IPS 2008 - Abstracts

The contributions are sorted alphabetically by the last name of the submitter, and categorized by topic number (two digits) and type (1=poster, 2=parallel, 3=review, 4=plenary). The topic categories are:

- `#01` Quantum physics
- `#02` Statistical physics and complex systems
- `#03` Solid state physics (theoretical)
- `#04` Solid state physics (experimental)
- `#05` Optics and photonics
- `#06` Particle and nuclear physics
- `#07` Plasma physics
- `#08` Astrophysics and cosmology
- `#09` Biological and soft condensed matter physics
- `#10` Medical physics
- `#11` Non-linear physics
- `#00` Other

Category #05-1

A performance comparison of three terminal and four terminal monolithically integrated silicon light emitting devices (SiLEDs)

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Increasing the light output of single crystal silicon light-emitting devices (SiLEDs) will enable their utilization in integrated circuits. Here, we compare the performance of self invented three terminals and four terminals SiLEDs. Both devices posses a BJT-like structure, a design that take advantage of the inherent power gain of active devices. They share some common features, i.e, each of them is comprised of a main light emitting junction that is operated in the reversed bias charge multiplication (avalanching) mode. The excess multiplied carriers, undergo energy levels transitions, resulting light emission. An adjacently lying pn forward biased junction is located opposite to the light emitting junction. It injects minority carriers into the high electric field space charge region of the avalanching junction. As a result, additional high-density carrier multiplication takes place, increasing the emitted light intensity. The degree of the forward bias enables to control the light emission intensity from the avalanching junction. However, they are differently designed in order to further enhance light emission by creating high current density confinement at the light emitting junction, while keeping low overall operating current. The light emitting junction of the three terminals SiLED is wedge shaped, resulting high local light emission at and near the wedge tip due to the higher current density there. The four terminals SiLED structure contains four implanted regions into P- substrate, each with its external terminal. Its operation is similar to that of the three terminals SiLED , but it contains additional two light enhancing features:(A) The reversed biased light emitting PN junction includes a needle-like region, pointing towards a forward biased PN carrier-injecting junction, which is located directly opposite to this junction. This arrangement enables higher current density at the needle vicinity, and further increases the light emission. (B) Two additional P+P- junctions are located between the above junctions. Under proper biasing, their function is that of focusing action of the injected carriers, further increasing the local current density and emitted light emission intensity at and near the needle. The comparison shows that the four terminal device emits considerably higher light intensity.

Almog Boaz

Category #04-2

Observation of Andreev Saint-James reflections in nano-scale planar superconductor To ferromagnet contacts

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We studied ferromagnetic nickel/superconducting indium planar junctions. The junctions show Andreev-Saint-James reflections at low bias. This is possible due to natural formation of pinholes, smaller than the coherence length, between the nickel and indium layers. As a result there is a weak proximity effect which leads to a reduced energy gap of 300eV at the pinhole location, but with a very small effect on the critical temperature of the junctions. We use this technique to measure the properties of granular aluminum in which fluctuations of the order parameter take place above Tc. We show that Andreev-Saint-James reflections start only when the film is macroscopically superconducting.

Studying single gene transcription by autocorrelation analysis

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Transcription plays an important role in the gene expression regulation within the cell. It results in an RNA strand that exits the nucleus and translates into a protein. Nevertheless, the way that its functions are spatially and temporally coordinated is not yet understood.
Recent technological developments in live cell imaging have facilitated imaging on single RNA molecules in the nucleus of living cells. Imaging of mRNA transcription has unraveled the in vivo kinetics of RNA polymerase I and II. These experiments were based on tandem arrays harboring many copies of genes. For Pol II transcription, which results in a protein coding RNA (mRNA), such gene arrays do not allow the kinetic analysis of single gene transcription.
We use a human cell system that enables comparative measurements of mRNA transcription from a single-copy gene in vivo using fluorescence tagging of the transcribed mRNA. We perform our measurements using FRAP in order to detect minute fluctuations in the intensity of the transcribing site. These measurements provide high-resolution sensitive information otherwise undetected.
We will discuss the biological system, the imaging method, methods for measuring the intensity fluctuations and present preliminary data that may indicate on the transcription rate and time.

Category #07-2

Determination of the spatial distribution of the properties and size of plasma at stagnation

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The electron temperature (T_e) and density (n_e) in a hot-dense cylindrical plasma, imploded under an intense azimuthal magnetic field (z-pinch), were determined, as a function of space along the plasma column. The plasma is made of neon that is almost fully stripped as the plasma stagnates on axis. X-ray spectroscopy was developed to obtain with high-accuracy the time-integrated x-ray spectrum of the plasma, from the ~900 eV He_{α} spectral line to the ~2.4 keV tail of the recombination continuum radiation. In this presentation we will address the use of the continuum radiation due to free-bound recombination into the H-like neon for obtaining the stagnating-plasma properties. The electron temperature and density along the pinch column were determined, respectively, from the photon-energy slope and the intensity of this continuum. For the latter, the continuum intensity obtained at a given axial location was normalized to the density obtained from two other different methods, namely: i) The use of H-like-satellite ratio, and ii) Stark broadening of high-*n* Lyman lines. The plasma radius along the column was also obtained from pinhole photography. The data collected, together with a detailed collisional-radiative modelling of the highly-ionized neon plasma, allowed for determining the peak T_e throughout the stagnation within an accuracy of 5%. It was found that T_e peaks at about 200 eV with variations of 10% along the pinch column. Remarkably, it was also found that n_e ($\approx 10^{21}$ cm^{-3}) is lower by about 50% in the locations of higher T_e, and vice versa. The variations of T_e and n_e along the pinch column, and their correlations, are here obtained for the first time, thus stimulating discussions on the development of nonuniformities in the imploding plasma, and serving for examining detailed 3D magneto-hydrodynamic modeling.

Diffusion of a quantum particle in a time-correlated noisy environment

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We study the spreading of a wavepacket in a one-dimensional tight-binding model with a noisy potential. We consider a finite correlation time of the noisy environment, and treat the system by utilizing the separation of fast (dephasing) and slow (diffusion) processes. We show that diffusive behavior emerges at long times, with a diffusion coe±cient which depends on the correlation time. This generalizes the results of previous works, which considered only delta-function or perturbatively short correlation times. The results are applicable for a wide range of physical systems, for which the equivalent of the correlation time may indeed be large compared with the range of applicability of previous theories.

Anomalous diffusion of a monomer between absorbing boundaries

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We consider the motion of a single ("tagged") monomer that belongs to a very long linear polymer in a dilute solution. On time scales shorter than the relaxation time of the entire polymer the tagged monomer undergoes anomalous diffusion, i.e. its mean square displacement increases with the time t as t^{a}, where $a<1$. The value of a depends on the intermonomer potentials, as well as on the velocity-dependent interactions between the monomers. For a non-self-interacting ("ideal") polymer without velocity-dependent forces $a=1/2$. Dynamics of a polymer is frequently described in terms of the evolution of Rouse modes u_q, which are cosine transforms of the actual monomer positions, while q is the wave number. By modifying the q-dependence of the noise correlation functions (and friction coefficients), we can alter the value of a. Such changes approximately mimic the introduction of velocity dependent interactions that decay as a power-law of the separation between monomers r^{-k}, and lead to anomalous diffusion of the tagged monomer in an ideal polymer with $a=2/(2+k)$. We performed a detailed study of this model.

In particular, we employ our model to study the behavior of a tagged monomer in the presence of one and two absorbing boundaries, as the anomalous diffusion exponent is varied. We thus demonstrate the differences and similarities between this process and the fractional diffusion equation. We show that the mean time for absorption is finite in the presence of two absorbing boundaries, and that the probability distribution function of the tagged monomer decays as a power law near the boundaries. We also compare the behavior of a tagged monomer with the translocation of a polymer through a pore in a membrane, and find many qualitative similarities, as well as some quantitative differences.

Amusia Miron

Category #01-1

Modification of the Koester-Kronig decay in endohedral atoms

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We demonstrate here that the fullerene shell can in principle prominently affect the shape of the electron energy distribution in the Koester–Kronig decay of an atom A, caged inside the C60 shell, i.e. of an endohedral A@C60. This transition takes place between two atomic levels with the same principal quantum numbers. While the energy of emitted in the decay electron is small, the decay probability is big, leading as a result to a decay width of more than one eV that is at least by a factor of ten bigger than the typical Auger-decay width. For isolated atoms, the probability of decay and emitted electron spectrum depend strongly on details of the wave function of the vacancy and the emitted electron. It was demonstrated quite a while ago that taking into account electron correlations in the frame of Random Phase Approximation with Exchange alters considerably the Koester-Kronig decay probability. Recently a great deal of attention was given to the processes with endohedrals, mainly their photoionization. However the decay of vacancies can be also modified due to presence of the C60 (or other fullerene) shell. The presence of the fullerene shell adds new decay channels, modifies the interaction between atomic electrons and affects the outgoing electron wave function. As a concrete example we have considered the decay of vacancy in 2s subshell in Ar@C60 - 2s-1. The main channels of this decay are 2s-1 – 2p-13s-1(3p-1)ep (es,d). We estimated the modification of the interelectron interaction due to fullerene shell presence and found it inessential. We presented the outgoing electron spectrum and found that due to its reflection by the static potential of the fullerenes shell and found that the outgoing electron spectrum is modified by up to thirty percent. This effect may increase in other atoms due to variation of the outgoing electron energy. This result was obtained with both finite width fullerene potential and with zero-thickness pseudo-potential. The probability of the transition 2s-1 – 2p-1 via emission of the fullerenes shell electrons proofed to be negligible. Of some importance is the shake-off of fullerene shell electrons that accompany the atomic vacancy decay.

Amusia Miron

Category #01-2

Interference resonances in endohedral atoms

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We demonstrate the effect of fullerene shell upon the photoionization of subvalent ns subshells in noble gas heavy atoms, Kr and Xe, stuffed inside C60, thus forming a so-called endohedral atom. We show that new powerful and specific in shape resonances appear in the corresponding cross-sections. The following effects are taken into account in our calculations: a) the scattering of the atomic electrons in their real and virtual states by static potential of the fullerene shell, b) the polarization of the incoming electromagnetic field due to virtual excitation of the fullerenes shell electrons, c) the action of multi-electron neighboring shells upon the subvalent one. It was known since long ago that multi-electron neighboring shells affect dramatically the photoionization cross-section of the subvalent electrons, forming so-named interference maxima and minima. This effect is particularly strong for 5s electrons in Xe. The investigation of these peculiarities became a domain in atomic photoionization studies, both experimental and theoretical. Recently, the investigation of photoionization of endohedrals started to be a subject of considerable attention. This is understandable since electrons going from an atom stuffed inside a fullerene shell in the ionization process, makes it a sort of a lamp that “illuminates” the fullerenes shell from the inside. There are already several experimental investigations on this subject. This justifies further theoretical efforts in this direction. In our studies we have considered two approximations to the static fullerenes shell potential, namely, the finite thickness square well and zero-thickness delta-type pseudo-potential. At low photoelectron speed the results are shape-independent, but with speed growth became strongly shape-dependent. All calculations were performed in the frame of properly generalized familiar from studies of isolated atoms Random Phase Approximation with Exchange. Of course, it would be desirable to get rid of all simplifications of the static fullerenes potential. But this is impossible at this moment.

Amusia Miron

Category #02-1

Fermion condensation: a strange idea successfully explaining behavior of numerous objects in Nature

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Strongly correlated Fermi systems are among the most intriguing, best experimentally studied and fundamental systems in physics, but until now lacking theoretical explanations. Ideas based on the Kondo effect and quantum and thermal fluctuations taking place at a quantum critical point (QCP) have been put forward and used to explain the fascinating behavior of these systems known as the non-Fermi liquid (NFL) behavior. Alas, suggested to describe one property, the ideas failed to do the same with the others and there is a real crisis and a new quantum phase transition responsible for the observed behavior is required. Facts collected on heavy-fermion (HF) metals and two dimensional (2D) ^3He demonstrate existence of very high values of the quasiparticles effective mass M*, or even a divergence of M*. Fermion condensation quantum phase transition (FCQPT) preserving quasiparticles and intrinsically related with unlimited growth of M* is capable to describe strongly correlated systems. In that case, M* becomes temperature, density, magnetic field etc. depended but the very Landau concept of quasiparticles remains untouched. Having analyzed recent facts collected on both two dimensional ^3He and heavy-fermion (HF) metals, we find that despite of the quite different microscopic nature of 2D ^3He and HF metals, they exhibit the same non-Fermi liquid (NFL) behavior at their quantum critical points. We show both analytically and entirely based on the experimental grounds that the data collected on very different strongly correlated Fermi-systems have a universal scaling behavior, and materials with strongly correlated fermions can be unexpectedly uniform despite of their very prominent diversity. Thus, the NFL behavior is universal and independent of the peculiarities of strongly correlated Fermi-system such as its lattice structure, magnetic ground state, dimensionality etc.

