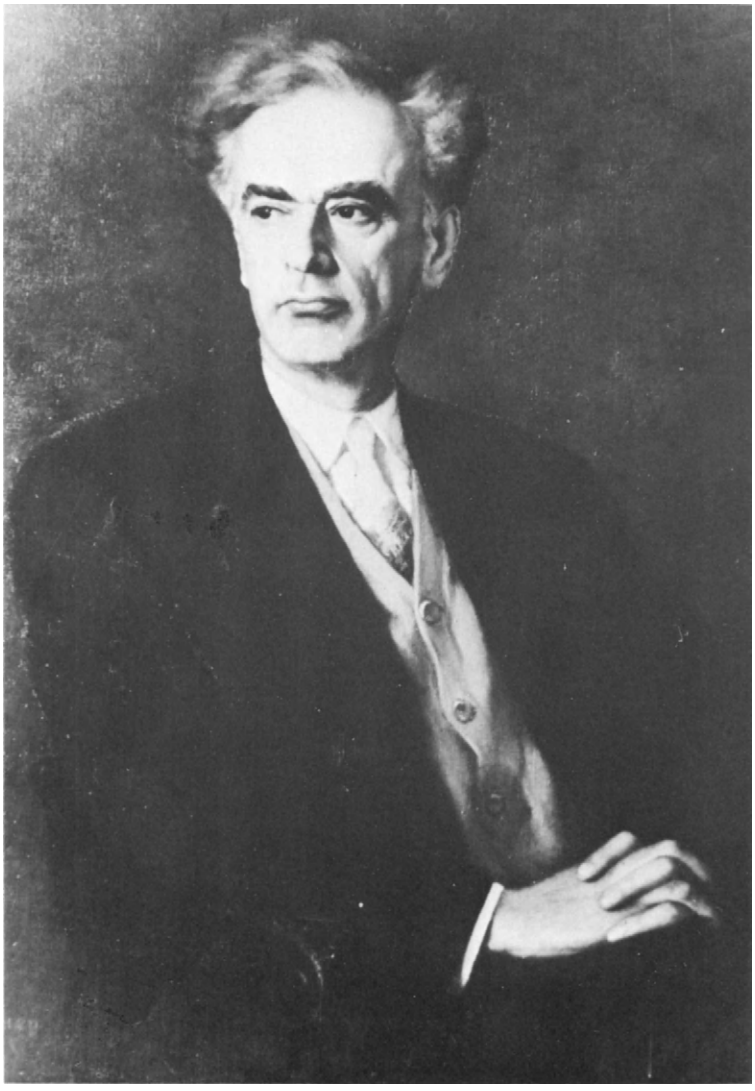

LEV DAVIDOVICH LANDAU
(From a portrait)

A. A. ABRIKOSOV

Recollections of L. D. Landau

I first saw Dau about 1942, in the Academy dining-room at Kazan. This place, which still exists, was set up in that lean time for the purpose of providing generous meals for members and senior staff of the Academy of Sciences. I, too, usually went there instead of eating at home, since my mother was working and my father had an ulcer that necessitated a special diet. Among those present, two friends were particularly noticeable: one tall, thin, and with a forelock; the other short, bald, with a pointed nose. They sat down, and the bald one began to look rapidly around the room. As soon as he saw a pretty woman, he would alert the other one, who would fix his prominent black eyes on her, thereby causing her no little embarrassment. The identity of this pair became known to me somewhat later, when a lecture on 'Liquid Air' for schoolchildren was advertised. It was to be given by Dr L. D. Landau, with the assistance of E. M. Lifshitz. The lecture was not out of the ordinary; afterwards, I heard many similar ones, and even gave some myself. The function of the assistant amounted to lowering erasers into a dewar and then smashing them with a hammer. Later on, V. I. Gol'danskiĭ gave a very fine parody of this kind of lecture ('Come, lad, take a drink from this beaker. See how his eyes are bulging! That's because the air is expanding inside him. In a few minutes he'll look like a barrel.').

Could I have guessed that this hack lecturer, as we all rated him at the time, would afterwards become my beloved teacher and indeed the person who most influenced my entire life? As to the lecture on liquid air, I discovered many years later that it was in accordance with Dau's idea of telling the audience only what they could understand. I argued with him about this. I demonstrated that a psychological approach was necessary also. If the hearer understands everything, he will conclude that the subject is a trivial one. One must somewhere demand more, without detriment to the remainder. This will create respect for science and for the speaker. But Dau did not agree.

