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Naum Natanovich Meiman (obituary)

Professor N. N. Meiman, prominent mathematician and author of fundamental results in the theory of functions of a complex variable, partial differential equations, and mathematical physics, passed away on 31 March 2001 at the age of 89. Naum Natanovich belonged to the first generation of mathematicians formed under the Soviet regime. This circumstance left an imprint on his very dramatic scientific destiny, with all its ups and downs. He was born in the family of a timber merchant on 12 May 1912 in the village of Bazar in Kiev Province. One of his two brothers was connected with Social-Democratic revolutionary circles and later became an economist. In 1928, after representing himself as a year older than he was, Meiman set out to enroll in the Physics and Mathematics Department of Moscow University. At that time there were rules in effect that made it difficult for children of 'bourgeoisie' families to get into universities, and to avoid this obstacle Meiman, with the help of his brother, had provided himself with a letter from a prominent Ukrainian Bolshevik to the chairman of the examination committee. As he later related, this letter played a bad joke on him, thanks to his naiveness and inexperience. Instead of giving the letter directly to the chairman, he gave it to the man's secretary. Arriving at the examination, he saw his letter of recommendation on a bulletin board, under the heading "Fight against those who get ahead by using their connections". In the end he was not admitted to the examinations, but he was successful in enrolling in the Plekhanov Institute of the National Economy. A year later he nevertheless transferred to the Physics and Mathematics Department of Moscow University, but he was soon expelled as a result of being denounced. The expulsion process was very specific. In the summer a commission arrived during military training where the students were, and one of its tasks was to deal with the 'Meiman matter'. In a special section of the unit he was asked among other things what his attitude was toward the Soviet regime. With a youth's spontaneity, preserved in large part to the end of his life, he answered that he was loyal to the regime. This apparently too restrained answer did not help his case, and he was banned from the university in disgrace. However naive his answer sounds, it truly reflected the attitude to the regime of Naum Natanovich and many other representatives of the scientific intellegentsia of his generation.

Subsequent events showed that this grievous episode, which changed Meiman's life so much, had positive value in the long run. On the recommendation of N. I. Akhiezer, whom he had known since childhood, he travelled 'as far as possible from trouble' to Kazan and to N. G. Chebotarev, an outstanding mathematician and a fine man. After passing the whole university course of studies in a year as an external student, he became a postgraduate student under Chebotarev and in parallel began to teach at Kazan Aeronautical Institute. His postgraduate student years determined in large part Meiman's subsequent research career. Chebotarev proposed to him an interesting and promising topic connected with the Routh–Hurwitz problem. Meiman was able to get important results, which he put together in 1937 as a Ph.D. dissertation. His work was recognized as being of such significance that he was at once awarded the degree of doctor of the physical and mathematical sciences. In two years, at the age of 27, he became a professor. In 1938 Meiman was awarded first prize for this cycle of work at an All-Union competition organized by the Central Committee of the All-Union Leninist Communist Youth League. During the year before his dissertation defence he moved to Khar'kov, where he worked for two years at the Institute of Mathematics at Khar'kov University. Meiman always recalled this period of his life with satisfaction. Here he met L. D. Landau, and their friendship lasted until the premature death of the great physicist.[1] In 1938 Meiman moved to Moscow, where in the course of several years he headed the mathematics branches of several institutions of higher education, and from 1939 to 1941 he worked also at the Steklov Institute of Mathematics. During the war years he was in the evacuation, chairing the mathematics department of a military college. After returning to Moscow at the end of the war, he began working at the Institute of Physical Chemistry of the Academy of Sciences, and from 1945 at the Institute for Problems in Physics as director of the mathematics laboratory in the theoretical section headed by Landau. The laboratory performed calculations connected with the creation of the atomic bomb. The mathematical work of this period was reflected in the joint report of Landau, Meiman, and I. M. Khalatnikov, read by Meiman at the 3rd All-Union Mathematical Congress in 1956. For this work the authors received a Stalin Prize of the 2nd degree in 1952. In 1955, after the return of P. L. Kapitsa to the Institute for Problems in Physics, the mathematical laboratory was broken up, and Meiman was transferred to the Heat Engineering Laboratory of the Academy of Sciences, headed by A. I. Alikhanov and later transformed into the Institute of Theoretical and Experimental Physics. Here he worked up to 1975, when he decided to emigrate to Israel. He was denied permission to leave, for a formal reason connected with his old work on the bomb. In his attempts to leave Meiman gradually went from being a 'refusenik' to being an activist in the human rights movement. He became a member of the Sakharov committee for the protection of human rights, and he headed this committee during the period when Sakharov was exiled to Gor'kii. In this work he showed himself to be both courageous and highly principled. Furthermore, he continued his active research work. During this time he published several research papers (see [59], [60]) and