Amusia Miron

Category #02-1

Common quantum phase transition in strongly correlated Fermi systems

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Such strongly correlated Fermi systems as high-temperature superconductors (HTSC), heavy-fermion (HF) metals and two-dimensional (2D) ^{3}He exhibit extraordinary properties. They are so unusual that the traditional Landau paradigm of quasiparticles does not apply. It is widely believed that utterly new concepts are required to describe the underlying physics. So, there is a fundamental question: how many concepts do we need to describe the above physical mechanisms? This cannot be answered on purely experimental or theoretical grounds. Rather, we have to use both of them. Recently, in HTSC, the new and exciting measurements have been performed, demonstrating a puzzling magnetic field induced transition from non-Fermi liquid to Landau Fermi liquid behavior [T. Shibauchi, L. Krusin-Elbaum, M. Hasegawa,Y. Kasahara, R. Okazaki and Y. Matsuda, Proc. Natl. Acad. Sci. USA, 105, 7120 (2008)]. We employ a theory, based on fermion condensation quantum phase transition which is able to resolve the above puzzle. We show for the first time, that in spite of very different microscopic nature of HTSC, HF metals and 2D ^{3}He, the behavior of HTSC is similar to that observed in both HF compounds and 2D ^{3}He, and their behavior belong to universal behavior of strongly correlated Fermi-systems. Our consideration is based on comprehensive theoretical study of vast majority of experimental facts for very different strongly correlated Fermi-systems, such as high-temperature superconductors, heavy-fermion compounds and two-dimensional ^{3}He. It clearly demonstrates for the first time the generic family resemblance of those systems. It follows from our study that there is at least one quantum phase transition inside the superconducting domain, and this transition is the fermion condensation quantum phase transition based on comprehensive theoretical study of vast majority of experimental facts for very different strongly correlated Fermi-systems, such as high-temperature superconductors, heavy-fermion compounds and two-dimensional ^{3}He. It clearly demonstrates for the first time the generic family resemblance of those systems. It follows from our study that there is at least one quantum phase transition inside the superconducting domain, and this transition is the fermion condensation quantum phase transition.

Estimation of the Optimal Wavelengths for Low-Level-Laser Therapy in Skin Tissue

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We estimate the optimal wavelengths for Low Level Laser Therapy (LLLT) treatments using photon migration model for skin tissue. According to earlier in vitro LLLT studies, the effect of short wavelengths (400-500 nm) on the irradiated cell is the highest, owing to the high efficiency of light absorption by cellular photosensitizers. However, one needs to take into consideration the irradiation effect on the entire tissue. For this purpose we model the two top layers of skin tissue, epidermis and dermis, by the two-layer version of the photon diffusion model. The two layers differ by their absorption coefficients. We calculate the mean absorption coefficients of both the epidermis, μ1, and the dermis, μ2, by referring to the most common chromophores in human tissue and evaluating their volume fraction and cell concentration in skin tissue. These mean wavelength dependent absorption coefficients are then substituted in the model expressions for the optical penetration depth in a two-layer tissue. The wavelengths, for which the penetration depth is the highest, are the optimal wavelengths to be used in LLLT treatments. Our model-based estimates agree very well with known clinical routines.

Spectral theory and WKB approximation for population quasi-stationarity and extinction

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I will report a new method for calculating the extreme statistics of stochastic birth-death processes or reaction kinetics. I will focus on single-species models which have an absorbing state at zero. Here the intrinsic noise ultimately drives the population to extinction. Of most interest is the regime of not too a small population. After a short-time relaxation transient, a long-lived quasi-stationary distribution (QSD) of the population size sets in here, peaked at a population size predicted by the deterministic rate equation of this system. This prediction, however, breaks down at long times. The QSD slowly decays in time, so that after an exponentially long time the true stationary probability distribution, corresponding to extinction of the population, is reached. To calculate the mean time to extinction (MTE) and the QSD, including its strongly non-Gaussian tails, we transform the infinite set of master equations to a non-Hermitian Schroedinger equation for the probability generating function, and analyze the spectrum of the corresponding differential operator. The first excited eigenfunction, which we find by combining a systematic WKB expansion with a boundary-layer analysis, encodes the QSD, while the corresponding eigenvalue yields the MTE. To demonstrate the power of the method, I will discuss several multi-step birth-death processes for which no accurate analytical results were previously available, and which we have recently solved.

Aviv Gal

Category #01-4

Bloch Qbit
Multiphoton Coherent Manipulations of an Atomic Two-State System

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The fast experimental progress made with neutral atoms in quantum optics in the last several years underlines the great potential of QIP (Quantum Information Processing) devices, and other applications such as clocks and sensors based on the internal degrees of freedom of the atom. We investigate the differences among several magnetic transitions in the ^{87}Rb hyper-fine ground state manifold. We compare properties of single-photon transitions with two-photon transitions. We focus on the following transitions:

$Single\text{-}photon, \Delta m_F = 0$:

$|F=1, m_F=0> \rightarrow |F=2, m_F=0>$

$Two\text{-}photon, \Delta m_F = 0$:

$|F=1, m_F=0> \rightarrow |F=2, m_F=0>$

$Two\text{-}photon, \Delta m_F = 2$:

$|F=1, m_F=-1> \rightarrow |F=2, m_F=1>$

The first transition, known as the "clock transition", is used as the common atomic frequency standard; the second is known as a (magnetic) "qubit" transition, as the qubit states are magnetically trapped states, for which the differential first order Zeeman shift is zero at the magnetic field value of 3.23 G. Furthermore, both states experience nearly identical trapping potentials in magnetic traps, thereby avoiding undesired coupling between internal and external degrees of freedom of the atoms. In this talk I will present experimental results and discuss the design of future studies.

Photovoltaic Laboratory Tester

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This paper describes development and implementation of a low cost laboratory instrument for testing photovoltaic (PV) systems by measuring their I-V characteristics and estimation of other PV parameters such as Fill Factor (FF) and conversion energy efficiency (δ). The developed system performs its measurements in an automatic mode using microprocessor PIC 18F452 and the "Hiper-Terminal" software. A conventional tungsten-halogen lamp of 20 W was used for the irradiation of the studied PV cells. This laboratory tester also enables comparison of various photovoltaic devices made of various technologies. The tester is successfully used in the Thin Films laboratory at Holon Institute of Technology - HIT.

Towards Synthetic Gene Systems on a Chip

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We are motivated to develop cell-free gene systems that mimic natural gene networks in living cells. We first explored the assembly of cell-free transcription–translation circuits and expanded the cell-free gene toolbox to include self-assembling proteins. A surface is a natural platform to regulate and spatially cascade biosynthetic reactions and we next developed a photolithographic interface for cell-free gene expression at the micron scale. Genes are immobilized on a chip forming DNA polymer brushes with controllable density. Gene expression from brushes has led to new forms of regulation that rely on physical constraints, DNA conformation and symmetry breaking, when the distance between neighboring genes is below ~100 nanometers. We demonstrated a two-stage gene cascade integrated on the chip, as a step towards multi-gene systems. Gene brushes emulate conditions of DNA crowding and we study DNA transactions in a dense medium.

Barness Doron

Category #04-2

Magnetic flux oscillations in partially irradiated $Bi_2Sr_2CaCu_2O_{8+x}$ crystals

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We report on generation of spatio-temporal oscillations of magnetic flux in $Bi_2Sr_2CaCu_2O_{8+\delta}$ crystals containing ion tracks as pinning centers. The ion tracks were produced by exposing a selected part of the sample to energetic Au ions of 2.2 GeV which create nanometric columnar defects through the crystal. Flux oscillations are spontaneously excited in samples exposed to a steady magnetic field near the order-disorder vortex phase transition line. The oscillations originate at the border between the irradiated and non-irradiated parts of the sample, and propagate into the non-irradiated region towards the sample edge. Previously reported flux oscillations were observed in the vicinity of undefined defects in as grown Bi2Sr2CaCu2O8+x crystals . Generation of such oscillations by inducing pinning centers in a controlled manner enables more systematic, in-depth study of this new phenomenon. In particular, the important role of the irradiation border in driving the system to instability will be discussed

Barness Doron

Category #04-1

Anisotropy induced pattern formation by thermomagnetic instability on interface separating regions of different voltage-current characteristics in $Bi_2Sr_2CaCu_2O_{8+\delta}$ crystals

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Magneto-optical imaging was employed to study magnetic flux propagation through an interface separating between heavy-ion irradiated and unirradiated parts of a $Bi_2Sr_2CaCu_2O_{8+\delta}$ crystal. The interface between the two regions behaves as a flux barrier and induces a controlled anisotropic voltage-current characteristics along the directions parallel and perpendicular to the irradiation border. At intermediate temperatures and low ramping rates flux penetrated the irradiated region forming finger patterns. The analysis suggests that finger patterns are generated by a thermomagnetic effect. We explain the flux behavior at the interface on the basis of the magnetic diffusion equation. Theoretically studying the thermomagnetic stability of the Bean critical state in a slab employing anisotropic E-J curve has been made. From this analysis it is predicted that strong anisotropy induces non-uniform, fingering type instability, which appears as readily as pattern formation in thin films. In particular, the fingering instability emerges for extremely small rates of the external magnetic field ramp.

Barth Ido

Category #07-2

A water bag model of driven phase space holes in non-neutral plasmas

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The formation and control of stable multi-phase space hole structures and the associated Bernstein– Greene–Kruskal modes in a trapped pure ion plasma driven by an oscillating, chirped frequency driving perturbation are cosidered. The holes are formed by passing kinetic bounce resonances $\omega_d = n\pi u/L$ in the system, u and L are the longitudinal velocity of the plasma species and the length of the trap, and n is the multiplicity of the resonance (the number of the phase space holes). An adiabatic, quasi-one-dimensional water bag model of this excitation for an initially flat-top distribution of the ions in the trap is suggested, based on the isomorphism with a related problem in infinite quasineutral plasmas. A multiwater bag approach allows us to generalize the theory to other initial distributions. Numerical simulations yield a very good agreement with the theory until the coherent phase space structure is destroyed due to the resonance overlap when the decreasing driving frequency passes a critical value estimated within the water bag theory.

[1] I. Barth, L. Friedland, and A.G. Shagalov, Phys. Plasmas 15, 082110 (2008).

Effect of Pair Breaking on Mesoscopic Persistent Currents Well above the Superconducting Transition Temperature

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We consider the mesoscopic normal persistent current (PC) in a very low-temperature superconductor with a bare transition temperature T_c^0 much smaller than the Thouless energy E_c. We show that in a rather broad range of pair-breaking strength, $T_c^0 < 1/\tau_s < E_c$, the transition temperature is renormalized to zero, but the PC is hardly affected. This may provide an explanation for the magnitude of the average PC's in the noble metals, as well as a way to determine their T_c^0's.

http://link.aps.org/abstract/PRL/v101/e057001

Bavli Pavel

Category #00-1

Bulk and surface melting HCP crystal - magnesium

P. Bavli, E. Polturak and Joan Adler

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Melting of metallic solids with FCC and BCC symmetry was previously studied [1,2,3] at the Technion. It was shown that melting is a heterogeneous effect that starts at a particular surface orientation. In the present study we extended these molecular dynamics simulations to a non-Bravais lattice, choosing magnesium which has a hexagonal closed packed (HCP) structure.. First we selected a potential for our system and verified it for bulk magnesium. Later we built samples with free surfaces in either the (0001) or (10-10) orientations. Both melted at about 970K, with one obvious difference, the less dense surface (10-10) started to melt sooner than the close packed surface (0001). The samples contained up to 11664 atoms in the bulk and up to 10240 in the samples with a surface. MPI was used to speed up the simulations, which were carried out on NANCO, the RBNI funded cluster at the Technion.

