

# Doppler Institute: Activities in 1999

It became a habit to summarize our activities at the end of a calendar year. Here we are again with a report on the seventh year of our existence.

## 1 Basic information

### 1.1 Members to date

Č. Burdík, *Dept of Mathematics, FNSPE, Czech Technical University, 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 University, Prague*  
L. Hlavatý, *Dept of Physics, FNSPE, Czech Technical University, Prague*  
P. Šeba, *Nuclear Physics Institute, AS, Prague/Řež*  
P. Šťovíček, *Dept of Mathematics, FNSPE, Czech Technical University, Prague*  
J. Tolar, Director, *Dept of Physics, FNSPE, Czech Technical University, 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. 1048801  
**Spatially restricted quantum systems**  
J. Dittrich, P. Exner (responsible), P. Šeba, M. Tater
2. AS CR Grant No. 1048804  
**Transport properties of electron wave structures**  
P. Exner, P. Šeba (responsible), P. Středa, M. Tater
3. The projects **ME099** and **ME170** 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,
4. College Development Fund Grant No. 767/1999  
**New algebraic structures in physics**  
M. Havlíček (responsible), Z. Masáková, S. Pošta
5. College Development Fund Grant No. 791/1999  
**Stability of time-dependent quantum systems**  
P. Šťovíček (responsible), Č. Burdík, O. Váňa, R. Krejcar
6. College Development Fund Grant No. 0828/1999  
**Integrability of quantum and classical models**  
L. Hlavatý, (responsible), L. Šnobl
7. AS CR Grant No. 1019601  
**Current problems of mathematics and mathematical physics**  
Č. Burdík, M. Havlíček, L. Hlavatý, P. Šťovíček, J. Tolar (responsible)
8. Ministry of Education CEZJ04/98210000018  
**Mathematical problems and fundamental experiments in the physics of microworld**  
Č. Burdík, M. Havlíček, L. Hlavatý, P. Šťovíček, J. Tolar (responsible)
9. Internal CTU Grant 309912604  
**Modernization of project education**  
M. Havlíček, E. Pelantová, J. Tolar (responsible)

## 2 Survey of activities

### 2.1 Edited volumes

1. J. Dittrich, P. Exner, M. Tater, eds.: *Mathematical Results in Quantum Mechanics*, Proceedings of a conference held in Prague, June 22–26, 1998; Operator Theory : Advances and Applications, vol. 108; Birkhäuser, Basel 1999.
2. Č. Burdík, ed.: *Quantum Groups and Integrable Systems*, Proceedings of the 8th Colloquium on Quantum Groups and Integrable Systems; Czech. J. Phys. **49** (Jan. 2000)

### 2.2 Publications in journals

1. M. Andrlé, Č. Burdík, J.-P. Gazeau, R. Krejcar: *Wavelet multiresolutions for the Fibonacci chain*, J. Phys. **A**, to appear
2. F. Bentosela, R.M. Cavalcanti, P. Exner, V.A. Zagrebnov: *Anomalous electron trapping by localized magnetic fields*, J. Phys. **A32** (1999), 3029–3039.
3. E.A. Bulgakov, K.A. Pichugin, A.F. Sadreev, P. Štředa, P. Šeba: *Hall-like effect induced by spin-orbit interaction*, Phys. Rev. Lett. **83** (1999), 376–379.
4. Č. Burdík, O. Navrátil: *The  $q$ -boson realizations of the quantum groups  $U_q(D_n)$* , J. Phys. **A32** (1999), 6141–6147.
5. Č. Burdík, O. Navrátil: *The  $q$ -boson realizations of the quantum groups  $U_q(C_n)$* , Int. J. Mod. Phys. **14** (1999), 4491–4500.
6. P. Duclos, P. Exner, D. Krejčířík: *Locally curved quantum layers*, Ukrainian J. Phys., to appear
7. P. Duclos, P. Šťovíček, M. Vittot: *Perturbation of an eigen-value from a dense point spectrum: a general Floquet Hamiltonian*, Ann. Inst. H. Poincaré **71** (1999), 241–301.
8. P. Exner, D. Krejčířík: *Quantum waveguide with a lateral semitransparent barrier: spectral and scattering properties*, J. Phys. **A32** (1999), 4475–4494.
9. P. Exner, S.A. Vugalter: *On the number of particles that a curved quantum waveguide can bind*, J. Math. Phys. **40** (1999), 4630–4638.
10. P. Exner, A. Joye, H. Kovařík: *Edge currents in the absence of edges*, Phys. Lett. **A**, to appear
11. M.F. Fernández, R. Guardiola, J. Ros, M. Znojil: *A family of complex potentials with real spectrum*, J. Phys. **A32** (1999), 3105–3116.
12. M. Havlíček, J. Patera, E. Pelantová: *Gradings of the real forms of classical Lie algebras*, Lin. Alg. Appl., to appear
14. M. Havlíček, S. Pošta, A.U. Klimyk: *Representations of cyclically symmetric  $q$ -deformed algebra  $so_q(3)$* , J. Math. Phys. **40** (1999), 2135–2161.
15. M. Havlíček, S. Pošta, A.U. Klimyk: *Representations of  $q$ -deformed algebra  $U_q(iso(2))$* , J. Math. Phys. **40** (1999), 3104–3122..
16. M. Havlíček, P. Winternitz, S. Pošta: *Nonlinear superposition formulas based on imprimitive group action*, J. Phys. **A32** (1999), 1–10.

