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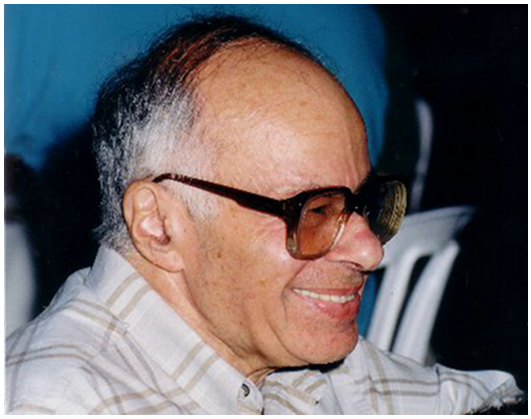
A TRIBUTE TO AN OUTSTANDING PHYSICIST



Y. LEVINSON (1932–2008)

This issue of our journal is devoted to the memory of Yehoshua (Yoshua) Levinson, an outstanding theoretical physicist whose 80 years anniversary is celebrated this year. Y. Levinson was born in Kaunas, Lithuania, and almost 40 years of his life and the beginning of his scientific career were tightly related to Lithuania. In the sixties, Levinson frequently published his papers (see [1–12]) in our journal. He left an important trace in atomic and solid state physics, especially in the fields related to electronic transport and non-equilibrium phenomena in solids.

Along with an impressive contribution to these fields of physics, Y. Levinson is also known as a legendary teacher. Formally, he had about 20 PhD students, but actually much more people acknowledge his influence to their formation as scientists. Maybe this was the reason why preparation of the commemorative issue moved so smoothly. In the beginning of 2011 we wrote a number of letters to Levinson's students, friends and colleagues trying to find those who would like to participate in our project. We expected some interest, but could not anticipate that so many people, in one way or another, felt obliged to help us – with information and photos, as well as scientific or commemorative contributions. We think that this has something to do with the fact that Levinson himself was open to other scientists and did not count time he spent trying to understand, explain and sometimes solve the problems of his colleagues. A lot of physicists sought his opinion and advice which often directed them to more promising ways of handling the problem. The physicists of elder generation from Vilnius remember his ability to grasp the problem, reformulate it and deliver back in a simple way, often without formulae. Though probably inconceivable for an English-speaking community, in Lithuanian as well as in Russian there is an expression *to explain physics on fingers*. It means an explanation of a complicated problem in a simple way, using, for example, a one-dimensional model instead of a three-dimensional one or, if possible, a classical instead of a quantum explanation. Y. Levinson was an unrivaled master of understanding and explaining physics *on fingers* and this was widely acknowledged by both experimental and theoretical physicists. F. Anisimovas remembers: "As a young undergraduate I was invited to participate in the seminar. From the start I thought that I did not understand anything. But when Levinson made his presentation, it turned out that I knew physics."

The life of Y. Levinson features dramatic periods related to the crucial events of the 20th century. He outlived the invasion of Nazis to Lithuania in 1941, fleeing of the family to Russia and war-time difficulties. After the war, when the family returned to Lithuania, Y. Levinson graduated from the grammar school with a gold medal and entered the Moscow Engineering Physics Institute. The pride of being accepted to the prestigious institution was soon overshadowed by expulsion from it during ethnic cleansing in 1953. As a result, Y. Levinson was transferred to the Moscow Tractor Institute. He managed to relocate to the University of Gorkiy (now, Nizhni Novgorod), but just for a short time. Later, he returned to Vilnius, graduated from the Vilnius University and started his scientific career with an important contribution to atomic theory. He invented graphical representation of the angular momentum

quantities applying the Racah diagrammatic technique while working as a penman in the army office in Vilnius. In our issue, R. Karazija outlines the beginning of Levinson's scientific career related to atomic theory and adds a detailed list of references. The memoirs of R. Katilius are devoted to an unofficial seminar of theoretical physicists in Vilnius in the sixties. The soul and leading spirit of this seminar was Y. Levinson. This seminar was important for all participants, but for Levinson in particular. Here he could sharpen and test his skills in understanding physics, presenting physical ideas and participating in scientific discussions which soon became an integral part of Levinson – scientist. The sixties were a crucial period for Levinson – he drastically changed the field of his scientific interests and moved to semiconductor physics, where he became the founder of the Lithuanian school of solid state physics theory. In 1971, Y. Levinson left Vilnius. He was invited to the Landau Institute for Theoretical Physics in Chernogolovka and found himself among prominent theoretical physicists of the former Soviet Union. It was a challenge for Levinson and he took some risk, but he did not get lost among the top level scientists. In his recollection, E. Rashba, a long-time friend and colleague at the Landau Institute, comments Levinson's life, some important decisions and scientific achievements. As especially important works at the Landau Institute, E. Rashba mentions Levinson's theories of the propagation of nonequilibrium phonons and the quantization of electrical current across narrow one-dimensional channels. S.A. Bulgadaev, a former student of Levinson, remembers that Levinson was the catalyst of discussions at the seminars at the Landau Institute: his questions and concluding comments purified and clarified the problems discussed. Here we also publish interesting reminiscences of his students: S. Esipov, U. Gavish, M. Rokni, M. Schechter. After the collapse of the Soviet Union, in 1992, Y. Levinson went to Israel, where he got a professor position at the Weizmann Institute. He found a new life there, had many students and friends. "He was arguably the most successful example of the absorption of a mature scientist in Israel," write in their commemorative text M. Heiblum and Y. Imry, his friends at the Institute.

