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# Chronicle

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**Abstract**

**Full Text**

**Chronicle**

## **THIRD ALL-UNION SYMPOSIUM ON WAVE DIFFRACTION**

In accordance with the decision adopted at the Second All-Union Symposium on Wave Diffraction (Gorky, 1962), and according to the plan of activities of the USSR Academy of Sciences (the section on diffraction of electromagnetic, acoustic, and other waves of the Acoustics Council of the USSR Academy of Sciences) for the coordination of scientific research in the field of diffraction theory, the Third All-Union Symposium on Wave Diffraction was held in Tbilisi from September 24 to 30, 1964. It was organized by the section on diffraction of electromagnetic, acoustic, and other waves of the Acoustics Council of the USSR Academy of Sciences and the USSR State Committee for Radio Electronics, jointly with the Academy of Sciences of the Georgian SSR, with the participation of the Acoustics Institute, Tbilisi State University, and the Georgian Polytechnic Institute. Like the two preceding symposia, the Third Symposium was devoted to new theoretical studies of the behavior of waves of any nature under conditions complicated by various factors (the shape of the region, boundary conditions, variable coefficients in the equations, anisotropy, etc.), and to the development of mathematical methods for such studies. In terms of the number of participants and the number of reports submitted for discussion and presented, the Third Symposium was the most representative. The work of the Symposium, held in the building of Tbilisi State University, was directed by an organizing committee consisting of: V. D. Kupradze (chairman), G. D. Malyuzhinets (deputy chairman), D. Z. Avazashvili, V. A. Borovikov, L. A. Weinstein, S. S. Voit, G. V. Glekin, N. A. Kuzmin, G. I. Makarov, V. L. Marchenko, M. A. Miller, G. I. Petrashen, and Yu. A. Ukhanov (scientific secretary of the organizing committee). After the opening address by V. D. Kupradze, who opened the Symposium, and the speeches of Academician N. I. Muskhelishvili—President of the Academy of Sciences of the Georgian SSR and Professor A. Khorava—Rector of Tbilisi State University, who warmly welcomed the participants of the Symposium, the Symposium began its work, which was conducted daily in plenary and sectional sessions.

At the plenary sessions 11 reports were heard and discussed.

The report by L. N. Sretensky, “Poincaré’s Methods in the Theory of Diffraction of Radio Waves,” was devoted to the method of establishing an asymptotic formula for a function represented by an infinite series in which each term depends on a large parameter (the transmitter frequency), proposed by Poincaré in solving the problem of diffraction of Hertz waves by the terrestrial sphere (vol. XXIX of *Rendiconti del Circolo Matematico di Palermo* for 1910). It was

noted that this method can be applied with great success to the solution of various problems in the hydrodynamics of wave motions, to questions of architectural acoustics, and to the theory of gas jets.

G. D. Malyuzhinets, in the report “Analytic Dependence on a Parameter and Stationary Diffraction Problems,” gave various formulations of diffraction problems for the scalar Helmholtz wave equation

$$\Delta U + k^2 U = 0$$

using the radiation principle (the limiting absorption principle), the principle of emission in the case of free space (with or without dispersion), and, in the case of an arbitrary region filled with an inhomogeneous medium, using a radiation condition at infinity, or taking into account the requirement of uniform boundedness. Methods were presented for studying the analyticity of the dependence of solutions on the complex parameter  $k$  and their analytic continuation with respect to the parameter  $k$  (or  $m$  for the equation  $\Delta U - m^2 U = 0$  in the case of media with dispersion), and the problem of the existence and uniqueness of solutions of certain exterior stationary boundary-value problems in diffraction theory was considered.

In the report by V. D. Kupradze, “On an Approximate Solution of Boundary-Value Problems of Mathematical Physics,” using as an example one of the Dirichlet problems for a harmonic function, a new “variant” of the method of generalized Fourier series was described, making it possible to construct approximate solutions for almost all linear problems of mathematical physics and continuum mechanics: for linear “elliptic” problems in the case of homogeneous and piecewise-inhomogeneous media, for equations and systems of equations of various types, in particular for boundary-value problems of diffraction theory, theories of elasticity, and hydrodynamics.