[1] A. Kanigel, J. Adler and E. Polturak, Int. Jou. Mod. Phys. C, **12**, 727 (2001)
[2] V. Sorkin, J. Adler and E. Polturak, Phys. Rev. B, **68**, 174102 (2003)
[3] V. Sorkin, J. Adler and E. Polturak, Phys. Rev. B, **68**, 174103 (2003)

http://phycomp.technion.ac.il/~pavelba

Beilis Itzhak

Category #07-1

Aluminum film deposition by an expanding plasma from a Hot Refractory Anode Vacuum Arc

I.I. Beilis, Y.Koulik, D. Arbilly and R.L. Boxman

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The metallic plasma jet generated in a Hot Refractory Anode Vacuum Arc (HRAVA) was used to deposit thin aluminum film on glass substrates. The arc was sustained between a water-cooled cylindrical aluminum cathode (30 mm diameter, 30 mm height) and a non-consumed cylindrical graphite anode (32 mm diameter, 30 mm height) with a 10 mm gap between them. The anode was heated by cathode spot generated plasma jets and was deposited by cathode material in the beginning of the arc. After some time, the cathode material re-evaporated from the hot anode, and in the developed HRAVA stage a plasma plume was generated that radially expanded away from the electrode axis. The experiment was conducted for time periods up to 135 s, with currents (I) of 120 and 145 A. Thin Al films were deposited on 76×25 mm2 glass substrates exposed to the plasma plume. A mechanical shutter was used to control the deposition onset and to set a 15 s exposure duration. The distance from the arc axis to the substrate was 110 mm. The film thickness was measured by a profilometer. The deposition rate of Al film increased with time during the arc, and reached a steady state of 0.9 μm/min at about 100 s for both arc currents and considered period of arc time. It was found that the deposition rate with I=145 A had a maximum of 1.1μm/min at 75 s. Maxima were not previously observed during HRAVA Cu film deposition. The maximum can be understood by considering that Al is a low melting temperature material with a much larger cathode spot macroparticle (MP) generation rate than in Cu arcs. The MPs deposited early during the arc on the cold anode surface, and evaporated from the anode during a relatively brief interval when the anode was heated to an appropriate temperature. The deposition rate then declined towards its steady-state value when a balance was achieved between impinging material and its evaporation at the hot anode surface.

Category #04-2

Anomalous magneto-transport properties of a two dimensional electron gas formed at the interface between the insulators SrTiO3 and LaAlO3

M. Ben Shalom, Cheuk-Wai Tai, Y. Dagan

School of Phisics & Astronomy Tel Aviv University

8 unit cells of LaAlO3 were epitaxially deposited on atomically flat TiO2 terminated SrTiO3 single crystals. A two dimensional electron gas is formed at the interface between these two insulating perovskites. As previously reported by other authors this gas has strong dependence on oxygen pressure during deposition. We study the magneto-transport properties of this interface at low temperatures and at field of up to 14 Tesla. Various scattering processes at this interface will be discussed.

Crystals and beyond

Shelomo I Ben-Abraham

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I discuss some current issues in crystallography and materials science. Since the discovery of quasicrystals there is an ongoing discussion on what is a crystal. The best up-to-date answer is that it is a solid whose Fourier spectrum has a pure point part, in other words, it shows Bragg peaks. On the other hand, there is growing interest in quasiregular heterostructures. These are layer structures artificially fabricated according to certain algorithms consisting mainly of substitution rules. Some of them are expected to have quite exotic diffraction patterns, such as a singular continuous spectrum.

Phenomenological Consequences of Modular Inflation

Ido Ben-Dayan[1], Ramy Brustein[2] and S. P. de-Alwis[2]

[1] *BGU*

[2] *University of Colorado*

We consider models of modular inflation at the SUGRA limit of perturbative string theory. The models are typically small-field and the inflaton rolls off an extremum for about a Planck distance. We prove that the Kahler potential determines whether inflation is possible at all for any superpotential. We then give a prescription on how to construct successful models, all of which share typical predictions of red spectral index, negligible gravitational waves (GW) and negligible running of the spectral index. If time permits we will demonstrate how to construct small field models with observable GW, contrary to the common lore.

http://arxiv.org/abs/0802.3160

Fabŕy-Perot interferometer in the Quantum Hall regime

Avee Bid, N. Ofek, M. Heiblum, Ady Stern, V. Umansky, D. Mahalu

Weizmann Institute of Science

We have measured Aharonov-Bohm/Coulomb blockade oscillations in a Fabŕy-Perot interferometer in the Integer as well as in the Fractional (ν = 1/3, 2/5) Quantum Hall regime. The device was patterned on a high mobility two-dimensional electron gas system using standard optical and electron beam lithography techniques. The measurements were carried out at a base temperature of 10mK using high frequency techniques. At ν = 2/5, when the inner channel is partially reflected (with the outer channel (1/3) being fully transmitted); the total transmission of the device oscillates as a function of magnetic field or modulation gate voltage. This is true also for integer filling fractions ν =2, 3, 4 when the interference is of a partially reflected lower lying channel (with the other channels being either fully transmitted or fully reflected). However, in the outermost channel of all filling factors (ν = 1/3, 2/5, 1, 4/3, 2, 3, 4, 5) we do not see any oscillations as a function of the magnetic field. This we interpret to be due to interplay between the magnetic field (which tries to modify the area of the compressible island inside the interferometer) and Coulomb energy (which prevents the density of quasiparticles within the island from building up indefinitely). The period of oscillations in modulation gate voltage in the inner channel of ν = 2/5 (partially partitioned) is found to be one-third of that observed in the second channels of the integer filling fractions which probably is an indication that the oscillations are due to the tunneling of quasiparticles of fractional charge 1/3. We repeated the measurements on a Fabŕy-Perot interferometer with an antidot in the middle. We find the oscillation period as a function of the voltage on the antidot corresponds to the voltage required to deplete a single electron from the two-dimensional electron gas underneath the antidot.

New mechanisms of spiral-pair-source creation in excitable media

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Excitable media are important in several areas: heart muscle, neurons, in the living body; chemical reactions such as the Belousov-Zhabotinsky, combustion; ecology; electrical circuits, etc. They are characterized by the following: when not stimulated or when the stimulus is below a certain threshold they remain stationary. Stimulation above the threshold usually creates a single pulse which propagates through the medium without change of shape. Following that, the system returns to its stationary state. No additional waves are created. Being an excitable medium, the heart tissue can sustain at normal conditions, the passage of only a single pulse, to be followed by a refractory period during which no additional pulse can be transmitted throughout the medium. However, in heart dysfunction situations an "ectopic" spiral, or spiral pair source happens to appear at some location in the heart. Such a source repeatedly emits pulses which interfere with the regular functioning of the heart, and can lead to severe and even deadly malfunctions. Ectopic spirals in the heart are commonly associated with different disturbances in the heart beat among which the problem caused by a spiral pair is specified as a "figure-eight reentry". In this research we present two new methods to create spiral pair sources which depend only on the medium geometrical structure and not on external stimuli. Such geometrical shapes can appear in the heart tissue due to a birth defect or to scars which arise as a result of heart attack. A profound understanding of the dynamics of such a system can lead to better understanding of the processes occurring in the heart and even to the formulation of solutions. We solve numerically the FitzHugh-Nagumo equation in a two dimensional domain which is a simple nonlinear model of the heart, with different sets of coefficients for different regions in and conditions of the heart. We choose a special geometry composed of a circular region adjoined externally by two opaque walls (of very low excitability).We found that this special geometry can lead to the formation of an independent source of double spirals. We observed two different types of sources. The first one is a "Flip-Flop" type of wave which travels back and forth across the circular region. The second type is a "point" source which forms at the edge of the circular region. This type, however, is formed after the passage of a synchronized sequence of several exciting waves.

Controllable Metallic Quantum Dot

L. Bitton, A. Frydman, R.Berkovits

Bar-Ilan University

We have developed a novel method for measuring the conductance versus gate voltage of a metallic nano-dot having variable coupling to large electric leads. These systems exhibit periodic Coulomb blockade peaks which strongly decrease in amplitude as the dot-lead coupling is increased. At the same time additional periodic peaks appear and become the dominant feature for strong coupling. While the Coulomb blockade peaks are relatively insensitive to the application of source-drain voltage, V_SD, in the regime where V_SD is smaller than the charging energy, the additional peaks drop exponentially with V_SD. We discuss possible scenarios for these results which seem to be associated with a new regime of single electron transport phenomena.

Beyond MSSM Baryogenesis

Kfir Blum and Yosef Nir

Weizmann Institute of Science

Taking the MSSM as an effective low-energy theory, with a cut-off scale of a few TeV, can make significant modifications to the predictions concerning the Higgs and stop sectors. We investigate the consequences of such a scenario for electroweak baryogenesis. We find that the window for MSSM baryogenesis is extended and, most important, can be made significantly more natural. Specifically, it is possible to have one stop lighter than the top and the other significantly lighter than TeV simultaneously with the Higgs mass above the LEP bound. In addition, various aspects concerning CP violation are affected. Most notably, it is possible to have dynamical phases in the bubble walls at tree level, providing CP violating sources for Standard Model fermions.

http://arxiv.org/PS_cache/arxiv/pdf/0805/0805.0097v2.pdf

Crystal Structure in High Dimensions

Shmuel Elitzur [1], Boaz Karni 1[1], Eliezer Rabinovici [1]

[1] *Hebrew University, Jerusalem Israel*

In a paper from 1978, S. Alexander and J. McTague showed that according to Landau's theory of phase-transition, monoatomic crystals in a 3-dimensional space, should have bcc structure, a result that was confirmed in experiments. Since string theory calls for a high-dimensional space, we check if this results holds in more than 3 dimensions, and try to gain some insight to the case of compact and curved extra dimensions.

Bormashenko Edward

Category #00-2

Measurable values, numbers and fundamental physical constants: Is the Boltzmann constant a fundamental physical constant?

Edward Bormashenko, Avigdor Sheshnev

Applied Physics Faculty, Ariel University Center of Samaria, 40700, Ariel, Israel.

The status of fundamental physical constants is discussed. The nature of fundamental physical constants is cleared up, based on the analysis of the Boltzmann constant. A new definition of measurable values, numbers and fundamental physical constants is proposed. Numbers are defined as values insensitive to the choice of both units and frames of reference, whereas fundamental constants are classified as values sensitive to transformations of the units and insensitive to transformations of the frames of reference. It is supposed that a fundamental physical constant necessarily allows diminishing the number of independent etalons in a system of units.

Brandhuber Andreas

Category #01-1

Hidden structures in gauge theory and gravity

A. Brandhuber

Queen Mary, London

In recent years several unexpected structures have been uncovered in supersymmetric quantum field theories by studying multileg or multiloop scattering amplitudes. In my talk I will describe examples of such novel structures: cross order relations in higher loop S-matrix elements in N=4 SYM and N=8 SUGRA, a novel duality between Wilson loops and amplitudes which has intriguing relations to the AdS/CFT correspondence, and dual superconformal symmetry.

Lattice explorations of QCD flux-tubes/strings, and their large-N limit

Barak Bringoltz

Seattle

I will present recent lattice explorations of the flux-tubes that stretch between quarks and anti-quarks in SU(N) gauge theories, and focus mostly on the 2+1 dimensional case. Using a large variational basis we study the way the spectra of these flux-tubes behave as a function of their length, energy, and electric flux. This allows us to make detailed and precise comparisons with several theoretical predictions. For one unit of flux, we find that our data can be described by a covariant string theory (Nambu-Goto) with an unnaturally small correction down to very short distance scales, and possibly on all distance scales at large-N. Moving up in energy, we see that strings that stretch between k quarks and k anti-quarks (and that carry k units of flux), are also in this bosonic universality class, but have larger corrections. I discuss how our results compare with the predictions of the Karabali-Kim-Nair approach, how they depend on N, and how the flux-tubes' spectra falls into sectors that belong to particular irreducible representations of SU(N). I conclude with a certain observed pattern of systematic deviations from the Nambu-Goto prediction, and with what it can teach us about the detailed nature of the interactions in the effective low energy theory. We have searched for, but not found, extra states that would arise from the excitation of the massive modes presumably associated with the non-trivial structure of the flux tube.

