

Proceedings of the International Conference



**DAYS on DIFFRACTION 2015**

May 25 – 29, 2015

St. Petersburg, Russia

Proceedings of the International Conference “Days on Diffraction 2015”, St. Petersburg, Russia

Edited by **O.V. Motygin** (Institute of Problems in Mechanical Engineering, St. Petersburg)  
**A.P. Kiselev** (St. Petersburg Department of V.A. Steklov Mathematical Institute)  
**P.A. Belov** (ITMO University)  
**L.I. Goray** (St. Petersburg Academic University & Institute for Analytical Instrumentation)  
**A.Ya. Kazakov** (St. Petersburg University of Aerospace Instrumentation)  
**A.S. Kirpichnikova** (Liverpool Hope University)

“Days on Diffraction” is an annual conference taking place in May–June in St. Petersburg since 1968. The present event is organized by St. Petersburg State University, St. Petersburg Department of the Steklov Mathematical Institute, the Euler International Mathematical Institute and the ITMO University.

More than 200 scientists came from different parts of the world to participate in “Days on Diffraction 2015”; the Organizing Committee thanks them all. Of special gratitude are the authors of extended abstracts submitted to the Proceedings; 73 of them (selected by peer-review) are published in the present issue.

**Organizing committee:** V.M. Babich /Chair/, A.S. Kirpichnikova /Secretary/,  
T.V. Vinogradova /Visas/, N.V. Zalesskaya /Accommodation/, I.V. Andronov,  
P.A. Belov, A.Ya. Kazakov, N.Ya. Kirpichnikova, A.P. Kiselev, M.A. Lyalinov,  
O.V. Motygin, M.V. Perel, A.M. Samsonov, V.P. Smyshlyaev, R. Stone, N. Zhu

**Web site of the conference:** <http://www.pdmi.ras.ru/~dd/>

**The conference is organized and sponsored by**



St. Petersburg Department  
of V.A. Steklov  
Institute of Mathematics



St. Petersburg State  
University



The Euler International  
Mathematical Institute



ITMO University



Russian Foundation  
for Basic Research



IEEE Russia (Northwest)  
Section AP/ED/MTT  
Joint Chapter



Russian Academy of Sciences



Ministry of Education  
and Science of the  
Russian Federation

IEEE Catalog No.:

**CFP15489-ART** (Electronic media)  
**CFP15489-PRT** (Print)

ISBN:

**978-1-4673-8630-2** (Electronic)  
**978-1-4673-8635-7** (Print)

Copyright and Reprint Permission: Abstracting is permitted with credit to the source. Libraries are permitted to photocopy beyond the limit of U.S. copyright law for private use of patrons those articles in this volume that carry a code at the bottom of the first page, provided the per-copy fee indicated in the code is paid through Copyright Clearance Center, 222 Rosewood Drive, Danvers, MA 01923. For reprint or republication permission, email to IEEE Copyrights Manager at [pubs-permissions@ieee.org](mailto:pubs-permissions@ieee.org). All rights reserved. Copyright © 2015 by IEEE.

