# Generating Functions of Hermite Polynomials

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In this talk we will first consider the Laguerre polynomials as a special case of the Jacobi polynomials and use the fact that the Laguerre polynomials can be entirely reduced to Hermite polynomials in order to obtain their generating function as the limit of the generating function for Jacobi polynomials.

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# Meritve s spektrometrom Belle

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Spektrometer Belle stoji ob asimetričnem pospeševalniku elektronov in pozitronov KEKB v Tsukubi na Japonskem. Pospeševalnik deluje pri težiščni energiji okoli $10,58$ GeV, kar ustreza masi resonance $\Upsilon(4S)$. Ta resonanca je prvo vezano stanje kvarkov $b\overline{b}$, katerega mirovna energija je nad pragom za razpad v par mezonov $B\overline{B}$. Ker je takih razpadov $\Upsilon(4S)$ zaradi luminoznosti nad $10^{34}$ cm$^{-2}$s$^{-1}$ veliko, pospeševalnik KEKB pogosto imenujemo kar tovarna mezonov B. Eksperimentu Belle je tako do sredine letošnjega leta uspelo zbrati že okoli 150 milijonov parov $B\overline{B}$, kar omogoča številne meritve redkih procesov. V predavanju bom predstavil nekaj najbolj odmevnih rezultatov meritev mednarodne raziskovalne skupine Belle, v okviru katere deluje tudi skupina slovenskih fizikov.

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# Measurements with the Belle Spectrometer

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The Belle Spectrometer is located at the energy-asymmetric electron-positron accelerator KEKB which is operated at Tsukuba, Japan. The centre-of-mass energy of the accelerator is about 10.58 GeV, corresponding to the mass of the $\Upsilon(4S)$ resonance. This resonance is the first bound state of $b\overline{b}$ quarks with the energy above the threshold for the $B\overline{B}$ meson pair production. Given a huge amount of the produced B meson pairs, the KEKB accelerator is often denoted as the B Factory. Since the end of ninety-nineties the Belle experiment has collected around 150 millions of $B\overline{B}$ pairs, enabling thus many measurements of the rare B meson decays. I shall discuss some of these measurements with the emphasis on the latest and the most interesting ones.

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# Generating Functions of Jacobi Polynomials

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We will derive Jacobi's form of the generating function using a proof due to Hermite. Then we will consider Legendre polynomials as a special case of Jacobi polynomials and use their generating function to obtain recurrence relations for Legendre polynomials.

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# Transport naboja v LED diodi na osnovi organskega polprevodnika

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Luminiscenčne diode (LED - light emitting device) na osnovi organskih polprevodikov predstavljajo novo zvrst mikroelektronskih elementov, ki so komercialno že dostopni na tržišču, čeprav obstaja vrsta fizikalnih pojavov, ki zadevajo električne lastnosti organskih polprevodnikov, še naprej nepojasnjenih. Tako n.pr. kažejo meritve I - U karakteristik vzorcev Ca/Alq3/Ca značilno odvisnost gostote toka kot funkcija pritisnjene napetosti od debeline plasti organskega polprevodnika v intervalu debelin od nekaj deset nm do nekaj sto nm. Takšne odvisnosti pri kristaliničnih ali pa amorfnih polprevodnikih ni opaziti. Dosedanje raziskave transporta naboja v organskih polprevodnikih so pokazale, da je mogoče opisati električni tok skozi tovrstne vzorce na osnovi prevajanja v pasti ujetih nabojev (trapped charge limited conduction, TCL), pri čemer je energijska odvisnost gostote pasti (ujetih nabojev) približno popisana z eksponencialno funkcijo. V prispevku bo prikazano v kakšnem obsegu zapisani TCL model transporta naboja v organskih polprevodnikih lahko popiše nekatere, v literaturi objavljene, eksperimentalne rezultate.

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# Dekodiranje kalcijevih oscilacij

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Celice se nenehno odzivajo na določene stimule. Ti stimuli pa ne delujejo direktno na mesta v celici, kjer se odvijajo procesi, temveč se informacije o stimulu prenašajo preko posrednikov. Takšen posrednik je v veliko primerih tudi kalcij. Informacija o vrsti in jakosti stimula se do ciljnih mest v celici prenese kot kalcijev signal v obliki kalcijevih oscilacij. Mehanizmi, ki omogočajo tak način prenosa informacije, potekajo v obliki zaporedja biokemijskih reakcij v celici. Obstaja močno prepričanje, da je informacija, ki jo nosi kalcijev signal, frekvenčno kodirana. To potrjujejo opažanja, da v vseh primerih, ko stimulacija celice poteka preko receptorja na celični membrani, frekvenca oscilacij narašča z višanjem jakosti stimula, amplituda pa ostaja večinoma konstantna. Obstaja pa tudi hipoteza, ki dopušča možnost, da je informacija kodirana v frekvenci, amplitudi in obliki oscilacije, čeprav mehanizem dekodacije še ni znan. V referatu bom predstavil model kalcijevih oscilacij, ki smo ga nadgradili z dvema vrstama proteinov z različno kinetiko vezave kalcija, ki na preprost način dekodirata kalcijev signal tako, da imata pri različnih frekvencah kalcijevih oscilacij različne aktivnosti.

# Decoding of calcium oscillations

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Cells response to many different stimuli, which act on the cell membrane. Those stimuli do not influence directly to the sites where those response processes are taking place but use calcium ions as a second messenger. Information about the type and the level of stimulant is mediated as a calcium signal in form of calcium oscillations to the target points in the cell. Mechanisms that enable such transfer of information are in form of several consecutive biochemical reactions in the cell. There exist a strong belief that the information carried by calcium signal is frequency encoded. This is strongly supported by experimental results, which show that the frequency of oscillations increases with increased level of stimulation, whereas amplitude stays almost constant. There also exist the hypothesis, which foresees that the information could be encoded in the frequency, amplitude and the waveform of the oscillations, however the mechanism of decoding is still not known. In my talk I will present a recent model of calcium oscillations upgraded by two different types of calcium-binding proteins with distinct binding kinetics, which are able to decode a calcium signal into different activities of proteins at different frequencies of calcium oscillations.

# Priljubljenost fizike v slovenskem šolstvu

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# Prenos obravnave dinamičnih sistemov na področje izobraževanja

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Na znanstveno raziskovalnem področju se ukvarjamo s proučevanjem dinamičnih procesov. V zadnjem času nas vse bolj zanima problematika prenosa obravnave dinamičnih sistemov na področje izobraževanja. Pri obravnavi fizikalnih vsebin v osnovni in srednji šoli je velikega pomena razumevanje sistemov. Sisteme moramo znati opazovati, poiskati ključne dele sistema ter razumeti povezave med njimi. Govorimo o razvijanju t.i. sistemskega mišljenja. Na nižjih stopnjah izobraževanja je poudarek predvsem na kvalitativnih odnosih med posameznimi količinami, ki ga kasneje dopolni še matematični opis relacij, oz. t.i. matematično modeliranje. Uporabnost modelnega pristopa v šoli bomo predstavili na primeru kroženja vode.

