

# Doppler Institute: Activities in 2000

It seems we made it to the new millennium. Nobody knows how many New Years are ahead, but for the moment we are here with a report on the eighth 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. 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*  
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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. 1048801 (expired at the end of 2000) **Spatially restricted quantum systems** J. Dittrich, P. Exner (responsible), P. Šeba, M. Tater
2. AS CR Grant No. 1048804 (expired at the end of 2000) **Transport properties of electron wave structures** P. Exner, P. Šeba (responsible), P. Středa, M. Tater
3. AS CR Grant No. 1019601 (expired at the end of 2000) **Current problems of mathematics and mathematical physics** Č. Burdík, M. Havlíček, L. Hlavatý, P. Šťovíček, J. Tolar (responsible)
4. The projects **ME099** and **ME170** (expired at the end of 2000) 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
5. The project **KONTAKT** of the Ministry of Education of the Czech Republic supporting a collaboration with Poland. J. Tolar (responsible)
6. AS CR Grant No. 1048004 **New methods in the perturbation theory**. M. Znojil (responsible)
7. AS CR Grant No. 1048801 (from 2001) **Quantum graphs and related systems**. J. Dittrich, P. Exner (responsible), M. Havlíček, H. Kovařík, D. Krejčířík, J. Kříž, K. Němcová, K. Pičugin, S. Pošta, P. Šeba, P. Šťovíček, M. Tater
8. Internal CTU Grant 300013304 **Education in the Doppler Institute**. M. Havlíček, E. Pelantová, J. Tolar (responsible)

## 2 Survey of activities

### 2.1 Edited volumes

1. Č. Burdík, ed.: *Quantum Groups and Integrable Systems*, Proceedings of the 8th Colloquium on Quantum Groups and Integrable Systems; Czech. J. Phys. **49** (2000), 1-224.
2. Č. Burdík, ed.: *Quantum Groups and Integrable Systems*, Proceedings of the 9th Colloquium on Quantum Groups and Integrable Systems; Czech. J. Phys. **49** (2000), No. 11.

### 2.2 Publications in journals

1. M. Andrlé, Č. Burdík, J.-P. Gazeau, R. Krejcar: *Wavelet multiresolutions for the Fibonacci chain*, J. Phys. **A33** (2000), L47-L51.
2. Č. Burdík, A. Pashnev, M. Tsulaia: *Auxiliary representations of Lie algebras and the BRST constructions*, Mod. Phys. Lett. **A15** (2000), 281-291.
3. Č. Burdík, P. Grozman, D. Leites, A. Sergeev: *Realizations of Lie algebras and superalgebras via creation and annihilation operators I*, Teor. Mat. Fyz. **124** (2000), 1048
4. D. Borisov, P. Exner, R. Gadyl'shin, D. Krejčířík: *Bound states in weakly deformed strips and layers*, Ann. Inst. H. Poincaré, to appear
5. G. Chadzitaskos, J. Tolar: *The 2-diffraction system*, Optics Commun., to appear
6. T. Cheon, P. Exner, P. Šeba: *Wave function shredding by sparse potential barriers*, Phys. Lett. **A277** (2000), 1-6.
7. H.D. Doebner, P. Šťovíček, J. Tolar: *Quantization of kinematics on configuration manifolds*, Rev. Math. Phys. (2001), to appear
8. P. Duclos, P. Exner, D. Krejčířík: *Locally curved quantum layers*, Ukrainian J. Phys. **45** (2000), 595-601.
9. P. Duclos, P. Exner, B. Meller: *Open quantum dots: resonances from perturbed symmetry and bound states in strong magnetic fields*, Rep. Math. Phys., to appear
10. P. Exner, H. Kovařík: *Magnetic strip waveguides*, J. Phys. **A33** (2000), 3297-3311.
11. P. Exner, V.A. Geyler: *Berry phase in magnetic systems with point interactions*, J. Geom. Phys. **36** (2000), 178-197.

