Institute of Physics
Slovak Academy of Sciences
2012-2015

Evaluation Meeting, Bratislava
November 11, 2016

Short history

Institute of Physics was founded in 1955 mainly on iniciative of Prof. Dionýz Ilkovič, former associate of Czech Nobel laureate prof. Heyrovský.

At the beginning, emphasis was on solid state and nuclear physics, but the diversity was already laid into the genes

After 60 years of evolution, Institute has six departments

- Department of Complex Physical Systems
- Department of Metal Physics
- Department of Multilayers and Nanostructires
- Department of Nuclear Physics
- Department of Theoretical Physics
- Research Center for Quantum Information

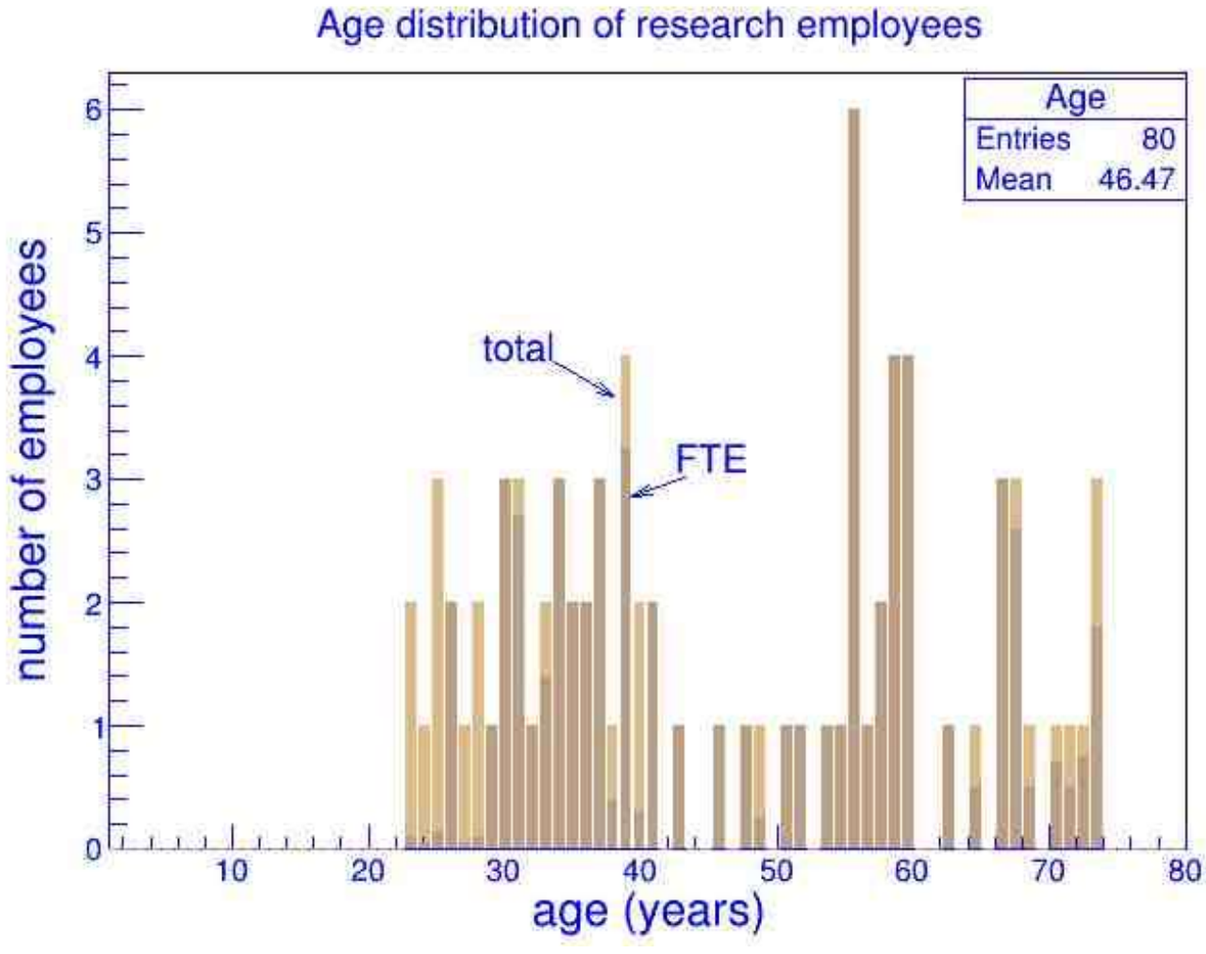
Personnel

- Research employees including PhD students ~ 80
- PhD students 13-17, number is limited by central resources

  PhD students from Slovakia, Italy, Ukraine, India

Plot of age distribution from December 2015 shows an uneven distribution with two maxima.

Situation temporarily improved by 4 SASPRO granties from Slovakia, Hungary, India



Budget

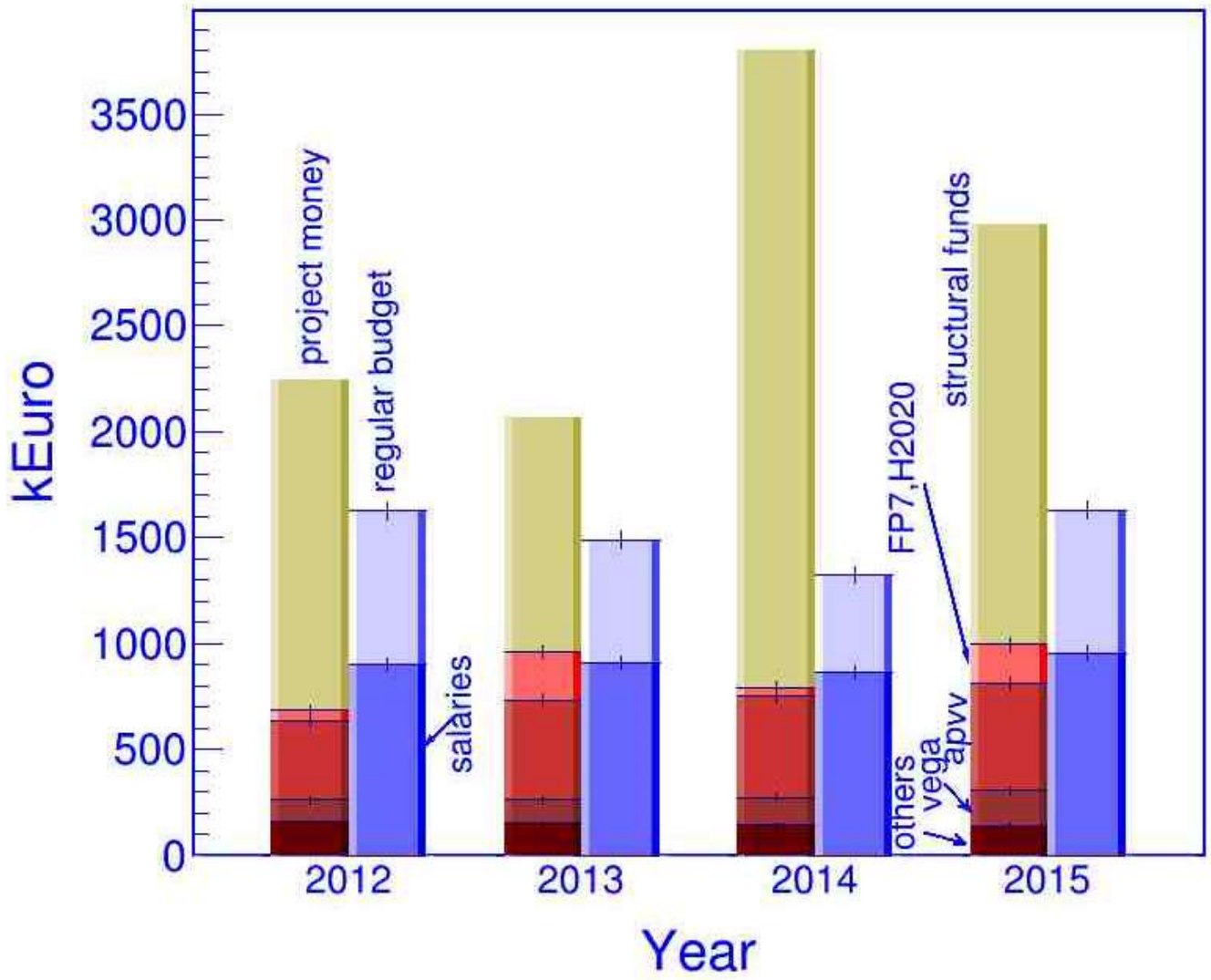
Two separate components
→ running costs from allocated budget
→ project money from grant agencies, bound by the contract