The report by N. A. Kuzmin, “Questions of Diffraction and Propagation of Waves in Plasma,”

was devoted to the character of the differential equations and the types of boundary conditions that waves in a plasma must satisfy, and also to identifying the limits of applicability of the phenomenological theory of the “mean electron” in studying the effects of propagation and diffraction of electromagnetic waves in a plasma, which are of interest for radio engineering. The report presented some results on the theory of wave propagation in a plasma placed in a waveguide with conducting walls. Generalized impedance boundary conditions were given for anisotropic layered media, and results were reported on the scattering of waves by the simplest plasma formations (sphere, cylinder).

The special case of wave propagation in which the field forms a thin long beam arising in open resonators and open (lens and mirror) transmission lines owing to phase correctors was the subject of the report by **B. Z. Katsenelenbaum**,

“Some Problems of Quasioptics.” The speaker gave an overview of the main directions in which modern theory describing such fields is developing: the theory of phase correctors and the theory of exciters for open lines. It was noted that the most difficult and unclear problem is that of creating a mathematical apparatus that would make it possible to use the methods of geometrical optics in field theory. An analogous situation has arisen in quasioptical problems encountered in studying the laws of wave propagation in very wide waveguides.

In the report by **L. A. Weinstein**, “Excitation of Open Resonators,” two problems of interest in the theory of open resonators were considered:

- a) the excitation problem, reducible to the solution of the inhomogeneous Helmholtz wave equation  
 $\Delta\Phi + k^2\Phi = -4\pi\rho$  with the boundary condition  $\Phi = 0$  on  $S$  and the absorption condition  $\lim_{R \rightarrow \infty} R\Phi = 0$  for  $\text{Im } k > 0$ , where  $\rho$  is a prescribed function;
- b) the Cauchy problem for the nonstationary wave equation

$$\Delta\Phi - \frac{1}{c^2} \frac{\partial^2\Phi}{\partial t^2} = 0,$$

with the same boundary condition and the initial conditions

$$\Phi = \Phi^0, \quad \frac{1}{c} \frac{\partial\Phi}{\partial t} = \Phi^1 \quad \text{for } t = 0,$$

where  $\Phi^0(x, y, z)$  and  $\Phi^1(x, y, z)$  are prescribed functions decreasing sufficiently rapidly as  $R \rightarrow \infty$ . The general (formal) solution of both problems is obtained by expansion in eigenfunctions of the continuous spectrum. Then the “resonance part” is extracted from it; this part has an explicit expression and is of principal practical interest. It was noted that the results of the study can easily be generalized to other boundary conditions and to the case of an inhomogeneous medium.

**V. A. Marchenko** delivered a report on the topic “Spectral Theory of Operators and Some Problems of Diffraction.”

In the report by **G. I. Markov** and **V. V. Novikov**, “Propagation of Radio Waves in the Super-Long-Wave Range,” a survey was given of the principal problems that arise in studying the theory of propagation of low-frequency electromagnetic waves in the Earth-ionosphere waveguide channel, and of results obtained by various authors in recent years. Some results were presented of studies and numerical calculations of the electromagnetic field carried out at the Department of Radiophysics of Leningrad State University.

The report by **A. N. Tikhonov**, “On Methods for Solving Integral Equations of the First Kind,” was devoted to questions of the numerical solution of homogeneous integral equations arising in ill-posed problems of mathematical physics.

In the report by **V. A. Borovikov** and **A. F. Filippov**, “Diffraction by Polygons and Polyhedra,” a systematic theory for solving two-dimensional and three-dimensional (stationary and nonstationary) problems of electromagnetic-wave diffraction by polygons and polyhedra was presented; prospects for its further development were discussed, and limits of applicability of the theory were indicated.

In the report by **M. L. Levin** and **S. M. Rytov**, “Diffraction and Thermal Radiation,” several questions of the phenomenological correlation theory of thermal fluctuations in electrodynamics were considered, and it was shown that the solution of any diffraction problem under irradiation by a wave from an elementary source (in particular, by a plane wave) contains within it the solution of a definite problem on thermal radiation.

The sectional meetings were held in parallel in four sections: *A, B, C, D*.