Building and Testing Small Diode Pumped Solid State Nd:YVO_4 Laser

A. Brodsky, M. Hakham-Itzhaq and C. Bruma

Applied Physics Department
Ariel University Center of Samaria

We have built and tested the characteristics of small and low cost Diode Pumped Solid State (DPSS) Nd:YVO_4 laser as an advanced future experiment for undergraduate students in Applied Physics. Our DPSS laser works quite well with decent power and stability even with second harmonic generation mode lasing generating several tens of milliwatts power at 532 nm. One has to make clever adjustments between the diode laser power and the Nd:YVO_4 and Potassium Titanyl Phosphate (KTP) crystals size. Thermal heating affects the system components and perturbs the stability of the lasing power. It must be minimized for getting long lived high power and reliable lasers. Stable power supply is needed for controlling the current stability of the laser diode.

Statistical properties of polymers attached to hard probes

Roy Bubis[1], Yacov Kantor[1] and Mehran Kardar[2]

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In single-molecule experiments, force is applied to a polymer via a probe attached to it, and the response of the polymer is measured. Usually in such experiments the size of the probe is of the order, or larger than the investigated polymer. We study theoretically the influence of circular and parabolic probes on the properties of a polymer attached to them. The main properties of interest are the separation between the free end of the polymer and the probe, the response of the endpoint to an external force, and the number of available configurations of the polymer. These properties depend on the ratio between the mean polymer size and the size of the probe. In the limiting cases of very high or very low ratio the situation can be characterized analytically. We perform numerical simulations of model polymers with and without self-avoiding interactions on discrete lattices in two and three dimensions. The numerical results provide a good description of the system over a broad range of parameters.

An interesting observation is in regard to the response of the polymer endpoint to an applied force, as the presence of the probe induces anisotropy in the force-displacement characteristics. The prefactor of one of the force constants exhibits non-monotonic behavior when the size of the polymer is of the same order as the probe. Our results suggest that probes exert an important influence on the polymers, and that theoretical interpretation of the experimental results should account for such factors.

Microdrilling of polymer films.

Gilad Chaniel

The Ariel University Center of Samaria, Ariel, 40700, Israel

The practical method of drilling micrometric holes in thermoplastic polymers is presented. We used the water as a tunable convex lens in order to focus the laser beam. Our goal was manufacturing holes in the scale of hundred microns in several kinds of polymer films, including polypropylene, polyethylene, polysulfone, polyvinylidene fluoride, TPX. The focal point of the drop was calculated. A scaling law describing heating of the drilled film was developed. The holes with a diameter of 100 micro-meters were drilled with the solid state laser at the wavelength 532 nm with a power of 0.2 W. The wood support plays an important role in drilling.

Using Geant4 based simulations in Positron Annihilation Spectroscopy experiments

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Positron Annihilation Lifetime Spectroscopy (PALS) is an established method that allows characterization and quantification of point defects inside a material, as small as vacant atoms, with high sensitivity. Point defects include mono-vacancies, vacancy clusters, voids and bubbles – vacant defects with gas atoms inside them. The basic concept behind PALS is that point defects in the material act as positron (e+) traps with low electron density. Thus, the lifetimes of trapped positrons are enlarged compare to those in the undamaged bulk region of the material. The e+ lifetime is measured via the time difference between two photons. One photon is emitted almost simultaneously with the positron from a 22Na source and carries 1,274keV. The second is one of the two photons, which are emitted from the e+-e- annihilation process and, carry 511keV. A spectrum of positron lifetimes include contributions from the material under study and its point defects, as well as from annihilation processes in the surrounding materials, such as the source holder and the sample housing. The lifetime spectrum is fitted to a sum of decaying exponentials in convolution with the time-resolution function that characterizes the measuring system. In order to extract correct mean lifetime values of the positrons in the studied material it is crucial to define as many parameters of the fit in an uncorrelated way. One set of parameters: The relative intensity of the different contributions to the lifetime spectrum, can be defined using a simulation program. This program should account for the range of positrons in the different materials and backscattering processes. The simulation output is the relative intensities of annihilation processes, in the sample, source holder and other surrounding materials. For this purpose we examine the GEANT4 simulation program. In the work presented here we evaluate its ability to correctly calculate these relative intensities. We examine it compare to various benchmark cases from the literature, EGS5 simulation, and compare to our previous measurements.

Dynamics of condensed Bose particles in a driven few site system, and the many body Landau-Zener transition

Maya Chuchem

Department of Physics, Ben-Gurion University, Beer-Sheva 84105, Israel

We consider the dynamics of condensed Bose particles in a two site system, with emphasis on the occupation statistics. Considering first a time independent Bose-Hubbard model, we explore the dependence of the Bloch-Josephson oscillation on the state preparation. Proceeding with the many-body version of the Landau-Zener problem, we identify and analyze the fingerprints of the adiabatic-diabatic-sudden crossovers.

[1] K. Smith-Mannschott, M. Chuchem, M. Hiller, D. Cohen, and T. Kottos, "Counting Statistics for the Wavepacket Dynamics of a single bosonic josephson junction", (in preparation).
[2] E. Boukobza, M. Chuchem , D. Cohen , and A. Vardi, "Phase sensitivity of phase-diffusion between weakly coupled Bose-Einstein condensates", (in preparation).

http://physics.bgu.ac.il/~chuchem/tlk_cst.pdf

Optically-induced quasi-phase-matching in high-harmonic generation

Oren Cohen

Physics Department, Technion—Israel Institute of Technology, Israel

Weak counter-propagating pulse trains or multiple quasi-cw waves can induce complex amplitude and phase modulated structures in the high-harmonic field. These “photonic” structures can be used for characterizing, manipulating, and enhancing the efficiency of the high-harmonic generation process

Atomic Scale Visualization of Electronic Structure in the Cuprate Superconducting and Pseudogap States

J. C. Séamus Davis

Cornell University and Brookhaven National Laboratory

The introduction of spectroscopic imaging scanning tunneling microscopy (SI-STM) has revolutionized our ability to image complex electronic quantum matter at atomic scale. I will review here the advances in visualization and understanding of the electronic structure of cuprate superconductivity. A comprehensive and consistent picture of this highly complex state of electronic matter emerges. It reveals a fundamentally bipartite electronic structure with heterogeneous quasi-localized high-energy states dominated by dopant-induced electronic disorder, and spatially homogeneous low energy momentum-space states which are the excitations of Cooper pairs. We explore the evolution of all these phenomena as the carrier density of hole-doped cuprates is reduced from the robust high temperature d-wave superconductor towards the non superconducting Mott insulator phase. We also use high precision Fourier-transform scanning tunneling spectroscopy (FTSTS) to visualize the momentum-space excitations in the mysterious 'pseudogap' phase of the cuprates. We report a continuous temperature dependence of the complete 'octet' of quasiparticle interference signals from $T<0.1T_c$ to $T>1.25T_c$. A comprehensive and detailed understanding of all states with $E<50$meV and for a full reciprocal unit cell is achieved. Using these data, we can identify definitively the low temperature state of the cuprate 'pseudogap' regime which dominates transport and quantum oscillation phenomena. Finally we explore the distinct identity of the higher energy excitations which dominate the high temperature thermodynamic characteristics of these materials.

Dekel Gali

Category #11-1

Non-Linear Dynamics of BEC Macroscopic tunneling.

G. Dekel, O.V. Farberovich, A. Soffer, C. Stucchio, V. Fleurov

Tel Aviv University,
Rutgers University

I present published and preliminary results, obtained from analytical and numerical study on dynamics of macroscopic tunneling, in systems governed by the Gross-Pitaevskii or Non-Linear Schrodinger equation. The key result is the predicted emission of a short pulse ('blip') of matter density (light intensity) formed in the course of tunneling in wave-guided light or trapped BEC. This phenomenon, observed under various conditions, for nonlinearities of different signs, zero nonlinearity included, originates from tendency to shock wave formation, and may initiate a controllable emission of propagating bright soliton. I then present follow-up results that show pulsations of matter (light) remaining within the trap and a proposed mechanism to inducing emission of sequential pulses by properly narrowing the trap, therefore realizing Pulsed Atom Laser. I then allude on preliminary results from a new research on tunneling from a cigar shaped trap, and discuss further research objectives.

Critical swelling of fluctuating capsules

Emir Haleva, Haim Diamant

School of Chemistry, Tel Aviv University

In many natural transport processes the solute molecules to be transported are encapsulated in semipermeable, flexible membrane vesicles of micron size. We study the swelling of such fluctuating capsules, as the number of encapsulated particles is increased, or the concentration of the outer solution is decreased. The approach to the maximum volume-to-area ratio and the associated buildup of membrane tension involve a continuous phase transition and follow universal scaling laws. The criticality and its features are model-independent, arising solely from the interplay between volume and surface degrees of freedom.

Are cuprates BCS superconductors?

I. Diamant, R.Beck and Y.dagan

Tel-Aviv university

In electron-doped high temperature superconductors the superconducting gap is not obscured by the pseudogap, which does not exist in these compounds. The superconducting properties of these cuprates can therefore be studied directly by simple tunneling spectroscopy. We report a detailed study of lead/lead oxide/ $Pr_{2-x}Ce_xCuO_{4-\delta}$ (PCCO) junctions for x varying from x=0.125 (very under-doped) to x=0.19 (heavily over-doped). By fitting the tunneling spectra we could follow the superconducting gap amplitude both as a function of doping and temperature. Our results show a BCS like temperature dependence for the superconducting gap even in the very under-doped regime. We note that the gap amplitude follows the doping dependence of the critical temperature. This is in strong contrast with the celebrated doping dependence of the pseudogap for the hole-doped cuprates.

Category #10-2

Mapping and assessment of epileptogenic foci using frequency-entropy templates

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Much effort has been devoted to develop analysis methods of subdural EEG and depth electrodes recordings of epileptic patients being evaluated for surgical resection. The general approach is to investigate the brain activity at different locations as recorded by the different electrodes in an attempt to localize the epileptogenic focus or foci. We present a method that is based on the temporal dynamics combined together with the spectral distribution of energy in terms of frequency-entropy (F-E) templates. The F-E templates are based upon maximum information partitioning into a set of frequency bands. The F-E template is calculated by wavelet packets decomposition followed by an application of the best basis algorithm minimizing Entropy cost function. A comparison between two F-E templates is performed by a special quantitative similarity measure according to the overlap in the partitioning into frequency bands and weighted by the bands' Entropy. For localization of the epileptogenic foci the templates of each electrode during the interictal period are compared with a representative template evaluated from the ensemble of all electrodes during the ictal period. We suggest associating the locations that reveal high template similarity to the ictal template with the epileptogenic foci. To test the method and the underlying assumptions we perform retrospect analysis of the recorded brain activity, both from grid and depth electrodes, from eleven patients suffering from medically intractable epilepsy. Application of the ictal-interictal similarity analysis revealed regions in the epileptic brain in which the interictal characteristics are highly similar to those of the ictal period. To asses the foci we compared the interictal templates of the different electrodes to each other forming interelectrode similarity

matrices. Investigation of these similarity matrices revealed the existence of a single distinct subcluster of electrodes with high interelectrode similarity in the brain activity of seven patients (type I activity), and the existence of multiple high interelectrode similarity subclusters in the activity of four patients (type II activity). Comparisons of the analysis results to the medical presurgical evaluations and the outcomes of the surgical resections suggest that the method may be helpful in the chronic evaluation of the epileptogenic zone before operation, and in some cases (type I activity) without the need to wait for seizures to occur.

Category #01-2

Physical implementation of protected qubits

Benoit Doucot

Laboratoire de Physique Theorique et Hautes Energies, CNRS UMR 7589, Universite Paris 6 et 7, Paris, France

One of the most serious problems raised by attempts to build devices based on qubits is the decoherence induced by the residual couplings between these small systems and their environment. Instead of trying to eliminate this quantum noise, an alternative strategy has been proposed some years ago by Kitaev, namely to build quantum systems which would be to a large extent insensitive to external perturbations. This is achieved by a deeply non-local coding of the information in terms of many-body wave-functions.

Dvash Eyal

Category #03-2

Dendritic Instability of Magnetic Flux in Anisotropic Type-II Superconducting Slab.

