

Doppler Institute: Activities in 2002

Time is flying fast, faster than one would wish: we are here already for a decade. Let us survey our activities in the tenth year.

1 Basic information

1.1 Members to date

Č. Burdík, *Dept of Mathematics, FNSPE, Czech Technical Univ, Prague*
G. Chadzitaskos, *Dept of Physics, FNSPE, Czech Technical University, Prague; elected a member in November*
J. Dittrich, *Nuclear Physics Institute, AS, Prague/Řež*
P. Exner, *Nuclear Physics Institute, AS, Prague/Řež*
M. Havlíček, *Dept of Mathematics, FNSPE, Czech Technical Univ, Prague*
L. Hlavatý, *Dept of Physics, FNSPE, Czech Technical University, Prague*
P. Šeba, *Institute of Physics, AS, Prague*
P. Štoviček, *Dept of Mathematics, FNSPE, Czech Technical Univ, Prague*
J. Tolar, *Director, Dept of Phys, FNSPE, Czech Technical Univ, Prague*
M. Znojil, *Nuclear Physics Institute, AS, Prague/Řež*

1.2 Advisory board

S.A. Albeverio, *Universität Bonn, Germany*
J.E. Avron, *Technion, Haifa, Israel*
M.S. Birman, *St. Petersburg University, Russia*
J.-M. Combes, *Université de Toulon et du Var, France*
H.D. Doebner, *Technische Universität Clausthal, Germany*
J.R. Klauder, *University of Florida, Gainesville, USA*
S.T. Kuroda, *Gakushuin University, Tokyo, Japan*
E.H. Lieb, *Princeton University, USA*
L.A. Pastur, *Centre de Physique Théorique, Marseille, France*
J. Patera *Université de Montréal, Canada*

1.3 Current grant support

According to the statutes, DI members receive their salaries from the academic institutions to which they belong. The research performed in DI has been supported by the following research grants:

1. AS CR Grant No. 1048101 **Graph-type quantum systems**. J. Dittrich, P. Exner (responsible), M. Havlíček, H. Kovařík, M. Krbálek, D. Krejčířík, J. Kříž, K. Němcová, K. Pičugin, S. Pošta, P. Šeba, P. Šťovíček, M. Tater
2. The project ME482 **Quantum dynamics, integrable and chaotic systems** of the Ministry of Education of the Czech Republic supporting a collaboration with Japan. J. Dittrich, P. Exner (responsible), H. Kovařík, D. Krejčířík, J. Kříž, K. Němcová, P. Šeba, M. Tater
3. AS CR Grant No. 1048004 **New methods in the perturbation theory**. M. Znojil (responsible)
4. Votruba–Blokhintsev Grant **Zeta function technique and heat kernel expansion**. J. Dittrich, V.V. Nesterenko
5. Votruba–Blokhintsev Grant **Bethe Ansatz method**. J. Dittrich, V.I. Inozemtsev
6. Votruba–Blokhintsev Grant **New methods for obtaining integrable equations**. Č. Burdík, V.P. Melnikov
7. Votruba–Blokhintsev Grant **Higher spins in AdS space-time and structure of corresponding equations**. Č. Burdík, A. Pashnev
8. International Collaboration **Euro GDR** headed by M. Combescure. Czech participants: P. Exner (responsible), H. Kovařík, M. Krbálek, D. Krejčířík, J. Kříž, K. Němcová, P. Šeba, P. Šťovíček
9. ESF program **Spectral Theory and Partial Differential Equations (SPECT)** headed by A. Laptev. Czech participants: J. Dittrich, P. Exner (responsible), H. Kovařík, D. Krejčířík, J. Kříž, K. Němcová