[1] Very convincing evidence of this friendship is a letter from the head of the KGB to the head of a branch of the Central Committee containing records of monitored conversations of Landau with close friends. A considerable part of this unique document, dated 1956, involves conversations with Meiman.

was one of the organizers of the 'refusenik' research seminar, the papers of which were published abroad. The long fight for permission to leave, which was supported by many prominent Western scientists (L. Schwartz, A. Martin, and others) ended only in 1988, when the democratic perestroika and the disintegration of the USSR solved the problem automatically. Unfortunately, age and the years of exhausting struggle had taken their toll. In Israel Meiman felt quite lonely, despite the warm reception given him[2] and his post of honorary professor. To his final days he had a lively interest in science and in events in Russia, to which he reacted with intense emotion. His last paper [62] was devoted to the mathematical foundations of path integration and was presented at the Sakharov memorial conference in 1996.

Meiman's scientific achievements relate mainly to three areas: the theory of functions of a complex variable, the theory of partial differential equations, and mathematical physics. A feature of his investigations was the determination of very general results, starting from a concrete problem that was both difficult and current. His first cycle of papers was connected with the Routh–Hurwitz problem, which in its classical formulation going back to Maxwell (1868) consists in finding conditions on the coefficients of a polynomial under which the roots have negative real parts. Some of the most powerful mathematicians of the nineteenth and twentieth centuries (including Routh, Hurwitz, Schur, and others) devoted papers to the solution of this problem. An analogous question relating to quasi-polynomials and of interest to Chebotarev later became important in connection with the needs of automatic programming (and then radio engineering). In 1942 Chebotarev led a seminar on this problem, in which the Kazan mathematicians who took part were augmented by displaced mathematicians who had been evacuated to Kazan, including L. S. Pontryagin. The latter investigated the Routh–Hurwitz problem for the special but important case when the exponents of the quasi-polynomial are commensurable. In the general case studied by Chebotarev and Meiman other methods had to be invoked, connected with the analysis of the problem for a broader class of entire functions. It was Meiman's merit to determine the most general class of entire functions to which the problem can be extended in a natural way—the so-called class of B-functions—and to give an effective solution in this setting. The use of B-functions enabled him to get fundamental results for another circle of classical problems involving the construction of entire functions deviating least from zero. The results of these two cycles of investigations were summarized in [15] and [35]. Meiman's book [15], written together with his teacher Chebotarev (Meiman wrote the function-theoretic chapters), is an exemplary exposition of the solution of a most difficult mathematical problem, and it is the first systematic exposition of the theory of entire functions that demonstrates in a concrete example the effectiveness of general theorems in complex and functional analysis. The class of B-functions found by Meiman also turned out to be very useful in his analysis in [59] of the spectrum of the Schrödinger equation with a complex periodic potential. There he also obtained formulae for expansions in eigenfunctions of the corresponding operator.

Another cycle of papers in which Meiman was essentially ahead of his time was concerned with the study of stability and convergence for the grid method in

[2] In 1992 a conference was organized at Tel Aviv University in honour of his eightieth birthday.

the solution of the Cauchy problem for linear and quasi-linear partial differential equations ([22]–[24]). These papers arose from very applied problems connected with calculating the power of atomic and hydrogen bomb explosions, and because of secrecy considerations were published only several years after they were written (and even then in far from complete form).

Of Meiman's results in mathematical physics we should single out the paper [40], where he established the most general conditions under which the well-known theorem of Pomeranchuk holds on the asymptotic equality of the total cross-sections for the interaction of particles and antiparticles with one and the same target as the energy of the particles increases. The proof he gave, unlike previous proofs, did not use the dispersion relations but only general properties of analytic functions, and in [45] he extended the result to the differential cross-sections. In the course of this investigation Meiman established ([48], [49]) high-energy bounds on the scattering amplitudes, as a consequence of the localness of the interaction and the causality principle. The class of quantum fields singled out by his bounds turned out to be considerably broader than the operator-valued Schwartz distributions usually used in quantum field theory, and it corresponded to the Sato–Martineau hyperfunctions. It is essential that this is exactly the class of generalized functions to which Bogolyubov's well-known 'edge of the wedge' theorem extends in a natural way [52]. These results were a precursor of the formulation, developed considerably later, of a local field theory in terms of Fourier hyperfunctions. Moreover, they laid the foundation for a fundamentally new direction in non-local quantum theory in which the non-localness was connected with the high singularity of the interaction at small distances, corresponding to an exponential growth of the matrix elements of the fields in momentum space. It is this growth, with exponent proportional to the Planck length, that was later observed for propagators in superstring theory, at present regarded as the most fundamental theory of interaction. Meiman's scientific achievements are far from exhausted by the above list of results. Actively collaborating with physicists at the Institute of Theoretical and Experimental Physics, he completed a whole series of papers having important applied value. In addition there were the unique atlas he and his colleagues created for computing phase volumes in particle collision processes [52] and the paper [57] on application of the saddle-point method for tabulation of special functions (in particular, Bessel functions with arbitrary value of the index), and other work. His friendly help to physicists was reflected also in the famous Landau–Lifshits course in theoretical physics, where he wrote the section on dispersion relations in the volume on statistical physics. Also, it is impossible to forget his remarkable and unique Russian translation (the first up to that time) of the works of Galois.

