

# Doppler Institute: Activities in 2004

Dozen years is not so a short period, this is how long we are already here. Look at the report of our activities in the year drawing to its end.

## 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 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. Štovíček, *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. Alberverio, *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*  
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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. 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
2. AS CR Grant No. 1048302 **Quantum theory and pseudo-Hermitian Hamiltonians**. M. Znojil (responsible)
3. GA CR Grant No. 202/02/0088 **Analysis of nonlinear signals by means of random matrix theory**. P. Šeba (responsible)
4. CTU Grant No. 0415714 **Telescopic systems with a rotating objective element**. G. Chadzitaskos

## 2 Survey of activities

### 2.1 Edited volumes

1. Č. Burdík, O. Navrátil, eds.: *Proceedings of the International Colloquium "Quantum Groups and Integrable Systems" (Prague, June 2004)*, Czech. J. Phys. **54** (2004), No. 11.
2. Č. Burdík, O. Navrátil, S. Pošta, eds.: *Proceedings of the International Conference "Symmetry Methods in Physics" (Prague, June 2004)*, JINR Publ., Dubna 2004.
3. M. Znojil, ed.: *Proceedings of the Workshop "Pseudo-Hermitian Hamiltonians in Quantum Physics" (Prague, June 2003)*, Czech. J. Phys. **54** (2004), No. 1.
4. M. Znojil, ed.: *Proceedings of the Workshop "Pseudo-Hermitian Hamiltonians in Quantum Physics II" (Prague, June 2004)*, Czech. J. Phys. **54** (2004), No. 10.

## 2.2 Publications in journals

1. M. Andrlé, Č. Burdík, J.-P. Gazeau: *Bernoulli spline wavelets and sturmian sequences*, J. Fourier Anal. Appl. **10** (2004), 269–300.
2. J. Asch, R. Benguria, P. Šťovíček: *Asymptotic properties of the differential equation  $h^3(h'' + h') = 1$* , Asympt.Anal. **41** (2005), 23–40
3. D. Borisov, P. Exner: *Exponential splitting of bound states in a waveguide with a pair of distant windows*, J. Phys. **A37** (2004), 3411–3428
4. Č. Burdík, M. Haysak, M. Nagy: *The negative and positive charged two-dimensional three-body systems in adiabatic hyperspherical approach*, Czech. J. Phys. **54** (2004), 1191–1198.
5. G. Carron, P. Exner, D. Krejčířík: *Topologically non-trivial quantum layers*, J. Math. Phys. **45** (2004), 774–784
6. I. Catto, P. Exner, Ch. Hainzl: *Enhanced binding revisited for a spinless particle in non-relativistic QED*, J. Math. Phys. **45** (2004), 4174–4185.
7. T. Cheon, P. Exner: *An approximation to  $\delta'$  couplings on graphs*, J. Phys. **A37** (2004), L329–335.
8. J. Dittrich, P. Exner, M. Hirokawa: *A model of interband radiative transition*, J. Math. Soc. Japan **56** (2004), 753–786.
9. J. Dittrich, V.I. Inozemtsev: *On the ground state of ferromagnetic Hamiltonians*, Czech. J. Phys. **54** (2004), 775–779.
10. P. Exner: *An isoperimetric problem for point interactions*, J. Phys. **A38** (2005), to appear
11. P. Exner, P. Freitas, D. Krejčířík: *A lower bound to the spectral threshold in curved tubes*, Proc. Roy. Soc. **A469** (2004), 3457–3467.
12. P. Exner, T. Ichinose: *A product formula related to quantum Zeno dynamics*, Ann. H. Poincaré **6** (2005), to appear
13. P. Exner, S. Kondej: *Strong-coupling asymptotic expansion for Schrödinger operators with a singular interaction supported by a curve in  $\mathbb{R}^3$* , Rev. Math. Phys. **16** (2004), 559–582.
14. P. Exner, S. Kondej: *Schrödinger operators with singular interactions: a model of tunneling resonances*, J. Phys. **A37** (2004), 8255–8277.
15. P. Exner, S. Kondej: *Scattering by local deformations of a straight leaky wire*, J. Phys. **A38** (2005), to appear
16. P. Exner, H. Linde, T. Weidl: *Lieb-Thirring inequalities for geometrically induced bound states*, Lett. Math. Phys. **70** (2004), 83–95.
17. P. Exner, O. Post: *Convergence of spectra of graph-like thin manifolds*, J. Geom. Phys. **53** (2005), to appear