With a better-informed audience, Dau had his own way of giving a lecture or a report. He would begin from elementary things which his hearers certainly knew already. Their attention was inclined to stray. Then, in a completely logical manner, he would elicit more and more

complex ideas. One could more or less understand, but the gradient was so steep that those originally inattentive now could not summon up enough concentration and became completely lost. Again, it was useless to argue. Dau was sure that this was the only way to give a paper. Lifshitz was a far better lecturer, mainly because his beginning was not too elementary and his gradient was gentler.

Many contributors to this volume will certainly remark that Dau thought out most carefully not only his scientific work but everything he did: his life, his actions, his views on any topic. His seminar, his pupils, the 'theoretical minimum', the books, all were parts of a thought-out organized plan of life. This and much else he termed 'the theoretical physics approach to life'. Arguing with him was useless, because in matters of logic he could beat everyone, and any other type of argument he would not accept. He did nevertheless feel that a certain ossification resulted. In a fit of candour, he would confess that, although there was nobody in the world who could solve a given problem faster than himself, he did not possess the intuition of Einstein, Bohr, Heisenberg, and Dirac – the physicists he rated above all others.

Discussing a new piece of work with him was very difficult, and needed practice. I recall that V. V. Sudakov came to me and told me that he had worked out a simple 'parquet' method for the summation of boson scattering diagrams. I much admired the simplicity and elegance of the method. Dau appeared. Told that 'Sudak' had solved the 'parquet' problem, he showed immediate interest. Volodya began to explain in his unhurried way, with long pauses. Dau at once bombarded him with questions to which he had no ready answer. I then took over, and quite soon 'got through' to Dau. Volodya was surprised: 'But Alyosha has only told you exactly the same as I was doing.' Dau replied, 'No, you were talking nonsense, and what Alyosha said was entirely different.' Sudakov was right, of course. But he just had not had the practice.

Even I was not always successful. When Gor'kov and I devised the 'cross technique' for alloys, I sincerely hoped that *he* would submit it to the judgement of the Great Teacher. This was because Dau had more than once declared himself 'afraid' of Gor'kov. Indeed, the latter's tall figure, square glasses, and forbidding features might well terrify anyone who did not know him well. I wished to take advantage of this in order to avoid the inevitable beratings, stamping of feet, and other concomitants of introducing Dau to an unfamiliar method. Alas, Gor'kov was away somewhere and it fell to myself to get the work past Dau. This took a month, with a uniform daily programme. Dau arrived in the morning. I began talking. He quickly became agitated, and eventually, shouting 'If you go on talking this sort of nonsense, I'll never discuss science with you again!', he departed and slammed the door. He did not return for the rest of the day. Next morning, as if nothing had happened, he would come in and say,

'Where did we get to?' The rest was as on the previous day. The net result of all these discussions was: 'Of course, there is a simpler way, but I can't think of it at the moment, so all right, go ahead and publish.'

It has to be admitted that the Teacher was right. After all this arguing, the work was much improved, because the author himself came to understand it far better than at first.

In the opinion of many, Dau did not bother much about his pupils; did not provide them with topics, declined to identify their mistakes: 'This is your work, not mine, so look for them yourself,' or 'Your nonsensical efforts are a matter only for your biography.' The latter remark often gave offence, and people from outside to whom it was addressed might well never return, but merely revile Dau at every opportunity. We pupils, however, had no choice, especially as we gradually became aware how thoroughly his whole scheme of training was thought out. Give a student just one topic, and he will await your word for the rest of his life. Dau made it obligatory to leap the independence barrier. The pupil reached a new level, and this decided his subsequent career in science. Those who lacked the capability or the perseverance fell away and were not regretted. This was no doubt the right thing both for science and for the pupils themselves, even the rejects, since these often found another line more in accordance with their gifts and natures, with great success.

Dau thought, on the other hand, that writing papers is an art that must be taught. And this he did, without grudging the time. I remember that he sent back to me six times my first brief note for *JETP Letters*, finally saying 'Still no good, but I've had enough.' His own method of writing papers was interesting. He did not physically write them himself, but used an assistant even if he was the only author, and dictated the paper. This assistant was usually Lifshitz, of whom he remarked 'Evgeny is a great writer; he cannot write what he does not understand.' This sentence is the key to it all. Dau wrote for his readers, and wanted at least one of them to be physically present. He several times dictated papers to me. Sometimes I did not understand. I asked a question. He replied with a rewording. But once or twice Dau began to wriggle and left. The next day, the point was dealt with in a quite different manner.