17. L. Hlavatý: *Lax formulation of generalized  $SU(2)$  chiral models*, Rev. Math. Phys., to appear
18. L. Hlavatý, L. Šnobl: *Solution of the Yang-Baxter system for quantum doubles*, Int. J. Mod. Phys. **A14** (1999), 3029–3059.
19. M. Müller, K.A. Pichugin, I. Rotter, P. Šeba: *Collective modes in an open microwave billiard*, Phys. Rev. **E**, to appear
20. 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 **D**, to appear
21. P. Šeba, U. Kuhl, M. Barth, H.J. Stoeckmann: *Experimental verification of topologically induced vortices inside a billiard*, J. Phys. **A32** (1999), 8225–8230.
22. P. Šeba, K. Życzkowski, J. Zakrzewski: *Random matrix approach to “nonuniversal” conductance*, Acta Phys. Polon. **B30** (1999), 2797–2810.
23. P. Šťovíček: *A construction of representations and quantum homogeneous spaces*, Lett. Math. Phys. **47** (1999), 125–138.
24. P. Šťovíček: *Several remarks on comments by A. Moroz*, Europhys. Lett. **47** (1999), 275–276.
25. M. Znojil: *Exact solution for Morse oscillator in  $\mathcal{PT}$ -symmetric quantum mechanics*, Phys. Lett. **A264** (1999), 108–111.
26. M. Znojil: *Non-Hermitian matrix description of the  $\mathcal{PT}$ -symmetric anharmonic oscillators*, J. Phys. **A32** (1999), 7419–7428.
27. M. Znojil: *Bound states in the Kratzer plus polynomial potentials and the new form of perturbation theory*, J. Math. Chem., to appear
28. M. Znojil:  *$\mathcal{PT}$ -symmetric anharmonic oscillators*, Phys. Lett. **A259** (1999), 220–223.
29. M. Znojil: *Elementary doublets of bound states of the radial Dirac equation*, Mod. Phys. Lett. **A14** (1999), 863–868.
30. M. Znojil: *Singular potentials with quasi-exact Dirac bound states*, Phys. Lett. **A255** (1999), 1–6.
31. M. Znojil: *Harmonic oscillator well with a screened Coulombic core is quasi-exactly solvable*, J. Phys. **A32** (1999), 4563–4570.

### 2.3 Proceedings, submitted papers, etc.

1. Č. Burdík, Ch. Frougny, J.-P. Gazeau, R. Krejcar:  $\beta$  integers as a group, Proceedings of the Marseille meeting (1999), World Scientific, Singapore; to appear
2. Č. Burdík, P. Grozman, D. Leites, A. Sergeev: *Realizations of Lie algebras and superalgebras via creation and annihilation operators I*, submitted to Teor. Mat. Fiz.
3. Č. Burdík, O. Navrátil: *New boson realizations of quantum groups  $U_q(A_n)$* , Proceedings of the Srní Winter School (1999), Rendiconti del Circolo Matematico di Palermo, to appear