12. P. Exner, V.A. Geyler: *Berry phase for a potential well transported in a homogeneous magnetic field*, Phys. Lett. **A276** (2000), 16-18.
13. M. Havlíček, A.U. Klimyk, S. Pošta: *Casimir elements of algebras  $U_q(so(m))$* , Czech. J. Phys. **50** (2000), 79-84.
14. M. Havlíček, A.U. Klimyk, S. Pošta: *Classification of representations of the algebra  $U_q(so(3))$* , Czech. J. Phys. **50** (2000), 1235-1238.
15. M. Havlíček, J. Patera, E. Pelantová, J. Tolar: *On fine gradings and their symmetries*, Czech. J. Phys. **51** (2001), to appear
16. M. Havlíček, S. Pošta: *On the classification of irreducible finite-dimensional representations of  $U_q(so(3))$* , J. Math. Phys. **42** (2001), to appear
17. L. Hlavatý: *On the Lax formulation of generalized  $SU(2)$  principal models*, Phys. Lett. **A271** (2000), 207-212.
18. L. Hlavatý: *Principal models on a solvable group with nonconstant metric*, Phys. Lett. **A275** (2000), 419-423.
19. G. Lévai, M. Znojil: *Systematic search for  $\mathcal{PT}$  symmetric potentials with real energy spectra*, J. Phys. **A33** (2000), 7165
20. M. Krbálek, P. Šeba: *The statistical properties of the city transport in Cuernavaca (Mexico) and random matrix ensembles*, J. Phys. **A33** (2000), L229-L234.
21. M. Müller, K.A. Pichugin, I. Rotter, P. Šeba: *Collective modes in an open microwave billiard*, Phys. Rev. **E61** (2000), 66-70.
22. K.A. Pichugin, P. Středa, P. Šeba, A.F. Sadreev: *Resonance behavior of the Hall-like resistance induced by spin-orbit interaction in a four terminal junction*, Physica **E6** (2000), 727-730.
23. I. Rotter, E. Persson, K. Pichugin, P. Šeba: *Spectroscopic studies in open quantum systems*, Phys. Rev. **E62** (2000), 450-461.
24. 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), No. 4, to appear
25. P. Štoviček, S. Pošta: *Some remarks on  $U_q(sl(2, R))$  at root of unity*, Czech. J. Phys. **51** (2001), to appear
26. J. Weber, F. Haake, P. Šeba: *Frobenius-Perron resonances for maps with a mixed phase space*, Phys. Rev. Lett. **85** (2000), 3620-3623.
27. M. Znojil: *Perturbation method with triangular propagators and anharmonicities of intermediate strength*, J. Math. Chem., to appear
28. M. Znojil: *Spiked and  $\mathcal{PT}$ -symmetrized decadic potentials supporting elementary  $N$ -plets of bound states*, J. Phys. **A33** (2000), 6825

29. M. Znojil, G. Lévai: *The Coulomb — harmonic-oscillator correspondence in  $\mathcal{PT}$  symmetric quantum mechanics*, Phys. Lett. **A271** (2000), 327-333.
30. M. Znojil:  *$\mathcal{PT}$ -symmetrically regularized Eckart, Poeschl-Teller and Hulthén potentials*, J. Phys. **A33** (2000), 4561-4572.
31. M. Znojil, F. Cannata, B. Bagchi, R. Roychoudhury: *Supersymmetry without hermiticity within  $\mathcal{PT}$ -symmetric quantum mechanics*, Phys. Lett. **B483** (2000), 284-289.
32. M. Znojil: *New perturbation method with the matching of wave functions*, Intern. J. Quant. Chem. **79** (2000), 235-242.
33. M. Znojil: *Quasi-exactly solvable quartic potentials with centrifugal and Coulombic terms*, J. Phys. **A33** (2000), 4203-4211.
34. M. Znojil: *Comment on “Conditionally exactly soluble class of quantum potentials”*, Phys. Rev. **A61** (2000), 066101.
35. M. Znojil: *Perturbed Pöschl–Teller oscillators*, Phys. Lett. **A266** (2000), 254-259.
36. M. Znojil: *Short-range oscillators in power-series picture*, J. Phys. **A33** (2000), 1647-1659.
37. M. Znojil: *Shape invariant potentials with  $\mathcal{PT}$  symmetry*, J. Phys. **A33** (2000), L61-62.
38. M. Havlíček, J. Patera, E. Pelantová: *On Lie gradings III. Gradings of the real forms of classical Lie algebras*, Lin. Alg. and Applic. **314** (2000), 1–47.