18. P. Exner, M. Tater: *Spectra of soft ring graphs*, Waves in Random Media **14** (2004), S47–60.
19. V.A. Geyler, P. Štoviček: *On the Pauli operator for the Aharonov-Bohm effect with two solenoids*, J. Math. Phys. **45** (2004), 51–75.
20. V.A. Geyler, P. Štoviček: *Zero modes in a system of Aharonov-Bohm fluxes*, Rev. Math. Phys. **16** (2004), 851–907.
21. D. Helbing, S. Lämmer, T. Seidel, P. Šeba, T. Płatkowski: *Physics, stability, and dynamics of supply networks*, Phys. Rev. **E70** (2004), 066116
22. L. Hlavatý, L. Šnobl: *Poisson-Lie T-plurality of three-dimensional conformally invariant sigma models*, J. High Energy Phys. **JHEP05** (2004), 010.
23. L. Hlavatý, L. Šnobl: *Poisson-Lie T-plurality of three-dimensional conformally invariant sigma models II: Nondiagonal metrics and dilaton puzzle*, J. High Energy Phys. **JHEP10** (2004), 045.
24. M. Horowski, G. Chadzitaskos, A. Odziejewicz, A. Tereszkievicz: *Systems with intensity-dependent conversion integrable by finite orthogonal polynomials*, J. Phys. **A37** (2004), 6115–6128.
25. V. Jakubský, M. Znojil: *Periodic square-well potential and spontaneous breakdown of  $\mathcal{PT}$ -symmetry*, Czech. J. Phys. **54** (2004), 1101–1106.
26. V. Jakubský, M. Znojil, E.A. Luis, F. Kleefeld: *Trigonometric identities, angular Schrödinger equations and a new family of solvable models*, Phys. Lett. **A**, to appear
27. P. Středa, P. Šeba: *Rashba spin-orbit coupling and anti-symmetric spin filterings*, Physica **E22** (2004), 460–463.
28. M. Znojil: *Experiments in  $\mathcal{PT}$ -symmetric quantum mechanics*, Czech. J. Phys. **54** (2004), 151–156.
29. M. Znojil: *Relativistic supersymmetric quantum mechanics based on Klein-Gordon equation*, J. Phys. **A37** (2004), 9557–9571.
30. M. Znojil:  *$\mathcal{PT}$ -symmetric regularizations in supersymmetric quantum mechanics*, J. Phys. **A37** (2004), 10209–10222. Int. J. Pure Appl. Math. **12** (2004), 79–104.
31. M. Znojil: *Partial sums and optimal shifts in shifted large- $l$  perturbation expansions for quasi-exact potentials*, Int. J. Pure Appl. Math. **12** (2004), 79–104.
32. M. Znojil: *Linear representation of energy-dependent Hamiltonians*, Phys. Lett. **A326** (2004), 70–76.

33. M. Znojil: *Fragile  $\mathcal{PT}$ -symmetry in a solvable model*, J. Math. Phys. **45** (2004), 4418–4430.
34. M. Znojil, H. Břila, V. Jakubský: *Pseudo-Hermitian approach to energy-dependent Klein-Gordon models*, Czech. J. Phys. **54** (2004), 1143–1148.
34. E. Caliceti, F. Canata, M. Znojil, A. Ventura: *Construction of  $\mathcal{PT}$ -asymmetric non-Hermitian Hamiltonians with CPT-symmetry*, Phys. Lett. **A** (2005), to appear; math-ph/0406031.

### 2.3 Proceedings, submitted papers, etc.

1. Č. Burdík, M. Havlíček: *Boson realizations of the semi-simple Lie algebras*, in Proceedings of the Workshop “Symmetry in Physics, in Memory of R. Sharp”, CRM Proceedings & Lecture Notes **34**, AMS, Providence 2004.
2. Č. Burdík, O. Navrátil: *A method for construction of the matrix solvable models*, submitted to J. Phys. **A**
3. Č. Burdík, O. Navrátil: *Normal ordering for deformed Heisenberg algebra involving the reflection operator*, submitted to J. Phys. **A**
4. Č. Burdík, O. Navrátil: *The  $q$ -boson-fermion realizations of quantum superalgebra  $U_q(gl(m/n))$* , in Proceedings of the 5th International Workshop “Lie Theory and Its Applications in Physics” (Varna, June 2003; H.-D. Doebner, V.K. Dobrev, eds.), World Scientific, Singapore 2004; pp. 294–300.
5. Č. Burdík, O. Navrátil: *The  $q$ -boson-fermion realizations of quantum superalgebra  $U_q(osp(2/1))$* , in Proceedings of the 10th International Conference “Symmetry Methods in Physics” (Yerevan, August 2003), in print
6. Č. Burdík, O. Navrátil: *The  $q$ -boson-fermion realizations of quantum superalgebra  $U_q(gl(2/1))$* , in Proceedings of the International Workshop “Supersymmetries and Quantum Symmetries” (Dubna, July 2003; E. Ivanov, A. Pashnev, eds.), JINR Publ., Dubna 2004; pp. 174–180.
7. Č. Burdík, G. Pogosyan: *Two exactly solvable problems in one-dimensional hyperbolic space*, in Proceedings of the 5th International Workshop “Lie Theory and Its Applications in Physics” (Varna, June 2003; H.-D. Doebner, V.K. Dobrev, eds.), World Scientific, Singapore 2004; pp. 403–413.