Real running costs are higher than allocated budget

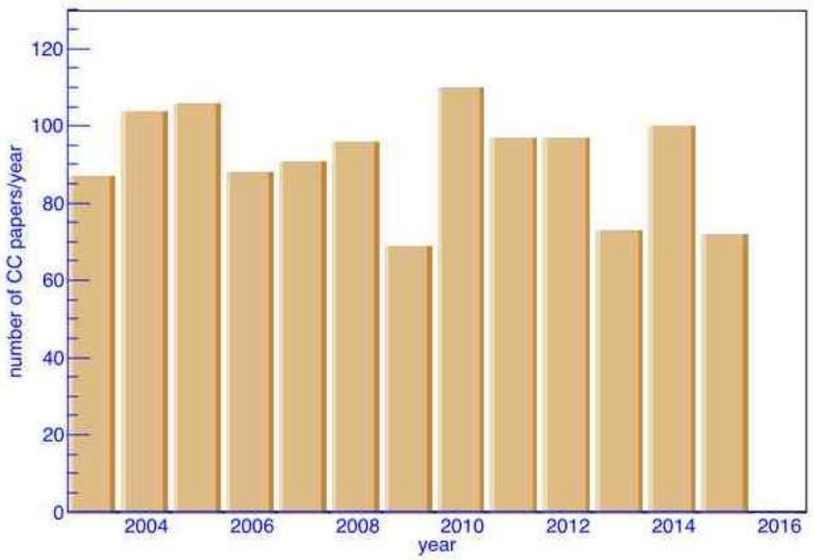
Budget structure determines our activities.

Ambitious development projects so far not possible

At the moment, we concentrate on utilization of Structural Funds, which is rather time consuming undertaking.

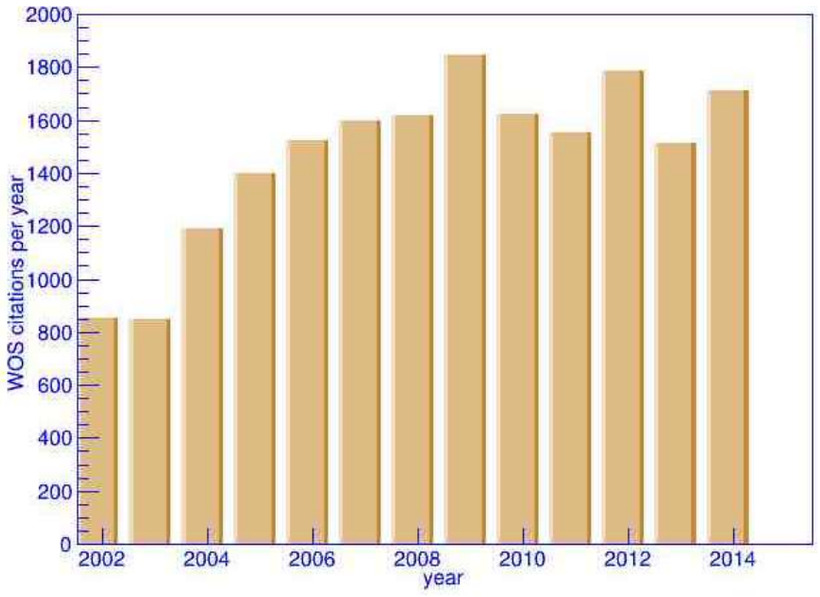


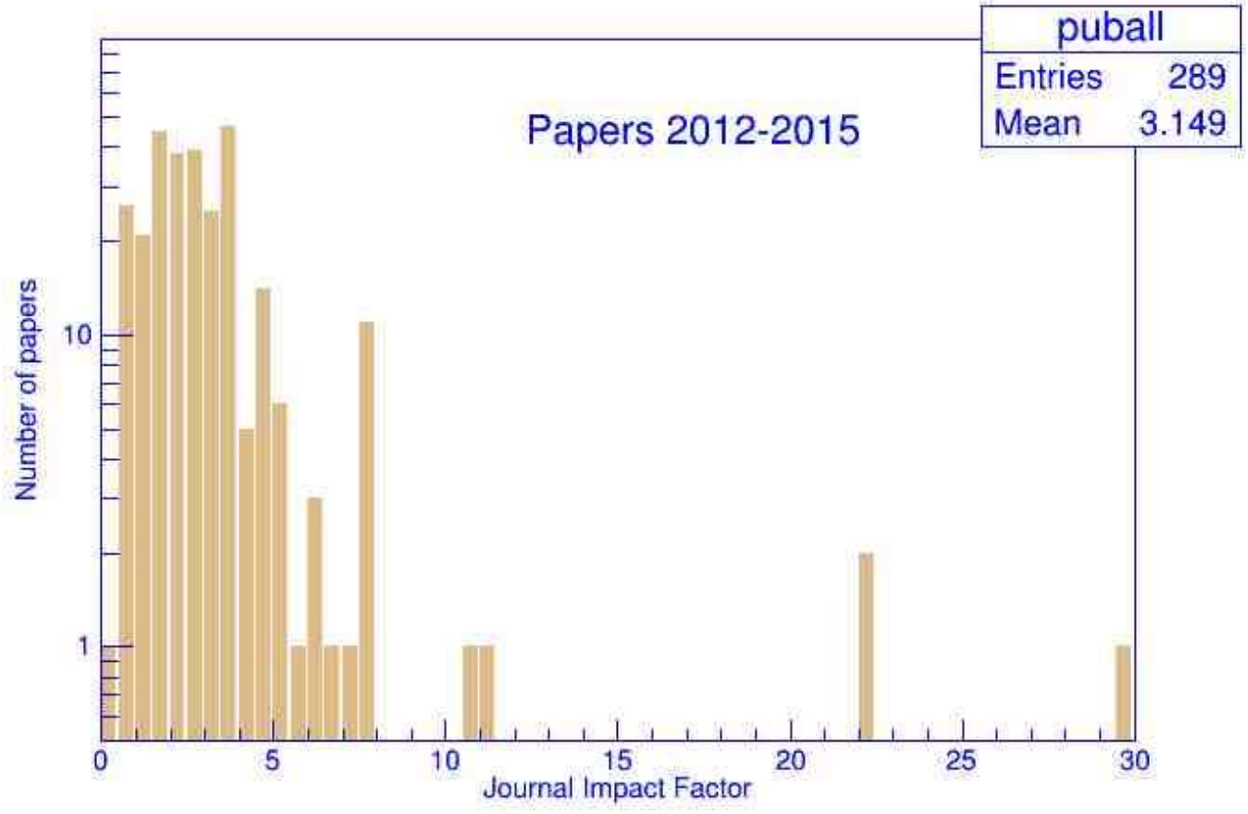
Scientific output



Number of CC papers published during the evaluation period and previously. Number of papers per year and mean impact factor seems to be slightly anticorrelated