In Section *A*, reports were presented on the following topics: integral equations of diffraction theory, the Wiener-Hopf-Fock method, nonstationary wave processes, discontinuous solutions and short-wave asymptotics, and asymptotic methods. The following reports were heard and discussed:

**V. I. Dmitriev, A. N. Tikhonov.** On the application of the regularization method to the calculation of diffraction problems.

**L. A. Galin, V. A. Kovaleva.** A spatial problem on the action of a nonstationary pressure wave on a plate of arbitrary shape in plan, moving in a gas stream.

**D. Z. Avazashvili.** On one problem of acoustic-wave diffraction for multiply connected and layered regions.

**V. N. Zorko, N. A. Rostovtsev.** On the solution of an axisymmetric contact problem of steady oscillations of a half-space.

**V. V. Kravtsov.** Application of integral equations in diffraction problems.

**Yu. V. Gandel’.** Paired integral equations and the solution of certain problems in diffraction theory.

**G. I. Makarov, V. V. Novikov.** Diffraction of electromagnetic waves by a plasma cylinder.

### THIRD ALL-UNION SYMPOSIUM ON WAVE DIFFRACTION

**B. M. Bolotovskii, G. V. Voskresenskii.** Radiation of currents and charges flying with constant velocity near ideally conducting bodies.

**P. S. Mikazyan, Ya. Ya. Zush.** Diffraction of electromagnetic waves by an anisotropic step in a plane waveguide.

**L. N. Lutchenko.** Nonstationary processes in wire antennas.

- I. A. Molotkov, I. V. Mukhina. Nonstationary propagation of waves in an inhomogeneous half-space with a minimum propagation velocity.
- V. S. Buldyrev. Investigation of Green' s functions in diffraction problems for a transparent sphere and a circular cylinder.
- V. I. Iunin. Interference wave field near the surface of an elastic inhomogeneous sphere.
- A. M. Kovalev. Investigation of the fundamental solution of the Cauchy problem for the equations of motion of an elastic anisotropic medium.
- L. I. Bezruchenko. Reflection of a pulsed signal from an Epstein layer.
- I. V. Sukharevskii. Asymptotic solution of a three-dimensional problem on the passage of short electromagnetic waves through thin layers.
- M. V. Fedoryuk. Short-wave asymptotics of the reflection coefficient.
- Yu. A. Kravtsov. Asymptotic solution of Maxwell' s equations near a caustic.
- V. S. Buldyrev. Change in the character of the singularity at the slip front after the passage of the caustic front.
- I. M. Yavorskaya. Watson' s method in the diffraction of elastic waves.
- G. D. Malyuzhinets, A. V. Popov, Yu. N. Cherkashin. On the development of one computational method in diffraction theory.
- G. I. Makarov, V. V. Novikov. Application of reference equations to the study of the propagation of electromagnetic waves in smooth inhomogeneous isotropic and anisotropic ionospheric layers.
- I. A. Molotkov. Diffraction in an inhomogeneous space with a refractive index depending on two coordinates.
- V. Yu. Zavadskii. Asymptotic approximations in the dynamics of an elastic layered inhomogeneous medium.
- E. M. Gyuningen, G. I. Makarov. Surface waves in problems of wave propagation.
- Yu. M. Yanevich. Propagation of radio waves over an inhomogeneous path.
- V. M. Babich. On the preservation of locality in diffraction problems for short waves.
- V. M. Babich, I. V. Olimp'ev. Estimate of the field in the shadow region in the diffraction of a cylindrical wave by a smooth convex cylinder.
- V. D. Andronov. On the problem of diffraction by an elliptic cylinder and some estimates of the Green' s function of the Helmholtz operator in the case of diffraction by an arbitrary convex cylinder.

V. S. Buslaev. Application of continual integrals for deriving short-wave asymptotics in diffraction problems.

A. D. Gondra, B. E. Kinber. Accounting for multiple interactions in the asymptotic solution of diffraction problems.

O. I. Fal'kovskii. Asymptotic representation of the solution of the problem of diffraction of a plane electromagnetic wave by an ideally conducting sphere.

V. P. Maslov. The overall behavior of discontinuities of hyperbolic systems and the problem of nonstationary diffraction and refraction. Behavior of the solution of the Helmholtz equation in the shadow region behind caustics in an inhomogeneous medium (short communication).