8. G. Chadzitaskos, J. Tolar: *Wigner quantization on the circle and  $R_+$* , in Proceedings of the workshop “Geometric Methods in Physics” (Bialowieza 2003; S.T. Ali et al, eds.), J. Nonlin. Math. Phys., suppl. to vol. 11 (2004), 174–178.
9. G. Chadzitaskos, J. Tolar: *Telescopic system with a rotating objective element*, in Proceedings of SPIE “Optical, Infrared, and Millimeter Space Telescopes” (Glasgow 2004; J.C. Mather, ed.), vol. 5487 (2004), 1137–1141.
10. H.-D. Doebner, J. Tolar: *Borel quantisation and nonlinear quantum mechanics*, in Proceedings of the symposium “Symmetries in Science” (Bregenz 2003; B. Gruber and G. Marmo, eds.), Kluwer, Dordrecht 2004; 17 p.
11. P. Exner, T. Ichinose: *Product formula for quantum Zeno dynamics*, submitted to Proceedings of the XIV International Congress on Mathematical Physics (Lisbon 2003)
12. P. Exner, T. Ichinose, H. Neidhardt, V.A. Zagrebnov: *New product formulæ and quantum Zeno dynamics with generalized observables*, submitted to Bull. London Math. Soc.; [mp-arc 04-379](#), [math-ph/0411036](#)
13. P. Exner, S. Kondej: *Leaky quantum wire and dots: a resonance model*, submitted to Proceedings of the XIV International Congress on Mathematical Physics (Lisbon 2003); [mp-arc 03-329](#); [math-ph/0307030](#)
14. P. Exner, V.A. Zagrebnov: *Bose-Einstein condensation in geometrically deformed tubes*, submitted to Phys. Rev. Lett.; [cond-mat/0409612](#)
15. M. Havlíček, J. Patera, E. Pelantov, J. Tolar: *On Pauli graded contractions of  $sl(3, \mathbb{C})$* , in Proceedings of the workshop “Geometric Methods in Physics” (Bialowieza 2003; S.T. Ali et al, eds.), J. Nonlin. Math. Phys., suppl. to vol. 11 (2004), 37–42.
16. J. Hrivnák, P. Novotný, J. Patera, J. Tolar: *Graded contractions of the Pauli graded  $sl(3, C)$ . 180 solutions of the contraction system*, submitted to J. Math. Phys.
17. P. Novotný, J. Hrivnák, J. Patera, J. Tolar: *Graded contractions of the Pauli graded  $sl(3, C)$ . Identification of contracted Lie algebras*, submitted to J. Math. Phys.
18. M. Znojil: *Conservation of pseudo-norm in  $\mathcal{PT}$ -symmetric quantum mechanics*, Rendiconti del Circ. Mat. di Palermo, Ser. II, Suppl. 72 (2004), pp. 211–218.

19. M. Znojil: *Multiparametric oscillator Hamiltonians with exact bound states in infinite-dimensional space*, Rendiconti del Circ. Mat. di Palermo, to appear
20. M. Znojil, D. Yanovich: *New type of exact solvability and of a hidden nonlinear dynamical symmetry in anharmonic oscillators*, in “Proceedings of the Fifth International Conference ‘Symmetry in Nonlinear Mathematical Physics’ ” (Proc. Inst. Math. NAS of Ukraine, vol. 50, part II; ed. A.G. Nikitin et al.), Kyiv 2004; pp. 1010–1017.
21. M. Znojil: *Imaginary cubic oscillator and its square-well approximations in  $x$ - and  $p$ -representation*, in “Advances in Numerical Analysis (Numerical Analysis Research)”, Nova Science Publishers: Hauppauge, ed. F. Columbus, to appear
22. B. Bagchi, A. Banerjee, E. Caliceti, F. Cannata, H.B. Geyer, C. Quesne, M. Znojil: *CPT-conserving Hamiltonians and their nonlinear supersymmetrization using differential charge-operators  $C$* , submitted to Nucl. Phys. **B**; hep-th/0412211
23. M. Znojil:  *$\mathcal{PT}$ -symmetry, ghosts, supersymmetry and Klein-Gordon equation*, in Proceedings of the International Conference “Symmetry Methods in Physics” (Prague, June 2004; Č. Burdík et al, eds.), JINR Publ., Dubna 2004.; hep-th/0408081