Thus it happened that Meiman, by education a pure mathematician, worked at physics institutes almost his whole life. Now, when contact between mathematicians and theoretical physicists has become so close that in some areas it is difficult to draw a line between the two professions, one cannot forget that the situation was quite different 30 years ago. Meiman can certainly be put among the pioneers of this progressive cooperation that has been useful for both sciences. Unfortunately, his situation as a mathematician among physicists has somewhat hindered a broader recognition in the mathematical world of his papers, many of which are not outdated and merit further study and development. In the memory of those who knew Naum

Natanovich he remains a brilliant, encyclopaedically educated person, ready to help at a difficult moment, and firm in his convictions.

D. V. Anosov, V. L. Ginzburg, A. B. Zhizhchenko,
M. I. Monastyrskii, S. P. Novikov, Ya. G. Sinai, M. A. Solov'ev

List of publications of N. N. Meiman

[1] "On roots of entire transcendental functions", *Mat. Sb.* **40** (1933), 521–528. (Russian)
[2] with N. G. Chebotarev, "On R-continuable polynomials", Proc. 2nd All-Union Math. Congress, vol. 2, Akad. Nauk SSSR, Moscow 1934, pp. 6–9. (Russian)
[3] "On poles of meromorphic functions", *Zap. Mat. Obshch.* (*Khar'kov*) **4 (14)** (1937), 97–104. (Russian)
[4] "Sur les polinômes R-prolongeables", *Mat. Sb.* **3 (45)** (1938), 591–650.
[5] "On continuable polynomials, II. On R-continuable polynomials", Collection in Memory of Academician D. A. Grave, Moscow 1940, pp. 117–165. (Russian)
[6] "On a certain boundary-value problem for polyharmonic equations", *Dokl. Akad. Nauk SSSR* **33** (1941), 275–278. (Russian)
[7] "On the Hermite–Hurwitz problem for entire transcendental functions", *Dokl. Akad. Nauk SSSR* **40** (1943), 55–58; English transl., *C. R.* (*Dokl.*) *Acad. Sci. URSS* (*N.S.*) **40** (1943), 46–49.
[8] "On the distribution of zeros of an entire function", *Dokl. Akad. Nauk SSSR* **40** (1943), 200–203. (Russian)
[9] "An estimate of the distance between adjacent zeros for a certain class of entire functions", *Dokl. Akad. Nauk SSSR* **53** (1946), 11–14. (Russian)
[10] "On a certain class of entire functions", *Dokl. Akad. Nauk SSSR* **62** (1948), 293–296. (Russian)
[11] "On the zeros of linear combinations of a certain class of entire functions", *Dokl. Akad. Nauk SSSR* **62** (1948), 453–456. (Russian)
[12] "On a certain class of entire functions", *Uspekhi Mat. Nauk* **3**:1 (1948), 206–207. (Russian)
[13] "Some questions on the distribution of zeros of polynomials", *Uspekhi Mat. Nauk* **4**:6 (1949), 154–188. (Russian)
[14] "On a note of L. B. Geiler", *Uspekhi Mat. Nauk* **4**:6 (1949), 194–195. (Russian)
[15] with N. G. Chebotarev, "The Routh–Hurwitz problem for polynomials and entire functions. Real quasi-polynomials with $r = 3$ and $s = 1$", *Trudy Mat. Inst. Akad. Nauk SSSR* **26** (1949), 1–331. (Russian)
[16] "On estimates of derivatives", *Uspekhi Mat. Nauk* **5**:2 (1950), 158–159. (Russian)
[17] "On conditions under which the derivative of a majorant of a function is a majorant of the derivative of the function", *Dokl. Akad. Nauk SSSR* **71** (1950), 609–612. (Russian)
[18] with B. M. Levitan, "On a uniqueness theorem", *Dokl. Akad. Nauk SSSR* **81** (1951), 729–731. (Russian)
[19] "Comparison theorems for analytic functions", *Uspekhi Mat. Nauk* **7**:1 (1952), 149–150. (Russian)
[20] "Some comparison theorems for analytic functions", *Dokl. Akad. Nauk SSSR* **82** (1952), 185–188. (Russian)
[21] "Differential inequalities and some questions on the distributions of zeros of entire and single-valued analytic functions", *Uspekhi Mat. Nauk* **7**:3 (1952), 3–62; Supplement and corrections **8**:6 (1953), 177–180. (Russian)
[22] "On the theory of partial differential equations", *Dokl. Akad. Nauk SSSR* **97** (1954), 593–596. (Russian)
[23] "On the heat equation", *Dokl. Akad. Nauk SSSR* **99** (1954), 209–212. (Russian)
[24] "Some theorems on approximation, uniqueness, and existence for partial differential equations", *Uspekhi Mat. Nauk* **10**:1 (1955), 207. (Russian)
[25] "On recursion formulae for power sums of the zeros of Bessel functions", *Dokl. Akad. Nauk SSSR* **108** (1956), 190–193. (Russian)