E. E. Dvash, I. Shapiro and B. Ya. Shapiro

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In many experiments, when a superconducting sample is subjected to an external magnetic field increasing with time, the thermomagnetic instability arises. In some experimental situations the instability is uniform and the flux penetrating into the sample has the shape of a uniform shock wave. However, in some cases, the instability is nonuniform and the flux front advances with the shape of fingers. The type of instability is determined by the competition between the motion of flux and the heat diffusion. According to the existing theory, in an isotropic slab, the nonuniform instability emerges only for a high ramping rate of the external magnetic field. We present theory showing that a strong anisotropy of the thermal conductivity and of the vortices viscosity significantly affect the instability onset. Applying a linear analysis of Maxwell and the thermal diffusion equations, the criteria for the nonuniform instability are obtained. In particular, it is predicted that in a strongly anisotropic superconducting slab the nonuniform, fingering type instability emerges for much lower ramping rates of the external magnetic field then in the isotropic case.

A new THz FEL Development Project

Egor Dyunin, Yuri Lurie*, Yosi Pinhasi*, Avraham Gover

Tel-Aviv University,
**Ariel University Center of Samaria*

We present a new project aimed towards the development of a superradiant Free Electron Laser (FEL) in the THz-frequency range with advanced performance parameters. The goal of the first stage of research and development is to construct an experimental RF gun with beam parameters and flexible operation pushing the present state of the art of technology. The RF gun will be subsequently used by the Israeli FEL group for the development and study of coherent THz radiation sources. As such, its energy and pulse length are critical parameters for enabling operation of high power THz frequencies. At this work we introduce most important operating parameters of the future THz radiation set-up.

Category #02-2

Dual-Transceiver Quantization Can Improve Error Performance in CDMA

Hadar Efraim[1], Nadav Yacov[1], Ori Shental[2] and Ido Kanter[1]

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A K-user direct-sequence spread-spectrum code-division multiple-access (CDMA) system with $(q<<log_2 K)$ - bit baseband signal quantization at the demodulator is considered. It is shown that additionally quantizing the $K+1$ level output signal of the CDMA modulator into q bits improves significantly the average bit-error performance in a non-negligible regime of noise variance, $\sigma 2$, and user load, β, under various system settings, like additive white Gaussian noise (AWGN), Rayleigh fading, single-user detection, multi-user detection, random and orthogonal spreading codes. For the case of single-user detection in random spreading AWGN-CDMA, this regime is identified explicitly as $\sigma<\gamma(q)\sqrt{\beta}$, where $\gamma(q)$, is a certain pre-factor depending on q, and the associated BER improvement is derived analytically for $q=1,2$. For the other examined system settings, computer simulations are provided, corroborating this interesting behavior.

Persistence in Reactive-Wetting Interfaces

Yael Efraim and Haim Taitelbaum

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The nontrivial persistence exponent describes a power law decay of the probability of a fluctuating variable to stay above or below a certain reference level, $p(t) \sim t^{-\theta}$. The persistence exponent has been calculated in the last decade for a wide range of theoretical, numerical and experimental systems. We study the persistence probability in propagating reactive-wetting interfaces of a mercury droplet ($\sim 150 \mu m$) spreading on a thin ($\sim 4000 Å$) flat silver substrate in room temperature. We calculate the persistence exponent and study its relation to well known exponents such as the growth exponent β, which describes the dynamic growth of the reactive-wetting interface width. Our results show that there are three kinetic regimes in our system. In the first one, while the interface width itself is not yet growing, the persistence exponent is $\theta = 0.5 \pm 0.05$, which is typical for random walk behavior. In the second time regime, there is an effective growth of the interface width, with growth exponent $\beta = 0.68 \pm 0.07$, and the value of θ is $\theta = 0.37 \pm 0.05$. In this time regime, the well known relation, $\theta = 1 - \beta$, seems to hold for our experimental system. The third time regime is where the interface width saturates, and the roughness exponent is measured. In this regime, the persistence exponent value is $\theta = 0.47 \pm 0.01$, which again reflects a random walker behavior. The results are compared with two sets of numerical simulations, based on two models, the QKPZ (Quenched Kardar-Parisi-Zhang) equation and the Ising model in zero temperature.

Elastic theory of unconstrained non-Euclidean plates and shells

Efi Efrati Raz Kupferman and Eran Sharon

Racah institute of physics
Hebrew University of Jerusalem

Non Euclidean bodies possess no stress free configuration, thus exhibit residual stress and nontrivial equilibrium configurations in the absence of external constraints. An appropriate hyper-elastic treatment of such bodies is achieved by measuring strain with respect to a reference metric rather than a reference configuration. Applying this formalism to thin sheets, we derive a reduced 2D elastic theory, which enables us to treat thin bodies which are neither plates nor shells in the classical sense. In this reduced theory the elastic energy is given as a function of the mid-surface properties (first and second fundamental forms). We show how prescribing a reference metric for a three-dimensional thin body, corresponds to setting a reference first fundamental form (2D metric) and a reference second fundamental form (curvatures) on the mid-surface. When the prescribed reference curvatures and 2D metric do not comply with one another, the system is frustrated (non-Euclidean). Such systems exhibit various phenomena such as spontaneous buckling and the emergence of a boundary layer.

Magnetars

David Eichler

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Magnetars - neutron stars with ultrastrong magnetic fields - were so identified 10 years ago. The progress of the field, including the more recent development of magnetar seismology, is reviewed. Many different diagnostics indicate that the magnetic fields of magnetars can be as high as 10^15 Gauss, which is enough to qualitatively change quantum electrodynamics.

From bioinformatics to systems biology: what's the physicist's role?

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Tel-Aviv University

In recent years, Molecular Biology is undergoing a true revolution. A number of technological breakthroughs enable data generation many orders of magnitude faster than ever. In parallel with this revolution in experimental methods, the emerging fields of bioinformatics and systems' biology aim at filling the huge gap in appropriate quantitative analysis methods. I will try to give a flavor of the problems facing us, concentrating on the role currently played by physicists' working in these fields, and where else can we go.

How to determine Tc for disordered superconducting films

Amir Erez, Yigal Meir

Ben Gurion University

We go beyond the standard mean-field approach to superconductivity to account for thermal phase fluctuations. Using a classical Monte Carlo technique, we evaluate several physical quantities, such as the helicity modulus (the sensitivity of the system to boundary conditions), correlation functions and the vorticity. This allows us to determine the critical temperature and probe the behavior of the system near the superconductor-insulator phase transition. We compare to recent experiments and to predictions from Kosterlitz-Thouless theory.

Particle Dynamics on a Ring Affected by Noisy Environments

Yoav Etzioni and Baruch Horovitz

Physics Department, Ben-Gurion University

We study a model of particle confined to a ring geometry, and affected by a noisy dissipative environments. A semiclassical Langevin equation for the particle dynamics is derived for environments that are either Cladira Legget (CL) type, or for the more applicable case of a dirty metal (DM). We focus on quantum effects at zero temperature. Solutions of the CL case at zero temperature show that the current is enhanced by the noise, and that correlation functions decay in time, indicating dephasing at zero temperature.

The Physics of Modification of the Maxwell-Boltzman Velocity Distribution

Netzach Farbiash[1,2] and Raphael Steinitz[1]

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The well established presence of superthermal tails in the velocity distributions are used by Scudder and others to model coronal heating due to "velocity filtering". These models, however, do not address the problem of how, in the first place, super thermal tails arise. Here we explore the evolution of a Maxwellian distribution into a distribution with a superthermal tails due to the combination of gravity and the diverging magnetic fields embedded in the plasma.

Cell Shape Dynamics with Sub-pixel Accuracy

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We use single cell phase-contrast and fluorescence time-lapse microscopy to monitor the morphological changes during the division of E. coli [1-3]. To bypass the limitations of optical resolution, we process the images using pixel intensity values for edge detection. This allows determining the location of the cell edge with 20 nm precision. We study the dynamics of the constriction width, W, and find that its formation starts shortly after birth much earlier than can be detected by simply viewing phase-contrast images. A simple geometrical model is shown to reproduce the behavior of W(t). Moreover, the time-dependence of the cell length, L(t), consists of three regimes. The growth rates in the different regimes are related to each other and to the parameters of our model.

[1] G. Reshes, S. Vanounou, I. Fishov and M. Feingold, 2008, Cell shape dynamics in E. coli, Biophys. J. 94, 251-264.
[2] E. Itan, G. Carmon, A. Rabinovitch, I. Fishov and M. Feingold, 2008, The shape of non-septated E. coli is asymmetric, Phys. Rev. E. 77, 061902.
[3] G. Reshes, S. Vanounou, I. Fishov and M. Feingold, 2008, Timing the start of division in E. coli: single cell study, Phys. Biol. 5, 046001.

Category #01-2

Transport and localization in periodic and disordered graphene superlattices

Valentin Freilikher [1], Yury P. Bliokh [2], Sergey Savel'ev [3], Franco Nori [4]

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Recent results, both theoretical and experimental, led to the surprising conclusion that there is no localization in disordered graphene, even in the one-dimensional case, i.e., when the random potential only depends on one coordinate. In this talk, we demonstrate that this conclusion, if taken unreserved, could be misleading. We show that although disorder cannot make a graphene sample a complete insulator, and there is always a minimal residual conductivity (an indication of delocalization), a well-pronounced localization could nevertheless take place, i.e., there exist a (quasi)-discrete spectrum with exponentially localized eigenfunctions. The charge transport in one-dimensional graphene superlattices created by applying layered periodic and disordered potentials is addressed and contrasted to the optical properties of dielectric structures composed of traditional (right-handed, RH) dielectric and left-handed (LH) metamaterial layers. It is shown that relatively weak disorder drastically changes the transmission properties of the underlying periodic configurations. The transport and spectral properties of disordered grapheme structures are strongly anisotropic. In the direction perpendicular to the layers, the eigenstates in a disordered sample are delocalized for all energies and provide a minimal non-zero conductivity, which cannot be destroyed by disorder, no matter how strong this is. However, along with extended states, there exist discrete sets of angles and energies with exponentially localized eigenfunctions (disorder-induced resonances). Depending on the type of the unperturbed system, the disorder could either suppress or enhance the transmission. Most remarkable properties of the transmission have been found in disordered graphene systems built of alternating p-n and n-p junctions, in which the transmission has anomalously narrow angular spectrum and, in some range of directions is practically independent of the amplitude of fluctuations of the potential.

Fridman Moti

Category #05-2

Fiber Lasers with Increase Output Brightness

Moti Fridman, Vardit Eckhouse, Micha Nixon, Nir Davidson, and Asher A. Friesem

Weizmann Institute of Science

We will consider three methods for increasing the output brightness from fiber lasers. Specificaly, they involve efficient generation of purely radially or azimuthally polarized light, coherent addition of high order modes and, finaly, simultaneous spectral and coherent additions of a two-dimensional array of lasers. The principles of operation, details of experimental configurations, procedures, theoretical models and results will be presented.

