BIOGRAPHY OF D. I. BLOKHINTSEV (1908 - 1979)

born Jan. 11, 1908, Moscow , Russia.
died Jan. 27, 1979, Dubna , Russia.

Professor D.I. BLOKHINTSEV studied physics at the Moscow State University (1926 - 1930). He was influenced by L. I. Mandelstam, S. I. Vavilov and I.E. Tamm. He received his Ph.D. in 1934 on a thesis entitled ``Selected Topics of Solid State Theory and Especially of Physics of Metals''. It was supervised by Professor I.E. Tamm.
Since 1935 he is the professor of the Department of Theoretical Physics of the Moscow State University. He was connected with the Moscow State University during all his life; in 1965-1979 he was the Chair of the Department of Theoretical Nuclear Physics. He had worked also at Lebedev Physics Institute of Acad.Sci. USSR since 1935 at the Department of Physics headed by Professor I.E. Tamm.
His first works were dedicated to the applications of quantum mechanics to atomic and solid state physics. Together with I.E. Tamm he constructed a detailed theory of the photoelectric effects when photoelectrons are emmitted from the metal surface (1933). In the next fundamental work (1933) he generalized the Felix Bloch theory of the motion of electrons in the periodic lattice for the case of the overlapping s- and p-bands. For the representation of the wave function of the electron, D.I. BLOKHINTSEV have used the method of the M.Born (1923), which was invented for the description of the lattice waves in crystals. It was made 14 year before the known paper of J.Korringa, who used a similar approach(1947).
In collaboration with L.W. Nordheim (1899 -- 1985) he introduced the fundamental notion of the "mass tensor" to describe the motion of an electron in an external field in the crystal (see: W. Shockley, *Electrons and holes in semiconductors, with applications to transistor electronics*, Krieger (1956)) and constructed a consistent theory of the thermoelectric effects in solids (D. I. BLOKHINTSEV and L. Nordheim, *Z. Physik* 84, 168 (1933)).
In 1936 he published a paper ``On the theory of colored crystals'', where he formulated the conditions of the colouring of crystals and estimated the mobility of F-centers. He used in this paper the tight-binding approximation. In the tight-binding model, it is assumed that the full Hamiltonian *H* of the system may be approximated by the Hamiltonian of an isolated atom centred at each lattice point. The atomic orbitals *\psi_n*, which are eigenfunctions of the single atom Hamiltonian *H_at*, are assumed to be very small at distances exceeding the lattice constant. This is what is meant by tight-binding. It is further assumed that any

corrections to the atomic potential *Delta U*, which are required to obtain the full Hamiltonian *H* of the system, are appreciable only when the atomic orbitals are small. The solution to the time-independent single electron Schrodinger equation *phi* is then assumed to be a linear combination of atomic orbitals (LCAO).
He analysed the condition of the existence of the auto-localized electron states nearly of the F-center. This paper stimulated later of S.I. Pekar (1917 -- 1985) to the development of the theory of polaron in ionic crystals, as it was pointed by S.I. Pekar himself.
During 1934 --1947 D.I. BLOKHINTSEV published 6 fundamental papers on the problems of fluorescence and optical properties of the various ionic crystals and compounds.

In 1938 he practically formulated the theory of the Lamb shift, which was reported at the Physical Institute but was not published. The Editorial Board of ZhExpTeorFiz has rejected this manuscript and it was published only later, in 1958 as Dubna preprint.

In his paper at *J.Phys. USSR* 2, 71 (1940) he showed on the basis of the uncertainty relation that it is impossible to construct the distribution function (density matrix) which could represent the quantum ensemble in the (p,x) phase space. It is well known that the statistical description of a microscopic system may usually be formulated in terms of its density operator. In 1932, E. Wigner proposed an approach of the calculating of the statistical average of measurements of a microscopic observable by transferring of statistical information from the density operator to a weight function w(Q) which refers to the density operator and whose complex argument Q represents a point (p,x) in the phase space of the system (E.P. Wigner, "On the quantum correction for thermodynamic equilibrium", Phys. Rev. 40 (June 1932) 749-759).
The goal was to replace the wavefunction that appears in Schrodinger equation with a probability distribution in phase space. It is a generating function for all spatial autocorrelation functions of a given quantum-mechanical wavefunction \psi(x), and corresponds to the density matrix in the map between phase space functions and Hermitean operators introduced by Hermann Weyl in 1931, in representation theory in mathematics (cf. Weyl quantization in physics). It was rederived later by J. Ville in 1948 as a quadratic (in signal) representation of the local time-frequency energy of a signal. It is also known as the "*Wigner function*" or the "*Wigner-Ville distribution*".