[26] with V. V. Vladimirskii, L. L. Gol'din, et al., Output beam from a proton accelerator with strong focusing at the energy 7 GeV", *Pribory i Tekhn. Èksper.* **3** (1956), 31–35. (Russian)
[27] "Some applications of the finite-difference method to differential equations", Proc. 3rd All-Union Math. Congress (Moscow, 1956), vol. 1, Moscow 1956, p. 60. (Russian)
[28] with L. D. Landau and I. M. Khalatnikov, "Numerical methods of integration of partial differential equations by the grid method", Proc. 3rd All-Union Math. Congress (Moscow, 1956), vol. 13, Moscow 1958, pp. 92–100. (Russian)
[29] "The monotone argument principle and differentiation of inequalities", *Dokl. Akad. Nauk SSSR* **120** (1958), 1191–1193. (Russian)
[30] "On zeros of a certain class of multivalued functions", *Dokl. Akad. Nauk SSSR* **124** (1959), 1211–1214; English transl., *Amer. Math. Soc. Transl.* (2) **19** (1962), 167–171.
[31] "On the theory of functions of the classes HB and B, *Dokl. Akad. Nauk SSSR* **125** (1959), 974–977; English transl., *Amer. Math. Soc. Transl.* (2) **19** (1962), 173–178.
[32] "On the theory of functions deviating least from zero in a domain", *Dokl. Akad. Nauk SSSR* **126** (1959), 274–277. (Russian)
[33] "On the theory of polynomials deviating least from zero", *Dokl. Akad. Nauk SSSR* **130** (1960), 257–260; English transl., *Soviet Math. Dokl.* **1** (1960), 41–44.
[34] "On polynomials deviating least from zero with any number of given coefficients", *Dokl. Akad. Nauk SSSR* **130** (1960), 503–506; English transl., *Soviet Math. Dokl.* **1** (1960), 72–75.
[35] "Solution of fundamental problems in the theory of polynomials and entire functions deviating least from zero", *Trudy Moskov. Mat. Obshch.* **9** (1960), 507–535; English transl., *Amer. Math. Soc. Transl.* (2) **32** (1963), 359–393.
[36] "Some theorems on the zeros and extremal properties of entire functions", *Dokl. Akad. Nauk SSSR* **140** (1961), 755–758; English transl., *Soviet Math. Dokl.* **2** (1961), 1261–1264.
[37] "On completeness of the zeros of entire functions", *Dokl. Akad. Nauk SSSR* **141** (1961), 796–799; English transl., *Soviet Math. Dokl.* **2** (1961), 1555-1558.
[38] with I. Gokhfel'd, "On solution of equations of Chew–Mandelstam type", *Zh. Èksper. Teoret. Fiz.* **43** (1962), 181–184; English transl., *Soviet Phys. JETP* **16** (1962), 129–131.
[39] "Some properties of analytic functions", *Questions on the physics of elementary particles*, Erevan 1962, pp. 223–232. (Russian)
[40] "On asymptotic equality of the total cross-sections of particles and antiparticles", *Zh. Èksper. Teoret. Fiz.* **43** (1962), 2277–2280; English transl., *Soviet Phys. JETP* **16** (1962), 1609–1611.
[41] "Analytic expressions for upper bounds of the coupling constants in quantum field theory", *Zh. Èksper. Teoret. Fiz.* **44** (1963), 1228–1238; English transl., *Soviet Phys. JETP* **17** (1963), 830–835.
[42] "Dispersion relations and general properties of scattering amplitudes", *Questions in the physics of elementary particles*, Erevan 1963, pp. 121–130. (Russian)
[43] "Functions of bounded type, the classes H_δ, and their applications to dispersion relations, *Uspekhi Mat. Nauk* **18**:4 (1963), 208–210. (Russian)
[44] with V. L. Ginzburg, "Dispersion relations for the indices of refraction and absorption", *Zh. Èksper. Teoret. Fiz.* **46** (1964), 243–253; English transl., *Soviet Phys. JETP* **19** (1964), 169–175.
[45] "Asymptotic equality of differential cross-sections for particles and antiparticles", *Zh. Èksper. Teoret. Fiz.* **46** (1964), 1039–1047; English transl., *Soviet Phys. JETP* **19** (1964), 706–711.
[46] "The asymptotic meson-nucleon scattering amplitude", *Zh. Èksper. Teoret. Fiz.* **46** (1964), 1502–1504; English transl., *Soviet Phys. JETP* **19** (1964), 1018–1019.
[47] with A. A. Slavnov, "On the upper limit of the $\pi - N$ coupling constant", *Phys. Lett.* **10**:1 (1964), 124–126.
[48] "The causality principle and the asymptotic behavior of the scattering amplitude", *Zh. Èksper. Teoret. Fiz.* **47** (1964), 1966–1983; English transl., *Soviet Phys. JETP* **20** (1964), 1320–1330.
[49] "The causality principle and the structure of generalized functions admissible in physics", Abstracts of Communications, International Congress of Mathematicians, section 12, Moscow 1966, p. 43. (Russian)