Category #09-2

Adaptive response from state-dependent inactivation

Tamar Friedlander [1,3] and Naama Brenner [2,3]

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Biological systems responding to stimuli often display adaptive responses. The phenomenological hallmark of these dynamics is that an abrupt change in stimulus elicits a rapid sharp response followed by a slower relaxation to steady state. These responses are of interest both with regard to their functionality - presumably an optimization of dynamic range in signal processing - and with regard to their underlying mechanisms. Here we suggest a theoretical framework unifying various biological adaptive systems, and show how apparently distinct systems are in fact special cases of a common fundamental model. We study a simple biochemical model which gives rise to adaptive behavior. The model comprises an ensemble of systems (such as a protein) having two functionally distinct states with input-dependent transitions between them, and an additional degree of freedom which can inactivate the responding unit and render it temporarily unavailable to respond to the stimulus. The fundamental ingredient in the model is that transitions to unavailability are state-dependent (and generally input-independent). This architecture is found in diverse biological systems such as ionic channels, chemotactic receptors and photoreceptors, and provides a coarse-grained description of more complex systems such as gene expression. We show that this general 3-state model can give rise to different kinds of adaptation including precise, exponential and power-law. The unavailable population acts as a buffer to register the system's history of activity and induces effective feedback on the dynamics. The kinetics of recovery from unavailability determines the effective memory kernel while the type of state-dependence determines the sign of feedback - either negative or positive. Exact adaptation emerges as a special case if the recovery kinetics is saturated. Asymmetric dynamics in response to step stimuli, as often observed in biological systems, arises as a natural property of the model. The suggested framework highlights a fundamental analogy between the dynamics of ion channels, membrane receptors and possibly other biological molecules, in spite of many apparent differences.

http://www.technion.ac.il/~tamarf

Fruchtman Amnon

Category #07-2

The blue mode in Helicon plasma

Amnon Fruchtman

H.I.T.-Holon Institute of Technology

In Helicons, radio-frequency waves penetrate as whistler waves into a magnetized plasma and provide the energy to sustain the discharge. When the wave power is high, the plasma density strongly peaks at the center of the discharge. In an argon discharge, a blue mode is excited due to a dominant radiation of ArII lines. I will attempt to explain the excitation of the blue mode as resulting from both enhanced ionization and reduced ambipolar cross-field diffusion at the center of the discharge. The reduced diffusion coefficient at the center is due to the temperature dependence of classical conductivity and due to neutral depletion [1]. The effect of nonuniform diffusion coefficient here is somewhat similar to its effect in forming a diffusion barrier and an enhanced-confinement mode in Tokamaks. [1] A. Fruchtman, G. Makrinich, J.-L. Raimbault, L. Liard, J.-M. Rax, and P. Chabert, Phys. Plasmas 15, 057102 (2008). Partially supported by the Israel Science Foundation (Grant No. 864/7)

Frydel Dariusz

Category #09-2

Short time Dynamics in Quasi-One-Dimensional (Q1D) Colloidal Suspension

Derek Frydel, Haim Diamant

Tel Aviv University

Because of strong confinement of channel walls, in a Q1D colloidal suspension the vorticity, which determines hydrodynamic interactions in an unbounded fluid, fails to develop beyond the length comparable to the channel height. On the other hand, the contribution of propagating sound to the hydrodynamic interaction, which is essentially unimportnant for an unbounded fluid, due to confinement of channel walls changes to a diffusive bahavior. With help of lattice-Boltzmann simulation results, we investigate the role of the diffusive sound in the collective short dynamics of a Q1D suspension.

Spatial and temporal organization of telomeres in the nucleus

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The human genome contains tenth of thousands of genes that are organized in chromosomes and packed in the nucleus of the cell in a non-random manner. It is not known by now, whether there is structure in the form of an organizing nuclear matrix or whether there is self-organization, perhaps governed only by the laws of molecular crowding.

Study of the dynamics of telomeres within short and long time scales and their organization in the nucleus volume can shed light on these questions. We are studying the organization of the genome in normal and cancer cells by observing the telomeres and the telomeres dynamics. These studies require combining three-dimensional microscopy, image processing algorithms and novel physics methods. By measuring a time sequence of three dimensional (3D) images, the position of each telomere at each time point can be found.

By analyzing the telomere images (single-particle tracking), the spatial organization, movement, diffusion coefficient, and the confined volume are found. We found that telomeres diffusion is anomalous (subdiffusion) at short time scales (10^{-2} sec) and changes to approximately normal diffusion at longer time scales. We overall measured the diffusion at ~6 orders of magnitude of time, 10^{-2} – 10^{4} sec. In the time scale of ~10^{3} sec, the results indicates random motion of the telomeres in a confined region, and both diffusive transport and anomalies motion are identified.

Gerber Alexander

Category #04-1

Magnetization driven metal – insulator transition in strongly disordered magnetic semiconductors.

O. Riss, A. Gerber, I.Ya. Korenblit

Tel Aviv University

We report on the metal-insulator transition in disordered Ge:Mn magnetic semiconductors characterized by magnetic ordering, magnetoresistance reaching thousands of percents and suppression of the extraordinary Hall effect by a magnetic field. Magnetoresistance isotherms can be scaled onto a universal curve with temperature and doping dependent scaling parameters. We argue that the transition to the insulating state is related to a strongly inhomogeneous distribution of magnetization that leads to localization of charge carriers.

Category #01-2

The mystery of the connection between the photon wave function and Maxwell's equations

Alexander Gersten

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Few derivations exist of wavefunctions for zero-mass particles with an arbitrary spin[1],[2]. The spin one case can be identified with the photon. We have shown that for a particular 3x3 matrix representation of spin one photon vector wavefunction P the substitution $P = E - iB$ generates the free field Maxwell's equations without sources and currents[2]. Above E and B are the electric and magnetic fields respectively. Up to the present time this substitution did not result from first principles and remains a mystery. Its resolution may shed new light on quantum physics. It is interesting to note that the Planck constant cancels out in free zero-mass wave equations. This is the reason that Maxwell's equations were not recognized as the first quantized one-photon equation.

[1] A. Gersten, "Quantum equations for massless particles of any spin". Found. Phys. Lett., 13, 185-192, 2000.
[2] A. Gersten, "Maxwell equations as the one-photon quantum equation". Found. Phys. Lett. 12, 291-8, 1999.

Quantum Information studies with trapped ions and flying photons

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The internal states of trapped ions are a promising candidate system for quantum information processing and storage. The polarization states of photons are good carriers for quantum information transfer over long distances. Here we describe an experimental setup in which quantum information studies will be performed using both the 5s2S1/2 Zeeman states of trapped Sr+ ions and the polarization states of spontaneously scattered photons as quantum bits (qubits). Ions are trapped in an ultra high vacuum environment (~10-11 Torr) by a linear RF Paul trap. With an ion-electrode distance of 275 um, 20 MHz RF frequency and various RF amplitudes and end-cap voltages the trap axial (radial) frequency varies between 0.2-1.2 (0.5-3) MHz. Laser cooling and Resonance fluorescence on the 5s2S1/2-5p2P1/2 transition (422 nm) are observed. Ions are imaged with a resolution of 0.8 um on either a CCD camera or two PMTs detecting photons of different polarization states. Magnetic field noise in the ions vicinity is actively stabilized to a few uGauss level, in order to achieve a relatively long coherence time (T2). A 405 nm external cavity diode laser is used to coherently manipulate the ion-qubit via stimulated Raman transitions. Work is done to lock and narrow the frequency of a 674 nm laser down to a bandwidth below ~1 kHz in order to shelve one of the 5s2S1/2 Zeeman states on the 5d2S1/2-4d2D5/2 quadruple transition, thus enabling fluorescence selective state detection. With this set-up we will study ion-photon entanglement both as a source of decoherence as well as an information resource.

Shot noise and noise power spectrum for tunneling through a quantum dot in the Kondo regime

Dotan Goberman

Racah Institute of Physics, The Hebrew University

The charge-current and spin-current noise power spectra are calculated for tunneling through an ultrasmall quantum dot in the Kondo regime. Modeling the dot by an infinite-U Anderson model, we use the noncrossing approximation to formulate the current-current correlation function for arbitrary frequency and voltage bias. Our formulation fulfills all the basic requirements of the current-current correlation function, including current conservation and the recovery of the fluctuation-dissipation theorem at zero frequency and zero bias. The full temperature, voltage and frequency dependences of the noise are analyzed, and the significance of the Kondo correlations that develop are discussed. Deficiencies of the slave-boson mean-field theory for calculating the noise are pointed out.

Category #05-2

Raman Spectral Signatures as Conformational Probes of Biomolecules

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A first application of ionization-loss stimulated Raman spectroscopy (ILSRS) for monitoring the spectral features of four conformers of a gas phase neurotransmitter (2-phenylethylamine) is reported. The Raman spectra of the conformers show bands that uniquely identify the conformational structure of the molecule and are well matched by density functional theory calculations. The measurement of spectral signatures by ILSRS in an extended spectral range, with a relatively convenient laser source, is extremely important, allowing enhanced accessibility to intra- and inter-molecular forces, which are significant in biological structure and activity.

Interacting resonant level side-coupled to a Luttinger liquid: Duality to resonant tunneling

Moshe Goldstein, Richard Berkovits

The Minerva Center, Department of Physics, Bar-Ilan University, Ramat-Gan 52900, Israel

We study equilibrium as well as transport properties of a single level quantum dot side-coupled to a one-dimensional Luttinger liquid wire by both a hopping term and interactions. Using canonical transformations as well as the Yuval-Anderson approach, we show that an exact duality exists between this problem and that of resonant tunneling through a quantum dot connecting the edges of two wires with the inverse Luttinger liquid parameter g. In particular, the transport properties of the two models, both in and out of equilibrium are complementary: when one is conducting the other is insulating, and vice-versa. Using this results, as well as an exact solution by refermionization at g=2 and Monte-Carlo simulations on the Coulomb gas model, we fully characterize the conductance of the system. The latter exhibits an anti-resonance as a function of the level energy, whose width vanishes (so that transport is enhanced) as a power law for low temperatures and source-drain voltages whenever g>1, while it diverges (and transport is suppressed) for g<1. On resonance transport is always destroyed unless there are strong enough attractive interactions in the wire. Turning to the level population, we show, by similar methods, that it may be either continuous or discontinuous as a function of the level energy when the latter crosses the Fermi energy, depending on the system parameters. In the continuous phase we find a linear relation between the level occupation and its energy (when the latter is small) for g<2, and a power law for g>2.

Golosov Denis

Category #04-2

Two-fluid behaviour at the origin of the resistivity peak in doped manganites

D. I. Golosov(1), N. Ossi(1), A. Frydman(1), I. Felner(2), I. Nowik(2), M. I. Tsindlekht(2), and Y. M. Mukovskii(3)

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(2) Racah Institute of Physics, the Hebrew University, Jerusalem, Israel
(3) Moscow Institute of Steel and Alloys, Russia

We report a series of magnetic and transport measurements on high-quality single crystal samples of colossal magnetoresistive manganites, $La_{0.7}\ Ca_{0.3}\ Mn\ O_3$ and $Pr_{0.7}\ Sr_{0.3}\ Mn\ O_3$. 1 % Fe doping allows Moessbauer spectroscopy study, which shows (i) unusual line broadening within the ferromagnetic phase and (ii) a coexistence of ferro- and paramagnetic contributions in a region, $T_1<T<T_2$, around the Curie point T_C. In the case of $Pr_{0.7}\ Sr_{0.3}\ Mn\ O_3$, the resistivity peak occurs at a considerably higher temperature, $T_{MI}>T_2$. This shows that phase separation into metallic (ferromagnetic) and insulating (paramagnetic) phases cannot be generally responsible for the resistivity peak (and hence for the associated colossal magnetoresistance). Our results can be understood phenomenologically within the two-fluid approach, which also allows for a difference between T_C and T_{MI}. Our data indeed imply that while magnetic and transport properties of the manganites are closely interrelated, the two transitions at T_C and T_{MI} can be viewed as distinct phenomena. Published: Europhys. Lett., vol. 84, 47006 (2008).

Golubchik Daniel

Category #04-2

Magneto-optical imaging of phase transitions out of equilibrium

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According to a prediction by Zurek, magnetic flux lines are spontaneously created during a conductor-superconductor phase transition under nonequilibrium conditions. This prediction (the Kibble-Zurek model) is relevant both to cosmology and to nonequilibrium thermodynamics. Several conflicting predictions exist with respect to the spatial density of flux and the correlations within the flux array. We present an imaging magneto-optical system with a single flux-line resolution. Preliminary results obtained with this system will be presented.

Enhancement of the superconducting transition temperature in cuprate heterostructures

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Is it possible to increase T_c by constructing cuprate heterostructures, which combine the high pairing energy of underdoped layers with the large carrier density of proximate overdoped layers? We investigate this question within a model bilayer system using an effective theory of the doped Mott insulator. Interestingly, the question hinges on the fundamental nature of the superconducting state in the underdoped regime. Within a plain slave boson mean field theory, there is absolutely no enhancement of T_c. However, we do get a substantial enhancement for moderate inter-layer tunneling when we use an effective low energy theory of the bilayer in which the effective quasiparticle charge in the underdoped regime is taken as an independent phenomenological parameter. We study the T_c enhancement as a function of the doping level and the inter-layer tunneling, and discuss possible connections to recent experiments by Yuli et al. [1]. Finally, we predict a unique paramagnetic reduction of the zero temperature phase stiffness of coupled layers, which depends on the difference in the current carried by quasiparticles on the two types of layers as $(J_1-J_2)^2$.

[1] O. Yuli, I. Asulin, O. Millo and D. Orgad, L. Iomin, G. Koren, Phys. Rev. Lett. 101, 057005 (2008).