2 Survey of activities

2.1 Publications in journals

1. M. Andrieu, Č. Burdík, J.-P. Gazeau: *Bernoulli spline wavelets and Sturmian sequences*, J. Fourier Anal. Appl., to appear
2. D. Borisov, P. Exner, R. Gadyl'shin: *Geometric coupling thresholds in a two-dimensional strip*, J. Math. Phys. **43** (2002), 6265–6278.
3. E.N. Bulgakov, P. Exner, K.N. Pichugin, A.F. Sadreev: *Multiple bound states in scissor-shaped waveguides*, Phys. Rev. **B66** (2002), 155109
4. Č. Burdík, O. Navrátil: *Nonlinear superposition formulae on the Lie group $SO(n+1, n)$* , J. Phys. **A35** (2002), 2431–2440.
5. T. Cheon, P. Exner: *Persistent currents due to point obstacles*, Phys. Lett. **A** (2003), to appear; quant-ph/0202147
6. J. Dittrich, P. Duclos: *Massive scalar field in a one-dimensional oscillating region*, J. Phys. **A35** (2002), 8213–8230.
7. J. Dittrich, J. Kříž: *Curved planar quantum wires with Dirichlet and Neumann boundary conditions*, J. Phys. **A35** (2002), L269–275.
8. J. Dittrich, J. Kříž: *Bound states in straight quantum waveguides with combined boundary conditions*, J. Math. Phys. **43** (2002), 3892–3915.
9. P. Duclos, O. Lev, P. Štoviček, M. Vittot: *Weakly regular Floquet Hamiltonians with pure point spectrum*, Rev. Math. Phys. **14** (2002), 531–568.
10. P. Exner, S. Kondej: *Curvature-induced bound states for a δ interaction supported by a curve in \mathbb{R}^3* , Ann. H. Poincaré **3** (2002), 967–981.
11. P. Exner, S. Kondej: *Bound states due to a strong δ interaction supported by a curved surface*, J. Phys. **A36** (2003), 443–457.
12. P. Exner, K. Němcová: *Quantum mechanics of layers with a finite number of point perturbations*, J. Math. Phys. **43** (2002), 1152–1184.
13. P. Exner, P. Štoviček, P. Vytřas: *Generalised boundary conditions for the Aharonov-Bohm effect combined with a homogeneous magnetic field*, J. Math. Phys. **43** (2002), 2151–2168.
14. P. Exner, K. Yoshitomi: *Asymptotics of eigenvalues of the Schrödinger operator with a strong δ -interaction on a loop*, J. Geom. Phys. **41** (2002), 344–358.
15. P. Exner, K. Yoshitomi: *Persistent currents for 2D Schrödinger operator with a strong δ -interaction on a loop*, J. Phys. **A35** (2002), 3479–3487.

16. M. Havlíček, J. Patera, E. Pelantová, J. Tolar: *Automorphisms of the fine grading of $sl(n, \mathbb{C})$ associated with the generalized Pauli matrices*, J. Math. Phys. **43** (2002), 1083–1094.
17. L. Hlavatý, L. Šnobl: *Poisson-Lie T-dual models with two-dimensional targets*, Mod. Phys. Lett. **A17** (2002), 429–434.
18. M. Krbálek, P. Šeba: *Headway statistics of public transport in Mexican cities*, J. Phys. **A36** (2003), L1–5.
19. G. Lévai, M. Znojil: *The interplay of supersymmetry and \mathcal{PT} symmetry in quantum mechanics: a case study for the Scarf II potential*, J. Phys. **A35** (2002), 8793–8804.
20. G.A. Luna-Acosta, J.A. Mendez-Bermudez, P. Šeba: *Classical versus quantum structure of the scattering probability matrix: Chaotic waveguides*, Phys. Rev. **E65** (2002), 046605
21. J.A. Mendez-Bermudez, G.A. Luna-Acosta, P. Šeba: *Directional emission from microlasers with open chaotic resonators*, Phys. Stat. Solidi **B230** (2002), 385–389.
22. J.A. Mendez-Bermudez, G.A. Luna-Acosta, P. Šeba, K.N. Pichugin: *Understanding quantum scattering properties in terms of purely classical dynamics*, Phys. Rev. **E66** (2002), 046207
23. O. Mustafa, M. Znojil: *\mathcal{PT} symmetric pseudo-perturbation recipe: an imaginary cubic oscillator with spikes*, J. Phys. **A35** (2002), 8929–8942.
24. R.G. Nazmitdinov, K.N. Pichugin, I. Rotter, P. Šeba: *Conductance of open quantum billiards and classical trajectories*, Phys. Rev. **B66** (2002), 085322
25. L. Šnobl, L. Hlavatý: *Classification of 6-dimensional real Drinfeld doubles*, Int. J. Mod. Phys. **A** (2002), to appear; [math.QA/0202209](#)
26. M. Znojil: *Should \mathcal{PT} symmetric quantum mechanics be interpreted as nonlinear?*, J. Nonlin. Math. Phys. **9**, suppl. 2 (2002), 122–133.
27. M. Znojil: *Solvable \mathcal{PT} -symmetric Hamiltonians*, Phys. Atom Nuclei **65** (2002), 1149–1151; transl. from Yad. Fiz. **65** (2002), 1182–1184.
28. M. Znojil: *Non-Hermitian SUSY and singular, \mathcal{PT} -symmetrized oscillators*, J. Phys. **A35** (2002), 2341–2352.
29. M. Znojil, F. Gemperle, O. Mustafa: *Asymptotic solvability of an imaginary cubic oscillator with spikes*, J. Phys. **A35** (2002), 5781–5793.

