# Doppler Institute: Activities in 2001

Here is briefly what we were doing in the ninth year of our existence.

# 1 Basic information

## 1.1 Members to date

Č. Burdík, *Dept of Mathematics, FNSPE, Czech Technical Univ, Prague*
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. Šťovíček, *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. Krejčiřík, J. Kříž, K. Němcová, K. Pičugin, S. Pošta, P. Šeba, M. Tater

2. The projects **ME099** and **ME170** (both expired at the end of 2001) of the Ministry of Education of the Czech Republic supporting a collaboration with Russia and Japan. J. Dittrich, P. Exner (responsible), P. Šeba, P. Šťovíček, M. Tater

3. AS CR Grant No. 1048004 **New methods in the perturbation theory**. M. Znojil (responsible)

4. Votruba–Blokhintsev Grant **Gradings, contractions and separation of variables**. J. Tolar, G.S. Pogosyan

5. Votruba–Blokhintsev Grant **Analytic results from hyper-radial approach to three-body problem**. M. Znojil, A.V. Matveenko

6. Votruba–Blokhintsev Grant **Zeta function technique and heat kernel expansion**. J. Dittrich, V.V. Nesterenko

7. Votruba–Blokhintsev Grant **Ordering of levels of the Heisenberg-van Vleck Hamiltonian**. J. Dittrich, V.I. Inozemtsev

8. Votruba–Blokhintsev Grant **Quantum symmetries and discrete dynamical models**. Č. Burdík, A.S. Isaev

# 2 Survey of activities

## 2.1 Publications in journals


1. S.A. Albeverio, P. Exner, V.A. Geyler: *Geometric phase related to point-interaction transport on a magnetic Lobachevsky plane*, Lett. Math. Phys. **55** (2001), 9–16.
2. B. Bagchi, C. Quesne, M. Znojil: *Generalized continuity equation and modified normalizers*, Mod. Phys. Lett. *A16* (2001), 204–2057.
3. D. Borisov, P. Exner, R. Gadyl'shin, D. Krejčiřík: *Bound states in weakly deformed strips and layers*, Ann. H. Poincaré **2** (2001), 553–572.
4. Č. Burdík, A. Pashnev, M. Tsulaia: *On the mixed symmetry irreducible representations of the Poincaré group in the BRST approach*, Mod. Phys. Lett. **A16** (2001), 731–746.
5. G. Chadzitaskos, J.Tolar: *The 2-diffraction system*, Optics Commun. **187** (2001), 359–362.
6. H.D. Doebner, P. Štovíček, J. Tolar: *Quantization of kinematics on configuration manifolds*, Rev. Math. Phys. **13** (2001), 799–845.
7. P. Duclos, P. Exner, D. Krejčiřík: *Bound states in curved quantum layers*, Commun. Math. Phys. **223** (2001), 13–28.
8. P. Duclos, P. Exner, B. Meller: *Open quantum dots: resonances from perturbed symmetry and bound states in strong magnetic fields*, Rep. Math. Phys. **47** (2001), 253–267.
9. P. Exner: *Bound states of infinite curved polymer chains*, Lett. Math. Phys. **57** (2001), 87–96.
10. P. Exner, T. Ichinose: *Geometrically induced spectrum in curved leaky wires*, J. Phys. **A34** (2001), 1439–1450.
11. P. Exner, A. Joye: *Avoided crossings in mesoscopic systems: electron propagation on a non-uniform magnetic cylinder*, J. Math. Phys. **42** (2001), 4707–4738.
12. P. Exner, A. Joye, H. Kovařík: *Magnetic transport in a straight parabolic channel*, J. Phys. **A34** (2001), 9733–9752.
13. P. Exner, D. Krejčiřík: *Bound states in mildly curved layers*, J. Phys. **A34** (2001), 5969–5985.
14. P. Exner, H. Neidhardt, V.A. Zagrebnov: *Potential approximations to $\delta'$: an inverse Klauder phenomenon with norm-resolvent convergence*, Commun. Math. Phys. **224** (2001), 593–612.