### 2.3 Proceedings, submitted papers, etc.

1. S.A. Albeverio, P. Exner, V.A. Geyler: *Geometric phase related to point-interaction transport on a magnetic Lobachevsky plane*, submitted to Lett. Math. Phys.
2. Č. Burdík, A. Isaev, O. Ogievetski: *Standard complex for quantum Lie algebra*, in “XXIII International Colloquium Group Theoretical Methods in Physics” (JINR, Dubna 2000), to appear
3. Č. Burdík, O. Navrátil: *New boson realizations of the quantum groups  $U_q(A_n)$* , Proc. of the “19th Winter School Geometry and Physics” (Srní, January 9-15, 1999) Suplemento ai Rendiconti del Circ. Mat. di Palermo, Serie II, Num. 63-2000

4. Č. Burdík, O. Navrátil: *New  $q$ -boson realizations of the quantum groups  $U_q(C_3)$* , in “New Symmetries and Integrable Models”, eds. A. Frydryszak, J. Lukierski, and Z. Popowicz (World Scientific, Singapore 2000), pp. 19-26.
5. Č. Burdík, O. Navrátil: *New  $q$ -boson realizations of the quantum groups  $U_q(A_n)$* , in “Supersymmetries and Quantum Symmetries”, eds. E. Ivanov, S. Krivonos, and A. Pashnev (JINR, Dubna 2000), pp. 351-357.
6. Č. Burdík, O. Navrátil: *Nonlinear superposition formulas based on Lie group  $SO(n+1, n)$* , submitted
7. J. Dittrich, P. Exner, M. Hirokawa: *A model of interband radiative transition*, submitted to J. Math. Phys.
8. J. Dittrich, V.I. Inozemtsev: *On the ground state of ferromagnetic models*, submitted
9. P. Exner: *Point interactions in a tube*, Proceedings of the Conference “Infinite-dimensional Stochastic Analysis” (Leipzig 1999); Canadian Mathematical Society, to appear
10. P. Exner: *Bound states of infinite curved polymer chains*, submitted to Lett. Math. Phys.
11. P. Exner, T. Ichinose: *Geometrically induced spectrum in curved leaky wires*, submitted to J. Phys. **A**
12. P. Exner, A. Joye: *Avoided crossings in mesoscopic systems: electron propagation on a non-uniform magnetic cylinder*, submitted to J. Math. Phys.
13. P. Exner, M. Tater, D. Vaněk: *A single-mode quantum transport in serial-structure geometric scatterers*, submitted Ann. Phys.
14. L. Hlavatý: *Lax formulation of generalized principal chiral model*, Proceedings of “World Congress of Nonlinear Analysts”, ed. N. Euler, (Catania 2000), to appear
15. M. Krbálek, P. Šeba: *Description of traffic systems by the random matrix theory*, Proceedings of “Nostradamus Conference” (Zlín 2000), to appear
16. M. Krbálek, P. Šeba, P. Wagner: *Headways in traffic flow – remarks from a physical perspective*, submitted to Phys. Rev. **E**
17. P. Štoviček: *Discrete series of representations for  $U_q(sl(2, R))$* , in “Quantum Theory and Symmetries”, eds. H.-D. Doebner, V. K. Dobrev, J.-D. Hennig, and W. Lücke, (World Scientific, Singapore 2000), pp. 470-474.

18. P. Šťovíček: *Quantum Grassmannian, Quantum Homogeneous Space, Quantum Sphere*, in “Encyclopaedia of Mathematics Supplement II”, ed. M. Hazewinkel, (Kluwer Academic Publishers 2000), pp. 394-396.
19. J. Tolar: *Translation invariant quantizations on discrete phase spaces  $Z_n \times Z_n$* , in “Quantum Theory and Symmetries”, eds. H.-D. Doebner, V. K. Dobrev, J.-D. Hennig, and W. Lücke, (World Scientific, Singapore 2000), pp. 524–529.
20. J. Tolar: *Quantum mechanics on phase spaces  $Z_N \times Z_N$* , in “Trends in Quantum Mechanics”, eds. H.-D. Doebner, S.T. Ali, M. Keyl and R.F. Werner, (World Scientific, Singapore 2000), pp. 48– 55.
21. M. Znojil, M. Tater: *Complex Calogero model with real energies*, submitted
22. M. Znojil: *Eight exactly solvable complex potentials in Bender-Boettcher quantum mechanics*, Proceedings of the XX. Winter School “Geometry and Physics” (Srní, January 15-22, 2000), Suppl. ai Rendiconti del Circ. Mat. di Palermo, to appear

## 2.4 Seminars

During the teaching period, regular seminars were held on Tuesday afternoons. There were also Thursday meetings within the PQS semester (see below). The list of speakers is the following:

- January 4* M. Petrini (Imperial College): Renormalization group flow from AdS dynamics
- January 11* L. Hlavatý: Chiral model for two-dimensional solvable groups (dedicated to M. Znojil)
- January 18* R. Gadylshin (Ufa): Asymptotics for some singularly perturbed boundary value problems for the Laplacian
- February 15* M. Arndt (Wien): Buckyball interferometry
- March 7* J. Valenta, P. Homola (CTU): A reconstruction of the top quark from final states of two leptons and two jets
- March 14* T. Hoffmann-Ostenhof (Vienna): Aharonov Bohm Hamiltonians and eigenvalues in symmetry subspaces [PQS]
- March 14* M. Hoffmann-Ostenhof (Vienna): Critical sets of solutions to elliptic PDE [PQS]
- March 16* Ch. Remling (Osnabrück): One-dimensional Schrödinger operators with long-range interactions I [PQS]

- March 23* Ch. Remling (Osnabrück): One-dimensional Schrödinger operators with long-range interactions II [PQS]
- March 28* T. Weidl (KTH Stockholm): Virtual bound states and magnetic fields [PQS]
- March 30* T. Weidl (KTH Stockholm): Recent results on Lieb-Thirring inequalities [PQS]
- April 4* Ph. Martin (EFPL Lausanne): Survey of exact results in low density Coulomb systems [PQS]
- April 4* S. Føurnais (Aarhus): On the magnetisation of large atoms in strong magnetic fields [PQS]
- April 6* Ph. Martin (EFPL Lausanne): Lifetimes of impurity states in crossed electric and magnetic fields [PQS]
- April 11* J. Asch (UTV Toulon): On the dynamics of crystal electrons, high momentum regime
- April 11* K. Němcová (Charles University): Dirichlet layer with point perturbations
- April 18* A. Joye (UJF Grenoble): Molecular propagation in the Born–Oppenheimer approximation [PQS]
- April 18* V.A. Geyler (Saransk): Point perturbations of the Schrödinger operator with a magnetic field - theory and applications I [PQS]
- April 25* V.A. Geyler (Saransk): Point perturbations of the Schrödinger operator with a magnetic field – theory and applications II [PQS]
- April 27* G.M. Graf (ETH Zürich): Extended edge states in quantum Hall systems [PQS]
- May 2* M. Beneš (CTU): Dynamics in differential geometry — curvature driven motion of closed curves in the plane
- May 4* B. Dalton (Brighton): Quasi-mode theory of the beam splitter
- May 9* J. Šála (CTU): Construction of representations from coadjoint orbits –  $SL(2, \mathbb{R})$  as an example
- May 16* P. Závada (IP AS): Relativistic wave equations with fractional derivatives
- May 16* T. Dorlas (DIAS Dublin): Anderson localisation and the quantum Hall effect [PQS]
- May 23* P. Duclos (UTV Toulon): On the stability of periodically driven quantum systems I [PQS]
- May 25* P. Duclos (UTV Toulon): On the stability of periodically driven quantum systems II [PQS]

- May 30* A. Jensen (Aalborg): Perturbation of eigenvalues embedded at a threshold [PQS]
- June 1* M. Loss (GIT Atlanta): Self-energy of electrons interacting with a radiation field [PQS]
- June 6* I. Herbst (Charlottesville): Holonomic constraints in classical and quantum mechanics [PQS]
- June 6* R. Purice (Bucharest): Exponential decay for embedded eigenvalues of perturbed periodic Hamiltonians [PQS]
- June 8* G. Nenciu (Bucharest): Almost invariant subspaces for time dependent Hamiltonians [PQS]
- June 13* A.U. Klimyk (Kiev): Laplace operator and q-harmonic polynomials on the quantum vector space
- June 13* A. Teta (Roma): Blow-up solutions for the Schrödinger equation with a nonlinear point interaction [PQS]
- July 4* K. Yoshitomi (Fukuoka): Eigenvalue problems on domains with cracks
- July 31* T. Ichinose (Kanazawa): On the norm convergence of the Trotter-Kato product formula with error bound
- July 31* V. Zagrebnov (Marseille): Operator-norm approximation of semigroups by sectorial contractions
- October 5* A. Vančura (Kaiserslautern): Left-handed medium and electrodynamics
- October 10* G. Chadzitaskos (CTU): Wigner-Weyl quantization on discrete and compact periodic spaces
- October 17* S. Berceanu (Bucharest): Symplectic area of geodesic triangles and coherent states
- October 24* Yu.S. Surovtsev (JINR Dubna): Constrained dynamical systems: separation of constraints into 1st and 2nd classes
- October 31* A. Connes (Bures sur Yvette): Renormalization and the Riemann-Hilbert problem
- November 7* M. Znojil: The  $\mathcal{PT}$  supersymmetry II
- November 14* A. Klimyk (Kyiv): Quantum dual pair  $(U'_q(so_n), U_q(sl_2))$
- November 21* A. Delgado (Ulm): The generalized XOR and its applications
- November 28* J. Dittrich: A model of interband radiative transmission
- December 5* P. Prešnajder (Bratislava): Quantum mechanics and field theory on noncommutative spaces
- December 12* M. Andrlé (CTU): Wavelet multiresolution for the Fibonacci chain