Along with short introductory part here we present the theoretical papers of Y. Levinson's students, friends and colleagues from all over the world. The editorial board of the *Lithuanian Journal of Physics* is very grateful to all authors of this journal issue and many other people who helped to make it.

This is our tribute to a great scientist who could explain physics on fingers.

References

[1] Y. Levinson, Energy criterion of comparing molecular orbital method contra localized valence bond method, Litovskii Fizicheskii Sbornik – Lietuvos fizikos rinkinys **1**, 309 (1961) [in Russian]

[2] A. Bolotin, Y. Levinson, and V. Tolmachev, Angular integration of Feynman diagrams in field perturbation theory of atoms, Litovskii Fizicheskii Sbornik – Lietuvos fizikos rinkinys **4**, 25 (1964) [in Russian]

[3] Y. Levinson, On the inversion centre in kinetic equation p-space, Litovskii Fizicheskii Sbornik – Lietuvos fizikos rinkinys **5**, 105 (1965) [in Russian]

[4] I. Burneika and Y. Levinson, Crystal symmetry in the method of orthogonalized plane waves, Litovskii Fizicheskii Sbornik – Lietuvos fizikos rinkinys **5**, 353 (1965) [in Russian]

[5] P. Kazlauskas and Y. Levinson, Momentum and energy relaxation by an electron in a crystal. I. General relations for test electron, Litovskii Fizicheskii Sbornik – Lietuvos fizikos rinkinys **6**, 33 (1966) [in Russian]

[6] P. Kazlauskas and Y. Levinson, Momentum and energy relaxation by an electron in a crystal. P. II, Litovskii Fizicheskii Sbornik – Lietuvos fizikos rinkinys **6**, 233 (1966) [in Russian]

[7] Y. Levinson and G. Mažuolytė, Electron-electron scattering influence on the nonohmic coefficient for "warm" electrons, Litovskii Fizicheskii Sbornik – Lietuvos fizikos rinkinys **6**, 243 (1966) [in Russian]

[8] P. Kazlauskas, Y. Levinson, and G. Mažuolytė, Momentum and energy relaxation by an electron in a crystal. P. III, Litovskii Fizicheskii Sbornik – Lietuvos fizikos rinkinys **6**, 377 (1966) [in Russian]

[9] A. Kazlauskas and Y. Levinson, Momentum and energy relaxation by an electron in a crystal. P. IV, Litovskii Fizicheskii Sbornik – Lietuvos fizikos rinkinys **6**, 513 (1966) [in Russian]

[10] R. Bakanas and Y. Levinson, Phonon-assisted cyclotron resonance observation in n-InSb, Litovskii Fizicheskii Sbornik – Lietuvos fizikos rinkinys **9**, 143 (1969) [in Russian]

[11] Y. Levinson, J. Požela, and A. Tetervov, Waves instabilities in a drifting plasma, Litovskii Fizicheskii Sbornik – Lietuvos fizikos rinkinys **9**, 149 (1969) [in Russian]

[12] M. Rokni and Y. Levinson, Kinetic equations in the presence of level broadening effects, Lith. Phys. J. **36**, 528 (1996) [in Russian]

Y. LEVINSON, YEARS IN ATOMIC PHYSICS

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I knew Y. Levinson only by sight; he worked in another physics institute, in the field of solid state physics, and at that time did not participate in the seminars on atomic physics any more. However, when I was preparing for the publication of the selected works of prof. Adolfas Jucys and was collecting material for his biography and compendium of his documents [1], I often encountered information on Levinson. Some material was found in A. Jucys' archive and documents of the Institute of Physics and Mathematics, but mostly I rely on what I heard from some physicists of elder generation – J. Batarūnas, V. Vanagas, K. Ušpalis, A. Bolotin and others. In their opinion, Y. Levinson was one of the most talented students of A. Jucys.

Yoshua was a boy when he got acquainted with A. Jucys; this happened before the Second World War. At that time A. Jucys worked at the Vytautas Magnus University in Kaunas and rented a flat from Y. Levinson's father.

In 1953, Y. Levinson returned to Vilnius and was allowed to continue his studies at the Vilnius State University. He was accepted to the next-to-last (fourth) year and chose the studies of theoretical physics. The head of the Theoretical Physics Department, prof. A. Jucys, asked his student A. Bolotin (who was preparing his own PhD) to supervise the diploma work of Levinson. However, Jucys himself regularly cared of what his co-workers and graduates were doing. Apart from that, the qualifying seminars with participation of students periodically took place in the Department. At that time the theory of groups and matrices from *A Course of Higher Mathematics* by V. Smirnov was studied. Every participant had to prepare one section and present it to others. Y. Levinson and his university-mate V. Vanagas also made their presentations.