## CONTENTS

<b>Eron L. Aero, Anatolii N. Bulygin, Yurii V. Pavlov</b> Mathematical methods for solution of nonlinear model of deformation of crystal media with complex lattice .....	8
<b>Yauheni Y. Arlou, Dzmitry A. Tsyantenka, Eugene V. Sinkevich</b> Wideband computationally-effective worst-case model of twisted pair radiation .....	14
<b>Gerassimos A. Athanassoulis, Christos E. Papoutsellis</b> Nonlinear irrotational water waves over variable bathymetry. The Hamiltonian approach with a new efficient representation of the Dirichlet to Neumann operator .....	20
<b>Pelin Aydiner, Tolga Birkandan</b> Physical problems admitting Heun-to-hypergeometric reduction .....	27
<b>V.M. Babich, A.A. Matskovskiy</b> The Buldyrev interference head wave and the locality principle .....	33
<b>Dmitry A. Baranov, Ivan I. Shishkin, Dmitry S. Permyakov, Kirill B. Samusev, Anton K. Samusev, Andrey A. Bogdanov</b> Dark-field spectroscopy of whispering gallery mode cavities .....	36
<b>Yuriy N. Belyayev</b> Characteristic matrices of layered periodic structures .....	42
<b>Yuriy N. Belyayev, Sergey O. Gridnev, Alexander M. Dronov</b> Coefficients of SH-wave conversion into SV- and P-waves by the crystal layer .....	49
<b>José A. Borda-Hernández, Michel Zamboni-Rached, Ioannis M. Besieris, Amr Shaarawi</b> Propagation of finite energy Airy pulses in dispersive media .....	54
<b>V.V. Borzov, E.V. Damaskinsky</b> On representations of generalized oscillator for two sequences of linearly related orthogonal polynomials .....	58
<b>Hakim Boumaza, Olivier Lafitte</b> An exactly solvable non $C^1$ periodic potential .....	62
<b>V.A. Buslov, P.V. Eskuzian</b> Modeling asymmetric Mössbauer spectra of a super-paramagnetic in the framework of DOM (Discrete Orientation Model) .....	67
<b>Alexander V. Chebykin, Maxim A. Gorlach, Alexey A. Gorlach, Pavel A. Belov</b> Spatial dispersion in metamaterials based on three-dimensional arrays of spheres and disks .....	70
<b>Tatyana A. Derzhavskaya, Stanislav B. Glybovski, Irina V. Melchakova, Alexander J.E. Raaijmakers, Cornelis A.T. van den Berg</b> Electromagnetic bandgap metasurfaces for decoupling of elements of MRI body coil array at 7 Tesla .....	75
<b>Pavel A. Dmitriev, Dmitriy A. Baranov, Ivan S. Mukhin, Anton K. Samusev, Pavel A. Belov, Constantin R. Simovski, Alexander S. Shalin</b> Antireflective properties of periodic nanopore arrays .....	81
<b>Robert Ducharme</b> On the relativistic constraint dynamics of electromagnetic beams .....	87

<b>George V. Filippenko</b>	
Axisymmetric vibrations of the semiinfinite cylindrical shell partially submerged into the liquid . . .	92
<b>Gavrilov S.N., Shishkina E.V.</b>	
Scale-invariant initial value problems with applications to the dynamical theory of stress-induced phase transformations . . . . .	96
<b>Larisa A. Glushchenko, Alexander M. Korzun, Victor I. Tupota, Vadim Ya. Krohalev</b>	
Possibility to extract information on an acoustic speech signal from reflected laser radiation . . . .	102
<b>Glushkov E.V., Glushkova N.V., Miakisheva O.A.</b>	
The interaction of source-generated spherical waves with an elastic plate immersed in acoustic fluid . . . . .	107
<b>Stanislav B. Glybovski, Valeri P. Akimov, Victor V. Zalipaev</b>	
Electromagnetic wave propagation along a thin wire over an arbitrary isotropic interface . . . . .	112
<b>Golovinski P.A., Astapenko V.A., Manuylovich E.S.</b>	
Diffraction of ultrashort pulse on a nanoscale conductive cone . . . . .	118
<b>Leonid I. Goray</b>	
Energy balance for weak formulation of diffraction by lossy anisotropic inhomogeneous gratings .	123
<b>Konstantin V. Greshnevikov, Georgiy P. Zhabko, Evgeniy L. Svechnikov</b>	
Study of elastic wave propagation in multilayered structures with uniform cross sections by the reflection coefficients method . . . . .	130
<b>Vladimir A. Gusev</b>	
Nonlinear sound beam propagation in the porous viscoelastic medium . . . . .	134
<b>Mehedi Hasan, Ivan Iorsh</b>	
Interaction of light with a hyperbolic cavity in the strong-coupling regime with Fano resonance .	140
<b>Andrey V. Ivanov, Irina A. Boginskaya, Alexander V. Vaskin, Konstantin N. Afanas'ev, Ilya A. Ryzhikov, Andrey N. Lagarkov, Andrey K. Sarychev, Ilya N. Kurochkin, Igor A. Budashov</b>	
The field enhancement and optical sensing in the surface photonic crystal . . . . .	146
<b>M.M. Kabardov, N.M. Sharkova</b>	
Numerical simulations of electron transport in nanowires near thresholds . . . . .	150
<b>Koshelev K.L., Bogdanov A.A.</b>	
Homogenization of quantum metamaterial . . . . .	154
<b>D.P. Kouzov, M.G. Zhuchkova</b>	
Transmission of a flexural-gravitational wave through an obstacle in an elastic plate floating atop a two-layer fluid. Thin-upper-layer approximation . . . . .	158
<b>V.N. Kovalenko, A.M. Puchkov, V.V. Vechernin, D.V. Diatchenko</b>	
Restrictions on pp scattering amplitude imposed by first diffraction minimum data obtained by TOTEM at LHC . . . . .	165
<b>Alexander Krasnok, Alexey Slobozhanyuk, Pavel Belov, Constantin Simovski, Ravindra Sinha</b>	
Input impedance of small antenna provides Purcell factor . . . . .	170
<b>Kravchenko O.V.</b>	
Application of $ch_{a,n}$ atomic basis to solution of scalar hyperbolic equation . . . . .	176