Actually, Wigner introduced a method of performing quantum-mechanical ensemble averages in terms of phase-space integration over *c*-number variables. Since that time, a number of extensions, modifications, discussions, derivations, applications, etc., have appeared in the literature.
What is important, the function w(Q) is not, in general, interpretable as a probability distribution, but it plays so closely the role of one that it is usually referred to as a *quasi-propability* distribution. Actually, there exist an infinite number of *quasi-distribution* functions which can be used for the same purpose as the Wigner distribution function.

In 1949, Jose' Enrique Moyal, who had also rederived it independently, presented it as the quantum moment-generating functional, and thus an elegant encoding of all quantum expectation values (cf. Weyl quantization). It has applications in statistical mechanics, quantum chemistry, quantum optics, classical optics and signal analysis in diverse fields such as electrical engineering, seismology, biology, and engine design.
A classical particle has a definite position and momentum and hence, is represented by a point in phase space. When one has a collection (ensemble) of particles, the probability of finding a particle at a certain position in phase space is given by a probability distribution, the *Liouville* density. This is not true for a quantum particle, due to the uncertainty principle. Instead, the above *quasi-probability Wigner distribution*, plays an analogous role, but does not satisfy all the properties of a normal probability distribution, and satisfies boundedness properties unavailable to the classical distributions.
For instance, the Wigner distribution can and normally does go negative for states which have no classical model---and is a convenient indicator of quantum mechanical interference. Smoothing the Wigner distribution through a filter of size larger than *\hbar* (e.g., convolving with a phase-space Gaussian to yield the Hussimi representation), results in a positive-semidefinite function, i.e., it may be thought to have been coarsened to a *semi-classical* one. Regions of such negative value are provable (by convolving them with a small Gaussian) to be "small": they cannot extend to compact regions over a few *\hbar*, and hence disappear in the classical limit. They are shielded by the uncertainty principle, which does not allow precise location within phase-space regions smaller than *\hbar*, and thus renders such "*negative probabilities*" less paradoxical.
These questions were fully clarified by R. J. Glauber (Nobel Prize winner 2005) in his fundamental paper at 1969. The early paper of D. I. BLOKHINTSEV, which describe the problem in a particularly simple and elegant manner, was an important contribution in the field. In fact, an early analysis of D. I. BLOKHINTSEV contains the seed of many subsequent developments of the theory of mixed quantum-classical dynamics.
For details see:
C. Zachos, D. Fairlie, and T. Curtright, eds.
***Quantum Mechanics in Phase Space* (World Scientific, Singapore, 2005).**

During 1935 - 1950 Professor D. I. BLOKHINTSEV worked at Physical Institute (FIAN) and Moscow State University.

Professor D. I. BLOKHINTSEV worked second half of his life (1956 - 1979) at Joint Institute for Nuclear Research, , Dubna.

He was founder and first Director of JINR (1956 -1965). He was Director of the Laboratory of Theoretical Physics JINR during 1965 - 1979 (now Bogoliubov Laboratory of Theoretical Physics), Joint Institute for Nuclear Research, Dubna.

Professor D. I. BLOKHINTSEV published well known monograph:
Fundamentals of Quantum Mechanics, first edition, Moscow, 1944,
fifth edition, Moscow, 1976.

This book was translated to many foreign languages and become the classics of scientific literature.
He is known for his original INTERPRETATION OF QUANTUM MECHANICS which is based on the conception of quantum ensembles. A detailed analysis of this approach can be found in the extended review:
Home D., Whitaker M. A. B. ``Ensemble Interpretation of Quantum Mechanics. A Modern Perspective.'' Phys.Rep. 1992. Vol.210. P.223.
He published also many well known monographs and books on physics for broader audience and many articles in popular magazines like "Priroda", etc.