Several years before that, A. Jucys had generalized Hartree–Fock equations for the many-configuration approximation. Therefore, at that time the members of Jucys' group tried to obtain the solutions of these equations by integrating them with an arithmometre, while the obtained wave functions were further used to calculate the energy levels and transition probabilities. Though the simplified equations were solved only in the two-configuration approximation for light atoms, the finding of a set of consistent radial orbitals required long and thorough work. These results of rather accurate calculations for atoms were published in *Zhurnal Eksperimental'noi i Teoreticheskoi Fiziki* (*JETP*), the best physical journal in the USSR; later these papers were translated into English and found recognition abroad. Y. Levinson also started his scientific career by performing such calculations. Still, this work did not seem attractive to him, and Y. Levinson asked A. Jucys to give him additionally some other theoretical problem. Via M. Eliashevich, A. Jucys knew about G. Racah's papers published in the war times in the *Physical Review* journal [2]. In these papers, by using the irreducible tensorial operators and fractional parentage coefficients, a new mathematical apparatus was developed which allowed expressing atomic quantities more efficiently, especially in the case of complex configurations with open electronic shells. These papers were written very laconically and used some concepts which were unusual in atomic physics. Thus, to understand them and, especially, to learn how to apply these methods was not an easy task for a young theoretician. Levinson translated the papers from English and persistently studied them. During diploma work he used this method to obtain the expression for the line strength of electric dipole transitions in the two-configuration approximation [3]. Later, the results of his diploma work were included into two scientific papers [4, 5]. Soon after that, the Racah technique was applied in the incomplete separation of variables theory in two papers of Jucys' group with Y. Levinson being a co-author [6, 7]. The development and application of a mathematical apparatus of irreducible tensorial operators became one of the most important directions of Jucys' school of atomic theory.

After graduation from the University, in 1954 Y. Levinson and V. Vanagas were engaged as younger research associates in the Division of Physics, Mathematics and Astronomy of the Institute of Physics and Technical Sciences. Unfortunately, soon Y. Levinson was drafted to exercise his military service, because he had not taken a corresponding training course during his studies at the Moscow Engineering Physics Institute. A. Jucys visited a military commissar responsible for army draftees in Lithuania and managed to get permission for Levinson to exercise his service in Vilnius. Thus, Y. Levinson had an opportunity to continue research studies working as a penman in the military office. It was there that Levinson invented a graphical representation of the angular momentum quantities which played an important role in atomic physics. The impulse, as Levinson stated himself, was

a triangular-conditions diagram of the angular momentum invariant ($12j$ coefficient) presented in R. Ord-Smith's paper [8]. Levinson found a way how to represent the projections-dependent quantity (Wigner, or $3j$, coefficient) and how to perform graphically the summation and other transformations of products of these coefficients.

Y. Levinson, dressed in military uniform, used to visit A. Jucys, the supervisor of his research work, for discussion of the obtained results. However, the results were published by Y. Levinson as a single author [9–11]. The contribution of the supervisor is indicated in Acknowledgements: "the author is sincerely thankful to prof. A. Jucys for a fruitful discussion of this work" and "the author expresses deep gratitude for attention to this work and discussion of results". It was known that A. Jucys, while holding regular interest in research of his students and offering valuable suggestions, sometimes refused to be a co-author of papers if he assumed that his student worked rather independently. It is also hard to answer the question why all three papers were published in Lithuanian scientific journals, two of them in the works of the Institute. At that time Jucys' group published their papers in *JETP* and another journal, *Optika i Spektroskopiya*, which just started to be issued. Possibly, Levinson's wish to defend his PhD as soon as possible was the reason.

Without entering doctoral studies, Y. Levinson prepared his PhD thesis and defended it at the Scientific Council for Physics, Mathematics and Chemistry of Vilnius University in December of 1957. The title of his thesis was rather general: *Some Generalizations in the Theory of Complex Spectra* [12]. In the most part it was the development of the angular momentum theory. In five chapters out of fourteen the graphical method was described and applied to represent and manipulate $3nj$ and projections-dependent jm coefficients. In addition, the work [13] performed earlier with V. Vanagas was included. In this work, some general properties of transformation matrices and $3nj$ coefficients were studied by an algebraic method. In two chapters of the thesis, the generalization of fractional parentage coefficients for configurations with several open shells [14] was presented and these coefficients were used to express the matrix elements (the idea of complex coefficients proved to be unfruitful and they are not used nowadays). The application of the developed methods was demonstrated by unpublished result – calculation of the energy level spectrum of d^3sp configuration for vanadium. The papers dealing with the two-configuration approximation [3, 4] and incomplete separation of variables [5, 6] were not included into the thesis. The text was written in a brilliant style so characteristic of Levinson.

At that time A. Jucys was writing a monograph *Theory of Angular Momentum*, some compendium of the special course he used to read to his students. Considering a new possibility to present it in a more optimal form using the mathematical apparatus of irreducible tensorial operators and graphical angular momentum technique, he decided to invite Y. Levinson and V. Vanagas to collaborate in the project. A new version of the monograph was written very easily and quickly during several months of 1958. The co-authors wrote chapters and sections separately, then Vanagas and Levinson discussed their parts on the beach in Valakampiai near Vilnius and eventually went to the professor for approval, and this part also went smoothly. The book turned out to be of a modest size, 11 printer's sheets. The first two chapters were devoted to the introduction to the angular momentum theory, and in the following four the graphical method of angular momentum along with the properties of $3nj$ coefficients and transformation matrices were generalised. In the last chapter the irreducible tensorial operators and the expressions of their transformation matrices were concisely described. In addition, seven small, but informative supplements presenting algebraic expressions for $3nj$ and jm coefficients and their sums were included. This book was written in Russian. Due to the bureaucratic publishing system, it was published in Vilnius only in 1960 [15].

This original monograph was soon noticed abroad. In 1962, even two translations into English were published in Jerusalem [16] and London [17] and after two years it was repeatedly published by *Gordon and Breach* publishing house in New York [18]. The book is still widely used and referred to.