Impact factor of CC papers, published during the evaluation period





Number of citations in WOS per year

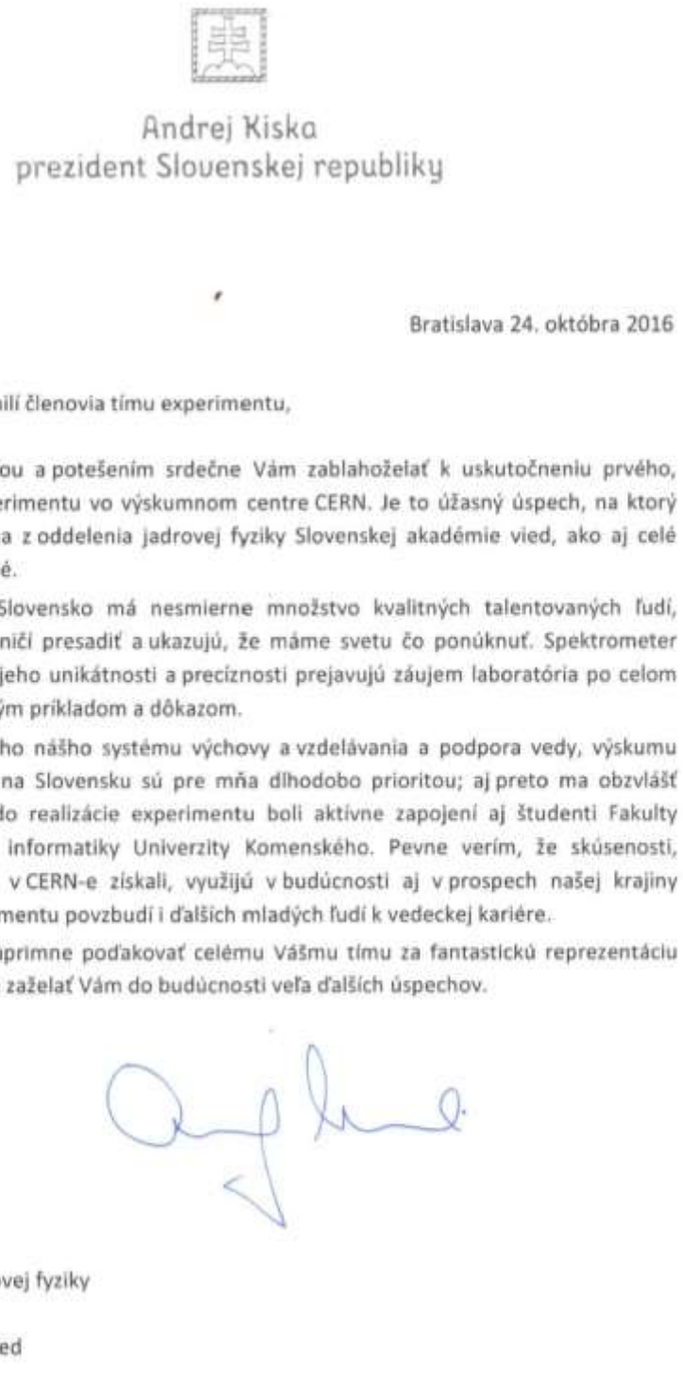
Jean Marie Dubois Award
for excellence in quasicrystal research

- Our colleague Marek Mihalkovic received Jean Marie Dubois Award during the 13th International Conference on Quasicrystalls, Kathmandu, September 2016 .

- Award recognizes important, sustained research on any aspect of quasicrystalls within 10 years period preceeding the Award.

Congratulations of the President of the Slovak Republic Mr. Andrej Kiska

Mr. President congratulates spokesman of IS523 experiment and the whole team for carrying out the first solely Slovak experiment at CERN



Andrej Kiska
prezident Slovenskej republiky

Bratislava 24. októbra 2016

Vážený pán Venhart, milí členovia tímu experimentu,

je pre mňa veľkou cťou a potešením srdečne Vám zablahoželať k uskutočneniu prvého, plne slovenského experimentu vo výskumnom centre CERN. Je to úžasný úspech, na ktorý môže byť Vaša skupina z oddelenia jadrovej fyziky Slovenskej akadémie vied, ako aj celé Slovensko, právom hrdé.

Často opakujem, že Slovensko má nesmierne množstvo kvalitných talentovaných ľudí, ktorí sa vedia v zahraničí presadiť a ukazujú, že máme svetu čo ponúknuť. Spektrometer TATRA, o ktorý vďaka jeho unikátnosti a precíznosti prejavujú záujem laboratória po celom svete, je toho ukážkovým príkladom a dôkazom.

Kvalita vzdelania, celého nášho systému výchovy a vzdelávania a podpora vedy, výskumu a inovačných trendov na Slovensku sú pre mňa dlhodobo prioritou; aj preto ma obzvlášť potešilo zistenie, že do realizácie experimentu boli aktívne zapojení aj študenti Fakulty matematiky, fyziky a informatiky Univerzity Komenského. Pevne verím, že skúsenosti, ktoré vďaka projektu v CERN-e získali, využijú v budúcnosti aj v prospech našej krajiny a úspech Vášho experimentu povzbudí i ďalších mladých ľudí k vedeckej kariére.

Dovoľte mi na záver úprimne poďakovať celému Vášmu tímu za fantastickú reprezentáciu Slovenska v zahraničí a zaželať Vám do budúcnosti veľa ďalších úspechov.

S pozdravom

Vážený pán
Martin VENHART
vedúci oddelenia jadrovej fyziky
Fyzikálny ústav
Slovenská akadémia vied
B r a t i s l a v a

Department of complex physical systems
Main Activities

→ Ab-initio simulations of electronic structure

→ Statistical mechanics of low-dimensional systems

- macroscopic systems of particles with Coulomb interaction
- effective one-dimensional description of transport in nanochannels

→ Device independent quantum protocols

→ Lattice QCD and QCD in extreme deconfinement phase transitions

P. Filip is member of "Star Collaboration & RHIC, Brookhaven Nat. Lab.

Department of Complex Physical Systems Highlights

nature COMMUNICATIONS

ARTICLE

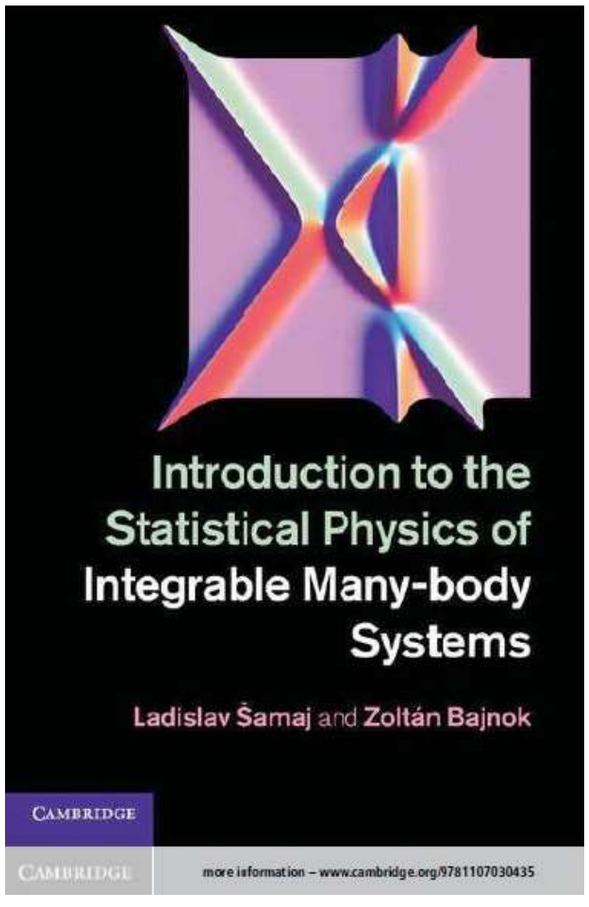
Received 4 Mar 2014 | Accepted 20 Jun 2014 | Published 31 Jul 2014

DOI: 10.1038/ncomms5476

Vertical atomic manipulation with dynamic atomic-force microscopy without tip change via a multi-step mechanism

J. Bamidele[1], S.H. Lee[2], Y. Kinoshita[2], R. Turanský[3], Y. Naitoh[2], Y.J. Li[2], Y. Sugawara[2], I. Štich[3] & L. Kantorovich[1]

Manipulation is the most exciting feature of the non-contact atomic force microscopy technique as it allows building nanostructures on surfaces. Usually vertical manipulations are accompanied by an abrupt tip modification leading to a change of contrast. Here we report on low-temperature experiments demonstrating vertical manipulations of 'super'-Cu atoms on the $p(2 \times 1)$ Cu(110):O surface, both extractions to and depositions from the tip, when the imaging contrast remains the same. These results are rationalized employing a novel and completely general method that combines density functional theory calculations for obtaining energy barriers as a function of tip height and a Kinetic Monte Carlo algorithm for studying the tip dynamics and extraction of manipulation statistics. The model reveals a novel multi-step manipulation mechanism combining activated jumps of 'super'-Cu atoms to/from the tip with their drag by and diffusion on the tip.



SCIENTIFIC REPORTS

OPEN

SUBJECT AREAS:
THERMODYNAMICS
THEORETICAL PHYSICS

Maxwell's Daemon: Information versus Particle Statistics

Martin Plesch[1,2,3], Oscar Dahlsten[3], John Goold[3,4] & Vlatko Vedral[3,5]

[1]Institute of Physics, Slovak Academy of Sciences, Bratislava, Slovakia, [2]Faculty of Informatics, Masaryk University, Brno, Czech Republic, [3]Department of Physics, University of Oxford, Clarendon Laboratory, Oxford, OX1 3PU, UK, [4]The Abdus Salam International Centre for Theoretical Physics, 34014 Trieste, Italy, [5]Center for Quantum Technology, National University of Singapore, Singapore.