Professor D.I. BLOKHINTSEV was talented lecturer and teacher and educated many first-rank scientists - A.V. Efremov, G.V. Efimov, B.M. Barbashov, N.A. Chernikov, P.S. Isaev, G.I. Kolerov and many others.

His BIBLIOGRAPHY consists of about 300 items. The best papers will be published in 2 volumes "*Collected Papers*" in Moscow in 2008.
His list of publications shows that during his life his scientific interests were divided nearly equally between three fields of investigations: physics of solid state and statistical physics, atomic and nuclear physics and harness of nuclear energy, and high-energy physics and elementary particles physics.
He worked also on the epistemological problems of knowledge and physics, in particular. He wrote a number of essays about scientific creativity and inter-relation between science and art.

Professor D. I. BLOKHINTSEV stimulated greatly the development of researches in various fields of theoretical physics. In spite of his many administrative duties he was very kind and simple person in the everyday behavior. He was especially open to discussions, conversations on arts and science and was interested in the philosophy and history of science. He was good painter and liked winter sport at Dubna. He died when he skied at Dubna on the heart attack. His mental influence on the intellectual atmosphere at Dubna was extremely strong and his presence at JINR, Dubna still persists.

Concise but clear and instructive account of Blokhintsev's works and life was given by B.M. Barbashov and A.N. Sissakian in Vestnik RFFI No.1 (2008) pp.33-36.

Collected Works of D.I. BLOKHINTSEV are free available on the PORTAL RFBR:
D.I. BLOKHINTSEV, "*Collected Papers*" , Vol.1
D.I. BLOKHINTSEV, "*Collected Papers*" , Vol.2

A detailed analysis of the works of D.I. BLOKHINTSEV on quantum physics and relevant References can be found in the extended review:
A.L.Kuzemsky, *Works of D.I. Blokhintsev and Development of Quantum Physics*
Physics of Particles and Nuclei, 2008, vol. 39, Issue 2, pp.137-172.
(http://theor.jinr.ru/~kuzemsky/preprints/Blokhintsev08.pdf) (in English).
Russian version is available at:
Physics of Elementary Particles and Atomic Nuclei, 2008, vol. 39, Issue 1, pp.5-81.

http://theor.jinr.ru/~kuzemsky/preprints/DIBREV08.pdf.

See also:

- **KUZEMSKY A.L.**
  Comments to the Papers 4-15, ``Solid State Physics.Optics" in: D.I. BLOKHINTSEV, "*Collected Papers*" , Vol.1, Moscow, Fizmatlit, 2009. (see Table of Content, vol.1)
- **KUZEMSKY A.L.**
  Comments to the Papers 38-47, ``Quantum Physics" in: D.I. BLOKHINTSEV, "*Collected Papers*" , Vol.2, Moscow, Fizmatlit, 2009. (see Table of Content, vol.2)
- **D.I. Blokhintsev: Scientist, Teacher, Thinker (reduced version);**
  Kuzemsky A.L.,
  Ref: in: Dmitrii Ivanovich Blokhintsev (100th Anniversary of the Birthday). Eds. V.V.Balashov, M.I.Panasiuk, E.A.Romanovskii. Moscow, Moscow State University and University Book Publ., 2008, p.52-63. (in Russian)
  (PDF, 4.40 Mb)
- **FULL VERSION of the Article *D.I. Blokhintsev: Scientist, Teacher, Thinker* - in RUSSIAN;**
  Kuzemsky A.L.,
  (PDF, 220 Kb)

A detailed REPORTAGE from the 13th Int.Conference on Selected Problems of Modern Theoretical Physics, Dubna, June, 2008, dedicated to 100th Anniversary of the Birthday of D.I.Blokhintsev can be found in the PDF file: (http://theor.jinr.ru/~kuzemsky/DIBConf08.pdf)

Additional information (in Russian) can be found in Russian Wikipedia article about Blokhintsev.

See also an article *LAMB SCHIFT* in Russian Wikipedia.

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