## 2.4 Seminars

### 2.4.1 Regular seminar

*January 6*

D. Krejčířík (Lisboa): The nature of the essential spectrum in curved quantum waveguides

*March 16*

F. Hinterleitner (Brno): Introduction to loop quantum gravity

*March 23*

D. Kazhdan (Jerusalem): Wess-Zumino-Witten model in eyes of a mathematician

*April 27*

L. Hlavatý: Classical sigma models and their dualities

*May 4*

L. Hlavatý: Quantum sigma models and their dualities

*May 11*

F. Kleefeld (Lisboa): On nontrivial implications of (anti)causality to mathematical physics

*May 18*

P. Jizba (CTU): World according to Renyi – thermodynamics of multifractal systems

*June 3*

D. Sternheimer (Dijon): On the connection between internal and external symmetries of elementary particles – revisited after 40 years

*October 19*

M. Uhlíř (CTU): A hybrid theory of electron spin

*October 26*

P. Jizba (CTU): Geometric background for thermal quantum field theories

*November 2*

Č. Burdík: New matrix Calogero models

*November 9*

O. Kern (TU Darmstadt): Quantum algorithms and quantum maps - implementation and error correction models

*December 7*

R. Campoamor-Stursberg (Madrid): Matrix and determinantal methods for the computation of Casimir operators of Lie algebras

*December 14*

K. Chatzisavvas (Thessaloniki): Universal quantum gates. An approach beyond the standard circuit model

*December 21*

V. Košťák (CTU): Universal processes in quantum information

*December 21*

M. Turek (CTU): Lie-Poisson T-duality

#### **2.4.2 The “Quantum Circle” seminar**

*January 6*

Akira Iwatsuka (Kyoto University): Asymptotic distribution of eigenvalues for Pauli operators with nonconstant magnetic fields

*February 17*

Hagen Neidhardt (WIAS Berlin): Hybrid models for semiconductors and dissipative Schrödinger-Poisson systems

*April 13*

Hynek Kovařík (Universität Stuttgart): On the discrete spectrum of the magnetic Schrödinger operator in a waveguide



*April 27*

Jaroslav Dittrich: Proof of a Sutherland conjecture

*May 18*

Vladimir Geyler (Saransk University): Continuity properties of the integral kernels of resolvents

*May 25*

Ricardo Weder (UNAM, Mexico City): Borg-Marchenko two spectra uniqueness theorem for Schrödinger operators with continuous spectrum

*June 1*

Petr Šeba: Force plate data analysis: control processes of human stability and manifestations of haemodynamics

*June 3*

Mikhail Solomyak (Weizmann Institute, Rehovot): On a family of partial differential operators appearing in the theory of irreversible quantum graphs

*August 17*

Valentin Zagrebnov (Universté d'Aix-Marseille II): Trotter product formula and fractional powers of self-adjoint generators

*August 24*

Kazushi Yoshitomi (Tokyo Metropolitan University): Identification of the absent spectral gaps in a class of periodic Jacobi operators

*October 18*

leszek Sirko (PAN Warsaw): Experimental simulation of quantum graphs by microwave networks

*November 2*

Jozsef Lörinczi (TU Munich): Ground state properties and infrared behaviour of the Nelson model

*November 9*

Ivan veselić (TU Chemnitz): Spectral averaging induced by random, geometric perturbations

*November 16*

Jaroslav Novotný (CTU): Optimal copying of entangled states

*November 23*

Takashi Ichinose (Kanazawa University): On the spectral zeta function for the non-commutative harmonic oscillator

*December 14*

Masao Hirokawa (Okayama University): Operator theory of infrared catastrophe

*December 15*

Georgi Raikov (Universidad de Chile): Global continuity of the integrated density of states for a random Landau Hamiltonian