Maxwell's daemon is a popular personification of a principle connecting information gain and extractable work in thermodynamics. A Szilard Engine is a particular hypothetical realization of Maxwell's daemon, which is able to extract work from a single thermal reservoir by measuring the position of particle(s) within the system. Here we investigate the role of particle statistics in the whole process; namely, how the extractable work changes if instead of classical particles fermions or bosons are used as the working medium. We give a unifying argument for the optimal work in the different cases: the extractable work is determined solely by the information gain of the initial measurement, as measured by the mutual information, regardless of the number and type of particles which constitute the working substance.

Department of Complex Physical Systems
Future Plans

- In computational material science we will focus on study of electronic properties of 2D, graphene-like, materials, group-IV-semiconductor nanocomposites for photonics and computational support to SPM imaging and nanomanipulation (including nanotribology)
- Study of classical Coulomb fluids at low temperatures with emphasis on anomalous phenomena, like an attraction of the likely charged colloids in electrolyte. Cooperation with J.K. Percus and D. Haldane is foreseen.
- High energy subgroup will focus on study of quantum oscillation phenomena in matter medium, in particular, neutral meson oscillations in dense baryonic matter created in nucleus-nucleus collisions, and also in a low-density medium

Department of Multilayers and Nanostructures
Main activities

- Nanoparticle self-assembly and nanoparticle Langmuir films
- Development and pilot application of new elements of X-ray optics for an extreme X-ray beam compression and expansion
- New organic photovoltaic materials and advanced diagnostic methods for their characterization

Department of Multilayers and Nanostructures Highlights

THE JOURNAL OF PHYSICAL CHEMISTRY C

Article

Electrochemical Spectroscopic Methods for the Fine Band Gap Electronic Structure Mapping in Organic Semiconductors

Katarína Gmucová, Vojtech Nádaždy, František (Franz) Schauer, Michal Kaiser, and Eva Majkova

J. Phys. Chem. C, **Just Accepted Manuscript** • DOI: 10.1021/acs.jpcc.5b04378 • Publication Date (Web): 18 Jun 2015

Functionality of organic photonic devices is markedly influenced by the electronic band structure of the used materials. An easy and quick determination of the density of states function (DOS) in the whole energy range from HOMO to LUMO, including the presence of defect states in the band gap, is a prerequisite to a successful design of photonic devices. In this study we present the fine band gap electronic structure mapping in P3HT with two electrochemical spectroscopic methods: the energy-resolved electrochemical impedance spectroscopy (ER-EIS) and the kinetic sensitive voltcoulometry (VCM). We showed that the P3HT exposition to air results in the change of light-induced polaron states in the band gap. The electrochemically measured data are compared with those from the literature, obtained with combined optical spectroscopic methods, electrical methods, or first-principles calculations. The ER-EIS method has been shown as capable of providing valuable information on the DOS in the whole energy range from HOMO to LUMO, and the VCM method opens the possibility to study separately the charge transfer (redox) processes with different kinetics.

Langmuir Article

pubs.acs.org/Langmuir

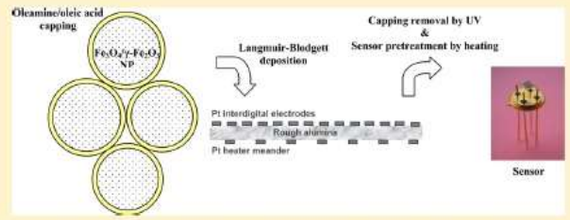
Fe_3O_4/γ-Fe_2O_3 Nanoparticle Multilayers Deposited by the Langmuir–Blodgett Technique for Gas Sensors Application

S. Capone,[†] M. G. Manera,[†] A. Taurino,[†] P. Siciliano,[†] R. Rella,*[,†] S. Luby,[‡] M. Benkovicova,[‡] P. Siffalovic,[‡] and E. Majkova[‡]

[†]Institute of Microelectronics and Microsystems (C.N.R.-I.M.M.), via Monteroni, Campus Ecotekne, 73100 Lecce, Italy

[‡]Institute of Physics, Slovak Academy of Sciences, Dubravska cesta 9, 845 11 Bratislava, Slovakia

ABSTRACT: Fe_3O_4/γ-Fe_2O_3 nanoparticles (NPs) based thin films were used as active layers in solid state resistive chemical sensors. NPs were synthesized by high temperature solution phase reaction. Sensing NP monolayers (ML) were deposited by Langmuir–Blodgett (LB) techniques onto chemoresistive transduction platforms. The sensing ML were UV treated to remove NP insulating capping. Sensors surface was characterized by scanning electron microscopy (SEM). Systematic gas sensing tests in controlled atmosphere were carried out toward NO_2, CO, and acetone at different concentrations and working temperatures of the sensing layers. The best sensing performance results were obtained for sensors with higher NPs coverage (10 ML), mainly for NO_2 gas showing interesting selectivity toward nitrogen oxides. Electrical properties and conduction mechanisms are discussed.



Department of Multilayers and Nanostructures
Future plans

- Functionalized 2D nanomaterials for sensing, detection and bioapplications -> project 2D nanoplatform for cancer diagnostic and therapy
- The organic/inorganic perovskite-based solar cell structures with high power conversion efficiency with incorporation various carbon 2D nanomaterials
- New elements of high-throughput X-ray optics to enhance resolution in the reciprocal or direct space
- Challenges in applied research: High-quality active surfaces for the next generation of the crystal X-ray optics.

Department of Metal Physics
Main activities

- Ab initio calculation of properties of metallic alloys, compounds and quasicrystalls
- Nanocrystalline and quasicrystalline metallic systems with tailored structure and morphology
- Application of Advanced Metallic Materials for Stiffness Enhancement of Lightweight Structural Components
- Prediction of structure and stability of metallic alloys with complex structure
- Study of magnetic properties of RQ metallic alloys
- Thermal analysis of micro-, nano and non-crystalline materials and applications of thermal analysis for preservation of cultural heritage and environment

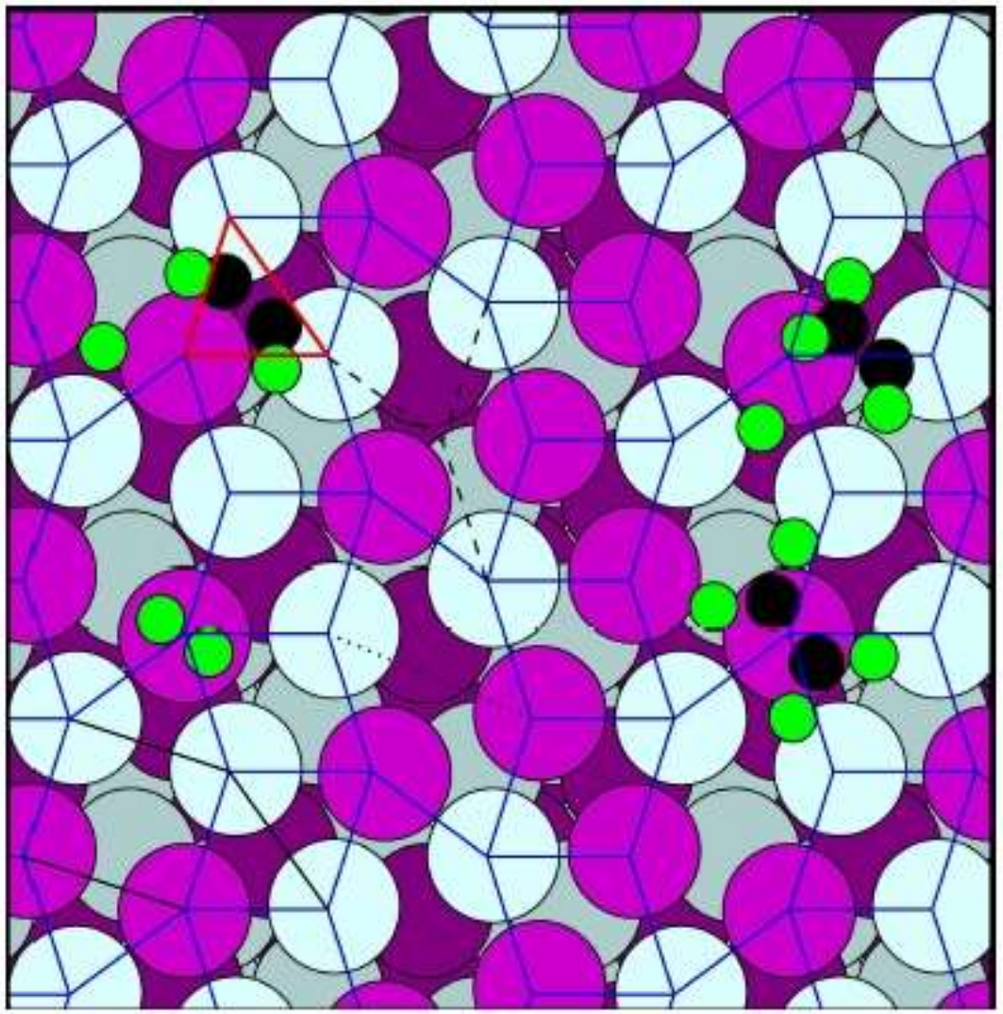
Department of Metal Physics

Highlights

ChemPubSoc Europe
DOI: 10.1002/cctc.201500733
CHEMCATCHEM Reviews

Intermetallic Compounds as Selective Heterogeneous Catalysts: Insights from DFT

Marian Krajčí[a,b] and Jürgen Hafner[a,b]