<b>Victor F. Kravchenko, Oleg V. Kravchenko, Yaroslav Y. Kononov, Dmitry V. Churikov</b> Generalization of Kravchenko wavelets based on the family of atomic functions $ch_{a,n}$ . . . . .	180
<b>Krevchik V.D., Semenov M.B., Zaitsev R.V., Krevchik P.V., Egorov I.A., Skorosova I.K., Budyansky P.S.</b> 2D-tunnel bifurcations for interacting quantum molecules in the matrices of metamaterials . . . . .	185
<b>Kurseeva V.Yu., Valovik D.V.</b> Electromagnetic TE wave propagation in a two-layered waveguide with nonlinear permittivity . . . . .	189
<b>Sergey V. Makarov, Valentin A. Milichko, Alexander E. Krasnok, Pavel A. Belov, Alexey M. Mojarov, Ivan S. Mukhin</b> Laser writing of nanoparticle-based plasmonic structures . . . . .	195
<b>V.S. Makin, E.I. Logacheva, R.S. Makin</b> Origin of anomalous nanostructures formation under linear polarized femtosecond laser irradiation of condensed matter . . . . .	201
<b>Mikhail Y. Medvedik, Yury G. Smirnov, Marina A. Moskaleva</b> The subhierarchical approach to study the problem of electromagnetic wave diffraction by a system of bodies and screens . . . . .	208
<b>A.S. Mikhaylov, V.S. Mikhaylov</b> On recovery of inverse spectral data from inverse dynamical data by means of Boundary Control method . . . . .	212
<b>Ilya Mogilevskiy, Alla Kunik</b> A numerical finding of a 2D surface by its mean curvature . . . . .	217
<b>Oleg V. Motygin</b> On evaluation of the Heun functions . . . . .	222
<b>T.F. Pankratova, M.P. Faleeva</b> An approach to a multi-dimensional tunneling . . . . .	228
<b>Nikita D. Pavlov, Yuri A. Baloshin</b> Electromagnetic properties of liquids at GHz frequencies for medical tasks and metamaterial applications . . . . .	233
<b>Dmitry V. Permyakov, Ivan S. Sinev, Dmitry L. Markovich, Pavel Ginzburg, Anton K. Samusev, Pavel A. Belov, Vytautas Valuckas, Arseniy I. Kuznetsov, Boris S. Luk'yanchuk, Andrey E. Miroshnichenko, Dragomir N. Neshev, Yuri S. Kivshar</b> Direct measurements of magnetic and electric optical responses from silicon nanoparticles . . . . .	237
<b>Anastasiia A. Pervishko, Oleg V. Kibis, Skender Morina, Ivan A. Shelykh</b> Electronic transport in a two-dimensional electron gas strongly coupled to light . . . . .	244
<b>M.I. Petrov, A.A. Bogdanov, S.V. Sukhov, A. Dogariu, A.S. Shalin</b> Optical forces induced at the metal surface . . . . .	250
<b>Petrov P.S., Ehrhardt M.</b> Transparent boundary conditions for the high-order parabolic approximations . . . . .	255
<b>Vladimir E. Petrov, Anastasiya N. Volkova, Alexey V. Strepetov, Galina N. Dyakova</b> On solving the magnetostatics equations for convex domains . . . . .	261
<b>M.M. Popov</b> On the computation of the Morse index on rays between the source and observation points by means of Gaussian beam technique . . . . .	264