15. P. Exner, K. Němcová: *Bound states in point interaction star graphs*, J. Phys. **A34** (2001), 7783–7794.
16. P. Exner, K. Němcová: *Quantum mechanics of layers with a finite number of point perturbations*, J. Math. Phys., to appear
17. P. Exner, M. Tater, D. Vaněk: *A single-mode quantum transport in serial-structure geometric scatterers*, J. Math. Phys. **42** (2001), 4050–4078.
18. P. Exner, K. Yoshitomi: *Asymptotics of eigenvalues of the Schrödinger operator with a strong $\delta$-interaction on a loop*, J. Geom. Phys., to appear
19. P. Exner, K. Yoshitomi: *Band gap of the Schrödinger operator with a strong $\delta$-interaction on a periodic curve*, Ann. H. Poincaré, to appear
20. T. Gorin, M. Müller, P. Šeba P: *Comment on "Models of intermediate spectral statistics" - art. no. 068201*, Phys. Rev. **E63** (2001), art. 068201
21. M. Havlíček, J. Patera, E. Pelantová, J. Tolar: *On fine gradings and their symmetries*, Czech. J. Phys. **51** (2001), 383–391.
22. M. Havlíček, J. Patera, E. Pelantová, J. Tolar: *Automorphisms of the fine grading of $sl(n, C)$ associated with general Pauli matrices*, J. Math. Phys. **43** (2002), to appear
23. M. Havlíček, S. Pošta: *On the classification of irreducible finite-dimensional representations of $U_q(so(3))$*, J.Math.Phys. **42** (2001), 472–500.
24. M. Havlíček, S. Pošta, P. Winternitz: *Representations of the q-deformed algebra $U_q(so_4)$*, J. Math. Phys. **42** (2001), 5389–5416.
25. L. Hlavatý, L. Šnobl: Principal models on non-semisimple groups, *J. Phys.* **A34** (2001), 7795–7809.
26. M. Krbálek, P. Šeba, P. Wagner P.: *Headways in traffic flow: remarks from physical perspective*, Phys. Rev. **E64** (2001), art. 066619
27. G. Lévai, M. Znojil: *Conditions for complex spectra in a class of PT symmetric potentials*, Mod. Phys. Lett. **A16** (2001), 1973–1981.
28. R. Nazmitdinov, K. Pichugin, I. Rotter, P. Šeba: *Whispering gallery modes in open microwave cavities*, Phys. Rev. **E64** (2001), to appear
29. R. Roychoudhury, P. Roy, M. Znojil, G. Lévai: *Comprehensive analysis of conditionally exactly solvable models*, J. Math. Phys. **42** (2001), 1996–2007.
30. P. Šeba, P. Exner, K.N. Pichugin, A. Vyhnal, P. Středa: *Two-component interference effect: model of a spin-polarized transport*, Phys. Rev. Lett. **86** (2001), 1598–1601.

31. P. Šeba, I. Rotter, M. Müller et al.: *Open microwave cavities*, Physica **E9** (2001), 484–487.
32. J. Weber, F. Haake, P.A. Braun, P. Šeba: *Frobenius-Perron operator for a Hamiltonian map with a mixed phase space*, J. Phys. **A34** (2001), 7195-7211.
33. M. Znojil: *Pöschl-Teller paradoxes*, J. Phys. **A34** (2001), 9585–9592.
34. M. Znojil: *PT symmetric square well*, Phys.Lett. **A285** (2001), 7–10.
35. M. Znojil: *PT symmetrized SUSY quantum mechanics*, Czech. J. Phys. **51** (2001), 420–428.
36. M. Znojil: *Eight exactly solvable complex potentials in Bender-Boettcher quantum mechanics*, Rendiconti del Circ. Mat. di Palermo, Serie II, Suppl. **66** (2001) 213–218.
37. M. Znojil, G. Lévai: *Spontaneous breakdown of PT symmetry in the solvable square well model*, Mod.Phys.Lett. **A16** (2001), 2273–2280.
38. M. Znojil, G. Lévai, P. Roy, R. Roychoudhury: *Anomalous doublets of states in a PT symmetric quantum model*, Phys. Lett. **A290** (2001), 249–254.
39. M. Znojil, M. Tater: *Complex Calogero model with real energies*, J. Phys. **A34** (2001), 1793–1803.
40. M. Znojil, M. Tater: *Exactly solvable three-body Calogero-type model with translucent two-body barriers* ), Phys. Lett. **A284** (2001), 225–230.