$$CH_3OH + H_2O \rightarrow 3\,H_2 + CO_2 \quad (1)$$
$$\rightarrow 2\,H_2 + CO + H_2O \quad (2)$$

Materials Science & Engineering A 605 (2014) 108–118

Contents lists available at ScienceDirect

Materials Science & Engineering A

journal homepage: www.elsevier.com/locate/msea

Microstructure and texture development during friction stir processing of Al–Mg alloy sheets with TiO_2 nanoparticles

F. Khodabakhshi [a], A. Simchi [a,b,*], A.H. Kokabi [a], M. Nosko [c], F. Simančík [c], P. Švec [d]

[a] Department of Materials Science and Engineering, Sharif University of Technology, P.O. Box 11365-9466, Azadi Avenue, 14588 Tehran, Iran
[b] Institute for Nanoscience and Nanotechnology, Sharif University of Technology, P.O. Box 11365-9466, Azadi Avenue, 14588 Tehran, Iran
[c] Institute of Materials and Machine Mechanics, Slovak Academy of Sciences, Račianska 75, 83102 Bratislava, Slovakia
[d] Institute of Physics, Slovak Academy of Sciences, Dúbravská cesta 9, 845 11 Bratislava 45, Slovakia

ARTICLE INFO

Article history:
Received 17 November 2013
Received in revised form
26 February 2014
Accepted 2 March 2014
Available online 12 March 2014

Keywords:
Friction stir processing
Texture
Nanocomposite
Microstructure
Al–Mg alloy

ABSTRACT

Aluminum matrix nanocomposites were fabricated by friction stir processing of Al–Mg alloy sheets with pre-placed TiO_2 nanoparticles at a concentration of 2 to 6 vol%. Microstructural studies showed that solid state reactions between the metal matrix and TiO_2 particles caused *in situ* formation of MgO and Al_3Ti nanophases with an average size ~50 nm. These nanophases were homogenously distributed in an ultra-fine grain structure (0.2–2 μm) of the base metal. The results of pole figures evaluation obtained by electron back scattered diffraction studies revealed that the random orientation of initial annealed sheet was changed to components near to shear and silver texture in the friction stir processed alloy without and with pre-placed powder, respectively. The concentration of TiO_2 particles affected the preferred texture orientation as the ceramic inclusion restricted the severe plastic deformation and dynamic recrystalization of the metal matrix. Hardness and tensile yield strength of the Al–Mg alloy sheet were also significantly improved by employing friction stir processing in the presence of TiO_2 nanoparticles (up to ~3.1 vol%). Fractographic studies showed a mixture of ductile–brittle fracture modes with an increase in the content of catastrophic manner at higher TiO_2 fractions.

Department of Metal Physics
Future plans

- Theoretical, experimental and technological research of complex metastable systems, combining atomic structure modeling with chemically resolved atomic microstructure studies
- Research and development of special alloys (incl. high-entropy alloys) for extreme conditions
- Research and development of new soft and hard magnetic materials
- To gain new basic knowledge about the developed structures, phenomena and properties and to assess potential applicability of the developed material

Department of Nuclear Physics
Main activities

- Development of own setup for experiments at European facitities (TATRA spectrometer). One of critical parts developed by DMP.

- Experiment IS521 at CERN Isolde for study of properties of radioactive Hg isotopes

- Experiments S17 and JR 115 at Jyväskylä, PR235 at iThemba Labs to study nuclear structure

- Experiments HADES & GSI to study dense nuclear matter and strangeness production

- Experiment at MASHA spectrometer in JINR Dubna to study production of super-heavy elements

- Experimental and theoretical studies of nuclear equation of state

Department of Nuclear Physics Highlights

nature COMMUNICATIONS

ARTICLE

Received 21 Aug 2012 | Accepted 27 Mar 2013 | Published 14 May 2013

DOI: 10.1038/ncomms2819 OPEN

Measurement of the first ionization potential of astatine by laser ionization spectroscopy

S. Rothe[1,2], A.N. Andreyev[3,4,5,6], S. Antalic[7], A. Borschevsky[8,9], L. Capponi[4,5], T.E. Cocolios[1], H. De Witte[10], E. Eliav[11], D.V. Fedorov[12], V.N. Fedosseev[1], D.A. Fink[1,13], S. Fritzsche[14,15,†], L. Ghys[10,16], M. Huyse[10], N. Imai[1,17], U. Kaldor[11], Yuri Kudryavtsev[10], U. Köster[18], J.F.W. Lane[4,5], J. Lassen[19], V. Liberati[4,5], K.M. Lynch[1,20], B.A. Marsh[1], K. Nishio[6], D. Pauwels[16], V. Pershina[14], L. Popescu[16], T.J. Procter[20], D. Radulov[10], S. Raeder[2,19], M.M. Rajabali[10], E. Rapisarda[10], R.E. Rossel[2], K. Sandhu[4,5], M.D. Seliverstov[1,4,5,12,10], A.M. Sjödin[1], P. Van den Bergh[10], P. Van Duppen[10], M. Venhart[21], Y. Wakabayashi[6] & K.D.A. Wendt[2]

The radioactive element astatine exists only in trace amounts in nature. Its properties can therefore only be explored by study of the minute quantities of artificially produced isotopes or by performing theoretical calculations. One of the most important properties influencing the chemical behaviour is the energy required to remove one electron from the valence shell, referred to as the ionization potential. Here we use laser spectroscopy to probe the optical spectrum of astatine near the ionization threshold. The observed series of Rydberg states enabled the first determination of the ionization potential of the astatine atom, 9.31751(8) eV. New *ab initio* calculations are performed to support the experimental result. The measured value serves as a benchmark for quantum chemistry calculations of the properties of astatine as well as for the theoretical prediction of the ionization potential of superheavy element 117, the heaviest homologue of astatine.

Nuclear Instruments and Methods in Physics Research A 812 (2016) 118–121

Contents lists available at ScienceDirect

Nuclear Instruments and Methods in Physics Research A

journal homepage: www.elsevier.com/locate/nima

TATRA: a versatile high-vacuum tape transportation system for decay studies at radioactive-ion beam facilities

V. Matoušek, M. Sedlák, M. Venhart *, D. Janičkovič, J. Kliman, K. Petrík, P. Švec, P. Švec, Sr., M. Veselský

Institute of Physics, Slovak Academy of Sciences, SK-84511 Bratislava, Slovakia

ARTICLE INFO

Article history:
Received 1 October 2015
Received in revised form
17 December 2015
Accepted 18 December 2015
Available online 6 January 2016