Y. Levinson published some more papers extending and applying the graphical method of the angular momentum. The method was proposed to derive recursively the diagrams of higher $3nj$ coefficients, and as a result all diagrams of $15j$ coefficients were found [19]. A very important result was to prove the topologic equivalence of angular momentum and Feynman diagrams as well as to determine their correspondence rules. This result allows performing graphically the integration of Feynman diagrams with respect to angular variables [20].

A. Jucys and his other disciples were also developing the graphical method of angular momentum and obtained some significant results. A different version of diagrams which simplified the determination of phases was suggested, representations of tensorial operators were introduced, the graph theory was applied to study diagram

properties, the mirror reflection symmetry was found. All these results were later generalized in the monograph of A. Jucys and A. Bandzaitis [21] and the review paper [22].

In the mid-fifties, A. Jucys' group increased, and the professor started to encourage his most talented students after defence of their PhDs to turn their investigations from atomic theory to adjacent fields of physics. Around 1954, he suggested A. Bolotin to pursue the studies of molecular physics. In 1956–57, he encouraged V. Vanagas to study atomic nucleus, Y. Levinson and J. Batarūnas to focus on solid state physics. Being the director of the Institute of Physics and Mathematics, A. Jucys managed to organize internships or longer-term visits to scientific centres of Moscow and Leningrad. The visitors were supplied with accommodation and permission to visit seminars and libraries, but not so much with the scientific problems. It cost a great effort and persistence for Y. Levinson and J. Batarūnas over a period of a few years to establish themselves in the solid state physics.

In the transition time, Y. Levinson with A. Jucys and other co-workers prepared a review article about two main refined methods of atomic theory: the incomplete separation of variables and the many-configuration approximation [23]. Y. Levinson together with his first graduate, A. Gutman, considered the inhomogeneous coupling schemes for excited configurations [24] and complex fractional parentage coefficients. Besides, Y. Levinson with his diploma work supervisor, A. Bolotin, applied the group theory to simplify the calculations of matrices for some molecules [25]. Apart from that, Y. Levinson with an astrophysicist A. Nikitin from Leningrad started writing the *Handbook for Theoretical Computation of Line Intensities in Atomic Spectra* [26]. In this book, in a clear and fluent style the theory of atomic spectra lines was presented along with many useful formulae for practical calculations. In the appendix, the translations of three papers of G. Racah into Russian with exhaustive commentary were given.

A. Jucys learned about this book from an advert of the Publishing House in 1961 and was very discontented with the fact that it was written secretly from him as the director of the Institute. Moreover, he intended to prepare a monograph himself in a similar, just somewhat broader field. Levinson's behaviour was discussed in a formal meeting of the Institute's division with participation of the directorate and social organizations. Y. Levinson was mainly accused of not informing the administration about the book in preparation, of insufficiently referring to the works of the Vilnius group, and even of including some yet unpublished results of collaborators. Y. Levinson affirmed that the book was just a handbook written for money and his time actually was devoted to solid state physics and that unpublished works were discussed in open seminars and some authors were aware of their results being used. A. Nikitin proposed A. Jucys to be a co-author of the book, but this just made the things worse: A. Jucys felt even more insulted and rejected the offer. The relations between Jucys and Levinson never improved, though Yoshua continued to work at the Institute of Physics and Mathematics. Nevertheless, Y. Levinson as other talented disciples of A. Jucys was invited to read lectures in the Summer School on Atomic Physics and Spectroscopy which was held in Trakai in May 1962.

Though Y. Levinson left a significant trace in atomic theory, he deliberately turned to the solid state theory and in 1967 started to work at a newly organized Semiconductor Physics Institute. In the same year he defended his second thesis and became the first A. Jucys' disciple who became a doctor of science in the field other than atomic theory.

References

[1] 1. R. Karazija, *Green Tree of Theory* (*Žalias teorijos medis*) (Vilnius, Inforastras, 2003) [in Lithuanian]

[2] G. Racah, Theory of complex spectra, Phys. Rev. **61**(3–4), 186–197 (1942), http://dx.doi.org/10.1103/PhysRev.61.186; **62**(9–10), 438–462 (1942), http://dx.doi.org/10.1103/PhysRev.62.438; **63**(9–10), 367–382 (1943), http://dx.doi.org/10.1103/PhysRev.63.367

[3] I.B. Levinson, *Some applications of two-configuration approximation for calculation of transition probabilities*, Graduation dissertation, Vilnius State University, Faculty of Physics and Mathematics, Department of Theoretical Physics, 1954 [in Russian]

[4] A.B. Bolotin, I.B. Levinson, and L.I. Levin, Two-configuration approximation for carbon-type atoms, Zh. Eksp. Teor. Fiz. **29**, 449–453 (1955) [in Russian]

[5] I.B. Levinson, A.B. Bolotin, and L.I. Levin, Two-configuration approximation for carbon-type atoms, Vilniaus valstybinio V. Kapsuko vardo universiteto mokslo darbai, Gamtos ir matematikos mokslų serija **5**, 49–55 (1956) [in Russian]