# Transfer of dynamical system research into schools

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Our research is oriented into studying the dynamical systems. Recently, we are very interested in finding possibilities of transferring the dynamical systems research into schools. In teaching of Physics in primary and secondary school it is of much importance that pupils understand the discussed systems. They have to learn how to observe the system, to find the key parts of the system and to understand the relation between all these parts. We speak about the so-called system thinking. At the basic level, the qualitative relationships between particular quantities are of interest, whereas at higher educational levels, the qualitative relationships are replaced by mathematical relations; we speak about the mathematical modelling. The use of modelling approach in school is demonstrated by example of water cycling.

# Mehanske lastnosti polielektrolitskih lupin

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S preprostim teoretičnim modelom želimo predvideti obremenitve stene lupine glede na mehanske lastnosti polielektrolitskih lupin-kapsul. Suspenzija kapsul v nemoteni raztopini je izpostavljena različnim osmoznim tlakom glede na pH, poliione in sol. Vrednost pH nemotene raztopine je regulirana s PSS polimerom, zaradi katerega se mikroioni razporedijo preko polprepustne stene kapsule. Stena kapsule ne prepusti polimerov z molekulsko maso večjo od 4000. Mikroioni se razporedijo glede na Donnanovo ravnovesje. Razlika pH med nemoteno raztopino in raztopino v kapsuli se izniči v limiti velike soli (NaCl). Teoretični model opisuje pH v obeh raztopinah. PSS s protiioni v nemoteni raztopini ustvarja osmozni tlak, ki je pomemben pri preučevanju mehanskih lastnosti kapsul. V modelu smo preučili dva primera in sicer s PSS v kapsuli in izven nje.

# Mechanical properties of polyelectrolyte shells

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With simple theoretical model we are trying to predict burden of a shell wall according to mechanical properties of hollow polyelectrolyte shells-capsules. Capsules are dispersed in bulk and exposed to different osmotic pressers due to pH, polyions, and added salt. Acidity of bulk is regulated by polymeric buffer PSS which is responsible for rearranging of microions across semipermeable shell wall. Capsule wall excludes polyions with molecular weight more then 4000. Donnan equilibrium of microions between bulk and inner capsule solution is created. The pH difference between bulk and pH inner capsule solution is established and can be decreased by addition of salt (NaCl). In the limit of high salt concentration pH difference is zero. A developed theoretical model describes the pH in both solutions. PSS with counterions produces high osmotic pressure that is important for mechanical properties of capsules. With our model we investigated two cases of capsules, with encapsulated PSS and PSS in bulk.

# Enosmerni transport serpentinastega biljarda

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Predstavljamo analizo dinamike *klasične verige biliardov (kanal)* polkrožnih sten, ki lahko služi tudi kot prototip optičnega vodnika. Model ima zanimivo lastnost: fazni prostor je sestavljen iz dveh disjunktnih invariantnih komponent pripadajoči gibanju v levo oz. desno stran. Dinamiko vzdolž kanala razstavimo na *preslikavo skakanja* (Poincaréjeva preslikava) med dvema koncema osnovnih celic in *funkcijo časa*, ki meri čas potovanja skozi osnovno celico v odvisnosti od vstopne točke. Preslikava skakanja ima mešan fazni prostor z velikostjo kaotične komponente odvisno od širine kanala. Za določene širine je preslikava skoraj popolnoma kaotična. Numerično smo študirali tudi eksponente Lyaponova, auto-korelacijske funkcije in difuzijo delcev vzdolž verige. Zaradi singularnosti v časovni funkciji ugotovimo, da je difuzija pri odšteti povprečni translaciji marginalno normalna. Slednje potrjujemo tudi z analitičnimi argumenti.

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# Uni-directional transport properties of a serpent billiard

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We present a dynamical analysis of a *classical billiard chain — a channel* with parallel semi-circular walls, which can serve as a prototype for a bended optical fiber. An interesting feature of this model is the fact that the phase space separates into two disjoint invariant components corresponding to the left and right uni-directional motions. Dynamics is decomposed into the *jump map* — a Poincare map between the two ends of a basic cell, and the *time function* — traveling time across a basic cell of a point on a surface of section. The jump map has a mixed phase space where the relative sizes of the regular and chaotic components depend on the width of the channel. For a suitable value of this parameter we can have almost fully chaotic phase space. We have studied numerically the Lyapunov exponents, time auto-correlation functions and diffusion of particles along the chain. As a result of a singularity of the time function we obtain marginally-normal diffusion after we subtract the average drift. The last result is also supported by some analytical arguments.

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# Spinsko injektiranje, dielektrične lastnosti vlažnih zemljin in okenska stekla z nanodelci

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V prispevku predstavljamo raziskovalne aktivnosti in dosežke članov Katedre za aplikativno fiziko Fakultete za gradbeništvo, ki potekajo na področjih fizike kondenzirane materije in gradbene fizike.

# Spin injection, dielectric spectroscopy of moist soil, and nanoparticle-doped window glass

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In this contribution the research activities and achievements of the members of the Chair for Applied Physics at the Faculty of Civil Engineering are briefly presented. The current research work on certain problems in condensed matter physics and building physics is discussed.

# Stohastična simulacija znotrajceličnih kalcijevih oscilacij

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Kalcijeve oscilacije lahko opazujemo v celicah različnih vrst. Zgrajena je bila cela vrsta determinističnih modelov, ki opisujejo tovrstne oscilacije. Rezultate in simulacije tega pojava dobimo tako, da numerično integriramo navadne diferencialne enačbe, ki ta pojav obravnavajo. Glede na to, da pa je v tem pojavu vključenih le majhno število receptorjev in kanalov, je potrebno preuiti vpliv stohastičnih efektov pri simulaciji tega pojava. Izvedli smo tako deterministične, kot stohastične simulacije enostavnih, bursting in kaotičnih kalcijevih oscilacij in pri tem preuevali prehod iz stohastičnega v deterministično vedenje sistema. Prehod se pojavi pri določenem številu delcev, ki dokaj dobro ustreza številu receptorjev in kanalov v celici. Ugotovimo lahko, da je ta prehod iz stohastičnega v deterministično vedenje sistema močno povezan z atrakcijskimi lastnostmi faznega prostora za obravnavan sistem. Močni atraktorji se vedejo deterministično že pri majhnem številu delcev, medtem, ko je za šibke atraktorje potrebno uporabiti veliko število delcev, da bi dobili ustrezne rešitve. Ker pri opazovanem modelu bursting kalcijeve oscilacije ustrezajo šibkim atraktorjem in za njihovo simulacijo potrebujemo veliko število delcev, lahko zaključimo, da so stohastični efekti pri opisu tovrstnih kalcijevih oscilacij močno izraženi in lahko zelo pomembni pri raunalniški analizi tega pojava.