## 2.2 Proceedings, submitted papers, etc.

1. J. Asch, R.D. Benguria, P. Štovíček: *Asymptotic properties of the differential equation* $h^3(h'' + h') = 1$, submitted to J. Diff. Eq.
2. Č. Burdík, A. Pashnev, M. Tsulaia: *The Lagrangian description of representations of the Poincaré group*, Nucl. Phys. Proc. Suppl. **102** (2001), 285–292.
3. Č. Burdík, R. King, T.A. Welsh: The explicit construction of irreducible representations of the quantum algebra $U_q(sl(n))$ *in Proc. 37th Karpacz Winter School of Theoretical Physics Karpacz "New Developments in Fundamental Interaction Theories" (February 6-15, 2001), AIP Conference Proceedings, vol. 589; Melville, NY 2001.*
4. J. Dittrich, P. Exner, M. Hirokawa: *A model of interband radiative transition*, submitted to Rev. Math. Phys.
5. J. Dittrich, J. Kříž: *Bound states in straight quantum waveguides with combined boundary conditions*, submitted to J. Math. Phys.

6. P. Duclos, O. Lev, P. Šťovíček, M. Vittot: *Weakly regular Floquet Hamiltonians with pure point spectrum*, submitted to Commun. Math. Phys.
7. P. Exner, P. Šťovíček, P. Vytřas: *Generalised boundary conditions for the Aharonov-Bohm effect combined with a homogeneous magnetic field*, submitted to J. Math. Phys.
8. M. Havlíček, J. Patera, E. Pelantová, J. Tolar: *The fine gradings of $sl(3,C)$ and their symmetries*, in Proc. XXIIIth International Colloquium on Group Theoretical Methods in Physics (Dubna 2000; Y. Pogosyan, ed.), to appear
9. M. Havlíček, J. Patera, E. Pelantová, J. Tolar: *The distinguished bases of $sl(n,C)$ and their symmetries*, in "Quantum Theory and Symmetries 2" (H.-D. Doebner et al., eds.), World Scientific 2002, to appear
10. M. Havlíček, A.V. Klimyk: *Superposition formulae based on nonprimitive group action*, in CRM Proceedings and Lecture Notes **29** (2001), 225–231.
11. L. Hlavatý, L. Šnobl: *Poisson-Lie T-dual models with two-dimensional targets*, submitted; hep-th/0110139
12. P. Šťovíček: *Construction of raising and lowering operators for $U_q(sl(2,R))$*, to appear in Proceedings of "Quantum Theory and Symmetries (QTS2)", Krakow 2001, World Scientific
13. J. Tolar: *Quantum mechanics in finite–dimensional Hilbert spaces: factorization properties*, in "Coherent States, Quantization, and Gravity", Proc. of XVIIth Workshop on Geometric Methods in Physics (Białowieża 1998; M. Schlichenmaier et al., eds.); pp. 88–95.

## 2.3 Seminars

From this year the DI seminar was extended. In addition to the regular Tuesday afternoon seminar we have a new "Quantum Circle" seminar aimed at students and PhD students in the first place. As a "junior" seminar it usually takes place on Tuesdays preceding the main seminar, with the exception of occasions when it is held at the University of Hradec Králové; then it meets on Wednesdays.