2.2 Proceedings, submitted papers, etc.

1. J. Brüning, P. Exner, V.A. Geyler: *Large gaps in point-coupled periodic systems of manifolds*, submitted to J. Phys. **A**; mp_arc 02-523; math-ph/0212052
2. Č. Burdík, O. Navrátil, O. Pashnev: *On the Fock space realizations of nonlinear algebras*, in Proc. XVI Max Born Symposium “Supersymmetries and Quantum Symmetries” (Karpacz, 2001); E.A. Ivanov et al. eds.; Dubna 2002
3. Č. Burdík, M. Havlíček: *Boson realizations of the semi-simple Lie algebras*, in Proc. CRM B. Sharps meeting (Montreal 2002), subm.
4. T. Cheon, P. Exner, P. Šeba: *Extended standard map with spatio-temporal asymmetry*, submitted to Physica **D**; cond-mat/0203241
5. J. Dittrich, P. Exner, M. Hirokawa: *A model of interband radiative transition*, submitted to J. Math. Soc. Japan; mp_arc 00-442; math-ph/0011009
6. J. Dittrich, J. Kříž: *Straight quantum waveguides with combined boundary conditions*, Mathematical Results in Quantum Mechanics QMATH-8 (Taxco, Mexico, 2001); R. Weder, P. Exner, B. Grébert, eds.; Contemporary Mathematics vol. 307, American Mathematical Society, Providence 2002, pp. 107–112.
7. P. Exner: *Spectral properties of Schrödinger operators with a strongly attractive δ interaction supported by a surface*, Proceedings of the NSF Summer Research Conference (Mt. Holyoke 2002); AMS “Contemporary Mathematics” Series, Providence, R.I., 2003;
8. P. Exner, K. Němcová: *Magnetic layers with periodic point perturbations*, submitted to Rep. Math. Phys.; mp_arc 02-524; math-ph/0212053
9. L. Hlavatý, L. Šnobl: *Classification of 6-dimensional real Manin triples*, submitted; math.QA/0202209
10. V.V. Nesterenko, I.G. Pirozhenko, J. Dittrich: *Nonsmoothness of the boundary and the relevant heat kernel coefficients*, submitted to Class. Quant. Grav.; hep-th/0207038
11. P. Šťovíček: *Construction of raising and lowering operators for $U_q(sl(2, \mathbb{R}))$* , in “Quantum Theory and Symmetries”, E. Kapuscik, A. Horzela, eds.; World Scientific, Singapore 2002; pp. 601–606.
12. M. Znojil: *A generalization of the concept of \mathcal{PT} symmetry*, in “Quantum Theory and Symmetries”, E. Kapuscik, A. Horzela, eds.; World Scientific, Singapore 2002; pp. 626–631.