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[5] Programski paket StODE je prosto dostopen na: http://atlas.villa-bosch.de/bcb/software/Carel/

# Stochastic simulation of intracellular calcium oscillations

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Calcium oscillations have been observed in a number of cell types. Several deterministic models have been developed in order to describe this phenomenon. All the resulting simulations have been done by numerical integration of ordinary differential equations. However, due to small number of receptors and channels involved in this process, it is important to study the influence of stochastic effects. We have performed stochastic simulations of simple, bursting, and chaotic calcium oscillations and have studied the transition from stochastic to deterministic behaviour. The transition occurs within a range of particle number, which corresponds to the number of receptors and channels in the cell. In particular, we found that the transition depends heavily on the attractive properties of the phase space of the system. Strong attractors behave deterministic-like for lower particle number, whereas for weak attractors larger particle number is required. Since in the observed model bursting calcium oscillations correspond to weaker attractors, we conclude that for the model under consideration stochastic effects might be of importance during bursting calcium oscillations and should be taken into account in computational analysis of this behaviour.

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[5] Software package StODE is freely available from the authors: http://atlas.villa-bosch.de/bcb/software/Carel/

# Dosežki Laboratorija fizika kompleksnih sistemov v letu 2003

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V letu 2003 smo člani laboratorija Fizika kompleksnih sistemov teoretično preučevali (i) anihilacijo defektov v tekočih kristalih (TK), (ii) pojav HLM, (iii)TK ograjen v celico z nanostrukturirano površino, (iv)vpliv šibkega nereda na fazno obnašanje TK, (v) fiziko vzorcev v nematičnih TK in (vi) zrnatih sistemih. Raziskave(ii)-(iv) so močno vezane na vzporedno eksperimentalno delo, ki se izvaja na Odseku za fiziko trdne snovi na Institutu Jožef Stefan v Ljubljani. Raziskave so bile povečini izvedene v okviru bilateralnih projektov z Rusijo, Italijo, Brazilijo, Avstrijo, Romunijo in ESF mreže Cosmology in the laboratory. V nadaljevanju na kratko podajamo poglavitne rezultate našega dela.

(i) Preučali smo anihilacijo nematičnih (N) točkovnih in anihilacijo smektičnih A (SmA) robnih dislokacij. V teh primerih obstajajo defekti v orientacijskem (N) in translacijskem (SmA) redu. Prvi smo detajlno preučili zlitje v brezdefektno (t.i. vakuumsko) stanje v potrkovnem režimu. Pokazali smo univerzalno obnašanje pojava. (ii) HLM pojav je soroden z Giggsovim mehanizmom v kozmologiji. Pri tem pojavu sklopitev med SmA ureditvenim parametrom in namatičnim direktorskim poljem, ki igra vlogo umeritvenega polja, predvidoma sproži kvalitativno spremembo N-SmA prehoda. Slednji prehod pripada 3DXY univerzalnostnem razredu v primeru zanimerljive sklopitve z orintacijskim ureditvenim parametrom. Potrdili smo domnevo, da HLM pojav povzroči nezvezen N-SmA prehod v 8CB TK. (iii) Izračunali smo nematično ureditev in pripadajočo prehodnost svetlobe v nematični celici, kjer so ograjevalne površine nano-tretirane ali pa netretirane. V prvem primeru smo razložili opažene površinsko zamrznjene domene s Kibble-Zurkovim mehanizmom, ki je bil v osnovi vpeljan za razlago dinamike defektne mreže Higgsovega polja v zgodnjem vesolju. (iv)Pokazali smo, da lahko opišemo TK ograjene v porozne matrike

in mešanice TK in aerosilnih delcev s prilagojenim naključnim anizotropnim modelom. Modeli te vrste so bili originalno uvedeni za opis vpliva nereda na magnetne sisteme. Naši rezultati podpirajo trditev Imry-Ma argumenta. Slednji napoveduje, da že majhna prisotnost nereda povzroči domensko strukturo v fazah, ki so dosežene z zlomom zvezne simetrije. (v) Razvili smo splošen kriterij za nastanek vzorcev v nematičnih TK, ki razodeva tudi značilni valovni vektor undulacij. (vi) Začeli smo preučevati nastanek vzorcev v zrnatih sistemih.
Rezultate raziskav smo poslali v 11 člankov (5 je že objavljenih v letu 2003 in 3-je so sprejeti v objavo), večina v revijah zgornjega kakovostnega razreda (JCR IF>2).

# Achievements of the Laboratory of physics of complex systems in 2003

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In 2003 the members of the Laboratory of physics of complex systems have studied theoretically (i) annihilation of defects in liquid crystals (LC), (ii) HLM effect, (iii) LC confined within a cell with nanostructured surfaces, (iv) influence of weak disorder on LC phase behavior, (v) pattern formation in nematic LCs and (vi) granular systems. The studies (ii)-(iv) are strongy linked with parallel experimental work carried out at Solid state group of Institute Jozef Stefan in Ljubljana. The research activities were mostly realized within bilateral projects with Russia, Italy, Brazil, Austria and Romania and ESF network Cosmology in the laboratory. In the following we briefly described the main results emerging from our work.

(i) We have studied annihilation of nematic (N) point defects and annihilation of smectic A (SmA) edge dislocations. In these cases the defects exist in the orientational and translational degree of ordering, respectively. In particular we were the first to calculate in detail gradual transition into defectless states in the post-collision regime. We show the universal behavior of the phenomenon. (ii) The HLM effect is reminiscent to the Higgs mechanism in cosmology. In it the coupling between the smectic order parameter and the nematic director field, playing the role of the gauge field, is suspected to trigger a qualitative change of the character of the N-SmA transition, belonging to the 3D XY universality class. We show evidences that this is indeed the case. (iii) We calculated nematic ordering and the resulting light transmission in a nematic cell, were the confining surfaces were nontreated or nanopatterned. In the former case we explain the observed memorized surface domains using the Kibble-Zurek mechanism, originally introduced to explain the coarsening dynamics of the Higgs field in the early universe. (iv) We show that LCs confined to porous matrices and LCs filled with aerosil particles can be described

with random anisotropy type models. These models were originally introduced to study the influence of disorder in magnetic systems. Our results supports the Imry-Ma prediction that the weak disorder breaks the phase reached via a continuous symmetry breaking transition into a domain-type pattern. (v) We developed a general criterion for pattern formation in nematic LCs, that yields also the characteristic wavevector of undulations. (vi) We started studies of pattern formation in granular systems.
The research work is currently presented in 11 articles (5 already published and 3 accepted for publication in 2003) in high ranking reviews.