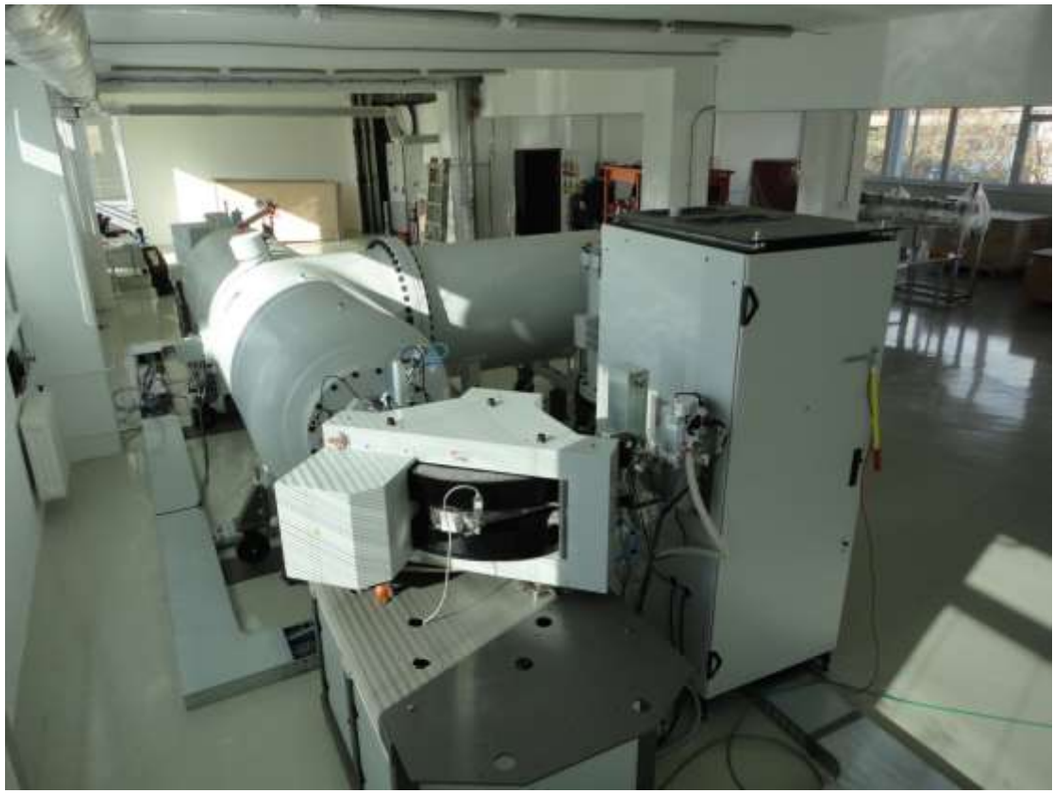
Keywords:
Tape transportation system
Amorphous metal
High vacuum

ABSTRACT

A compact and versatile tape transport system for the collection and counting of radioactive samples from radioactive ion beam facilities has been developed. It uses an amorphous metallic tape for transportation of the activity. Because of this material, the system can hold very good vacuum, typically below 10^{-7} mbar.

Department of Nuclear Physics
Future Plans

New infrastructure in Piestany - 2MV HVEE Tandetron



- Study of low energy nuclear reactions of astrophysical interest (p,γ), (α, γ)
- Nuclear structure study using inelastic neutron scattering
- Surface analysis using ion beams

Nuclear structure and reaction studies at European facilities

- Already approved experiment IS581 at CERN-ISOLDE for fission studies of radioactive nuclei
- Study of nuclear structure of heavy radioactive nuclei with the help of TATRA spectrometer at CERN and other European Laboratories.
- Application potential – radiopharamceutics on the basis of Auger electrons. TATRA allows very precise measurement of low energy Auger electrons, collaboration with Australian National University

Department of Theoretical Physics

Main activities

The department is currently focused on the fundamental theoretical research of the structure and decays of strong interacting elementary particles – mesons and baryons, all in the cooperation with the Joint Institute for Nuclear Research in Dubna and CERN in Switzerland.

- Proved the Existence of scalar meson f0(500) and from $\pi + \pi$ scattering determined the values of its parameters
- Correct Prediction of electric and magnetic structure of octet hyperons in the time-like region, measured by BES-III & BEPC-II collaboration in the framework of their own Unitary and Analytic model
- Study of heavy X, Y and Z Meson decays within covariant confined quark model and proposed that heavy quarkonia are composed of four quarks

Department of Theoretical Physics
Highlights

Progress in Particle and Nuclear Physics 67 (2012) 479–485

Contents lists available at SciVerse ScienceDirect

Progress in Particle and Nuclear Physics

journal homepage: www.elsevier.com/locate/ppnp

Review

New value of the proton charge root mean square radius

C. Adamuscin [a], S. Dubnicka [a], A.Z. Dubnickova [b,*]

[a] Institute of Physics, Slovak Academy of Sciences, Bratislava, Slovak Republic

[b] Department of Theoretical Physics, Comenius University, Bratislava, Slovak Republic

ARTICLE INFO

Keywords:
Form factor
Proton
Nucleon electromagnetic structure
Root mean square radius

ABSTRACT

The non-dipole behavior of $G_{Ep}(Q^2)$ in the space-like region with the zero around $Q^2 = 13$ GeV^2 is found in a global analysis of all existing nucleon electromagnetic form factor data by means of a sophisticated analytic model of nucleon electromagnetic structure. From such behavior of $G_{Ep}(Q^2)$, the charge proton root mean square (rms) radius is compatible with the value obtained recently from spectroscopy of the muon hydrogen atom.

PHYSICAL REVIEW D **87,** 074021 (2013)

Decays $B_s \to J/\psi + \eta$ and $B_s \to J/\psi + \eta\prime$ in the framework of covariant quark model

S. Dubnička,[1] A. Z. Dubničková,[2] M. A. Ivanov,[3] and A. Liptaj[1]

[1]*Institute of Physics, Slovak Academy of Sciences, Dúbravská cesta 9, 84511 Bratislava 45, Slovak Republic*

[2]*Department of Theoretical Physics, Faculty of Mathematics, Physics and Informatics, Comenius University, Mlynská dolina, 84248 Bratislava, Slovak Republic*

[3]*Bogoliubov Laboratory of Theoretical Physics, Joint Institute for Nuclear Research, 141980 Dubna, Russia*

(Received 2 January 2013; published 23 April 2013)

The covariant quark model represents an appropriate theoretical framework to describe the recent results on $B_s \to J/\psi + \eta$ and $B_s \to J/\psi + \eta'$ decays from the Belle and LHCb collaborations. In this article, we present the main features of the covariant quark model together with details on some of its aspects and methods, which we consider to be important. Further, we apply the model specifically to the studied decay processes and give numerical results on decay widths as they follow from the model. We conclude that the model, with most of its parameters previously fixed from different processes, is able to incorporate the new experimental measurements. In particular, we found that the ratio of the branching fractions of the decays B_s into $J/\psi + \eta'$ and $J/\psi + \eta$ is equal to $R = 0.86$, in agreement with the data reported by the Belle and LHCb collaborations.

DOI: 10.1103/PhysRevD.87.074021 PACS numbers: 13.25.Hw, 12.39.Ki

Department of Theoretical Physics
Future plans

- Further refinement of unitary analytic and covariant confined quark models
- Collaboration with theory groups from JINR Dubna and CERN
- Contribution to experiment proposals for BES-III & BEPC-II collaboration using own models on behaviour of Λ hyperon

Research Center for Quantum Information
Main activities

- Characterization of entanglement-annihilating processes
- Interactions in multimode random lasers in the Anderson localized regime
- Optimal discrimination of quantum measurement devices
- Quantum Information Theory, Randomness and Statistics
- Criticality without frustration for quantum spin-1 chains

Research Center for Quantum Information Highlights

PRL 111, 186805 (2013) PHYSICAL REVIEW LETTERS week ending 1 NOVEMBER 2013

Topological Superconductivity and Majorana Fermions in RKKY Systems

Jelena Klinovaja,[1,2] Peter Stano,[1,3] Ali Yazdani,[4] and Daniel Loss[1]

[1]*Department of Physics, University of Basel, Klingelbergstrasse 82, CH-4056 Basel, Switzerland*
[2]*Department of Physics, Harvard University, Cambridge, Massachusetts 02138, USA*
[3]*Institute of Physics, Slovak Academy of Sciences, 845 11 Bratislava, Slovakia*
[4]*Joseph Henry Laboratories and Department of Physics, Princeton University, Princeton, New Jersey 08544, USA*

(Received 4 July 2013; published 1 November 2013)

We consider quasi-one-dimensional Ruderman-Kittel-Kasuya-Yosida (RKKY) systems in proximity to an s-wave superconductor. We show that a $2k_F$ peak in the spin susceptibility of the superconductor in the one-dimensional limit supports helical order of localized magnetic moments via RKKY interaction, where k_F is the Fermi wave vector. The magnetic helix is equivalent to a uniform magnetic field and very strong spin-orbit interaction (SOI) with an effective SOI length $1/2k_F$. We find the conditions to establish such a magnetic state in atomic chains and semiconducting nanowires with magnetic atoms or nuclear spins. Generically, these systems are in a topological phase with Majorana fermions. The inherent self-tuning of the helix to $2k_F$ eliminates the need to tune the chemical potential.