[50] with V. A. Kolkunov et al., "On the saddle-point method", Second Summer School on Problems in the Theory of Elementary Particles, Inst. Fiz. i Astronomii Est. SSR, Otepää 1967, pp. 85–112. (Russian)
[51] with V. A. Kolkunov and E. S. Nikolaevskii, "Methods for computing phase integrals and distributions", *Yadernaya Fiz.* **9** (1969), 552–564; English transl., *Soviet J. Nuclear Phys.* **9** (1969), 316–322.
[52] with O. N. Baloshin, I. N. Borodina, et al., "Atlas of distributions", preprint, Inst. Teoret. i Èksper. Fiz., Moscow 1967, pp. 85–112. (Russian)
[53] with M. I. Monastyrskii, "Local field theories and the 'edge of the wedge' theorem", Abstracts of reports, All-Union Conf. on the Theory of Functions of a Complex Variable, Khar'kov 1971, p. 139. (Russian)
[54] "The Poisson–Stieltjes integral for a finitely connected Jordan domain", *Dokl. Akad. Nauk SSSR* **197** (1971), 1272–1275; English transl., *Soviet Math. Dokl.* **12** (1971), 678–681.
[55] "On an upper bound for the potential of a plane electrostatic field", *Dokl. Akad. Nauk SSSR* **202** (1972), 1268–1270; English transl., *Soviet Math. Dokl.* **13** (1972), 285–288.
[56] "On the theory of functions of bounded type", *Dokl. Akad. Nauk SSSR* **204** (1972), 34–37; English transl., *Soviet Math. Dokl.* **13** (1972), 593–597.
[57] with I. M. Gokhfel'd and E. S. Nikolaevskii, "Saddle contours of the Sommerfeld integral representation of cylindrical functions", preprint, Inst. Teoret. i Èksper. Fiz., Moscow 1974. (Russian)
[58] with I. N. Borodina, "Riemann surfaces determined by Bessel functions", preprint no. 1, Inst. Teoret. i Èksper. Fiz., Moscow 1975. (Russian)
[59] "Eigenfunction expansion for a Schrödinger operator with a complex potential", *Pis'ma Zh. Èksper. Teoret. Fiz.* **21** (1975), 621–624; English transl., *JETP Lett.* **21** (1975), 292–293.
[60] "Functional integrals as integrals on locally noncompact groups with generalized measures", *J. Math. Phys.* **25** (1984), 1412–1433; Errata, ibid., 3357.
[61] "Reminiscences of Landau", *Frontiers of physics*, Pergamon Press, Oxford 1989, pp. 27–29.
[62] "What's what in path integration", preprint IAS 906-94, The Mortimer and Raymond Sackler Institute of Advanced Studies, Tel Aviv 1994.

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