MY COLLEAGUE AND FRIEND YOSHUA LEVINSON

Emmanuel I. Rashba
Department of Physics, Harvard University, Cambridge, USA

My reminiscences about Yoshua B. Levinson, an outstanding theoretical physicist with a deep interest in experiment and understanding of it, cover a period of about 50 years. I am not sure whether any of the contributors to this Memorial issue of the Journal had the privilege of knowing him for so long. Therefore, I will not try to cover his rich scientific heritage in detail, but will merely concentrate on his life, as I know it from our direct contacts and remember it from our numerous private conversations. Trying to restore in my memory the stories that he told me years ago, I will do my very best to tell them as accurately as possible.

The reasons why I am using the spelling of Levinson' first name as Yoshua (rather than the English Joshua and/or Hebrew Yehoshua) are not restricted to the fact that it properly reflects the traditional Russian pronunciation of this name. More importantly, all English translations of the scientific papers written by Yoshua in Russian during about 35 years of his work in the USSR appeared under the name I.B. Levinson. This spelling directly corresponds, in conformity with the rules of the translation of Russian names established by the American Institute of Physics, to Ioshua that is indistinguishable from Yoshua in Russian. Meanwhile, in the papers written in English, Yoshua used the initials Y. B., and later on Y. only. Therefore, the point is that the papers by I.B., Y.B., and Y. Levinson belong to the same researcher, and different initials only reflect various periods of his life.

Yoshua was born in Kaunas (Lithuania) to the family of an engineer, Benjamin Levinson, educated at a Florence Academy in Italy. At the end of June 1941, the family managed to flee to Russia immediately after the Nazi invasion. This saved their lives, and the family lived for a few years in Nizhni Novgorod (then Gorkiy) until returning to Lithuania and settling in Vilnius. As a result, Yoshua was fluent both in Russian and Lithuanian. After graduation from school, Yoshua was admitted to the Moscow Institute for Engineering and Physics (MIFI), one of the highest ranked in the USSR. However very soon, in the course of ethnic cleansings, he had been expelled together with a number of other students. Fortunately, he was accepted to the Vilnius University where he completed his education, and after graduation served in the army in Vilnius (in the ranks of the unit that he recalled as the Lithuanian Division).

While still in the University, Yoshua acquired some knowledge in atomic spectroscopy, which was the principal field of active research in Vilnius at that time, and when serving in army he invented a graphical technique for the Wigner-Racah theory. Getting any scientific job was nearly impossible for a young Jewish researcher at that time. However, when Yoshua came to Professor A.P. Jucys with his draft, Jucys immediately realized its scientific importance and Levinson was accepted to the Institute of Physics and Mathematics. As I remember the story, the first paper on this theory was published by Levinson in a Lithuanian scientific journal. Full development of the theory required extensive additional work, and the final version of it is presented in the book by A.P. Yutsis, I.B. Levinson, and V.V. Vanagas (the name of Prof. Jucys is spelled here according to the English translation of the Russian edition of the book). It made an epoch and became an indispensible tool in atomic and nuclear physics. I had the chance to evaluate the efficiency of this technique when we worked on the theory of nonradiative transitions in acceptor centers in semiconductors. Even with the graphical technique it was a challenging task, and performing the calculations without it would have been practically impossible. Once, when recollecting that period of his life, Yoshua told me that Jucys was an insightful and decent person.

I met Yoshua for the first time around 1960 at one of the Conferences on the Theory of Semiconductors that were held in the USSR regularly since 1955 and attracted a growing audience of solid-state theorists from around the country. A friendly contact among us was established nearly immediately because both of us were interested in the problems of spatial and time-inversion symmetry, as applied to atomic physics for him and to the band theory of solids for me. In the spring of 1962 Yoshua invited me to take part in a Summer School in Trakai. In the audience I only remember the people from the Baltic area and a small group from the Leningrad University, Maria I. Petrashen' and her collaborators. When walking across the Karaim cemetery, Yoshua confided to me that inviting two participants from Kiev had been a challenging task for him because the local tradition excluded anybody from outside the Baltic area with the exception of the people from the Fock group at the Leningrad University. I am aware of the long history of painful relations inside the Poland-Lithuania-Russia triangle, the multiple bloody wars during many centuries, and the enormity of human suffering, but it is my deep and sincere belief that self-isolation of a small scientific community is highly damaging for it and does not help in resolving political problems.