DOI: 10.1103/PhysRevLett.111.186805 PACS numbers: 71.10.Pm, 74.20.−z, 75.70.Tj, 75.75.−c

PRL 109, 050501 (2012) PHYSICAL REVIEW LETTERS week ending 3 AUGUST 2012

Quantum Speedup by Quantum Annealing

Rolando D. Somma,[1] Daniel Nagaj,[2] and Mária Kieferová[2]

[1]*Los Alamos National Laboratory, Los Alamos, New Mexico 87545, USA*
[2]*Research Center for Quantum Information, Slovak Academy of Sciences, Bratislava, Slovakia*

(Received 9 March 2012; revised manuscript received 17 May 2012; published 31 July 2012)

We study the glued-trees problem from A. M. Childs, R. Cleve, E. Deotto, E. Farhi, S. Gutmann, and D. Spielman, in *Proceedings of the 35th Annual ACM Symposium on Theory of Computing* (ACM, San Diego, CA, 2003), p. 59, in the adiabatic model of quantum computing and provide an annealing schedule to solve an oracular problem exponentially faster than classically possible. The Hamiltonians involved in the quantum annealing do not suffer from the so-called sign problem. Unlike the typical scenario, our schedule is efficient even though the minimum energy gap of the Hamiltonians is exponentially small in the problem size. We discuss generalizations based on initial-state randomization to avoid some slowdowns in adiabatic quantum computing due to small gaps.

IOP Publishing Journal of Physics B: Atomic, Molecular and Optical Physics
J. Phys. B: At. Mol. Opt. Phys. 45 (2012) 154006 (6pp) doi:10.1088/0953-4075/45/15/154006

Simulation of indivisible qubit channels in collision models

Tomáš Ryhár[1], Sergey N Filippov[2], Mário Ziman[1,3] and Vladimír Bužek[1]

[1] Institute of Physics, Slovak Academy of Sciences, Dúbravská cesta 9, 845 11 Bratislava, Slovakia
[2] Moscow Institute of Physics and Technology, Moscow Region, Russia
[3] Institute for Theoretical Physics, ETH Zürich, 8093 Zürich, Switzerland

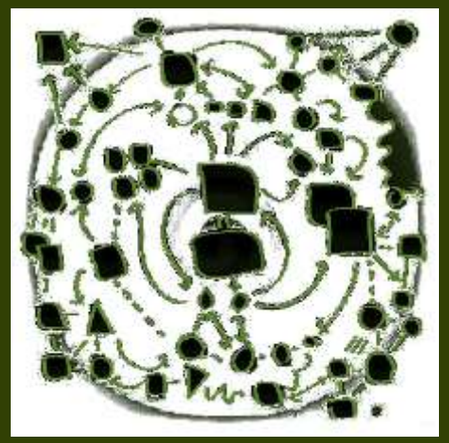
E-mail: ziman@savba.sk

Received 28 February 2012, in final form 15 April 2012
Published 30 July 2012
Online at stacks.iop.org/JPhysB/45/154006

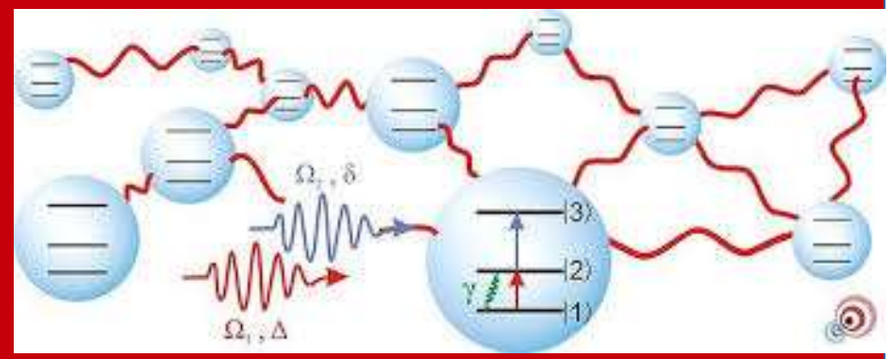
Abstract
A sequence of controlled collisions between a quantum system and its environment (composed of a set of quantum objects) naturally simulates (with arbitrary precision) any Markovian quantum dynamics of the system under consideration. In this paper we propose and study the problem of simulation of an *arbitrary* quantum channel via collision models. We show that a correlated environment is capable to simulate *non-Markovian* evolutions leading to any indivisible qubit channel. In particular, we derive the corresponding master equation generating a continuous time non-Markovian dynamics implementing the universal NOT gate being an example of the most non-Markovian quantum channels.

Research Center for Quantum Information
Future directions

quantum communication / dynamics



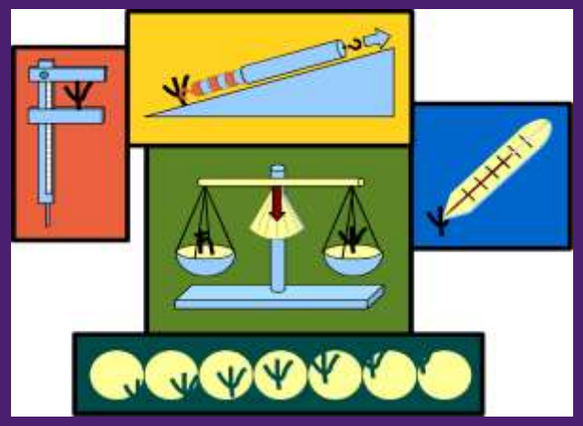
quantum algorithms / dynamics



quantum complex networks

Quantum simulations

quantum metrology



quantum machine learning

quantum measurements / foundations

quantum information / complexity

Quantum Megatrends → Prof. Bužek

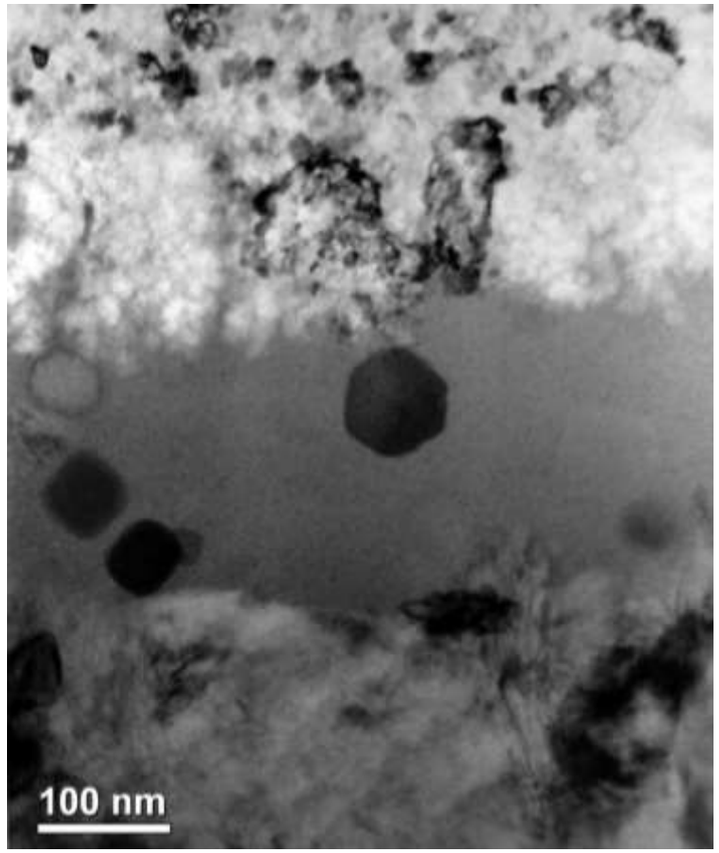
Societal impact – Applied research

Shaping of RQ ribbons
PP 44-2013

Ductility preserved
Amorphous state preserved
Application potential!!!