<b>A.M. Puchkov, V.A. Roudnev, A.V. Kozhedub</b>	
Influence of the shape of a quantum ring on the structure of its energy spectrum	266
<b>Anna Rozanova-Pierrat</b>	
Approximation of a compressible Navier–Stokes system by non-linear acoustical models	270
<b>Rybin M.V., Samusev K.B., Limonov M.F.</b>	
Multiscale modeling of all-dielectric metamaterials	276
<b>R.S. Savelev, M.I. Petrov, R.K. Sinha, A.E. Krasnok, P.A. Belov, Y.S. Kivshar</b>	
Fano resonance in chains of dielectric nanoparticles with side-coupled resonator	281
<b>E.S. Sedov, A.P. Alodjants, I.V. Iorsh, A.V. Kavokin</b>	
Quantum hyperbolic metamaterials with exciton-polaritons in semiconductor Bragg mirrors	285
<b>E.S. Sedov, M.V. Charukhchyan, S.M. Arakelian, A.P. Alodjants, You-Lin Chuang, Ray-Kuang Lee</b>	
Atomic Bose–Einstein condensates as nonlinear hyperbolic metamaterials	289
<b>Alexander S. Shalin, Pavel A. Belov, Yuri S. Kivshar</b>	
Scattering suppression with homogeneous ENZ-media	295
<b>Alena V. Shchelokova, Alexander N. Poddubny, Alexey P. Slobzhanyuk</b>	
Usage of meta-resonators for improvement of magnetic resonance imaging	300
<b>Shvartz A.G., Samsonov A.M., Semenova I.V., Dreiden G.V.</b>	
Numerical simulation of bulk solitons in elongated shells	303
<b>S. Slavyanov</b>	
Antiquantization of deformed equations of Heun class	310
<b>Yuri G. Smirnov, Eugene Yu. Smolkin, Aleksei A. Tsupak</b>	
Scalar problem of diffraction of a plane wave from a system of two- and three-dimensional scatterers	313
<b>Eugene Yu. Smolkin</b>	
On the problem of propagation of nonlinear coupled TE–TM waves in a double-layer nonlinear inhomogeneous cylindrical waveguide	318
<b>Mingzhao Song, Polina Kapitanova, Ivan Iorsh, Pavel Belov</b>	
Metamaterials for wireless power transfer	323
<b>Alexander O. Spiridonov, Evgenii M. Karchevskii, Alexander I. Nosich</b>	
Analytical regularization of a generalized eigenvalue problem for weakly guiding step-index optical fibers by Muller boundary integral equations	327
<b>Alexander S. Starkov, Oleg V. Pakhomov, Ivan A. Starkov</b>	
Diffraction of plane wave on a thin/narrow body: influence of the curvature and torsion	333
<b>Ivan A. Starkov, Oleg V. Pakhomov, Alexander S. Starkov</b>	
Asymptotic solution of the heat conduction equation with weak nonlinearity and rapidly oscillating heat source	338
<b>V.A. Trofimov, D.Yu. Zagursky, I.G. Zakharova</b>	
Propagation of laser pulse with a few cycle duration in multi-level media	342
<b>Yuri Trushkov, Ivan Iorsh</b>	
Graphene based anisotropic metasurface	347

**Andrei B. Utkin**  
 Spacetime triangle diagram technique for line sources with finite cross section ..... 354

**Farkhat F. Valiev**  
 About the limits of applicability of the model of linear current in gaseous environment ..... 360

**Valery A. Vasil'ev, Pavel S. Chernov**  
 Time-dependent simulations of two-dimensional quantum waveguides of arbitrary shape ..... 362

**Natalya F. Yashina, Tatyana M. Zaboronkova, C. Krafft**  
 Interaction of electromagnetic surface waves guided by dielectric cylinder surrounded  
 by an anisotropic plasma ..... 366

**Oleh Y. Yermakov, Anton I. Ovcharenko, Ivan V. Iorsh, Andrey A. Bogdanov,  
 Yuri S. Kivshar**  
 New types of surface waves on hyperbolic metasurface ..... 371

**Author index** ..... 376