[6] I.B. Levinson, V.V. Vanagas, and A.P. Jucys, On the application of the apparatus of irreducible tensorial operators in the calculations using incomplete separation of variables, Trudy Akademii Nauk Litovskoi SSR – Lietuvos TSR MA darbai, Ser. B **5**, 21–32 (1956) [in Russian]
[7] A.P. Jucys, K.K. Uspalis, V.I. Kaveckis, and I.B. Levinson, Total strength of dipole in the approximation of incomplete separation of variables for two-electron atoms, Opt. Spektrosk. **1**(5), 601–605 (1956) [in Russian]
[8] R.J. Ord-Smith, The symmetry relations of the $12j$ symbol, Phys. Rev. **94**, 1227–1228 (1954) http://dx.doi.org/10.1103/PhysRev.94.1227
[9] I.B. Levinson, Sums of the products of Wigner coefficients and their graphical representation, Trudy Fiziko-Tekhnicheskogo Instituta – Fizikos-technikos instituto darbai **2**, 17–30 (1956) [in Russian]
[10] I.B. Levinson, Dependence of the sums of Wigner coefficients products on magnetic quantum numbers, Trudy Fiziko-Tekhnicheskogo Instituta – Fizikos-technikos instituto darbai **2**, 31–44 (1956) [in Russian]
[11] I.B. Levinson, Some formulae for the transformation and summation of jm-symbols, Trudy Akademii Nauk Litovskoi SSR – Lietuvos TSR MA darbai, Ser. B **4**, 3–15 (1958) [in Russian]
[12] I.B. Levinson, *Some Generalizations in the Theory of Complex Spectra*, Dissertation for the degree of candidate of physics and mathematics, Institute of Physics and Mathematics, Sector of Theoretical Physics, Vilnius, 1957 [in Russian]
[13] I.B. Levinson and V.V. Vanagas, Transformation matrix and $3nj$ symbol in the theory of complex spectra, Opt. Spektrosk. **2**, 10–20 (1957) [in Russian]
[14] I.B. Levinson, Fractional parentage coefficients for configuration with several shells, Trudy Akademii Nauk Litovskoi SSR – Lietuvos TSR MA darbai, Ser. B **4**, 3–15 (1958) [in Russian]
[15] A.P. Jucys, I.B. Levinson, and V.V. Vanagas, *Mathematical Apparatus of the Theory of Angular Momentum* (Gospolitizdat, Vilnius, 1960) [in Russian]
[16] A.P. Yutsis, I.B. Levinson, and V.V. Vanagas, *Mathematical Apparatus of the Theory of Angular Momentum* (Israel Program for Scientific Translations, Jerusalem, 1962)
[17] A.P. Yutsis, I.B. Levinson, and V.V. Vanagas, *Mathematical Apparatus of the Theory of Angular Momentum* (Oldbourne Press, London, 1962)
[18] A.P. Yutsis, I.B. Levinson, and V.V. Vanagas, *Mathematical Apparatus of the Theory of Angular Momentum* (Gordon and Breach, New York, 1964)
[19] I.B. Levinson and J. Čiplys, Recursion derivation of diagrams for nj-symbols. $15j$-symbols, Trudy Akademii Nauk Litovskoi SSR – Lietuvos TSR MA darbai, Ser. B **1**(13), 3–9 (1958) [in Russian]
[20] A.B. Bolotin, I.B. Levinson, and V.V. Tolmachev, Angular integration of Feynman diagrams in field perturbation theory of atoms, Litovskii Fizicheskii Sbornik – Lietuvos fizikos rinkinys **4**(1), 25–33 (1964) [in Russian]
[21] A.P. Yutsis and A.A. Bandzaitis, *Theory of Angular Momentum in Quantum Mechanics* (Mintis, Vilnius, 1965)
[22] G. Merkelis, Jucys graphs of angular momentum theory, Lith. J. Phys. **44**, 91 (2004), http://dx.doi.org/10.3952/lithjphys.44202
[23] A.P. Jucys, I.B. Levinson, I.V. Batarunas, and V.V. Vanagas, On the methods of quantum-mechanical calculation improvement for atoms and their relations, Trudy Akademii Nauk Litovskoi SSR – Lietuvos TSR MA darbai, Ser. B **3**(15), 35–45 (1958) [in Russian]
[24] A. Gutman and I.B. Levinson, On the question of vectorial coupling in atomic spectra, Trudy Akademii Nauk Litovskoi SSR – Lietuvos TSR MA darbai, Ser. B **1**(24), 35–45 (1957) [in Russian]
[25] A.B. Bolotin and I.B. Levinson, Application of molecular symmetry in the simple method of molecular orbitals, Trudy Akademii Nauk Litovskoi SSR – Lietuvos TSR MA darbai, Ser. B **3**(23), 21–32 (1960) [in Russian]
[26] I.B. Levinson and A.A. Nikitin, *Handbook for Theoretical Computation of Line Intensities in Atomic Spectra* (Leningrad University Press, Leningrad, 1962) [in Russian]

Y. LEVINSON AND VILNIUS SEMINAR OF THEORETICAL PHYSICISTS

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We did not use his full name and always called him Yuzik. I suppose this was usual in his family (once I met him and his father riding bicycles in Vilnius environs). Yuzik called me Romka. I remember him from around 1958 when I started attending the Vilnius seminar of atomic theory. Levinson was the most visible participant of this seminar headed by professor Adolfas Jucys. Yuzik distinguished himself not only by knowledge, but also by his creativity, intolerance to banality, stormy reactions which even irritated prof. Jucys a bit. I remember once we, two or three younger participants of the seminar, escorted in solidarity harshly scolded Levinson up to his home. (It does not mean that Jucys was bent against Levinson; I know that when Yuzik became a victim of anti-Semitic purge of Moscow higher schools in 1953, Jucys cared for Levinson and helped him to acquire the diploma of the Vilnius University. But the difference of characters showed up.)