## 2.5 Meetings

**The 13th Student Winter School** (Horní Polubný, January 25–31) organized by G. Chadzitaskos

**The 13th Colloquium “Integrable Systems and Quantum Groups”** (Prague, June 17-19), organized by Č. Burdík with the participation of D. Arnaudon, Yu. Bakhturin, D. Baleanu, S. Bellucci, P. Blasiak, Y. Brihaye, R. Coquereaux, T. Curtright, A. Das, P. Desrosiers, A. Dimakis, V.K. Dobrev, L. Féher, A. Frydryszak, J.F. Gomez, V.V. Gribanov, N.A. Gromov, H. Grosse, A. Horzela, M. Huerta, W.P. Joyce, E. Kapuscik, K. Kowalski, O. Lechtenfeld, D. Leites, P. Maslanka, P. Mathieu, R.M. Mir-Kasimov, A.I. Molev, A. Mostafazadeh, M. Nagy, A. Odziejewicz, E. Paal, Z. Popowicz, A. de Souza Dutra, J. Wess, B.M. Zupnik, and others

**The 11th International Conference “Symmetry Methods in Physics”** (Prague, June 21-24), co-organized by Č. Burdík with the participation of M. Arai, F. Ardalan, D. Arnaudon, D. Baleanu, S. Baskal, N. Belalouiy, A. Brodlie, B.L. Burrows, A.F. Chervakov, M. Cohen, N. Cotfas, V.K. Dobrev, P.G. Estevez, A. Frydryszak, J.-P. Gazeau, F. Gieres, J.F. Gomes, F.J. Herranz, A. Horzela, E. Ivanov, E. Kapuscik, M.R. Kibler, Y.S. Kim, S. Krivonos, M. Milekovic, M. de Montigny, S.S. Moskaliuk, G. Moultaqa, V. Rosenhaus, N. Sadooghi, O.P. Santillan, O.V. Selyugin, A.S. Shumovsky, C. Sochichiu, A.I. Solomon, C. Sophocleous, D.K. Volin, R.J. Wiltshire, A. Yakhno, and others

**The 2nd workshop “Pseudo-Hermitian Hamiltonians in Quantum Physics”** (Prague, June 14-16), organized by M. Znojil with the participation of Zafar Ahmed, Bijan K. Bagchi, Carl M. Bender, Michael Berry, Emanuela Caliceti, Hendrik B. Geyer, Uwe Guenther, W. Dieter

Heiss, Hugh Jones, Frieder Kleefeld, Roman Kotecký, Heinz Langer, Géza Lévai, Ali Mostafazadeh, Giuseppe Sclarici, Izak Snyman, Christiane Tretter, Stefan Weigert, Christian Wyss, and others

One of the traditional DI conferences, “**Mathematical Results in QM**” (**QMath9**) was held at Presque Île de Giens on September 11-16, with P. Exner in the organizing committee

## 2.6 Students

### 2.6.1 Students

#### Defended PhD theses in 2004:

K. Němcová (Charles U., supervised by P. Exner); “Solvable models of quantum systems with a nontrivial geometry”

#### Graduate:

H. Bíla (Charles U., supervised by M. Znojil); “Pseudo-Hermitian Hamiltonians in quantum theory”

P. Hejčík (University of Hradec Králové, supervised by P. Šeba); “Application of the theory of quantum chaotic systems to description of time series obtained by measurements at a force plate”

I. Hradecký (CTU, supervised by P. Šťovíček); “Adiabatic analysis of a model with time-dependent Aharonov-Bohm fluxes”

J. Hrivnák (CTU, supervised by J. Tolar); “Graded contractions of Lie algebras”

V. Jakubský (CTU, supervised by M. Znojil); “Pseudo-Hermitian quantum physics”

O. Lev (CTU, supervised by P. Šťovíček); “Semiclassical analysis of quantum operator matrix elements”

P. Luft (CTU, supervised by G. Chadzitaskos); “Quantization and coherent states”

P. Novotný (CTU, supervised by J. Tolar); “Graded contractions of Lie algebras”

P. Stránský (Charles U., supervised by P. Šeba); “Correlation analysis of time series by a random matrix method”

P. Vytrás (CTU, supervised by P. Šťovíček); “A many-body system in a strong magnetic field”

**5th course:**

M. Fraas (Charles U., supervised by P. Exner); “Time evolution in Winter model and concentric families of singular interactions”

**4th course:**

S. Petráš (CTU, supervised by J. Tolar); “Quantum systems on 2-dimensional configuration manifolds with magnetic fields”

M. Turek (CTU, supervised by L. Hlavatý); “Lie-Poisson T-duality”

O. Turek (CTU, supervised by P. Exner); “Approximations of quantum graph vertices”

**3rd course:**

A. Černý (CTU, supervised by L. Hlavatý); “Classification of the Lie algebras and its application for solving the Einstein equations”

L. Kučerová (CTU, supervised by L. Hlavatý); “Integrable systems and surfaces with constant curvature ”