In Section **B**, sessions were held on the following topics: application of infinite systems of equations in diffraction theory, diffraction of electromagnetic waves, long-wave approximations and small perturbations, gratings, application of functionally invariant solutions and boundary-value problems for analytic functions, mixed problems in regions with a moving boundary, hydrodynamic problems, waves in elastic media. The following papers were discussed:

V. P. Shestopalov. New solutions of diffraction problems on periodic structures.

E. A. Ivanov. Diffraction by composite bodies.

Yu. P. Lysanov. Diffraction of a plane wave, after passing through an inhomogeneous layer, by a periodically inhomogeneous surface of arbitrary shape.

E. N. Podolskii. Mathematical questions of the theory of diffraction by a plane periodic grating.

V. A. Kalyuzhnyi, A. A. Pistol'kors. Diffraction of a plane electromagnetic wave by a cylindrical wire in a plane dielectric layer.

V. B. Krasovitskii, V. I. Kurilko, O. A. Tretyakov, S. S. Tretyakova, V. P. Shestopalov. Application of the theory of diffraction on periodic structures to certain problems of electrodynamics.

A. I. Rubinshtein, L. B. Tartakovskii. On one approximate method for solving the problem of diffraction of electromagnetic waves at the open end of a plane waveguide and some related problems.

V. B. Tseitlin. Application of asymptotic methods to the analysis of measurements of directional diagrams in the near zone.

Yu. A. Erukhimovich. Solution, using approximations, of the problem of diffraction of a plane electromagnetic wave by a sphere of large radius.

V. A. Moskalev. Diffraction of a plane electromagnetic wave by an inclined corrugated structure.

N. I. Kontorovich, M. I. Astrakhan, M. N. Spirina. Averaged gra-

boundary conditions on the surface of conducting meshes with rectangular cells and diffraction of electromagnetic waves by such meshes.

I. V. Smirnova, L. A. Cherkas. Diffraction by weakly deformed and separated bodies.

G. Sh. Kevanishvili. Diffraction of waves by certain periodic structures.

I. E. Tarapov. The diffraction problem for a grating of contours of arbitrary shape.

V. V. Meriakri, M. V. Persikov, A. N. Sivov. On the question of the propagation of electromagnetic waves in waveguides with a large number of longitudinal slots.

D. B. Turvich, Yu. Ya. Iossel, E. S. Kochanov, E. A. Svyadosh. An algorithmic method for computing the electromagnetic field of a low-frequency radiator.

L. M. Flitman. The wave field arising from a discontinuity at the boundary of two elastic bodies.

B. V. Kostrov. Some model problems in the dynamic theory of elasticity.

E. A. Krasilshchikova. A method for solving mixed problems with a moving boundary for the three-dimensional wave equation.

V. N. Krasilnikova. Diffraction of a wave by a sphere with a time-varying radius.

P. S. Lineikin. On the diffraction of long waves in the ocean.

Yu. M. Krylov. Theory of reflection and diffraction of sea waves.

Ya. I. Sekerzh-Zenkevich. On the theory of finite-amplitude standing waves on the free surface and on the interface of a heavy liquid from two layers of finite depth and different density.

A. Sh. Afremov. The action of waves on a submerged circular cylinder at an arbitrary heading angle.

S. S. Voit. Diffraction on a half-plane of waves formed on the surface of a liquid and on an interface in a layered liquid by a periodically acting source.

Voinich-Syanozhenitskii, Kereselidze, Gvazava. On certain properties of the wave motion of flows of a real liquid flowing in deformable channels of finite depth.

P. A. Krauklis, L. A. Molotkov. On the propagation of low-frequency waves in plane and cylindrical layers in contact with an elastic medium.

A. G. Alenitsyn. Lamb's problem for an elastic inhomogeneous half-space.

Yu. K. Konechkov. Diffraction of bending waves by a circular obstacle in a plate.