13. M. Znojil: *Generalized Rayleigh-Schrödinger perturbation theory as a method of linearization of the so called quasi-exactly solvable models*, Proc. Inst. Math. NAS (Ukraine), vol. 43/2 (2002), pp. 777–781.

2.3 Seminars

2.3.1 Regular seminar

February 19

D. Olive (Swansea): The principal $so(1, 2)$ subalgebra of the hyperbolic Kac-Moody algebra

March 5

M. Uhlř (CTU): Brans-Dicke theory: rest energy of proper fields of classical point sources

March 19

T. Kopf (Opava): Spectral geometry of spacetime

March 26

E. Weimar-Woods (FU Berlin): Generalized Inönü-Wigner contractions, contractions and deformations

April 16

G. Lévai (Debrecen): The interplay of different symmetry concepts in quantum mechanical potential problems

April 23

M. Krbálek (CTU): Transport as a system of interacting particles

April 30

K. Yoshitomi (Fukuoka): Persistent currents for 2D Schrödinger operator with a strong δ interaction on a loop

May 7

V. Šimák and P. Homola (IP): Quark physics and the top quark, mass of the top quark

May 7

E. Paal (Tallin): Operadic curvature as a tool for cogravity

May 14

J. Ruostekoski (Hatfield): Bose-Einstein condensation: fundamentals and trends

May 21

L. Hlavatý: T-duality and classical Drinfeld doubles

May 28

L. Šnobl (CTU): A classification of 6-dimensional Drinfeld doubles

June 4

A. Lebedev (Minsk): Dynamical systems: stochastics, information, entropy

June 4

E. Andersson (Strathclyde): Bounds on measurement based on the no-signaling condition

October 8

L. Šnobl (CTU): On modular spaces of semisimple Drinfeld doubles

October 15

H.-D. Doebner (Clausthal): Nonlinear transformations in nonlinear quantum mechanics

October 22

A. Chefles (U. of Hertfordshire, Hatfield): The general theory of quantum state transformations

October 29

J.-P. Gazeau (Paris VII): Berezin-Toeplitz quantization of the unit interval

November 19

G. Rozenblioum (Chalmers): Regularisation of Chern-Simons classes and cyclic cohomologies

November 26

V.N. Tolstoy (Moscow): About rational-trigonometric deformation

2.3.2 The “Quantum Circle” seminar

January 8

David Krejčířík (Reims): Quantum strips on surfaces

January 15

Denis Borisov (Ufa): The eigen-elements of the Laplacian with frequently alternating boundary conditions. The two-dimensional case.

January 22

Pierre Duclos (Toulon): Progressive diagonalisation and applications

March 5

Timo Weidl (Stockholm): On the discrete spectrum of a pseudo-relativistic two-body pair operator

March 12

Sylwia Kondej (NPI): Self-adjoint operators with singular additive perturbations

April 23

Jan Kříž (NPI): Curved planar quantum wires with Dirichlet and Neumann boundary conditions

April 30

David Krejčířík (Reims): Quantum strips on surfaces (continued)

May 9

Ari Laptev (Stockholm): A geometrical version of Hardy's inequality

May 28

Petr Šeba: Wave chaos in the human brain: a random matrix analysis of the EEG signal

July 18

Masao Hirokawa (München and Okayama): Two charges interacting through a massless scalar field. Removal of infrared and ultraviolet cutoffs

October 15

Olaf Post (Aachen): Spectral gaps and eigenvalues in a gap of a period manifold

October 29

Pierre Duclos (Toulon): Asymptotics of the gaps of one dimensional Schrödinger periodic operators

October 31

Joachim Asch (UTV Toulon): On transport in periodic potentials in the semiclassical limit

November 5

Andrea Posilicano (Como): Singular perturbations on Fock space

November 12

Petr Novotný: The number of elements and the action of the group $SL(m, \mathbb{Z}_n)$