# Analiza kritičnosti skladišča za izrabljeno gorivo TRIGA

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V skladišču za izrabljeno gorivo reaktorja TRIGA v primeru neprimerne razporeditve zgorelih gorivnih elementov, (kar je lahko posledica nesreče, kot je npr. potres,) lahko pride do nadkritičnosti. Analiza stanj, ki lahko privede do tega, temelji na zmanjševanju razmika med gorivnimi elementi in izračunu nevtronskega pomnoevalnega faktorja keff. V dosedanjih raziskavah je bil med drugim proučen vpliv dodanih absorberjev, medtem ko vpliv zgorelosti ni bil upoštevan. Opisal bom vpliv vzajemnega delovanja učinka razmika med gorivnimi elementi, števila enakomerno razporejenih absorberjev in zgorelosti goriva. Rezultati kažejo, da med tremi preučenimi dejavniki (spreminjanje razmika od stika pa do 8 cm, števila absorberjev od 0 do 8 in zgorelosti goriva vse do 30%) ima razmik največji vpliv na pomnoževalni faktor keff in zgorelost najmanjšega. Za naprej je v načrtu preučitev drugih absorpcijskih materialov, ki imajo velike termične absorpcijske preseke za nevtrone (Gd, Sm, Eu, Cd, Rh, Hf in Ag) in njihova kombinacija glede na porazdelitev resonanc ter porazdelitev nevtronskega fluksa v bazenu.

**Reference**

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[2] B. Glumac, M. Ravnik, M. Logar, "Criticality Safety Assessment Of A TRIGA Reactor Spent Fuel Pool Under Accident Conditions", Nucl. Technol., 117, 248 (1997).

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# Criticality Safety Analysis for TRIGA Spent Fuel Pool

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In a case of postulated accident like an earthquake, followed by an inappropriate arrangement of fuel elements, supercriticality might occur. The analysis of such a case deals with pitch decrease among fuel elements, calculating neutron multiplication factor keff. In the up-to-now research, the effect of added absorbers was studied while the burnup of the fuel was not accounted for. I will describe the combined effect of pitch among fuel elements, the number of uniformly mixed absorbers and fuel burnup. The results show that out of the three studied effects: pitch from contact up to rack design pitch (8 cm), number of absorbers from 0 to 8 and burnup up to 30%, the pitch has the greatest influence on the multiplication factor keff and burnup the smallest one. In the future, the studying of some other absorber materials with high thermal neutron absorption cross-sections (Gd, Sm, Eu, Cd, Rh, Hf, Ag) is planned and their combination due to distribution of resonances and the neutron flux in the pool.

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# Primeri uporabe merjenja fleksibilnosti in robustnosti dinamičnih sistemov

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Fleksibilnost in robustnost predstavljata pomembni lastnosti dinamičnih sistemov. Kot mero fleksibilnosti in robustnosti predlagamo lokalno divergenco, pri čemer moramo dobljene rezultate primerno ovrednotiti in interpretirati v skladu s tipom dinamičnega sistema. Kvantifikacija fleksibilnosti in robustnosti sistema nam omogoca boljši vpogled in globlje razumevanje nekaterih značilnih fenomenov in problemov v teoriji dinamičnih sistemov. V tem prispevku predstavljamo tri primere uporabe merjenja fleksibilnosti in robustnosti dinamičnih sistemov. Izkaže se, da so sklopitvene lastnosti sistemov odvisne od njihove fleksibilnosti. Fleksibilni sistemi, ki imajo na velikem območju lokalno divergenco blizu nič, so bolje sklopljivi. S proučevanjem fleksibilnosti dinamičnih sistemov je mogoče pojasniti tudi povečanje robustnosti sistemov pri dodanem šumu. Na koncu pokažemo še, da lahko konstruktivno in destruktivno vlogo šuma pri stohastični resonanci razložimo z merjenjem fleksibilnosti in robustnosti dinamičnih sistemov.

# Applications of measuring flexibility and robustness of dynamical systems

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Flexibility and robustness are important properties of dynamical system. We measure the flexibility and robustness by local divergence. The results have to be evaluated and interpreted very carefully in dependence on the type of dynamical system. By quantifying flexibility and robustness of the system, we obtain a deeper insight and understanding of different well-known phenomena and problems in the theory of dynamical systems. Here we show three applications of measuring flexibility and robustness of dynamical systems. First, we show that coupling properties of two different systems depend on their flexibility. Flexible systems, characterised by close to zero local divergence, can be more easily coupled. Furthermore, by studying the flexibility of dynamical systems, the enhanced robustness achieved by adding noise can be explained; and as the last example, we show that in the case of stochastic resonance, both the constructive and destructive role of noise can be explained by measuring flexibility and robustness of dynamical systems.

# Projekt OKO: uvajanje Linuxa v šole

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V letu 2003 je Ministrstvo za šolstvo, znanost in šport spodbudilo uvajanje odprtokodne programske opreme v vzgojno izobraževalne zavode. V okviru projekta OKO so angažirali strokovnjake iz širokega spektra institucij, ki se ukvarjajo z odprto kodo. Tako je, med drugim, v okviru projekta nastala tudi slovenska Linux izdaja OKO/Pingo 2.0. Le-ta bo nameščena na vseh 6.000 računalnikov, katerih nabavo za šole bo sofinanciralo MŠZŠ.

Predstavil bom slovensko izdajo OKO/Pingo, ki je osnovana na RedHat Linuxu. Poleg poslovenjene namestitve in večine pomembnih programskih paketov, omogoča tudi avtomatizirano nadgradnjo in namestitev dodatnih paketov iz repozotorijev na Internetu. Predstavil bom trende razvoja najpomembnejših Linux izdaj v svetu in vpliv na odločitve, ki smo jih sprejeli v okviru projekta OKO. Navedel bom nekaj najpogostejših zmot v zvezi z odprtokodnimi in prosto dostopnimi licencami. Nazadnje bom osvetlil še nekaj vdorov in poskusov napadov na odprtokodno infrastrukturo, ki so se zgodili v zadnjem času. Zanimiva je predvsem reakcija odprtokodne skupnosti, ki je v popolnem nasprotju s tem, kar smo bili do zdaj vajeni od komercialnih ponudnikov.

**Povezave**

[1] http://oko.edus.si/ - spletna stran projekta OKO
[2] http://slorpms.pingo.org/ - slovenska Linux izdaja OKO/Pingo
[3] http://lwn.net/ - Linux novice

# The OKO Project: Introducing Linux into Schools

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In 2003, the Slovenian Ministry of Education, Science and Sports started to support the introduction of open source software into educational institutions. They invited a number of open source experts from a wide spectrum of institutions to join the OKO project. One of the first results of the project is a Slovenian Linux distribution OKO/Pingo. The distribution will be installed on all of the 6.000 computers, commissioned for schools and partially funded by the Ministry.

I will present the Slovenian Linux distribution OKO/Pingo, based on RedHat Linux. It features a Slovenian installation interface, and most of the important software packages translated to Slovenian. Further, it facilitates remotely controlled upgrading and installation of additional packages from the Internet repositories. I will highlight trends in some major Linux distributions and their impact on decisions we made within the OKO project. Some common misconceptions about free and open source software licensing will be clarified. Finally, I will discuss recent break-ins and attempted compromises of the open source infrastructure. Of special interest is the reaction of the open source community, in sharp contrast to the typical reactions of commercial vendors we have seen so far.