Our relations became closer when I graduated from the Vilnius University in 1959 and was invited to participate in the activities of the "underground" theoretical seminar which had come into being some time before. After Yuzik Levinson, Vladas Vanagas, Raimundas Dagys, Jonas Batarūnas and Aron Gutman, I became the sixth participant of the seminar. The seminar emerged because a group of younger physicists felt a necessity to deepen and broaden the knowledge of physics theory – in Jucys' official seminar, atom theory was the main and the only subject. The new generation did not like to comply with those limits.

The first meetings of the seminar took place in a hostel for post-graduates of the Academy of Sciences (at Gynėjų street, close to the Mažvydas Library), in a room where Vladas and Jonas resided. Then we moved to my parents' flat at Liejyklos street in the Old Town of Vilnius – I had a spacious room there. "Moved" means that we transported there the main working tool – a large and heavy blackboard which by Yuzik's plea was hammered by his father. We used to gather on Saturdays, in the afternoon (Saturday was a shorter working day in the Soviet Union at those times). We worked approximately three hours, sometimes longer, and then sometimes, though in an incomplete cast, moved to the nearby *Neringa* café – we all were unmarried then.

With respect to the handling of theoretical physics methods, our sextuplet could seem rather unequal. On the one hand, Levinson, Vanagas, Batarūnas were already PhDs, prestigious scientists, the authorities. The former two were lucky to be at the last stage of preparing their monograph on the theory of angular momentum, later translated into English (*Mathematical Apparatus of the Theory of Angular Momentum* by A.P. Yutsis, I.B. Levinson and V.V. Vanagas). On the other hand, I was a first-year PhD student. But, in fact, the desire to assimilate something new united us. As the subjects of our attention, we pursued to choose the fields of theory more or less unfamiliar to all of us, so that we had more or less equal advantage. We did not have and did not need an outright leader. The desire to know served as our leader. I learned from other participants of the seminar (Yuzik first of all) how to become a theorist, how to think as a theorist, how to live as a theorist. I learned from Yuzik how to see and find simplicity in sometimes very complicated cases and problems and show it to others. And not only a simplicity, but even more – a beauty! While presented by Yuzik, physics – especially theoretical physics – was always BEAUTEOUS!

We tried to study quantum electrodynamics (the course was not taught at the University), but hit the wall – neither Bogolubov-Shirkov nor Akhiezer-Berestetskii were easily accessible for us, so the progress was slow. Apart from other things, we lacked knowledge of the continuous group theory; therefore, at the beginning we started to work on the monograph of Gelfand-Minlos-Shapiro on rotation and on the Lorentz group representations. The elder colleagues encouraged me, and I dared to prepare the "serials" of reports.

I participated in the activities of the seminar for about two years. Stimulated by my colleagues Batarūnas and Vanagas, I moved to Leningrad in 1961. This determined my all further scientific career for which the knowledge and skills acquired at our seminar played a decisive role.

When I left, the blackboard was transported somewhere else, I do not know where. Unfortunately, now I am the only one from our sextuplet, who can evidence how significant for maturation as scientists was our participation in the activities of this seminar in the years 1959–1961. Sad to say, all the other participants of the seminar have already passed away. Vladas Vanagas (1930–1990), a well-known specialist of nuclear theory, the author of several monographs, unexpectedly died during his scientific visit to the Yale University – just after "the first in-breath"

of our freedom. We have already lost Jonas Batarūnas (1926–1990) and Raimundas Dagys (1930–1996), well-known solid state theorists, also Aron Gutman (1936–1999), Levinson's first disciple, the author of monographs on biophysics (and a member of the Parliament of the *Sąjūdis* Reform Movement).

After I and (later) Yuzik left Vilnius, we mostly met each other at conferences in Moscow, Leningrad or Vilnius. But we kept our friendly relations. A few weeks before his death I received an e-mail message from him; he asked me to send him my review article on fluctuations of hot electrons published in a journal hardly accessible for him. He complained about health, immobility, but the mood of his e-mail was not sad. I sent him an electronic version of the article, he thanked me and explained why he needed it – he was still prepared to live and work.

Y. Levinson and A. Matulis at a conference in Vilnius, 1977.

During the years spent in Vilnius, many Y. Levinson's students – R. Bakanas, R. Mažuolytė-Lasienė, A. Kazlauskas, I. Vosylius – received PhDs under his supervision; thanks to Levinson they found their way in physics. As far as I realize, Levinson as an elder friend, adviser and sometimes co-author played an important role in the scientific careers of A. Gutman, A. Matulis, B. Shapiro, L.M. Shcherbakov, A. Tetervov, P. Fridberg and some others.

My colleague Algirdas Matulis, who got acquainted with the solid state theory thanks to Levinson and regards him a teacher, emphasizes three main things which he learned from him:

(i) theoretical physics is a set of the simplest analytically solvable models;

(ii) when preparing a presentation for a seminar or lecture, one has to spend time which equals to the duration of the presentation multiplied by the number of listeners;

(iii) a good scientific paper is the one which remains readable and interesting after removal of all the formulae and figures.

MY COLLEAGUE AND FRIEND YOSHUA LEVINSON

Emmanuel I. Rashba
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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 the parents of both of them 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 Yoshua Levinson' 80th birthday.