The most astonishing thing about the Teacher was that he seemed to be guided by his egocentric interests, but everyone benefited. Now, after many years, I feel that this was not due to chance. Dau was most profoundly civilized, and for that reason he always thought of the benefit and convenience of others – indeed did not think, but just acted instinctively. Take his seminar, which he explained by saying that he himself did not like reading papers and preferred to hear about them from others. How many notable theoreticians that seminar produced! For a long time I acted as the seminar secretary, and I know how seriously Dau treated it. I took journals to him, and he marked what was to be reported on. I made a card

index, and the participants, in strictly alphabetical order, chose cards from it. Nothing was more reprehensible than a poorly given report. Dau administered a reprimand (his favourite word of castigation was 'goose'); if the offence was repeated, the person was no longer asked to give reports, and Dau had no further scientific dealings with him.

There were some amusing incidents. I once reported on some good work and, though it was not a simple topic, I gained approval. For some reason, I forgot to remove the card, and two years later a colleague reported on the same item. As he did not understand it very well, Dau began to curse and swear. I then quietly said to him, 'Dau, I reported on this two years ago, and you understood it all then.' Dau denied this, and the speaker had to go. The same thing happened again, but on the third occasion the report was up to scratch. It afterwards appeared that this speaker had become so immersed in the topic that its development formed a large part of his later scientific work. But Dau would never admit that he had heard it previously.

Another case. On one occasion, V. G. Levich did not come to give his report: either something happened, or he was not prepared. The next time, it was evident that Dau was already steamed up. Levich appeared, went up to Dau and, before the latter could say anything, thrust a piece of paper at him. Dau read it and began to roar with laughter. It was a formal certificate, signed and sealed, that Levich was dead. He was forgiven.

It happened that I was the last of Dau's pupils to get the Ph.D., and the last, it seems, for whom he himself administered the examinations of the theoretical minimum. Afterwards, there was a change. From then on, graduate students were assigned to his colleagues: Lifshitz, Khalatnikov, and myself, although he himself advised them. The rest of us began to administer the examinations also. At that time, there were crowds of people from the Moscow Physicotechnical Institute. We soon realized that the students were simply copying from each other the few problems in the examination. I then devised a difficult complex integral and failed one such cheat, of which I was very proud. When I told Dau of this, he began to rebuke me and demand that we should return to his standard problems. 'But, Dau,' I objected, 'these are nothing, they won't know anything else.' 'They don't need to know anything else,' he replied.

I remember a story about the students (by then, our students). Although Dau liked women, he did not think them capable of engaging in theoretical physics. 'If I had a third of the average woman's problems, I shouldn't be able to think about theoretical physics,' he said. Nevertheless, he rightly observed that women like to learn, and that was why they could pass the theoretical minimum. I resolved to show Dau that a woman can become a theoretical physicist. I took as a diploma student one who had passed the theoretical minimum (at the third attempt). I had to do the work for her

and of course did not wish to recommend her as a Ph.D. student, but she stubbornly insisted. I was on the point of agreeing when it turned out that I could not get a Ph.D. student place at Moscow University, where also I had a job. I was delighted, but my stubborn diploma student said, 'If Landau wants to take a Ph.D student, they will provide a place. Let him formally accept me.' I went along to Dau and asked him to accept her for my sake. 'Is she your mistress?' he asked. 'No,' I replied. 'Well, perhaps you hope she will be?' 'Really, Dau, I have no such thoughts.' 'Then is she a theoretical genius?' he inquired with a highly sceptical expression. 'Hardly,' I answered, remembering how the diploma went. 'Then I will come to your rescue,' said Dau; 'I will not accept her as a Ph.D student, and you can tell her that.' I did so with great relief. In consequence, she changed to another subject and was extremely successful. I see her rarely, but we are on excellent terms. I will add only that I made other attempts to refute Dau's proposition. I once had a very able French girl. But in the end Dau proved to be right.

Many who did not know Dau were prejudiced against him, apparently because of the influence of some who were offended by his abruptness, and repeated many stupid untruths. He was said to be malevolent and unapproachable. In reality, I know of no one more approachable and benevolent. He was willing to receive a completely unknown person and listen to an incoherent account of his work, and if that person was unable to put up with all the abruptnesses, he often went away with the idea that his work had been regarded as so much wrapping-paper. Dau never signed his name to others' writings. Nowadays, it is very usual for students to include their supervisors, department heads, and institution heads as co-authors. If Dau was a co-author, this meant that (*a*) the idea behind the work was largely or wholly his own, and (*b*) he actually took part in the calculations. If either of the conditions was not met, he would not be a co-author. If that had not been so, the number of his publications (some 120) would have to be increased by a factor of 30–40, since all his pupils brought their papers to him and there was never a case where he failed to contribute something.