**Links**

[1] http://oko.edus.si/ - The OKO Project homepage
[2] http://slorpms.pingo.org/ - Slovenian Linux distribution OKO/Pingo
[3] http://lwn.net/ - Linux Weekly News

# Strukturna analiza XAFS

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Preiskave materialov z rentgensko svetlobo izkoriščajo dejstvi, da je valovna dolžina rentgenske svetlobe reda velikosti razdalj med atomi v snovi in da je energija fotonov reda velikosti vezavnih energij najglobljih elektronskih lupin v atomu. Primerljivost valovnih dolžin vodi do bogatih interferenčnih vzorcev, iz katerih z metodami rentgenske difrakcije (XRD x-ray diffraction) določamo lego atomov v dobro urejenih periodičnih strukturah, primerljivost energij pa omogoča identifikacijo vrste atomov v snovi z metodami absorpcijske spektroskopije (XAS x-ray absorption spectroscopy): ob pragu za vzbuditev notranje lupine absorpcijski koeficient močno naraste, v absorpcijskem spektru opazimo rob, energija robu je karakteristična za določeno vrsto atoma.

Kadar je atom, v katerem se absorbira foton, vezan v kemijsko okolico, se izbiti fotoelektron siplje na sosednjih atomih. Interferenca med izhajajočimi in sipanimi valovi vpliva na verjetnost fotoabsorpcije. Torej lahko analiza fine strukture rentgenskih absorpcijskih robov (XAFS - x-ray absorption fine structure) razkriva še soseščino atoma. Metoda deluje kot radar in omogoca identifikacijo nekaj zaporednih lupin sosedov: določimo lahko vrsto sosedov, njihovo število, oddaljenost in stopnjo urejenosti. Razen tega lahko določimo tudi oksidacijsko število centralnega atoma, vrsto vezi in simetrijske parametre. Metoda XAFS je posebej dragocena pri tehnološko pomembnih novih materialih, ki so pogosto snovi z nizko stopnjo urejenosti, kjer običajne (difrakcijske) metode strukturne analize odpovedo.

Čeprav je z metodo v načelu mogoče rekonstruirati bližnjo okolico (izbranega) atoma tudi ab initio, ker znamo določiti sipalne faktorje sosedov neposredno iz teorije, je zanesljivejša in manj zamudna primerjalna metoda. Največkrat zgradimo model približek okolice in ga z iterativnim popravljanjem uskladimo z meritvijo.

# XAFS structural analysis

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X-ray structural diagnostic of materials is based on two properties of x-ray light: its wavelength is of the same order of magnitude as interatomic distances, and the energy of the x-ray photons is of the order of binding energies of the most tightly bound electrons. The first property provides for rich and meaningful interference patterns from which the positions of the constituent atoms in the basic unit of a periodic structure can be deduced by methods of x-ray diffraction (XRD). The second property enables identification of elemental species in the material by methods of x-ray absorption spectroscopy (XAS): the absorption of x-rays increases abruptly at a threshold for excitation of inner electronic shell, the energy position of this edge in the absorption spectrum is characteristic for the elemental species.

If the photon is absorbed by the atom incorporated in some chemical surrounding, the outgoing photoelectron scatters on the neighbor atoms. The interference of the outgoing and scattered waves affects the probability of the photoeffect. So, by studying the fine structure of the x-ray absorption edges (XAFS - x-ray absorption fine structure) the surrounding of the atom can be deduced. The method has been likened to an atomic radar detecting the distances from the chosen central atom to a few consecutive shells of neighbors, their occupation number and atomic species, and the degree of order in the structure. For the central atom, the oxidation number, the bond type and the symmetry of the site can be determined as well. XAFS methods are especially useful for diagnostics of some technologically important new materials without long range order for which usual (diffraction) methods are inefficient.

Although ab initio identification of structure is possible in principle by using theoretical scattering factors for neighbor atoms, faster and more reliable results can be expected from relative, comparative analysis. Usually, a model of the near surrounding of the central atom is built and the model parameters are adjusted to measured data in an iterative procedure.

# Merjenje fleksibilnosti in robustnosti dinamičnih sistemov

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Fleksibilnost in robustnost sta pomembni lastnosti dinamičnih sistemov, ki določata odzive sistema na različne zunanje perturbacije, kot so stopničaste funkcije, periodični signali in šum. V prispevku analiziramo ključne lastnosti dinamičnih sistemov, ki kvantificirajo njihovo fleksibilnost in robustnost. Pokažemo, da je lokalna divergenca atraktorjev v faznem prostoru ključna lastnost, ki določa odzive dinamičnega sistema na različne zunanje motnje. Atraktorji, ki imajo na velikem območju lokalno divergenco blizu nič, so izredno dovzetni za zunanje motnje, medtem ko so atraktorji, ki imajo izrazito negativno lokalno divergenco izredno robustni in torej težko zmotljivi z zunanjimi signali. Nadalje poudarimo, da je potrebno poleg lokalne divergence, ki jo izračunamo kot vsoto vseh Lyapunovih eksponentov sistema, pri določitvi robustnosti in fleksibilnosti upoštevati tudi posamezne Lyapunove eksponente, ki predstavljajo kontrakcijo faznega prostora v različnih med seboj ortogonalnih smereh v tangentnem prostoru glede na trajektorijo. Slednji pristop je še posebej pomemben pri analizi dinamičnih sistemov, ki vsebujejo spremenljivke z zelo različnimi časovnimi skalami, kot so npr. relaksacijski sistemi. Metodo demonstriramo na različnih primerih.

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# Measuring flexibility and robustness of dynamical systems

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Flexibility and robustness are important system properties. They characterise responses of a dynamical system to various external perturbations, such as deterministic pulses or periodic signals, as well as noise. Our communication is devoted to analysing the key system properties determining the flexibility and robustness of a dynamical system. We show that the local divergence of attractors in the phase space represents the crucial system property determining responses of a complex dynamical system to various external perturbations. In particular, we show that parts of attractors with close to zero local divergence are highly susceptible to external perturbations, thus facilitating signal detection and transduction, whereas highly negative local divergence areas characterize extremely robust regions that are virtually impossible to modify even with strong external signals. Moreover, we emphasize that besides the local divergence, which can be calculated as the sum of all Lyapunov exponents of a system, also individual Lyapunov exponents representing the contraction in various orthogonal directions in the tangent phase space with respect to the trajectory have to be taken into account. The more accurate approach is particularly important when analysing dynamical system that incorporate variables with very distinct time scales, such as relaxation systems. We demonstrate our method on several examples.

## References

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# Ali nam kvantni kaos lahko pomaga pri načrtovanju kvantnega računalnika?

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V zadnjih letih smo priča velikim eksperimentalnim in teoretičnim naporom pri razvoju kvantnega računalnika t.j. naprave za kontrolirano manipulacijo s čistimi kvantnimi stanji. Izkaže se, da lahko s pomočjo kvantnih algoritmov rešimo nekatere pomembne probleme z eksponentno pohitritvijo (v številu osnovnih dvonivojskih sistemov - qubitov) glede na optimalen klasični algoritem. Ena glavnih ovir pri delovanju kvantnega računalnika je dekoherenca zaradi praktično neodpravljive sklopitve z okoljem, ali pa nenatančnost sklopitev med qubiti. V predavanju bom poleg splošnega uvoda predstavil naš predlog kako analizirati in izboljšati stabilnost kvantnega algoritma na takšne motnje. Osnovna ideja je priredba fluktuacijsko-disipacijskega izreka, ki v našem kontekstu pove, da se disipacija kvantne informacije izraža s časovnimi korelacijskimi funkcijami operatorja motnje.