22 September 2011

IN MEMORY OF PROFESSOR LEVINSON

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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

the diagrams was separated and summed up, but the result was still not the one that was expected. After numerous discussions, which were always conducted by Levinson quietly and reasonably and which always gave me a new understanding and confidence, we succeeded to determine and sum up all the essential diagrams and demonstrate that the spectrum of the electron in the quantizing field contains a bound state "electron + optical phonon".

While still working on this problem, Levinson became interested in the properties of strongly nonequilibrium phonon states which form in a crystal due to laser emission. In particular, his attention was drawn by experimental works on parametric generation of shortwave acoustical phonons. He proposed me to study these problems in my PhD thesis and became the scientific advisor of my thesis.

The usual kinetic equations are not sufficient to describe the properties of strongly nonequilibrium parametrically generated phonons. Therefore, we had to develop a Keldysh diagram technique and derive generalized equations which took into account all features of these strongly nonequilibrium states. On the basis of these equations, we succeeded to find some solutions for the nonequilibrium distribution of acoustical phonons under different regimes of phonon generation and some unusual properties of such strongly nonequilibrium states. Later on, some of the found properties of these states were experimentally corroborated.

Noteworthy is Levinson's exceptional ability to calculate complex integrals of various special functions. For example, once we studied the stability of obtained nonequilibrium states and had to calculate the coefficients, generalizing the so-called $3j$-symbols, which, by the way, had been described in the abovementioned book of three authors. Eventually, he refined some formulae from the world-known handbook by Gradsteyn and Ryzhik.

My work with Levinson on these problems was a good school for me. It allowed me to write and successfully defend my PhD thesis, and I was recruited to ITP on his recommendation.

Of course, I was not the only one who had a chance to discuss the tasks and problems with Levinson. Such an opportunity was intensively exploited by his other students as well as his co-workers from all departments of ITP and even other physics institutes in Chernogolovka. In my opinion, he had a gift (or a method) similar to that of Socrates, who compared the art of finding a truth in a dispute to the "art of a mid-wife". Maybe for this reason, in the institute Levinson was generally recognized as a person who stimulated discussions and clarified the very content of seminar presentations by his questions and comments. Recently, at the ITP conference dedicated to the 100-year anniversary of Academician A.B. Migdal, a former, now honourable, director of ITP, Academician I.M. Khalatnikov, remembered and especially emphasized this ability of Levinson.

We had very good personal relations with Levinson. Sometimes I visited him at home, and he acquainted me with his wife, a nice and sociable woman. We participated together in several scientific conferences. Levinson also took part in the intellectual life of Chernogolovka. He and his wife were active members of the cinema club at the Scientists House in Chernogolovka, where known films by soviet and foreign producers were demonstrated, including the films which were not always shown in official movie theatres. Sometimes, discussions of films with participation of film directors or critics were organized after film demonstration.

Later on, we went our separate scientific ways: I began to study physics of low dimensional systems, including quantum contacts, and Levinson with his new students continued the studies of nonequilibrium phonons and semiconductors. At the same time, in the second half of the 1980s he became interested in the transport properties of low-dimensional electronic systems. After the breakdown of the USSR, Levinson emigrated to Israel, where he continued investigations of the transport properties of mesoscopic electronic systems at the Weizmann Institute. A greeting address from the ITP, signed by all co-workers, was sent to his 75-year anniversary. Unfortunately, he died soon after his jubilee. A fond memory of Levinson will forever remain in my heart.

In conclusion, I would like to express my acknowledgement to the editors of the journal for an opportunity to pay a tribute in memory of my teacher.

Sergei Esipov
Quant Isle LTD., Scarsdale, New York

* * *

When it was time to choose our thesis advisors, following sub-faculty Chair's suggestion, I approached Levinson at the Institute for Physical Problems and introduced myself. Our conversation was surprisingly short, as if he knew my responses. He warned me that there would be no trendy topics and inquired whether I was familiar with the so-called similarity solutions. Having received a negative response, he dispatched me to read his ZhETF article and made it clear that I should come back in exactly one week's time.

The article was devoted to the one-dimensional propagation of phonons, and I was asked to generalize the solution for the case of other dimensionalities. It was much simpler to rewrite the transport equation in two and three dimensions than to read the entire article, and I did just that, not particularly delving into the details of the whole problem. There was no solution in three dimensions, but for a few days I tormented myself over the two-dimensional case, before bringing back both answers, on time.

"Have you read the rest?" asked Levinson, "You haven't?! You should try. And start writing your thesis. Although, in three dimensions you ... missed the mark. There everything ends in finite time; one has to be careful when choosing the similarity variables." Clearly, Levinson had known this solution in advance.

* * *

Then, I recall working on the manuscript. I was at once captivated by his supernatural copy-book hand, his usage of pencils so that one could erase, and the colour pens in order to hi-lite and encircle formula pieces in the course of derivations. Wherever erasing was not an option, he applied a correction fluid, but at the places subject to significant revisions, he used to glue carefully cut pieces of pages on top of the dismissed parts, so that a single formula was written on three different layers of paper. The formulae were nicely parallel, despite the fact that paper was not ruled. His home office table, at his apartment on Central'naya Street, reminded me of a drawing desk, just short of a drafting machine, but equipped with rulers, triangles, a pair of compasses, and a protractor. A great number of books were on the bookshelves behind.