### 2.3.1 Regular seminar

*March 6*

Č. Burdík: Schur-Weyl duality for quantum groups

*March 13*

M. Znojil: Calogero-type models

*March 20*

P. Hellinger (IPP AS): Temperatures in a collisionless plasma's

*March 27*

P. Winternitz (Montreal): Superintegrability, superseparability and exact solvability in quantum and classical mechanics

*April 10*

B. Jurčo (Olomouc)¿ and P. Schupp (Munich): Gauge fields on noncommutative spaces

*April 17*

M. Tater (NPI): Scattering on infinite planparallel layers

*April 24*

P. Isaev (Dubna): Quantization of the classical r-matrices related to Belavin-Drinfeld triples

*May 15*

M. Bednář (IP AS) and M. Havlíček: On non-standard deformations of orthogonal Lie algebras d to Belavin-Drinfeld triples

*May 22*

R. von Unge (Brno): Scattering of non-commutative soliton

*June 5*

P. Duclos (Toulon): On the dynamics of crystal electrons – high momentum regime

*June 19*

M. Solomyak (Rehovot): Eigenvalues of a perturbed operator lying below the spectrum of the unperturbed one

*July 10*

K.B. Wolf (Cuernavaca): Finite oscillator models with coherent states

*October 9*

Č. Burdík: Quantum groups according to S.L. Woronowicz

*October 16*

A. Pashnev (Dubna): Higher spins, BRST constructions and Verma modules

*October 23*

V. Tolstoy (Moscow): Projectors for quantum groups On the dynamics of crystal electrons, high momentum regime

*October 26*

D. Mermin (Cornell): Whose knowledge?

*November 6*

B. Thaller (Graz): Visual quantum mechanics - using computer-generated animations to explain (relativistic) quantum mechanics

*November 13*

O. Mareš (CTU): An application of stochastic matrix method to a mathematical model of glass solidification

*November 13*

M. Anderle (CTU): A construction of spin wavelets on aperiodic sets

*November 20*

H. Narnhofer (Vienna): Quantum theory on $T^2$ torus with magnetic field

*November 27*

M. del Olmo (Valladolid): Symmetry and Landau systems

*December 4*

Z. Popowicz (Wroclaw): Supersymmetric hydrodynamics

### 2.3.2 The "Quantum Circle" seminar

*January 3*

David Krejčiřík (NPI): Bound states in quantum layers

*January 9*

Jan Kříž (NPI): Neumann Laplacian in unbounded regions

*January 17*

Milan Krbálek (Hradec Králové): Dynamics of a panicking crowd

*January 24*

Hagen Neidhardt (Weierstrass Institut, Berlin): Self-adjoint and dissipative Schrödinger-Poisson systems

*February 6*

Jan Kříž (NPI): Neumann Laplacian in unbounded regions (cont'd)

*February 21*

Petr Šeba: Transport of polarized electrons

*March 6*

Roman Shterenberg (Sankt Petersburg): Absolute continuity of the spectrum of two-dimensional Schrödinger operator with potential supported on a periodic system of curves

*March 13*

David Krejčiřík (NPI): Bound states in quantum layers (continued)

*March 20*

Takashi Ichinose (Kanazawa University): Recent results on the self-adjoint Trotter-Kato product

*March 28*

Konstantin Pichugin (Hradec Králové): Whispering gallery modes in open microwave cavities

*April 3*

Čestmír Burdík: Representations of Hecke algebras

*April 10*

Hynek Kovařík (NPI): Magnetic transport in a straight parabolic channel

*April 17*

Pavel Exner: Curvature-induced bound states of generalized Schrödinger operators

*April 25*

Milan Krbálek (Hradec Králové): Description of transport systems by means of the theory of random matrices

*May 15*

Jaroslav Dittrich: The ground state of a finite Heisenberg ferromagnet

*May 29*

David Krejčiřík (NPI): Bound states in quantum layers (continued)

*June 5*

Kazushi Yoshitomi (Fukuoka University): Asymptotics of eigenvalues of the Schrödinger operator with a strong delta-interaction on a loop