## 2.5 Meetings

**The Student Winter School** (Horní Polubný, January 23-29) organized by G. Chadzitaskos

**The 9th Colloquium “Quantum groups and Integrable Systems”** (Prague, June 22-24) see the proceedings volume mentioned above

**Semestral program “Prague Quantum Spring”** (March 13 – June 18) see above and <http://www.ujf.cas.cz/exner/PQS2000.html> for more information

**DI-CRM Workshop** (Prague, June 18-21) organized by E. Pelantová

## 2.6 Teaching activities

### 2.6.1 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. Seminar *Symmetries of differential equations* (CTU, Hlavatý)
3. *Applications of cohomology in physics* (CTU, Tolar)
4. *Quantum chaos* (Pedagogical College Hradec Králové, Šeba)
5. Seminar *Quasicrystals* (CTU, Burdík, Pelantová)

### 2.6.2 Students

#### Defended PhD dissertation in 2000:

- R. Krejcar (CTU, supervised by Č. Burdík and J.-P. Gazeau); “Canonical Meyer quasilattices of quasicrystals”
- Z. Masáková (CTU, supervised by E. Pelantová in collaboration with Université de Montréal - J. Patera); “Aperiodic Delone sets with self-similarities”

#### Graduate:

- A. Andrlé (CTU, supervised by Č. Burdík); “Wavelets”
- H. Kovařík (Charles U., supervised by P. Exner); “Soft and magnetic quantum waveguides”

- M. Krbálek (CTU, supervised by P. Šeba); “Transport on classical and quantum chaotic systems”
- D. Krejčířík (Charles U., supervised by P. Exner); “Spectral properties of quantum layers”
- J. Kříž (Charles U., supervised by J. Dittrich); “Neumann waveguides”
- K. Němcová (Charles U., supervised by P. Exner); “Solvable models of quantum waveguide systems”
- S. Pošta (CTU, supervised by M. Havlíček); “Representations of  $U_q(so_3)$ ”
  
- L. Šnobl (CTU, supervised by L. Hlavatý); “Principal models on non-semisimple groups”
- A. Teleki (Nitra College, supervised by P. Exner); “Schrödinger and Pauli operators in local magnetic fields”

**Graduated in 2000:**

- A. Čech (CTU, supervised by M. Havlíček); “Nonstandard deformations of  $U_q(so_n)$ ”
- L. Klouda (CTU, supervised by L. Hlavatý); “Sine-Gordon models on symmetric spaces”
- K. Němcová (Charles U., supervised by P. Exner); “Dirichlet layers with point interactions”
- J. Souček (CTU, supervised by L. Hlavatý); “Quantization of  $N = 2$  sigma model”

**5th course:**

- P. Kysela (external, supervised by P. Exner); “Window-coupled Dirichlet layers”
- J. Šála (CTU, supervised by P. Šťovíček); “Construction of  $Sl_q(2, R)$  representations by the method of orbits”
- V. Zuzák (Charles U., supervised by P. Exner); “Layers coupled through a leaky boundary”

**4th course:**

- 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”
- K. Maršálek (CTU, supervised by J. Krlín); “Diffusions of the types random walk and Lévy walk, comparison and application”
- R. Sýkora (Charles U., supervised by P. Exner); “Point interactions supported on curves”
- P. Vytrás (CTU, supervised by P. Šťovíček); “Magnetic strings on a homogeneous background”

**3rd course:**

- J. Hrivnák (CTU, supervised by J. Tolar); “Gradings and graded contractions of Lie algebras”
- V. Jakubský (CTU, supervised by M. Znojil); “Calogero model”
- M. Korbelař (CTU, supervised by E. Pelantová); “Mathematical models of quasicrystals”
- P. Luft (CTU, supervised by G. Chadzitaskos); “Coherent states for quantum systems with compact configuration spaces”
- P. Novotný (CTU, supervised by J. Tolar); “Jordan algebras and Jordan–Lie algebras in quantum physics”
- J. Smotlacha (CTU, supervised by J. Fischer); “Summation of perturbation expansions in quantum chromodynamics”
- M. Štefaňák (CTU, supervised by I. Jex) “Quantum information processing”
- S. Vymětal (CTU, supervised by I. Jex) “Quantum entanglement”