**Reference**

[1] M. A. Nielsen in I. L. Chuang, "Quantum Computation and Quantum Information", (Cambridge: Cambridge University Press 2000)

[2] T. Prosen in M. Žnidarič, *Journal of Physics A: Mathematical & General* **35** (2002) 1455-1481

# Can quantum chaos be of some use in a design of a quantum computer?

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In the last few years we are witnessing great experimental and theoretical efforts towards development and construction of a quantum computer, *i.e.* a machine for a controlled manipulation with pure quantum states. Surprisingly, it turns out that by means of quantum algorithms one can solve certain classically hard problems with exponential speed-up. One of the basis difficulties for the construction of a real and useful quantum computer is decoherence due to unavoidable small coupling to the environment and unwanted (residual) coupling between basic two-level units (qubits). In the talk I will review some interesting fundamental results in the field [1], and briefly outline our approach [2] on how to reduce errors and thus improve stability of quantum computation. The basic idea is the use of a special form of fluctuation-dissipation relationship which says in this context that dissipation of quantum information is related to time-correlation functions (fluctuations) of the operator of perturbation.

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Predstavil bom razvoj astronomije na Pedagoški fakulteti Maribor. Vse večje zanimanje za to področje na vseh nivojih slovenskega šolstva, tudi pri študiju fizike, je narekovalo potrebo po ustanovitvi Univerzitetnega observatorija Pedagoške fakultete Maribor, krajše Observatorij. Nanizal bom dosedanje aktivnosti članov Observatorija za študente Univerze in za javnost. Predstavljeni bodo načrti za prihodnje leto in vizija razvoja Observatorija.

# University observatory, Faculty of Education Maribor

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I will present the evolution of astronomy at the Faculty of education in Maribor. Interest for this field is evident at all levels of slovenian education system, also in study of physics. This triggered the establishement of the University observatory at Faculty of Education. I will summarize current activities of observatory members for University students and general public. Plans for the next year and the vision for future evolution will be given.

# Naključnost klasičnega determinističnega gibanja

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Predstavil bom nekaj novih univerzalnih vidikov difuzije v klasičnih deterministčnih in kaotičnih dinamičnih sistemih, še posebej v Hamiltonovih sistemih, med katerimi je Henon-Heiles sistem pomemben paradigmatični primer, kot sistem dveh nelinearno sklopljenih harmonskih oscilatorjev. Z naraščanjem jakosti sklopitve se povečuje velikost kaotične komponente, kakor tudi naključnost klasičnega kaotičnega gibanja znotraj te komponente. Pri razvoju teorije bomo najprej obravnavali ergodične (povsem kaotične sisteme), potem pa sisteme mešanega tipa, kot je n.pr. Henon-Heiles sistem, s tipičnim KAM scenarijem. Obravnavali bomo tudi nekaj posplošitev z upoštevanjem korelacij. Nazadnje bom pojasnil pomen teh raziskav v kontekstu stacionarnega kvantnega kaosa, namreč za strukturo stacionarnih lastnih funkcij in za statistične lastnosti energijskih spektrov.

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# Randomness in classical deterministic motion

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I shall discuss some new universal aspects of diffusion in classical deterministic and chaotic dynamical systems, especially in Hamiltonian systems, one of the important paradigmatic examples being the Henon-Heiles system, which is an example of two nonlinearly coupled harmonic oscillators. As the strength of the coupling increases, the size of the chaotic component increases, and so does the randomness of classical chaotic motion inside. In setting up a theory first ergodic (fully chaotic) systems will be discussed, and then the mixed type systems, like Henon-Heiles system, with a typical KAM scenario. Some generalizations by treating the correlations will be presented. Finally, I shall explain the relevance of these studies in the context of problems in stationary quantum chaos, namely the structure of stationary eigenfunctions and the statistical properties of the energy spectra.

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# Ladder Operators and Moment Problems

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Ladder operator formalisms typically arise in factorization approaches to Schrödinger operators. There, they serve to an algebraic understanding of spectral problems like finding suitable eigenvalues of the linear operators under consideration. Also when it comes to describing supersymmetric Schrödinger operators in quantum mechanics, the concept of lowering and raising operators turns out to have an important meaning. So far, typical scenarios when ladder operators arise are briefly sketched. In recent contributions, it has become apparent that methods involving ladder operators can also be used to deal with moment problems in context of special functions in analysis. We give several examples for this application.

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# Contributions of the AbiTUMath Program To Avoiding Global Antenna Problems

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The basic spirit of the AbiTUMath program is shortly described. Current research perspectives for young people within the program are presented. The fruitful international collaboration of students as a key role is mentioned.

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# Bose-Einstein Condensation in dilute gases

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I shall discuss some recent theoretical results [1-3] on confined Bose-Einstein condensates made of alkali-metal atoms at ultra-low temperatures [4].

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# Mreža dislokacij v tanki planparalelni celici

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Teoretično so raziskani površinsko induciran nastanek in odlepljanje robnih dislokacij v SmA tekočekristalni fazi. Omejimo se na študij stabilnosti mreže lokalnih dislokacij, ki nastanejo v SmA tekočem kristalu ograjenem v planparalelno tanko celico. Uporabljen je Landau-Ginzburgov model kjer smektično fazo opišemo s kompleksnim smektičnim ureditvenim parametrom. Tekoči kristal je ograjen v planparalelno celico z debelino L pri emer so smektične plasti usmerjene pravokotno na rob celice. Zaradi spominskega efekta površina plastem vsiljuje periodičnost qs, ki se razlikuje od naravne periodičnosti smektičnih plasti v notranjosti celice q0. Periodičnost, ki jo vsiljuje površina je posledica močenja na začetku nastale smektične faze. Razmere in vpliv površinske interakcije določa površinska interpolacijska dolžina d=C/W, kjer je W jakost površinskega pozicijskega sidranja, C pa je karakteristična elastična konstanta smektičnih tekočih kristalov. Analiza je narejena v približku enakih smektičnih konstant. Stabilnost realiziranih struktur je odvisna predvsem od L, d, in qs/q0. Omejili se bomo na homogeno (bookshelf), deformirano homogeno in homogeno strukturo z lokalnimi dislokacijami, ne bomo pa obravnavali ševronske strukture. Pri relativno šibki jakosti površinskega pozicijskega sidranja W se smektične plasti uredijo v paralelno strukturo. Za večje vrednosti W in pri celicah, katerih debelina L je velika v primerjavi z d se formira struktura z mrežo lokalnih dislokacij ob površini. Dislokacije se z naraščajočo jakostjo sidranja odlepljajo od površine, kar rezultira v homogeno strukturo z lokalnimi dislokacijami. Če je celica tanka v primerjavi z d, posamezne dislokacije interegirajo z ekvivalentnimi dislokacijami, ki nastanejo na nasprotni strani celice, kar vodi do anihilacije dislokacijskih parov in stabilizira se deformirana homogena struktura, katere periodinost vsiljuje površina. Iz izračunanega faznega diagrama lahko razberemo, da obstaja trojna točka, v kateri vse tri strukture koeksistirajo.