*June 13*

Petr Šeba: Chaos in brain

*September 25*

Kateřina Němcová (NPI): Spectrum of a 2D magnetic Schrödinger operator with periodic point interactions (a review)

*October 30*

Sergei Dobrokhotov (IPM Moscow): The global semiclassical description of the spectrum of 2D magnetic Schrödinger operator in periodic electric field

*November 6*

Konstantin Pankrashkin (IPM Moscow): Quadratic forms for point interaction Hamiltonians

*November 13*

Vladimir Geyler (Saransk University): Quantum-mechanical scattering on Riemannian manifolds with horns

*November 20*

Walter Thirring (Vienna): Broken symmetry in quantum mechanics

*December 18*

Valentin Zagrebnov (C.N.R.S. Marseille): Equilibrium states for a Bose-gas with non-conventional condensation

## 2.4 Meetings

**The 10th Colloquium "Quantum groups and Integrable Systems"** (Prague, June 21-23), organized by Č. Burdík with the participation of D. Arnaudon, D. Baleanu, N. Bazunova, A. Borisov, A. Borowiec, J. Cornwell, A.V. Chizhov, S. Duplij, J. Ding, V. Dobrev, A. Elashvili, T. Ernst, Shao-Ming Fei, A. Frydryszak, F. Gavarini, A.S. Gevorkyan, E. Gradzka, M. Havlíček, M. Irac-Astaud, S. Khoroshkin, M. Klimek, S. Kolb, A.K. Kwasniewski, E.Krot, J. Lukierski, V. Lyakhovsky, N. Mackay, J. McKay, V.K. Melnikov, J. Morava, F. M"uller-Hoissen, M. Nagy, O. Navrátil, A. Odzijewicz, R. Oeckl, E. Paal, J. Patera, H. Pfeiffer, Z. Popowicz, B. G. Pusztai, E. Raineri, Shi-shyr Roan, A. Ryzko, O.P. Santillian, A. Schueler, S. Sergeev, L. Šnobl, C. Sochichiu, P. Stachura, A. Stolin, P. Štovíček, V. Tolstoy, L. Vaksman, I. Yaar, and D. Yazici

## 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. *Mathematical methods of the quantum theory* (Charles Univ., Exner)
2. *Quantum chaos* (University of Hradec Králové, Šeba)

### 2.5.2 Students

**Defended PhD theses in 2001:**

H. Kovařík (Charles U., supervised by P. Exner); "Soft and magnetic quantum waveguides"

D. Krejčiřík (Charles U., supervised by P. Exner in collaboration with P. Duclos, UTV); "Spectral properties of quantum layers"

S. Pošta (CTU, superv. by M. Havlíček); "Representations of $U_q(so_3)$"

**Graduate:**

A. Andrle (CTU, supervised by Č. Burdík); "Wavelets"

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

O. Mareš (CTU, supervised by Č. Burdík); "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"

L. Šnobl (CTU, supervised by L. Hlavatý); "Chiral models"

A. Teleki (Nitra College, supervised by P. Exner); "Schrödinger and Pauli operators in local magnetic fields"

P. Tobiška (UHK, supervised by P. Šeba); "A mathematical analysis of EEG and NIRS signals"

**5th course:**

V. Kavka (CTU, supervised by L. Hlavatý); "Painleve analysis of nonlinear Klein Gordon systems"

P. Kysela (external, supervised by P. Exner); "Window–coupled Dirichlet layers"

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"

R. Sýkora (Charles U., supervised by P. Exner); "Point interactions supported on curves"

J. Šála (CTU, supervised by P. Šťovíček); "Construction of $Sl_q(2,R)$ representations by the method of orbits"

P. Vytřas (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:**

J. Hrivnák (CTU, supervised by J. Tolar); "Gradings and graded contractions of Lie algebras"

V. Jakubský (CTU, supervised by M. Znojil); "PT symmetrization of solvable models of the Calogero type"

P. Novotný (CTU, supervised by J. Tolar); "Jordan algebras and Jordan–Lie algebras in quantum physics"