N. S. Smirnova. On the behavior of the field of a once-reflected wave near the initial point (brief communication).

D. P. Kouzov. Diffraction of a hydroacoustic wave by a system of cracks in an elastic plate.

I. G. Filippov. On some problems of wave dynamics in elastic-plastic bodies.

In Section C, sessions were held on the following topics: inverse problems of diffraction theory; diffraction by a strip, a slit, and angular domains; the Sommerfeld integral; open resonators and quasi-optics; use of integral identities and particular solutions of special form; plasma; wave propagation. The following reports were heard and discussed:

E. G. Zelkin. Synthesis of an antenna with a plane aperture.

K. S. Shifrin, A. Ya. Perelman. Determination of the particle spectrum using light-scattering data.

Yu. N. Dnestrovsky, D. P. Kostomarov. Scattering of waves by an inhomogeneous plasma.

A. F. Chaplan. Analysis and synthesis of structures with variable surface impedance.

O. P. Kozina. A magnetic dipole in a conducting medium.

A. A. Tuzhilin. Diffraction of waves in wedge-shaped regions with ideally reflecting faces (survey of new results).

G. Ya. Popov. On one approximate method for solving the integral equation for the diffraction of electromagnetic waves by a strip of finite width.

M. D. Khaskind, L. A. Vainshtein. Diffraction of plane waves by a slit and a strip.

V. A. Borovikov. Diffraction of a plane wave by a strip at grazing angles of incidence and observation close to grazing.

M. S. Bobrovnikov, V. N. Kislitsina, V. G. Myshkin, R. P. Starovoitova. Diffraction of a surface wave incident at an arbitrary angle on an impedance-plane discontinuity.

D. V. Shanin. An approximate method for calculating the field distribution in a sectoral horn with impedance walls.

V. S. Buldyrev, E. E. Fradkin. Some questions in the theory of open resonators.

N. G. Vakhitov. An open resonator formed by mirrors with a variable reflection coefficient.

L. A. Vainshtein. Diffraction in open resonators with confocal mirrors.

V. I. Talanov. Equivalent transformations of quasi-optical systems.

R. B. Vaganov. Scattering of waves of a Gaussian beam by inhomogeneities.

V. P. Bykov. Geometrical optics of open resonators.

M. L. Levin. On one modification of the diffraction integral in the theory of volume scattering (brief communication).

G. D. Malyuzhinets. On one theorem for analytic functions and its generalization for wave potentials.

I. G. Kondrat'ev, V. I. Talanov. Application of Lorentz' s lemma to the calculation of radiation fields of prescribed sources in various media.

L. M. Galonen. On one integral of the equations of thermal or elastic vibrations of anisotropic bodies with variable physical characteristics (brief communication).

V. Yu. Zavadsky. On the independent propagation of longitudinal and transverse waves in certain elastic inhomogeneous media.

B. A. Panchenko. Green's tensor functions of Maxwell's equations for cylindrical regions.

V. B. Gildenburg, I. G. Kondrat'ev. Diffraction of electromagnetic waves by a plasma sphere in the presence of spatial dispersion.

A. A. Andronov. Resonance diffraction of electromagnetic waves by a deformable cylinder (sphere).

Yu. I. Orlov, V. A. Permyakov, V. N. Vasil'ev. Impedance boundary conditions on the surface of a plasma with sharply varying parameters.

N. V. Tsepelev. On the dispersion properties of a transition layer.

Yu. A. Ryzhkov, V. V. Tamoikin. On the tensor of the effective dielectric permittivity of an inhomogeneous magnetized plasma.

Yu. I. Zhidko, V. P. Kopaleishvili. Effective cross sections of a cylinder in the Fresnel diffraction zone.

E. G. Guseva, D. S. Fligel'. Comparison of the results of asymptotic calculations in the problem of propagation of low-frequency electromagnetic waves in the Earth-ionosphere waveguide.

Z. A. Yanson. On the dispersion properties of Love waves in an elastic inhomogeneous sphere.

L. A. Ostrovsky. On the propagation of quasi-harmonic waves in an inhomogeneous dispersive medium.

A. D. Petrovsky. On the sliding of electromagnetic waves along a plane surface.

In Section D sessions were held on the following topics: mathematical formulations of diffraction problems; existence and uniqueness theorems; computational methods in diffraction theory; selected statistical questions of wave fields; general properties of solutions of diffraction problems; methods of functional analysis; application of the spectral theory of operators; direct methods; waveguides. The following reports were discussed:

- D. M. Eidus. Boundary-value problems of diffraction in regions with an infinite boundary.
- L. G. Magaradze. On certain generalizations of Sommerfeld' s radiation principle.
- B. R. Vainberg. Elliptic equations in the whole space and the generalized absorption principle.
- R. G. Barantsev. On the formulation of the scattering problem at a finite distance.
- E. G. Shtefel'. A priori estimates of solutions and solvability of general boundary-value problems for linear elliptic equations of arbitrary order with discontinuous coefficients.
- E. N. Vasil'ev, A. R. Seregina. Integral equations and the numerical solution of certain diffraction problems.
- M. V. Fedoruk. Method of stationary phase for multiple integrals.
- D. M. Sazonov. Matrix methods in problems of electromagnetic excitation of bodies of piecewise-coordinate form.
- U. K. Nigul. Transient wave processes of deformation of rods, plates, and shells caused by an impulse load.
- L. I. Bogin, A. G. Zhuravleva. Application of the Filon-Nikolaeva method to the calculation of an integral of a rapidly oscillating function (brief communication).
- I. G. Kondrat'ev, M. A. Miller. On the diffraction of electromagnetic waves by bodies placed in a weakly inhomogeneous medium.
- P. V. Blyokh. Compression of a radio-emission pulse in a dispersive medium with random inhomogeneities.
- Yu. A. Ryzhov, V. V. Tamoikin, V. I. Tatarsky. On the spatial dispersion of an inhomogeneous medium.
- L. A. Chernov. The method of a parabolic equation in the theory of wave propagation in a medium with random inhomogeneities.
- S. G. Krein, G. I. Laptev. Boundary-value problems with a parameter in the boundary condition (waveguides, oscillations of a viscous fluid).
- Ya. A. Roitberg. Inhomogeneous elliptic problems with discontinuous coefficients and a local increase in the smoothness of generalized solutions up to the boundary of the domain and the surface of discontinuity of the coefficients.
- V. A. Kondrat'ev. On the smoothness of solutions of elliptic equations in domains with corners and conical points.
- Yu. I. Grosberg. Expansion of growing functions in eigenfunctions of non-self-adjoint operators and diffraction problems.

V. F. Zhdanovich. Spectral theory of non-self-adjoint differential operators as applied to the study of processes in a one-dimensional medium.

M. I. Serov. Numerical estimates of the eigenvalues of a non-self-adjoint second-order operator with periodic coefficients.

E. Ya. Khruslov. Analytic properties of the resolvent of one boundary-value problem.

A. I. Lazutkin. On expansion theorems in eigenfunctions associated with the Watson transform.

A. G. Sveshnikov. Justification of the me...

methods for studying the propagation of electromagnetic oscillations in irregular waveguides.

V. V. Nikolsky. On the justification of direct methods for internal problems of electrodynamics.

D. I. Korinenko, V. P. Orlov, V. G. Feoktistov. Application of direct methods to the calculation of irregular waveguide systems.

I. B. Levinson, P. Sh. Fridberg. Slit junctions of rectangular waveguides.

A. S. Ilinsky. Propagation of electromagnetic oscillations in waveguides with an irregular lateral surface.

Abstracts of most of the above-listed papers and communications heard and discussed at the symposium have been published in the symposium's abstract collection: *Third All-Union Symposium on Wave Diffraction*. Nauka Publishing House, Moscow, 1964. Their content distinctly points to a rapid change in the nature of the development of the theory of wave diffraction. Mathematical methods of investigation have come to occupy an ever larger place in it, as a result of which it is being transformed from a branch of physics into a branch of applied mathematics, whose content is the development of effective analytical and computational methods for solving various types of problems for stationary and nonstationary wave equations. There is no doubt that the holding of the Third Symposium, at which considerable emphasis was placed on the mathematical aspect of the works discussed, will contribute to the further convergence of diffraction theory with mathematics and to the involvement of mathematicians in fruitful participation in the development of new problems in diffraction theory.

At the concluding plenary session of the symposium, the results of its work were summarized and a decision was adopted to hold the next, Fourth Symposium on Wave Diffraction in 1967 in the city of Kharkov.

In conclusion, one should also note the good organization of the symposium, which was conducted at a high scientific level, and the exceptional hospitality shown to its numerous participants in Tbilisi.

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