (1951)
- Derjaguin B V, Abrikosova I I *Dokl. Akad. Nauk SSSR* **90** 1055 (1953)
- Derjaguin B V, Titijevskaia A S, Abrikosova I I, Malkina A D *Discuss. Faraday Soc.* **18** 24 (1954)
- Lifshitz E M *Sov. Phys. JETP* **2** 73 (1956); *Zh. Eksp. Teor. Fiz.* **29** 94 (1955);
- Roldugin V I “Boris Vladimirovich Derjaguin” *Russ. Khim. Zhurn.* **50** (5) 134 (2006)
- Boinovich L B “Academician B.V. Derjaguin (1902–1994)” *Istoriya Nauki Tekh.* (11) 54 (2009)
- Dzyaloshinskii I E, Pitaevskii L P “Evgenii Mikhailovich Lifshitz (on his sixtieth birthday)” *Sov. Phys. Usp.* **18** 167 (1975); “Evgenii Mikhailovich Lifshitz (K shestidesyatiletiyu so dnya rozhdeniya)” *Usp. Fiz. Nauk* **115** 333 (1975)
- Andreev A F et al. “Evgenii Mikhailovich Lifshitz (Obituary)” *Sov. Phys. Usp.* **29** 294 (1986); “Pamyati Evgeniya Mikhailovicha Lifshitza” *Usp. Fiz. Nauk* **148** 549 (1986)