Meanwhile, Yoshua' scientific interests shifted in the direction of condensed matter physics, and he moved to a newly established Institute for Semiconductors in Vilnius. As far as I know, this change brought him also a promotion from a Junior to a Senior Scientist position. In the following years, Yoshua published his next breakthrough paper, this time in the field of hot electrons in semiconductors. He predicted that in strong crossed electric and magnetic fields, under the conditions of predominant scattering by optical phonons, hot electrons accumulate inside a trap in the momentum space away from the band bottom. The physical ideas underlying this phenomenon were afterwards described in Yoshua' brilliant review paper in *Sov. Phys. – Uspekhi*. This exciting prediction inspired several experimental groups, and a new semiconductor laser based on the Levinson trap has been created by their joint efforts. This collective work has been awarded a State Prize of the USSR. While a lot of exciting work has been done in the vast field of hot electrons, I would put the Levinson' trap, by its scientific beauty, next to the Gunn effect.

Simultaneously with his work on semiconductors, Yoshua took a part-time job in an engineering Institution (such institutions were called "Post Boxes" in the USSR) where he researched on theory of radars, mostly antennas and waveguides. This job provided him with extensive knowledge in the field and also the resources that allowed him to buy a three-room apartment for two (him and his wife Rima), a rare luxury by the standards of that epoch.

At this time, Yoshua established close connections with semiconductor scientists in Leningrad (currently, St. Petersburg), especially with Arkady G. Aronov and Gregory E. Pikus, and became a respected member of a wide community of semiconductor-physics theorists. In the meantime, Yoshua' position in his home Institution was getting rather ambiguous. As he explained to me in the summer of 1966, when we met at a Conference on the Theory of Semiconductors in Tartu (Estonia), the Institute was growing fast, new laboratories were being established, and young experimenters were promoted as the heads of the labs soon after earning the Candidate of Sciences (equivalent of PhD in the USSR) degrees. There were only two Doctors of Science in the Institute, the Director and Yoshua, but Yoshua could not be promoted to the position of the head of a theoretical lab because he was not a Lithuanian national. He envisioned a situation when one of his former students would be promoted to such a position and Yoshua subordinated to him. No less important, Yoshua dreamed to join a more diverse and vibrant scientific community. Therefore, Yoshua confided to me that he had decided to leave Vilnius and was looking for a position. He met fierce resistance inside his family because Rima admired Vilnius and both their parents lived in Vilnius and did not wish them to leave. Nevertheless, Yoshua was firm in his decision. He felt that his scientific future was at stake, and this was the highest priority for him.

This conversation happened about two months after I moved from Kiev to my new position at the Landau Institute for Theoretical Physics in Chernogolovka (an Academic campus near Moscow), and I proposed that Yoshua gives a seminar in the Landau. He gave an excellent presentation on his work on the Levinson trap at one of the Thursday seminars of the Landau Institute in Moscow, in the Conference Hall of the Kapitza' Institute for Physical Problems. The seminar made a strong impression on the audience and according to the Institute' regulations a special three-member Committee had been established for evaluating his previous work. Very soon, Yoshua was invited to join the Landau institute as a Senior Scientist, and he accepted this invitation. Yoshua moved to Chernogolovka in 1968, as soon as the Institute was in a position to provide him with a proper apartment in one of the new towers. I emphasize that even after leaving Vilnius, Yoshua retained close and friendly scientific connections with his former colleagues there. I well remember Algis Matulis visiting him in Chernogolovka, and Yoshua used to attend regularly the Conferences on hot electrons in Vilnius.