Bilayered and multilayered ribbons
PP 50045-2014

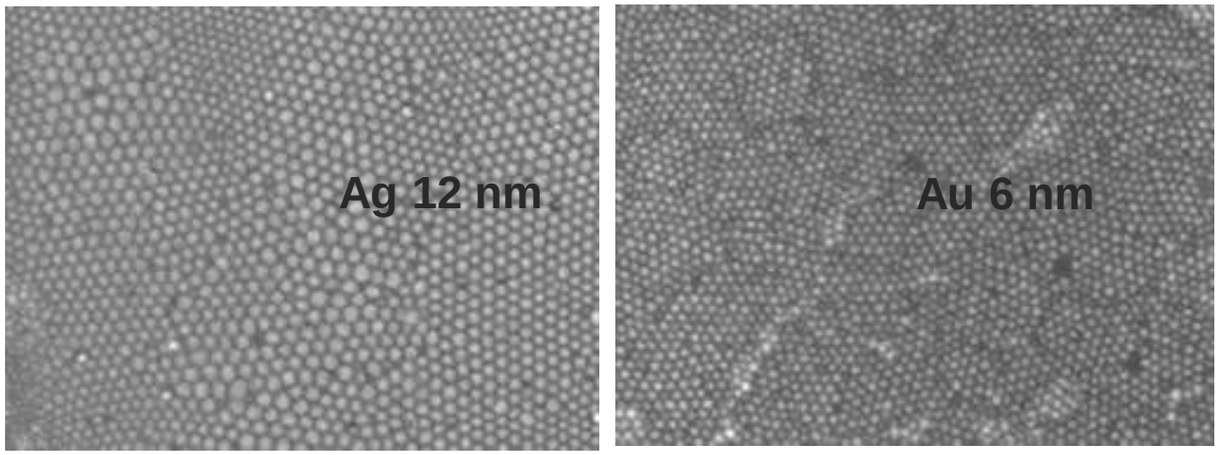
Basic ribbon thickness – 20 μm
n-layer → n x 20 μm (sheets ~0.1mm)
Same or different layer composition
→combination of physical properties
→enhancement of properties, …
→new physical effects



Magnetoimpedance Effect in Field Annealed Fe-Ni-Nb-B Bilayers …

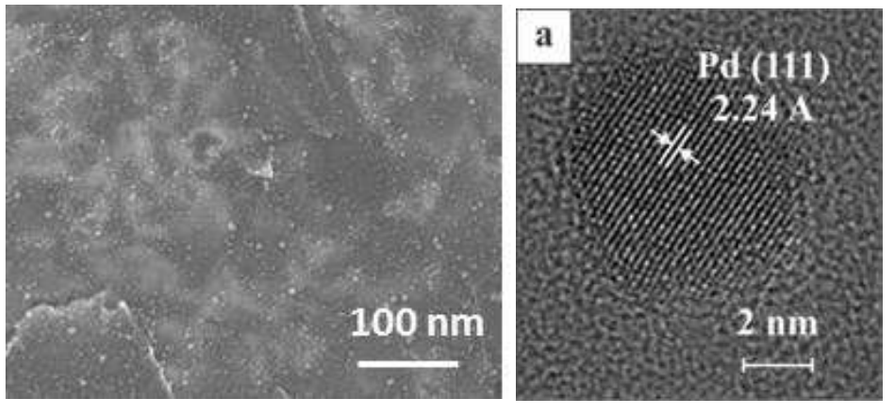
Societal impact – Applied research

Self-assembled monolayers of colloidal nanoparticles prepared by a modified Langmuir -Schaefer technique

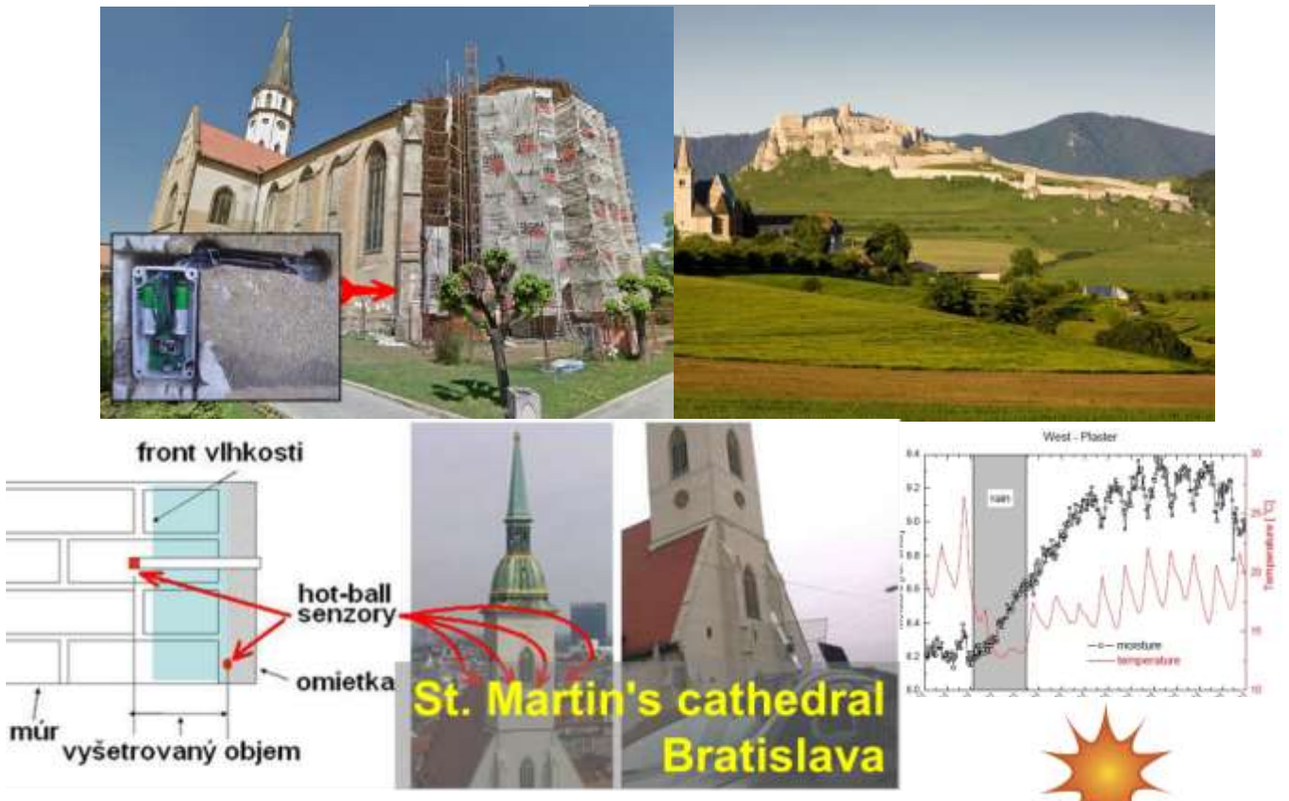


Slovak patent no. 288234, 2014

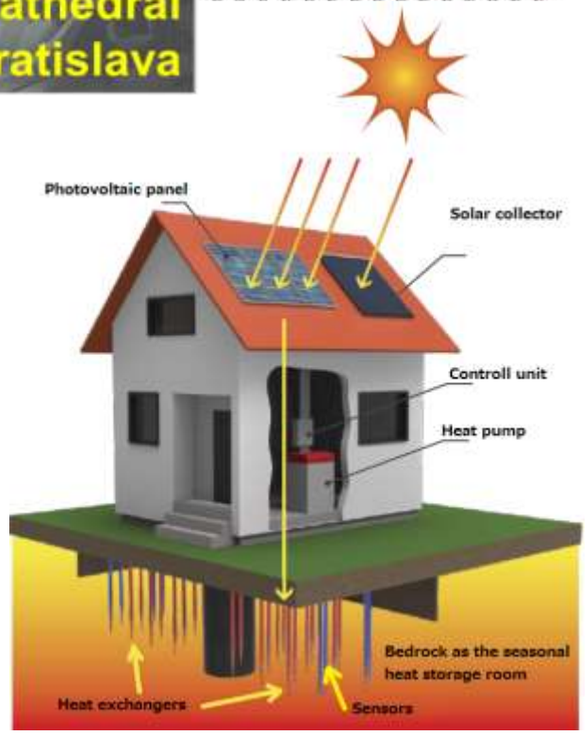
Graphene and nanoparticle-based high-performance gas sensors



Application of heat transient phenomena for preservation of historical monuments



Measurement of thermophysical properties of bedrock for optimization of Seasonal Heat Storage System



Conclusions – hints for the next period

- Fill the gap in age distribution of research staff, recruit people from abroad, most probably, but not only Slovak Nationals → source grant agencies
- New PhD students – Slovak and foreign
- Important task for experimentalists is to utilize effectively infrastructure acquired from EU Structural Funds in the past and conduct high quality research using this infrastructure

Thank You for Your Atention