Active Transport on Disordered Microtubule Networks: The Generalized Random Velocity Model

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The motion of small cargo particles on microtubules by means of motor proteins in disordered microtubule networks is investigated theoretically using both analytical tools and computer simulations. Different network topologies in two and three dimensions are considered, one of which has been recently studied experimentally by H. Salman et al. (Biophys. J. 89, 2134 (2005)). A generalization of the random velocity model is used to derive the mean square displacement of the cargo particle. We find that all cases belong to the class of anomalous super-diffusion, that is sensitive mainly to the dimensionality of the network and only marginally to its topology. Yet, in three dimensions the motion is very close to simple diffusion, with sub-logarithmic corrections that depend on the network topology. When details of the thermal diffusion in the bulk solution are included, no significant change to the asymptotic time behavior is found. However, a small asymmetry in the mean microtubule polarity affects the corresponding long time behavior. We also study a 3-dimensional model of the microtubule network in living animal cells. Three first passage time problems of intracellular transport are simulated and analyzed for different motor processivities: (i) cargo that originates near the nucleus and has to reach the membrane, (ii) cargo that originates from the membrane and has to reach the nucleus, and (iii) cargo (e.g., mRNA) that leaves the nucleus and has to reach a specific target in the cytoplasm (e.g., the ribosome). We conclude that while a higher motor processivity increases the transport efficiency in cases (i) and (ii), in case (iii) it has the opposite effect. We conjecture that the balance between the different network tasks, as manifested in cases (i) and (ii) vs case (iii), may be the reason for the evolutionary choice of a finite motor processivity.

http://scitation.aip.org/getabs/servlet/GetabsServlet?prog=normal&id=I

Category #10-1

Monytoring cryotherapy with interventional MRI - feasibility studies of umbilical cord

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Thermal therapy is a technique based on inducing extreme temperature changes in a specific target, in order to cause tissue-injury leading to regional ablation, sometimes applicable percutaneously. Some of the basic MR properties are temperature dependent, making MRI the only modality that can provide non-invasive time-dependent 3D temperature distribution maps with real-time imaging. This project aims to contribute to the scientific understanding of umbilical cord tissue dynamics inflicted by local extreme temperatures and its MRI appearances. Development of our approach might set the initial foundations for MRI monitoring of umbilical cord cryotherapy [1]. Our research focuses on feasibility studies of MRI monitoring of ex-vivo umbilical cord cryosurgery and phantoms. We have incorporated modeling and simulations of temperature dependent mechanisms in tissue and their influence on MR parameters such as R1. The project combines umbilical cord and placental grading, MRI scanning, cryotherapy administration, flow management, computational analysis and evaluation. The low field has its obvious disadvantages. However, its main advantages for minimally invasive cryotherapy are its open configuration and reduced susceptibility artifacts of the cryoprobes. This allows tracing of the entire frozen-front, as well as the derivation of thermal maps during cryotherapy. We apply an R1-based approach to MR thermometry, which we study and optimize. The cryoprobes vary in diameter and in the shape of the “ice-ball” that they create, using PC controlled flow rates of Argon for freezing and Helium for thawing. Temperature is continuously sampled by needle thermocouple. The resolution of interventional MR images of the cryoprobes is excellent and the induced artifacts are minimized. The formation of the “ice-ball” is clearly detected in the T1 and T2 weighted iMRI scans, and its gradual growth can be accurately traced. T1-maps can be calculated from the area surrounding the frozen front for the extraction of isotherms. Thus, we show initial feasibility of this approach. For immediate following research we proceed with emphasis on MRI study of the relevant flow mechanisms and MRI protocols. Thus, in the future it may lead to the use of the interventional MRI for comprehensive monitoring of umbilical cord cryotherapy. [1] Paul R Morrison, Stuart G Silverman, Kemal Tuncali and Servet Tatli. MRI-Guided Cryotherapy. JMRI 2008;27:410-420.

Grinvald Eran

Category #05-2

Photonic crystal approach to guided mode resonance

Eran Grinvald, Itzhak Evenor, Asher A. Friesem and Shimon Levit

Weizmann Institute of Science

Subwavelength photonic crystal slabs (PCS) of one or two dimensions exhibit a resonance type anomaly of abrupt variations in the amplitude and phase of the reflected and transmitted light. The anomaly is due to the resonant excitation of a discrete mode in the PCS, such as surface plasmons in metallic slabs and guided modes in dielectric slabs. We investigate guided mode resonance using the photonic crystal approach in which Maxwell's equations are written in the form of a linear hermitian operator on the magnetic field[1]. We treat the periodicity of the PCS as a perturbation of the homogeneous slab, and expand the eigenmodes of the PCS in a basis of the eigenmodes of a homogeneous dielectric slab. We show that the resonant frequency and spectral bandwidth can be calculated using formalisms, adapted from quantum mechanics, that describe scattering (Lippmann Schwinger) and resonance (Wigner Weisskopf). With such formalisms and symmetry considerations we calculate the coupling between the free space and guided modes and their relation to the spectral bandwidth.

[1] J. D. Joannopoulos, R. D. Meade and J. N. Winn, "Photonic Crystals: Molding the flow of light", Princeton University Press, NJ (1995).

Dynamics of fluctuations in driven diffusive systems: Finite-size effects

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Driven diffusive systems are generically out of equilibrium. I will consider two paradigmatic examples, the asymmetric simple exclusion process and the zero-range process. I will discuss size effects on the behavior of fluctuations in the nonequilibrium stationary state of these two processes on a one-dimensional periodic lattice of finite size. The exclusion process involves hard core particles executing biased diffusion with a constant rate. In the zero-range process, particles perform biased hopping between sites with a rate which depends on the occupancy at the departure site. In the stationary state, this process shows a phase transition as a function of the particle density, from a low-density disordered phase to a high-density condensed phase. In both these processes, size effects interplay with the nonequilibrium dynamics to bring in rich dynamical phenomena otherwise absent in equilibrium ([1],[2]).

[1] Shamik Gupta, Satya N. Majumdar, Claude Godrèche, and Mustansir Barma, Phys. Rev. E 76, 021112 (2007).
[2] Shamik Gupta, Mustansir Barma, and Satya N. Majumdar, Phys. Rev. E Rapid Comm. 76, 060101(R) (2007).

Gusarov Alexander

Category #05-1

3D multi-channel atomic magnetometer for bio-magnetism

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In an atomic magnetometer alkali vapor (Potassium, Cesium or Rubidium) is evaporated in a glass cell by warming it up. By optical pumping the spins are aligned along an incoming circularly polarized laser beam tuned to a specific atomic transition. A magnetic field perpendicular to the pumping laser rotates the spin by an angle proportional to the magnetic field intensity. A probe laser beam, linearly polarized, perpendicular to the pump laser and to the magnetic field monitors the spin angle of rotation and measures the absolute intensity of the local magnetic field. World-record sensitivity and source localization have been proven at Princeton University. Our magnetometer operates in a Spin-Exchange Relaxation Free (SERF) configuration characterized by a very low external magnetic field environment, high vapor density of K atoms at 180^{o}C, high buffer gas pressure and in a gradiometer configuration. The fundamental sensitivity limit of the atomic magnetometer was shown to be better than 0.5fT/Hz$^{1/2}$ [1], better than SQUID's best performance. Signals from the heart and brain have been recorded [2].

A SERF atomic magnetometer was built and operated at BGU. A cubic PYREX vapor cell of 3 cm on the edge is warmed up to 180^{o}C by hot air in a small oven mounted in the center of a 5 layers cylindrical magnetic shield. The magnetic noise is further reduced by three perpendicular sets of Helmholtz coils. 3D high sensitivity measurements of the magnetic field inside the vapor cell have been performed for the first time along with a multi-channel operation of the atomic magnetometer. The basic principles, sensitivity, spatial resolution and time response are discussed. Our preliminary measurements will be presented. The 3D operation of the atomic magnetometer opens the way to numerous applications demanding high sensitivity, high spatial resolution and fast response such as biomagnetism, and NDT.

[1] I. K. Kominis, T. W. Kornack. J. C. Allred and M. V. Romalis, "A subfemtotesla multichannel atomic magnetometer", Nature 422, 596 (2003). [2] H. Xia, A. Ben-Amar Baranga, D. Hoffman, and M. V. Romalis, "Magnetoencephalography with an atomic magnetometer", Appl. Phys. Lett. 89, 211104 (2006).

Harel Meital

Category #02-1

The Effect of Temperature on the Dynamics and Geometry of Reactive-Wetting Interfaces

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The temperature effect on the dynamics and geometry of mercury droplet ($\sim 150 \mu m$) spreading on silver substrate ($4000 A$) was studied. The system temperature was set in the temperature range of $-15^o C < T < 25^o C$ using a heating stage, and the spreading process was monitored using an optical microscope. In this reactive-wetting system, the temperature variation affects the surface tension of the materials, the chemical reaction rate and the mercury viscosity. We studied the wetting dynamics (droplet radius $R(t)$ and velocity) and the kinetic roughening properties (roughness (α) and growth (β) exponents), all as a function of time and temperature. At early times, $R(t) \sim t$ for all temperatures. However, the constant velocity of the interface at each temperature increases with temperature. Regarding the kinetic roughening of the triple line, we found that both the growth exponent (β) and the interface roughness increase with temperature, while the roughness exponent (α) was found to be the same for all temperatures, with a value around 0.8 below the correlation length. We discuss these results and compare them with relevant results in the literature.

Fractionally charged quasiparticles in the fractional quantum hall effect

moty heiblum

weizmann institute of science

The most surprising and interesting finding in the regime of the fractional quantum Hall effect is the presence of frictionally charged quasiparticles. Electrons, due to strong interactions in the presence of high magnetic field, behave as independent smaller units of charge. Initially, odd-denominator fractions had been found and studied, while recently even-denominator charges were measured. I will review the properties of such quasiparticles, mostly determined via shot noise measurements.

Intense Production of Light Radioactive Beams for Astrophysics and Neutrino Physics using Secondary Fast Neutrons

Tsviki Y. Hirsh[1,2], Michael Hass[1], Dan Berkovits[2], Vivek Kumar[1], Kuljeet Singh[1],Yoram Nir-El[2], Francois De Oliveira[3], Alexandre Pichard[3] and Leo Weissman[2]

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There is a growing interest in developing strong sources of light radioactive beams for the purpose of neutrino “β-Beam” facilities, nuclear astrophysics, physics of neutrinos and other nuclear structure studies. Modern ion accelerators such as the SARAF@Soreq or SPIRAL2@GANIL have opened the possibility of providing these intense beams. Detailed optimization simulations that we have preformed recently demonstrate that by using secondary neutrons from a 40 MeV d beam of few mA, orders-of-magnitude more intense beams of nuclei such as 6He, 8Li and others can be produced and subsequently extracted. As first experimental tests, we have embarked on a set of production experiments, by using a 14 MeV neutron generator which is placed at Soreq to benchmark our Monte-Carlo simulations. We measured the production of the γ emitter 24Na isotope, via the 27Al(n,α)24Na reaction by irradiation of Aluminum cubes with neutrons from the generator for various target geometries. This reaction serves as a tool for testing simulations due to its relatively long half life and ensuing high-energy γ lines that could be easily detected by a Ge detector. In subsequent experiments we intend to use a Boron-Nitride powder target in order to produce and measure the short-lived β emitter radioisotope 8Li. We are also planning to repeat these production experiments with the much more intense fast neutron source that could be produced using the SARAF phase I deuteron beam of 5.2 MeV. We present recent results as compared to Monte-Carlo simulations and discuss their significance. Further tests are also planned for the production and extraction of β emitters such as 6He and 8Li from porous BeO and BN targets, respectively, at ISOLDE@CERN by using spallation neutrons and at SPIRAL@GANIL by using 12C+12C neutrons.

Splitting the Wino Multiplet by Higher-Dimensional Operators in Anomaly Mediation

Micha Berkooz and Yonit Hochberg

Department of Particle Physics, Weizmann Institute of Science

In a class of AMSB models, the splitting in the Wino multiplet turns out to be very small, such as the often-quoted 170 MeV in minimal AMSB, which originates from MSSM loops. Such a small mass gap is potentially a window into higher scale physics, as it may be sensitive to higher-dimensional operators. We show that still within AMSB one can get a much larger splitting in the Wino multiplet--a few GeV--if the scale of the new physics is comparable to the gravitino mass. This is indeed often the scale of new physics in anomaly mediation.