# Oscilacije in fluktuacije v kardiovaskularni dinamiki
# Oscillations and fluctuations in cardiovascular dynamics

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# Modeliranje smektičnih tekočih kristalov v omejenih strukturah

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Površinsko stabilizirane celice feroelektričnih tekočih kristalov imajo v splošnem dve stabilni stanji. Ko jih postavimo med prekrižana polarizatorja, eno od stanj prepušča svetlobo in drugo ne. Celico preklopimo iz enega v drugo stabilno stanje z zunanjim električnim poljem, jakost katerega pa mora biti večja od neke kritične vrednosti. Dolgo je veljalo, da je v površinsko stabiliziranih celicah možno samo stanje "1" ali stanje "0". V zadnjih letih pa je vse več eksperimetalnih meritev, ki kažejo, da se površinsko stabilizirane celice lahko odzivajo linearno na zunanje električno polje, kar pomeni, da poleg stanj 1 in 0 dobimo še vsa vmesna stanja.

V predavanju bom predstavila teoretični model za opis površinsko stabiliziranih celic feroelektričnega tekočega kristala. Model je dokaj preprost, a kljub temu napove večino najpomembnejših lastnosti teh celic. Razložila bom, kako sta struktura in odziv teh celic odvisna od elastičnih konstant tekočega kristala, od vpliva površine in od velikosti spontane polarizacije. Pokazala bom, da se teoretične napovedi in numerični rezultati dobro ujemajo z obstoječimi eksperimentalnimi meritvami.

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# Modelling of ferroelectric liquid crystals in confined geometry

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Surface stabilized ferroelectric liquid crystal (SSFLC) cells in general exhibit two stable states. When a SSFLC cell is put between two crossed polarizers one state transmits light and the other one does not. Switching between the states is achieved by the application of the external electric field that must be higher than the threshold field. It was believed that SSFLC cells can exhibit only two states: 'on' and 'off', however it was recently shown that the 'gray scale', which requires thresholdless switching can also be realized in such cells.

In my talk I shall present the theoretical model to describe the structure and switching in SSFLC cells. The model is relatively simple but it accounts for all the most common features of the SSFLC cells. I shall discuss how the structure in such cells depends on the bulk elastic constants, on the surface requirements and on the magnitude of the spontaneous polarization. The theoretical predictions and the results of the numerical analysis will be shown to agree well with the existing experimental data.

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# Zvestoba perturbirane klasične evolucije in klasična interakcijska slika

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Stabilnost evolucije sistemov pod vplivom statične perturbacije je v zadnjem času pritegnila precej pozornosti na področju kvantnega računalništva. Osnovni problem je ugotoviti, kako dinamika vpliva na razhajanje evolucije dveh rahlo različnih sistemov. V našem delu smo se osredotočili na klasično dinamiko, ki je velikokrat osnova za razumevanje ustreznega kvantnega sistema. Primerjali smo evolucijo dane klasične verjetnostne gostote tako v izvirnem kot v perturbiranem sistemu. Prekrivalni integral propagiranih gostot kot funkcijo časa imenujemo klasična zvestoba. Pod določenimi pogoji je za kvantno zvestobo klasično kaotičnih sistemov moč opaziti eksponentno pojemanje zvestobe s časom, kjer je hitrost pojemanja podana z Ljapunovim eksponentom. V našem delu smo podali klasično razlago tega pojava, ki je bil doslej opisan predvsem s semiklasičnimi argumenti. Pojav smo opisali v klasični interakcijski sliki, ki nam je omogočila vzpostaviti povezavo med Ljapunovimi eksponenti, Ljapunovimi vektorji in pojemanjem zvestobe. Obenem naša teorija napove tudi nove, hitrejše načine razpada zvestobe. V sistemih z več kot dvema prostostnima stopnjama tako lahko vedno opazimo kaskadno povečevanje hitrosti pojemanja, kjer k razpadu s časom prispeva vedno več Ljapunovih eksponentov. V nekaterih posebnih sistemih pa lahko opazimo tudi hitrejše kot eksponentno, balistično pojemanje zvestobe.

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# Fidelity of perturbed classical evolution and classical interaction picture

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Stability of evolution under the influence of a static perturbation recently gained a lot of interest in the field of quantum computing. An important question is determining how the dynamics affects the divergence of evolutions of two slightly different systems. In our work we focused on classical dynamics which may often be used as a basis for understanding the corresponding quantum system. We compared the evolution of a classical phase space density in both the perturbed and unperturbed system. The overlap integral of these evolved densities is called the classical fidelity.

Under certain conditions the quantum fidelity of a classicaly chaotic system decays exponentially with time, where the decay rate is given by the Lyapunov exponent. In our work we give a classical explanation of this phenomenon, which until now has mostly been explained in semiclassical terms. We describe the phenomenon in the classical interaction picture and establish a connection between the Lyapunov exponents, the Lyapunov vectors and the decay of fidelity. At the same time the theory predicts several new phenomena. In systems with more than two degrees of freedom a cascade like behaviour is predicted, where more and more Lyapunov exponents contribute to the decay rate, while in some other special systems a faster than exponential, ballistic type of decay may be observed.

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# Kaos v helijevem atomu: O spektru resonančnih kvantnomehanskih stanj

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Helijev atom, kot coulombski problem treh teles, je paradigma klasičnega kaosa in zgodovinsko pomemben sistem v razvoju kvantne teorije. Klasična dinamika He atoma je že pri vrtilni količini nič, kjer je gibanje elektronov omejeno na ravnino, zelo bogata; najdemo lahko posamezne nižje-dimenzionalne konfiguracije, kjer je dinamika skoraj integrabilna, mešanega tipa (KAM) ali povsem kaotična. Poleg tega, je He atom zaradi odbojne interakcije med elektronoma tudi pri negativnih energijah odprt sistem, saj večina klasičnih trajektorij vodi do ionizacije oziroma pobega enega od elektronov, kar še posebej velja za kaotično "eZe" kolinearno konfiguracijo. Odraz avtoionizacije opazimo tudi v kvantnomehanskem spektru, kjer prava vezana stanja najdemo le pri energijah pod prvim ionizacijskim pragom, više pa le resonančna stanja s končnim življenskim časom, potopljena v kontinuum. Opisal bom metodo kompleksne koordinatne rotacije, s katero lahko razkrijemo in izračunamo kompleksna resonančna stanja v atomih in predstavil statistične lastnosti energijskega spektra resonanc v He atomu z vrtilno količino nič.