November 19

Vladimir Gejler (Saransk): Hofstadter butterfly for three-dimensional periodic Landau operator with point scatterers

December 17

Andrej Zlatoš (Caltech): Sum rules for Jacobi matrices

2.4 Meetings

The 11th Colloquium “Quantum groups and Integrable Systems”

(Prague, June 20-22), organized by Č. Burdík with the participation of D. Arnaudon, D. Baleanu, V.S. Barashenkov, N. Bazunova, A. Dimakis, V.A. Dolgushev, J. Donin, T. Golinski, Y. Güler, M. Haysak, M. Horowski, A. Horzela, A.P. Isaev, E. Kapuscik, M. Klimek, P.P. Kulish, J. Lukierski, S.L. Lyakhovich, V.D. Lyakhovsky, A. Mudrov, F. Müller-Hoissen, M. Nagy, A. Nowicki, A. Odziejewicz, V. Onysko, V. Ostapenko, E. Paal, A.A. Sharapov, T. Skrypnik, and others

The workshop “Guided Quantum Particles: from Mathematics to Mesoscopics”

(Prague, June 10-14), organized by P. Exner and J. Dittrich with the participation of F. Bentosela, D. Borisov, J.-M. Combes, P. Duclos, V. Falko, R. Gadylshin, V. Geyley, A. Joye, P. Kuchment, D. Murdock, R. Nazmitdinov, L. Parnowski, I. Rotter, A. Sadreev, M. Schatzman, A. Sobolev, P. Stollmann, members of DI, their students and others

2.5 Teaching activities

2.5.1 Courses and student seminars

In addition to the regular curriculum duties (for the DI members coming from CTU), the following teaching activities have been organized:

1. *Advanced chapters of the quantum theory* (CTU, Exner)
2. *Quantum chaos* (University of Hradec Králové, Šeba)

2.5.2 Students

Defended PhD theses in 2002:

- M. Andrlé (CTU, supervised by Č. Burdík and J.-P. Gazeau); “Model sets and adapted wavelet transform”
- L. Šnobl (CTU, supervised by L. Hlavatý); “On integrability and T-duality of principal models”

Graduate:

- J. Kříž (Charles U., supervised by J. Dittrich); “Waveguides with Neumann and mixed boundary conditions”

- O. Mareš (CTU, supervised by Č. Burdík and R. Kerner); “Stochastic matrix methods”
- M. Krbálek (UHK, supervised by P. Šeba); “A microscopic description of transport systems by means of random matrices ”
- K. Němcová (Charles U., supervised by P. Exner); “Solvable models of quantum waveguide systems”
- P. Tobiška (UHK, supervised by P. Šeba); “A mathematical analysis of EEG and NIRS signals”

5th course:

- V. Jakubský (CTU, supervised by M. Znojil); “PT symmetrization of solvable models of the Calogero type”
- V. Kavka (CTU, supervised by L. Hlavatý); “Painleve analysis of nonlinear Klein Gordon systems”
- H. Lavička (CTU, supervised by L. Hlavatý); “Symmetries of nonautonomous Burgers equation”
- O. Lev (CTU, supervised by P. Šťovíček); “Spectral properties of quasienergy-type operators”
- J. Šála (CTU, supervised by P. Šťovíček); “Construction of $Sl_q(2, R)$ representations by the method of orbits”
- P. Vytrás (CTU, supervised by P. Šťovíček); “Magnetic strings on a homogeneous background”
- V. Zuzák (Charles U., supervised by P. Exner); “Layers coupled through a leaky boundary”

4th course:

- H. Bíla (Charles U, supervised by M. Znojil); “Pseudo-Hermitian Hamiltonians in quantum theory”
- J. Hrivnák (CTU, supervised by J. Tolar); “Gradings and graded contractions of Lie algebras”
- P. Novotný (CTU, supervised by J. Tolar); “Jordan algebras and Jordan–Lie algebras in quantum physics”