Soon after Yoshua' arrival, we closely collaborated on polaron effects in magnetospectroscopy of semiconductors, and published three papers together. Afterwards, we kept close friendly relations and used to discuss our ongoing work. In the middle of the 1980s, after an Institute for Microelectronic Technology had been established in Chernogolovka, Yoshua was invited to take a position as the head of its Theoretical Department. He turned out to be perfectly suited to this position, and became highly efficient in developing new directions for the scientific research and assembling a group of gifted and devoted young scientists.

While in Chernogolovka, Yoshua worked on a number of various problems, and I would especially mention here his theories of the propagation of nonequilibrium phonons and the quantization of electrical current across narrow one-dimensional channels. In the latter paper, Yoshua applied artistically his knowledge in the theory of waveguides to electronic transport. His young collaborators are better positioned to write about his research at that time.

In 1992, Yoshua was invited to join the famous Weizmann Institute of Science in Rehovot and immigrated to Israel. The preceding years, while highly productive professionally, were very difficult for Yoshua personally. In 1991, Rima passed away from cancer, after a long battle that took many efforts and brought heavy pains to both of them.

About ten years ago, after attending a Conference in New England, Yoshua visited us in Boston with his second wife Natasha. We met with him for the last time in Rehovot in the fall of 2007 when the Weizmann Institute honoured Yoshua on the occasion of his 75th birthday. At that time, he had already battled his own cancer, stoically and with the highest dignity, for about five years. Natasha had been very supportive and took thoughtful care of him. Yoshua worked until the very last days of his life, and when we spoke with him on phone ten days before he passed away, it was only a day after he had seen his students and advised them. Everybody who has had the privilege of knowing Yoshua Levinson closely felt a deep loss when he passed away. However, his outstanding contributions to science survived him and will inspire new generations of researchers.

I am applauding the decision of the *Lithuanian Journal of Physics* to publish this special issue in honour of Yehoshua Levinson's 80th birthday.

22 September 2011

IN MEMORY OF PROFESSOR LEVINSON

Sergei A. Bulgadaev

Landau Institute of Theoretical Physics, Russian Academy of Sciences, Russia

I am very pleased for an opportunity to write about Yoshua Beniaminovich Levinson, my postgraduate and PhD advisor. For the first time I got to know him in my student years, indirectly. One of my hobbies was to visit bookshops and search for interesting books, especially related to physics and mathematics. At that time I noticed a book by three authors, Yutsis, Levinson and Vanagas, *Mathematical Apparatus of the Angular Momentum Theory*. Despite its a little bit old-fashioned (or possibly intentionally such) title, it impressed me by its thorough account of the text and deep penetration into the subject. I could not even imagine then that my road to science would take me to meet one of the authors of this book.

This meeting took place in 1972, when I as a postgraduate student came to the Landau Institute for Theoretical Physics (ITP) of the Academy of Sciences, USSR, in Chernogolovka, where Levinson worked at that time. The director of the institute, prof. I.M. Khalatnikov, introduced me to Levinson and he kindly agreed to become my scientific advisor. There was one unusual circumstance in our collaboration. I specialized in quantum field theory, and Levinson was a well-known expert in condensed matter physics, semiconductor physics in particular. Nevertheless, we were lucky to find a common language. At that time Levinson studied the effect of a strong, quantizing magnetic field on a spectrum of elementary solid state excitations. In collaboration with prof. E.I. Rashba he wrote several papers on magnetopolarons. In order to correctly find the spectrum of these quasiparticles, a diagram technique, taking into account the existence of the quantum Landau levels, had to be created. Levinson managed to develop such a technique for the one-electron Green function and proposed me to implement this technique for the calculation of the spectrum of the electron interacting with optical phonons in a quantizing magnetic field. Just shortly before that, some experiments on determination of such electron spectrum had been performed and it was shown that the spectrum has some peculiarities typical of the bound states of the electron. Levinson was a very benevolent and at the same time demanding teacher. Working on this problem we got to know each other much better. I did not succeed to determine at once all the diagrams which must be taken into account. In the beginning, one class of