Dau was very fond of talking to young people and explaining his ideas on a variety of topics. Since these ideas were carefully thought out, they were almost always described in the same words. We called this 'Dau's gramophone records'. Once, during a Kiev conference on low-temperature physics, a steamer trip on the Dnieper was arranged. On the way back, wandering around the ship, I noticed a group sitting in a most unsuitable place near the engine-room. It was hot, with a smell of burning oil-paint. I stopped to see what was happening. Dau was sitting preaching amid a group of young people. As soon as he noticed me, he said, 'You go away, you've heard all this before.'

He would never refuse an invitation and was soon at home in any com-

pany. Much younger and lower-ranking people somehow forgot that he was an Academician and one of the greatest physicists in the world. I recall how we took him home by motor cycle after an evening party. A friend drove, with myself behind him and Dau in the sidecar. He was terribly frightened. the wind made tears run down his face, but he said nothing. Only the next day did he acknowledge what terror he had endured.

Dau was, of course, not one for sport, and his friends made good-natured fun of him. I once found him trying to ski on the Vorob'evka. It looked like this. Most of the time he was talking away to friends, mainly to Migdal, while remaining stationary. At last, he decided to act. He walked a little way up the flat gully between two hills, pointed the skis down the slope, pointed the sticks forward and, laboriously getting the skis moving (as the slope was almost zero), slowly descended, eventually falling. I remember that someone was able to run in front of him, take a picture, and make off. Dau did not notice; his eyes were dimmed with fright. The gully was christened 'Mount Landau'. Many years later, when Dau had long since abandoned skiing, I heard one youngster say to another 'They've gone to Mount Landau.'

Outside theoretical physics, everyone was impressed by Dau's many-sidedness. He was interested in plays, films, books, art. Admittedly, in art he did not get beyond Renoir; the rest was 'daubings'. He had no interest in music, and his usual question to ladies he met was 'Do you like Lemeshev?', the result of his naïve belief that this was a topic of interest to ladies. (Lemeshev at that time had the same role as the pop singer V. Leont'ev today.) What he did know thoroughly was history. I once read Woolley's book *Ur of the Chaldees* and decided to give Dau a test. I asked him about something which I thought he could not possibly know without having read the book. Dau not only answered my question but put several questions to *me* about the same places and times which I was unable to answer.

At no time in Dau's life was he in any way receptive to perceivers of extra-sensory phenomena, diet faddists, self-taught yogis and such like, although from time to time there were discussions on telepathy and telekinesis. He was quite categorical about it, and when his friends suggested that there might be something in the matter, he would say 'No civilized person would ever believe in that nonsense.' His thinking was highly concrete, and any philosophizing or nebulous speculation about the human psyche was alien to him. All this he called 'hot air'. I recall his telling how at the age of 12 he took an interest in the works of Kant on his father's bookshelves. 'I saw immediately that it was all rubbish, and I have never changed my mind,' he concluded.

All that his pupils did, and not only in science, was close to his heart. He attached much importance to the proper organization of family life. Knowing that theoretical physics requires much mental concentration, he

believed that a theoretical physicist's wife should be such as to allow a division of labour, the husband being a scientist and earning the money, the wife managing the house. In real life, of course, wives did not always correspond to this ideal, and he then tried to re-educate them, and if that did not succeed, to end an unsuccessful marriage. If the marriage continued, he regarded the husband as ruined and the wife as greedy. He went thoroughly into every detail of family life, knowing its importance. When I married as a young man, he gave me my first lessons in what is now called 'sex education' and, truth to tell, I found them very useful.

All this, and not only admiration for his scientific talents, made his students very fond of him, and they did all they could to imitate him, even those who flaunted their independence. This affection was particularly shown at the evening party in honour of his fiftieth birthday, and again four years later, after the car accident. Others will no doubt describe these events, and I will not do so here. But certainly I never saw anything like them. I have many times watched on television the anniversary festivals of celebrated artists, with light-hearted greetings and gifts, but nothing to compare with the wit and sincerity of our Dau's golden jubilee. And who has seen anything like the way every theoretical physicist in Moscow took a turn of duty by day or by night at the hospital after the crash, the way the world's greatest physicists sent medicines and arranged telephone consultations with experts abroad, the way famous doctors flew in from overseas and would accept no fee?

After the accident and the Nobel prize, it was clear to the world in general that we had among us a brilliant physicist and a unique person. The public began to take an enormous interest in Dau. Articles and books were written about him, films were made. Perhaps Dau, had he been well, would have been pleased, for he was a human being and enjoyed popularity. But after the accident he was not the same person; he thought only of the pains that racked him, and soon he was no more.

One could never finish one's recollections of Dau. Sometimes they come on like a tidal wave, and I am ready to talk about him for hours. But really my life and those of his other pupils have been largely 'programmed' by him: we are what he made us, however much we differ in character and destiny.