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# Chaos in helium atom: On spectrum of resonant quantum states

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Helium atom as a three-body Coulomb problem is a paradigm of classical chaos and historically important system in the evolution of the quantum theory. Even at zero angular momentum where the motion of the two electrons is confined to a plane, the dynamics of He atom is very rich and lower dimensional configurations exist for which the dynamics can be near-integrable, of a mixed-type (KAM) or even fully chaotic. Due to the repulsive interaction between the electrons He atom is an open system even at negative energies, since the majority of classical trajectories lead to ionization, meaning towards one electron escape. In particular, almost all the trajectories (except the periodic ones) of the chaotic "eZe" collinear configuration are ionizing. As a consequence of the autoionization He atom spectrum possesses true bound states only in the energy range below the first ionization threshold. Higher in energy, only resonant states with finite life time exist. I shall describe the method of complex coordinate rotations enabling us to unfold and to compute the complex valued energies of atomic resonant states. I will also discuss some statistical properties of He atom resonant spectrum at zero angular momentum.

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# Smektični red ograjenih tekočih kristalov v poroznih steklih

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Ograjenost tekočih kristalov v poroznih steklih vpliva na fazne prehode zaradi tekmovanja med elastično in površinsko interakcijo. V prispevku bo predstavljeno smektično urejanje tekočega kristala oktilcianobifenil (8CB), ograjenega v različne vrste kontrolirano poroznega stekla (CPG). V neograjenem tekočem kristalu 8CB je fazni prehod med smektično A in nematično fazo pri temperaturi $T_{NA}$ okoli 307 K ter med nematično in izotropno fazo pri temperaturi $T_{IN}$ okoli 314 K.

Steklo CPG ima pore cilindrične oblike. Premer por za dano vrsto CPG je monodisperzen z natančnostjo do 10 odstotkov. Za meritev so bila izbrana stekla CPG s tipičnim premerom por od 24 nm do 400 nm.

Z meritvijo devterijevega spektra z jedrsko magnetno resonanco (NMR) je bil določen nematični parameter reda, z meritvijo rentgenskega sipanja pod majhnim kotom (SAXS) pa smektični parameter reda. Rezultati meritev kažejo, da se vpliv ograjenosti na nematični in na smektični fazni prehod močneje pozna v primeru manjših por. Rezultati meritev SAXS na tekočem kristalu 8CB ograjenem v poroznem steklu CPG nakazujejo, da se v smektični fazi pojavi domenski vzorec, skladno z napovedjo teorema Imry-Ma.

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# Smectic ordering of liquid crystals confined to porous glasses

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Confinement of liquid crystals to porous systems affects phase transitions due to the competition between the elastic and the surface interactions. Here we present a study of the smectic ordering of liquid crystal octylcyanobifenyl (8CB), confined to different types of controlled-pore glass (CPG). Bulk 8CB exhibits a smectic A to nematic phase transition at about 307 K and the nematic to isotropic phase transition at about 314 K.

Inside the CPG glass there are cylindrical pores characterised by a pore diameter, which is monodisperse with the accuracy of about 10 percent. Our experiments have been performed on different types of CPG glasses with a typical pore diameter between 24 and 400 nm.

Deuteron nuclear magnetic resonance (NMR) spectrum allows for the determination of the nematic order parameter, and the small-angle X-ray scattering (SAXS) allows for the determination of the smectic order parameter. Experimental results demonstrate that the confinement effect is stronger for smaller pores both in the nematic and the smectic case. SAXS experiments on 8CB confined to CPG glass further suggest that a domain-like pattern appears in the smectic phase in accordance with the Imry-Ma theorem.

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# Varna komunikacija

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S pojavom institucij oziroma organiziranih struktur v družbi, npr. države, se je pojavila potreba po varni komunikaciji. Šifrirana sporočila so uporabljali že egipčani, tudi dandanašnji voditelji in generali pa čutijo neusahljivo potrebo po izmenjavi zaupnih informacij, torej šifriranih sporočil, ki jih nasprotnih ni sposoben razvozlati. Dokler bodo torej paranoični voditelji potreba po varni komunikaciji vsekakor ne bo usahnila. Tudi navadni smrtniki nismo popolnoma imuni na tovrstne probleme. Treba je le pomisliti na banke, da o internetu niti ne govorim. Navsezadnje pravijo, da je današnja družba *informacijska*, katere pomemben sestavni del je izmenjava informacij, pogosto predvsem *varna izmenjava*.

Do nedavnega je bilo proučevanje načinov za varno komunikacijo v domeni matematikov in računalničarjev, v zadnjih desetih letih pa so se jim pridružili tudi fiziki. In to ne brez razloga. Uporaba kvantne mehanike pri prenačanju sporočil, t.i. kvantna varna komunikacija, nam omogoča *popolnoma varno komunikacijo*. Da bi razumeli zakaj je to kaj posebnega, je potrebno povedati nekaj besed o klasični teoriji šifriranja. Vse metode, ki so trenutno v uporabi za varno komunikacijo lahko razdelimo v dva razreda, asimetrične šifrirne metode (to so take z javnim ključem) in simetrične (take s privatnim ključem). Vse te metode imajo eno skupno lastnost: to je da niso varne! Njihova varnost temelji le na zahtevnosti nekaterih računskih operacij (npr. faktorizacije), torej lahko nekdo z dovolj zmogljivim računalnikom brez težav zaobide zaščito. Še več! Zahtevnost teh računskih operacij je *nedokazana* matematična trditev. Torej se prav lahko zgodi, da se jutri pojavi nek nov hitrejši algoritem, ki v trenutku razblini vso "varno" zaščito. Pregovor pravi: "security by obscurity is no security", torej je idealna varna komunikacija takšna, ki je *dokazano* varna. In natanko to omogoča kvantna varna komunikacija, ki jo bom predstavil v predavanju.

# Secure communication

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With the occurrence of institutions and organised structures in the society, eg. the state, the need for secure communication arose. Encoded messages have been in use already by Egyptians and also todays leaders and generals do not lack the irresistible need for secure exchange of confidential information that the enemy should not be able to decipher. As long as there will exist paranoid leaders we do not have to be afraid for the lack of need for secure communication. Ordinary humans are also not completely immune to such problems, one just has to think of banks or the Internet, to name the two. After all, they say today society is *information* society of which important part is communication and this frequently has to be *secure*.

Up to ten years ago research of secure communication has been in the domain of mathematicians and computer scientists, but lately physicists joined. Not by chance. Exploiting principles of quantum mechanics to achieve secure communication enabled them to build devices (that are already commercially available) that are unconditionally secure. To understand why is this any special we have to first understand what are the limitations of the classical secure communication. All classical cryptographic methods can be divided into two groups: asymmetric ciphers (those with public-key) and symmetric ciphers (secret-key). All these methods have on thing in common: they are not secure! Their security rests on the difficulty of certain mathematical operations (like factoring), so someone with a powerful enough computer could easily breach the protection. Even more, the difficulty of these operations is an *unproved* mathematical statement. Therefore it might happen that tomorrow someone comes up with a new clever algorithm and all the security is gone in a minute. The saying goes: "security by obscurity is no security" and so the ideal secure communication would be a *proved* secure communication. And precisely that is what is provided by the quantum secure communication which I will talk about in the following seminar.