4. Č. Burdík, O. Navrátil: *New Boson Realizations of Quantum groups  $U_q(C_3)$* , Proceedings of XIV-th Max Born Symposium (1999), World Scientific, to appear
5. G. Chadzitaskos, J. Tolar: *The 2-diffraction system*, submitted to Opt. Commun.
6. H.D. Doebner, P. Šťovíček, J. Tolar: *Quantization of kinematics on configuration manifolds*, submitted to Rev. Math. Phys.
7. P. Exner: *Point interactions in a tube*, Proceedings of the Conference “Infinite-dimensional Stochastic Analysis” (Leipzig 1999); Canadian Mathematical Society, to appear
8. P. Exner: *Magneto-resonances in quantum-dot resonators*, Proceedings of the “Days on Diffraction” (Sankt Petersburg 1999), S. Petersburg State University Press 1999; pp. 40–47.
9. P. Exner, V.A. Gejler: *Berry phase in magnetic systems with point interactions*, submitted to J. Geom. Phys.
10. P. Exner, M. Hirokawa, O. Ogurusu: *Anomalous Pauli electron states for magnetic fields with tails*, submitted to Lett. Math. Phys.
11. P. Exner, A. Joye, H. Kovařík: *Magnetic transport along one-dimensional perturbations in the plane*, Proceedings of the Conference “Problems of Theoretical and Mathematical Physics” (Dubna 1999), to appear
12. P. Exner, H. Kovařík: *Magnetic strip waveguides*, submitted to J. Phys. **A**
13. P. Exner, D. Krejčířik: *Waveguides coupled through a semitransparent barrier: a Birman-Schwinger analysis*, submitted to Rev. Math. Phys.
14. L. Hlavatý: *Towards the Lax formulation of  $SU(2)$  principal models with non-constant metric*, submitted to Phys. Lett. **A**
15. J. Tolar: *Quantum mechanics on phase spaces  $Z_N \times Z_N$* , in “New Insights in Quantum Mechanics”, (H.D. Doebner, V.K. Dobrev and J. Hilgert, eds.), World Scientific, Singapore 1999; pp. 118-125

## 2.4 Seminars

During the teaching period, regular seminars were held on Tuesday afternoons. The list of speakers is the following:

*January 5*

M. Zahradník (Charles University): Pirogov-Sinai theory of phase transitions and some recent applications

*February 16*

A. Suzko (Dubna): Inverse problem and Darboux transformations for two-dimensional finite-difference Schrödinger equation

*February 23*

M. Znojil: Paradoxes of a PT-symmetric quantum mechanics

*March 2*

J. Niederle (IP AS)): A fermion-boson similarity

- March 9*  
 J. Dittrich: A massive scalar field in an oscillating region
- March 23*  
 J. Kupsch (Kaiserslautern): Mathematical aspects of decoherence in quantum mechanics
- April 6*  
 O. Váňa (CTU): Time dependent Hamiltonians
- April 13*  
 A. Joye (Grenoble): Semiclassical estimates with exponentially small errors
- April 20*  
 F. Gemperle (CTU): The eigenvalue problems for large matrices and applications in quantum theory
- April 27*  
 A. Uhlmann (Leipzig): Quantum channels of the Einstein-Rosen-Podolsky kind
- May 4*  
 B. Geyer (Leipzig): Quantization of general gauge theories
- May 11*  
 J. Brasche (Bonn): Upper bounds for Neumann-Schatten norms of the Birman-Schwinger kernel
- May 13*  
 R. Mendez (Essen): Vibrating soap films: an analogue for quantum chaos on billiards
- May 25*  
 L. Hlavatý: Lax formulation of sigma models on  $SU(2)$
- June 1*  
 I. Rotter (Dresden): Avoided level crossings in open quantum systems
- June 15*  
 T. Suslina (Sankt Petersburg): Absolute continuity of periodic Schrödinger operators with electric and magnetic potentials and a variable metric
- September 7*  
 S. Pošta and A. Čech (CTU): A deformed algebra  $U_q(\mathfrak{so}_3)$
- September 14*  
 L. Klouda (CTU): WZWN model gauges
- September 14*  
 J. Souček (CTU): Classical aspects of N=2 strings
- September 28*  
 Yu. Neretin (Moscow): Matrix analogues of B-functions
- October 5*  
 A. Pashnev (Dubna): Nonlinear realizations of diffeomorphism groups and particle models
- October 12*  
 A. Isaev (Dubna): On quantum matrix algebras which satisfy Cayley-Hamilton-Newton identities

*October 19*

A.U. Klimyk (Kyiv): Nonstandard  $q$ -deformation of the universal enveloping algebra  $U(\mathfrak{so}(n))$