* * *

All that Levinson taught us – the ability to value formulae, ways to emphasize their physical meaning by introducing characteristic scales and times, drawings of asymptotically limiting cases and multiple parameters, the aesthetic appearance of the formulae and their most laconic forms, placements of numerical factors, the order and usage of letters in algebraic expressions, the correspondence of letters and physically meaningful quantities, the consonance of the letters and names of variables, aversion for long and complicated indices, absolute rejection of any senseless abbreviations, be it truncations, acronyms or initialisms – this is a list, far from being complete, of elements of "shorthand" as a physical discipline. This is particularly where he was a great master.

* * *

Levinson frequently used to think in terms of the similarity variables, using characteristic scales, in order to solve a problem on the back of the envelope, before reproducing and double-checking the solution using the methods of mathematical physics.

Sometimes it seemed to me that even his choice of problems had been motivated by some hierarchical "social universality" instead of the far-fetched universality in physics. Here is an example.

There is a threshold of optical phonon emission by electrons in semiconductors. Although the phonon emission process is quick, the carriers do spend some time above the threshold. Levinson first asked me whether they have enough time to establish a temperature, which was indeed the case. The majority of electrons at the bottom of conductivity band collided frequently with the photoexcited electrons above the threshold, and namely these collisions formed the temperature above the threshold. The particles at the bottom of the band were also photoexcited, so there was a threshold above a threshold. Back then it seemed to me that the ability of the quasiparticles above a threshold not only to overcome another threshold but to establish a temporary equilibrium distribution there by means of colliding with the majority of colder carriers had to have a meaning outside of physics.

Uri Gavish, Michal Rokni, and Moshe Schechter
Weizmann Institute of Science, Rehovot, Israel

Yehoshua arrived at the Weizmann Institute in 1992, but for us, who arrived as graduate students shortly afterwards, it seemed as if he had been there all along.

For all of us, Yehoshua Levinson's students, Yehoshua is remembered both for his great mastery of Physics and for his parental-like kindness. Receiving guidance from Yehoshua was much more than getting clear, insightful and often surprisingly simple answers to a limitless list of questions. Yehoshua had the ability to pass on the many bits of wisdom so essential to the art of scientific research, a wisdom that is well beyond the knowledge that books and papers can convey.

Jerusalem, December 1996

Whenever one of us would enter Yehoshua's (always welcoming) office, he or she could be assured not only to exit knowing a little more physics, but also to become a little wiser in the full sense of the word. Yehoshua feared no question, being it within his immediate interest or not, and became the Mecca of all students in the department, theorists and experimentalists alike. Faced with any question he would ask the student to describe it and then start analyzing it bit by bit until the student came out with a thorough understanding of the matter and a well-defined direction for further inquiry. Perhaps above all, what was so attractive about being taught by Yehoshua, was the quiet modesty, the non-pretentious way in which questions were accepted and answers were given. When answering a question he had the habit of pulling out a small piece of paper from his desk drawer ("Not to kill too many trees") which he would fill with his neat handwritten equations.

Still, perhaps his greatest attribute for us was his leadership by serving as a role model. Watching Yehoshua's love of science and teaching, and the depth, seriousness and devotion which he applied to his every day work, gave all us something to strive for. The loss of Yehoshua for us has not only been the loss of an esteemed and admired teacher, but also the loss of a father figure.

March 2012

Moty Heiblum and Joe Imry

Weizmann Institute of Science, Rehovot, Israel

Yehoshua Levinson, Professor of Physics at the Weizmann Institute, passed away on 28 July 2008 after a long illness. He joined the Weizmann in 1992 following a distinguished career in Vilnius and Moscow. He was an expert in, and made lasting contributions to a range of problems in theoretical atomic, solid state and nonequilibrium physics, while inspiring and interacting both with experimentalists and theoreticians. He never boasted of his outstanding technical and calculation abilities, but emphasized the fundamental understanding and the fun of mastering the Physics. He will be remembered also as a great teacher and a generous person of exceptional integrity and love for physics.

In 1992, Yehoshua started a new life in Israel, joining the Weizmann Institute. Having lost his first wife, Rima, he married Natasha and had a loving family. He quickly became a strongly contributing partner in the new environment. His originality, professionalism and outstanding human abilities clearly surfaced. In addition to his own research, his door was always open to give advice and discuss good physics. His courses were most popular and he played a very active part in the department seminars and colloquia. All this continued up to the last moment. He was arguably the most successful example of the absorption of a mature scientist in Israel. His success with the experimentalists was outstanding, as evidenced also by the papers with joint authorship. He seemed to tremendously enjoy his new life.

To summarize our feelings at the passing away of Yehoshua, we quote below three passages that were read at his funeral:

"We spoke only a bit more than a week ago. He had students a day before, Joe Imry came to talk to him. He worked and remained courageous, already under strong pressure. So, he passed away with highest dignity, just as he lived." (Written by Emmanuel Rashba)

"For Yehoshua a long period of suffering has come to an end. We will include Yehoshua and the dear ones he is leaving behind in our prayers." (Written by Peter Woelfle)

"We are very sad and dismayed at the loss of our beloved and deeply respected friend and colleague Yehoshua. He devoted himself to science and gave an outstanding example of research, teaching, integrity and helping others. His modest office has become a Mecca for people who needed advice and help, which he always gave selflessly. The way he fought his illness was exemplary in braveness and perseverance, and his spirit remained strong. His memory will stay with us." (Written by one of us, JI)

March 2012

(Based on an obituary written in 2008 with A. Finkelstein and Y. Gefen)