*October 19*

A.T. Filippov (Dubna): Integrable models of quantum gravity

*October 26*

E. Mourre (Marseille): On some spectral properties of discrete operators on  $\mathbf{Z}^d$

*November 2*

M. Vittot (Toulon): Weakly regular Floquet Hamiltonians with pure point spectrum

*November 9*

P. Jizba (Cambridge): Topological effects as an inhomogeneous condensate in QFT

*November 23*

P. Šeba: Bus transport in Cuernavaca (Mexico) and the (random) theory of random matrices

*November 30*

V. Karassiov (Moscow):  $G$ -invariant Jordan-like mappings and dual Lie-algebraic pairs in quantum many-body

*December 7*

G. Alber (Ulm): Wave packet dynamics on atoms and the short wavelength approximation of quantum mechanics

## 2.5 Meetings

**8th Student Winter School** (Polubný, January 24–30)

**The 8th Colloquium “Quantum groups and Integrable Systems”** (Prague, June 17–19)

with the contributions by D. Arnaudon, W. Bajguz, D. Băleanu, A.Z Borowiec, R. Coquereaux, E. Date, A. Dimakis, V.K. Dobrev, L. Feher, L. Frappat, X. Gomez, M. Irac-Astaud, R. Kerner, M. Klimek, A.U. Klimyk, P.P. Kulish, A.K. Kwaśniewski, V. Lyakhovsky, V. Mazorchuk, R.J. McDermott, N.J. MacKay, M. Mertens, F. Müller-Hoissen, P. Parashar, C. Quesne, E. Ragoucy, A. Schüler, D. Shklyarov, G. Sigurdsson, S. Silvestrov, M. Tarlini, V. Tarasov, V. Terras, F. Wagner, M. Welk, and others

## 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 University, Exner)

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

## 2.6.2 Students

### Defended thesis in 1999:

O. Navrátil (CTU, supervised by Č. Burdík);  
 “ $q$ -boson realizations of quantum groups”

### Graduate:

R. Krejcar (CTU, supervised by Č. Burdík);  
 “Canonical Meyer quasilattices of quasicrystals”

A. Andrlé (CTU, supervised by Č. Burdík);  
 “Wavelets”

Z. Masáková (CTI, supervised by E. Pelantová; in collaboration  
 with Université de Montreal – J. Patera);  
 “Properties of quasicrystals”

S. Pošta (CTU, supervised by M. Havlíček);  
 “Representations of quantum groups”

D. Krejčířík (Charles U., supervised by P. Exner);  
 “Spectral properties of quantum layers”

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

J. Kříž (Charles U., supervised by J. Dittrich);  
 “Neumann waveguides”

L. Šnobl (CTU, supervised by L. Hlavatý);  
 “Quantum doubles”

M. Krbálek (CTU, supervised by P. Šeba);  
 “Transport on classical and quantum chaotic systems”

### Graduated in 1998:

L. Šnobl (CTU, L. Hlavatý);  
 presented diploma work *Quantum doubles and the universal  $R$ -matrix*.

O. Váňa (CTU and UTV, P. Šťovíček and P. Duclos);  
 presented diploma work *Time dependent quantum systems*

R. Otec (CTU, J. Tolar);  
 presented diploma work *Quantum mechanics in a finite-dimensional  
 Hilbert space*

M. Malinský (CTU, J. Hořejší);  
 presented diploma work *Higgs particle masses in supersymmetric models  
 of interactions*.



K. Smolek (CTU, M. Tater);  
presented diploma work *Resonance effects in quantum system depending periodically on time*

**5th course:**

K. Němcová (Charles University, P. Exner);  
diploma work *Point perturbations in a layer*  
J. Taufer (Pedagogical College, Hradec Králové, P. Šeba);  
diploma work *Multimedia presentation of Schrödinger equation solutions*

**4rd course:**

P. Vytřas (CTU, P. Šťovíček);  
review and research work *Spectra of some two-dimensional Hamiltonians*

**3rd course:**

H. Lavička (CTU, L. Hlavatý);  
review *Quantum doubles*  
V. Kavka (CTU, L. Hlavatý);  
review *Quantum doubles*  
I. Hradecký (CTU, P. Exner);  
review *Infinite systems of  $\delta$  barriers*  
M. Stevica (CTU, Č. Burdík);  
bachelor thesis *Methods of linear programming*  
A. Čechová (CTU, Č. Burdík);  
bachelor thesis *Methods of linear programming*