Category #04-2

Coupling of Spin and Orbital Motion of Electrons in Ultra-Clean Carbon Nanotubes

S. Ilani

Weizmann Institute of Science

Electrons in atoms possess both spin and orbital degrees of freedom. In non-relativistic quantum mechanics, these are independent, resulting in large degeneracies in atomic spectra. However, relativistic effects couple the spin and orbital motion, leading to the well-known fine structure in their spectra. It is widely believed that the electronic states of defect-free carbon nanotubes are four-fold degenerate, owing to independent spin and orbital symmetries, and also possess electron–hole symmetry. In this talk I will show our recent measurements, which demonstrate that in ultra-clean nanotubes the spin and orbital motion of electrons are coupled, thereby breaking all of these symmetries. This spin–orbit coupling is directly observed as a splitting of the four-fold degeneracy of a single electron in ultra-clean quantum dots. It further breaks the electron-hole symmetry by aligning the orbital and spin magnetic moments differently for electrons and holes. Our observations are consistent with recent theories, which predict that in the cylindrical topology of nanotubes, the motion of electrons along closed orbits would be coupled to their spin. These findings have important implications on our basic understanding of the electronic properties of nanotubes as well as on the future use of carbon-based systems for spin-based applications.

Integrable theory of quantum transport in chaotic cavities

Eugene Kanzieper [1], Vladimir. Al. Osipov [2]

[1] *Department of Applied Mathematics, H.I.T. -- Holon Institute of Technology, Holon, Israel*

[2] *Fachbereich Physik, Universitaet Duisburg-Essen, Duisburg, Germany*

The problem of quantum transport in chaotic cavities with broken time-reversal symmetry is shown [1] to be completely integrable in the universal limit. This observation is utilised to determine the cumulants and the distribution function of conductance for a cavity with ideal leads supporting an arbitrary number n of propagating modes. Expressed in terms of solutions to the fifth Painlev\'e transcendent and/or the Toda lattice equation, the conductance distribution is further analysed in the large-n limit that reveals long exponential tails in the otherwise Gaussian curve. The same approach is also used to describe the universal statistics of thermal-to-shot-noise crossover [2] in chaotic cavities.

[1] V. Al. Osipov and E. Kanzieper, Phys. Rev. Lett. {\bf 101}, 176804 (2008).
[2] E. Kanzieper and V. Al. Osipov, unpublished (2008).

Kapilevich Boris

Category #05-2

THz Characterization of Lossy Materials Using Multi-Layers Measuring Cell

Boris Kapilevich, Yosef Pinhasi, Asher Yahalom and Boris Litvak

Ariel University Center of Samaria

A method of measurement of the real and imaginary parts of thin-layer materials at THz frequencies is described. The method is based on application of multi-layers measuring cell consisting of unknown lossy slab and the slabs of low loss material with known dielectric constant. The recorded power transmittance interferogram is employed for reconstructing the complex permittivity of a material under test. Reconstructing algorithm based on solution of the system of non-linear equations is proposed. The example of characterization of the thin lossy sample such as a paper sheet of thickness 0.1 mm in 0.8 – 1.1 THz is reported.

The energy production rate & the generation spectrum of UHECRs

Katz, Boaz; Budnik, Ran; Waxman, Eli

Weizmann Institute of Science

We derive simple analytic expressions for the flux and spectrum of ultra-high energy cosmic-rays (charged particles with energies E>~10^19 eV that impinge earth constantly, UHECRs) predicted in models where the CRs are protons produced by extra-Galactic sources. For a power-law scaling of the CR production rate with redshift and energy, d\dot{n} /dE\propto E^-\alpha (1+z)^m, our results are accurate at high energy, E>10^18.7 eV, to better than 15%, providing a simple and straightforward method for inferring the production rate from the observed flux. We show that current measurements of the UHECR spectrum, including the latest Auger data, imply E^2d\dot{n}/dE(z=0)=(0.45\pm0.15)(\alpha-1) 10^44 erg Mpc^-3 yr^-1 at E<10^19.5 eV with \alpha roughly confined to 2\lesseq\alpha<2.7. Simple models in which \alpha\simeq 2 and the transition from Galactic to extra-Galactic sources takes place at the "ankle", E ~10^19 eV, are consistent with the data. Models in which the transition occurs at lower energies require a high degree of fine tuning and a steep spectrum, \alpha\simeq 2.7, which is disfavored by the data.

Experimental quantum information processing - the state of the art

Nadav Katz

The Racah institute of physics, Hebrew University of Jerusalem

Quantum coherence/decoherence and control are at the center of a massive world-wide research effort. Deep and fundamental connections have been established between disciplines once thought unrelated (condensed matter, optics, atomic physics, information theory and communication). In this talk I will review some of these connections and present the leading experimental implementations (ion and atom traps, optics and superconducting/semiconducting devices) with emphasis on progress in recent years.

The stock market as a complex adaptive system - the functional role of the index

Dror Y. Kenett, Yoash Shapira, and Eshel Ben Jacob

School of Physics and Astronomy, Sakler faculty of exact sciences, Tel Aviv University

We present a bio-inspired system level analysis of two stock exchange markets: the New York Stock Exchange (NYSE) as representing a large and mature (fully developed) market and the Tel Aviv Stock Exchange (TASE), as representing a small and young one. For the NYSE, we used the S&P (Standard & Poor) and the DJIA (Dow Jones) indices and for the Tel Aviv market we used TA25 and the general index. The analysis was performed on the daily closing price for a time period of about 7 years. The approach is based on analyses of the stock-stock correlations (between the stocks daily changes). To decipher the special role of the index we treated it as an additional virtual variable by including the correlations between the stocks and the index in the correlation matrices. The matrices were analyzed by using a hierarchical tree of correlation distances and the Principal Component Analysis (PCA).By using partial correlations and by substracting the index from the above time series, we found that the observed correlations between the various stocks are mainly the result of the strong correlation of each one of them to the index and the coupling between the various stocks is quite weak. Consequently we see that the index provides a top down regulation mechanism that acts as an external collective driving force. This result is very similar to key concepts in economy, such as the CAPM and SCL, only these results are derived out of the actual market data, without any assumptions regarding the characteristics of the market. We also study the dynamics of the stock market correlation using a running window approach, and identify bursts of high correlation, which we believe to be associated to internal or external events affecting the market. We compare these bursts between the two types of markets, and discuss the possible causes of these bursts, and the reasons for the differnces between the two types of markets. Finally, we discuss the similarties and differences between our empirical results and well known theoretical economic theories.

http://tamar.tau.ac.il/~dror/index_files/stock_market_as_CAS.pdf

Pattern selection in parametrically-driven arrays of nonlinear resonators

Eyal Kenig[1], Ron Lifshitz[1], and M. C. Cross[2]

[1]Tel Aviv University
[2]California Institute of Technology

Motivated by recent experimental studies of microelectromechanical and nanoelectromechanical systems (MEMS & NEMS) [1] we have been studying the nonlinear dynamics of arrays of coupled nonlinear micromechanical and nanomechanical resonators [2,3]. Here we invetigate the problem of pattern selection in an array of parametrically-driven nonlinear resonators using a novel amplitude equation [4]. We describe the transitions between standing-wave patterns of different wave numbers as the drive amplitude is varied either quasistatically, abruptly, or as a linear ramp in time. We find novel hysteretic effects, which are confirmed by numerical integration of the original equations of motion of the interacting nonlinear resonators, suggesting new possibilities for future experiments [5].

[1] Buks & Roukes, J. MEMS 11 (2002) 802-807.
[2] Lifshitz & Cross, PRB 67 (2003) 134302.
[3] Lifshitz & Cross, Review of Nonlinear Dynamics & Complexity 1 (2008) 1-52.
[4] Bromberg, Cross, & Lifshitz, PRE 73 (2006) 016214.
[5] Kenig, Lifshitz, & Cross, Preprint (arXiv:0808.3589).

Experimental investigation of the coupling between magnetic and superconducting order parameters in underdoped LSCO thin films

Meni Shay[1], Amit Keren[1], Gad Koren[1], Amit Kanigel[1], Oren Shafir[1] Lital Marcipar[1] Gerard Nieuwenhuys[2], Elevezio Morenzoni[2], Moshe Dubman[2], Andreas Suter[2], Thomas Prokscha[2]

[1]*Department of Physics, Technion - Israel Institute of Technology, Haifa 32000, Israel*

[2]*Paul Scherrer Institute, CH 5232 Villigen PSI, Switzerland.*

We investigate the coupling between the magnetic and superconducting order parameters in an 8 m long meander line ("wire") made of a La1.94Sr0.06CuO4 thin film with a cross section area of 0.5×100 μm². The magnetic order parameter is determined by the new Low-Energy muon spin relaxation (LE-μSR) technique. The superconducting order parameter is characterized by transport measurements and modified by running a high current density through the wire during the LE-μSR measurements. We find that the current enhances the magnetic signal, namely, the magnetic freezing temperature increases when high current is applied. This result allows us to estimate the coupling between these order parameters.

Periodic and scale-free patterns: reconciling the dichotomy of dryland vegetation

Jost von Hardenberg[1] , Assaf Y. Kletter[2] , Hezi Yizhaq[3], Jonathan Nathan[3] and Ehud Meron[2,3]

[1]Istituto di Scienze dell'Atmosfera e del Clima, CNR, Italy
[2]Department of Physics, BGU, Israel
[3]Department of Solar Energy and Environmental Physics, BIDR, BGU, Israel

Field observations of vegetation patchiness in drylands reveal periodic patterns having characteristic length scales and patch sizes, along with patterns characterized by broad patch size distributions, often reported to obey power-laws. Despite the numerous theoretical and experimental studies that have been devoted to vegetation patchiness this dichotomy of patterns has remained poorly understood.

Using a mathematical modeling approach we elucidate the mechanisms that control patch size distributions in water-limited systems, and identify physical and ecological circumstances that lead to periodic patterns and broad patch size distributions. Vegetation patchiness in water-limited systems is often driven by competitive water-transport processes that promote the growth of vegetation patches and inhibit the growth in the patch neighborhoods. We show that finite-range competition leads to regular patterns with characteristic length scales, while global competition leads to a wide range of patch sizes. Global competition is favored when (i) the finite-range competition induced by water uptake is negligible, and (ii) the time-scale associated with surface water flow is much shorter than the time-scale associated with water infiltration into the soil. Vegetation patchiness is also affected by exogenous environmental factors such as soil heterogeneity and micro-topography.

We conclude by offering criteria for assessing the extent to which observed power-law patch size distributions reflect endogenous self-organization processes.

Kot Eran

Category #01-2

Coherent Scattering of a Single Atom by Localized BEC in Optical Lattice

E. Kot, V. Fleurov, S. Flach

Tel Aviv University
and the
Max Planck Institute for the Physics of Complex Systems

A model is presented for calculating the transmission and reflection coefficient for the scattering of a single boson on a localized condensate containing fixed number of particles. The resulting transmission depend on the spatial extension of the localized state, and shows points of total reflection for an extension of three lattice sites. We compare these results with recent works on the scattering of atom beams by Bose-Einstein condensate in an optical lattice which predicted the appearance of total reflection due to Fano resonance with the condensate made using the Gross-Pitaevskii mean-field model.

Kraus Kobi

Category #03-2

Observing Majorana Zero Modes in a Px+iPy Superconductor at High Temperature by Tunneling Spectroscopy

Yaacov E. Kraus[1], Assa Auerbach [1], H.A. Fertig [2] and Steven H. Simon [3]

[1] *Physics Department, Technion, 32000 Haifa, Israel*

[2] *Department of Physics, Indiana University, Bloomington, IN 47405, USA*

[3] *Alcatel-Lucent, Bell Labs, 600 Mountain Avenue, Murray Hill, NJ 07974, USA*

Directly observing a zero energy Majorana state in the vortex core of a chiral superconductor by tunneling spectroscopy requires energy resolution better than the spacing between core states Δ^2/ϵ_F. We show [1] that nevertheless, its existence can be clearly detected by comparing the temperature broadened tunneling conductance of a vortex with that of an antivortex even at temperatures $T \gg \Delta^2/\epsilon_F$. The Bogoliubov-de-Gennes (BdG) equation of a $p_x + ip_y$ superconductor is solved numerically on a sphere with vortex-antivortex pair at the poles. The robustness of the exponentially Majorana mode energy is verified by including a moderate white noise potential.

[1] arXiv:0811.2557, Phys. Rev. Lett. in press

Vision effects caused by glial cells in the retina

Labin Moshe and Erez N Ribak

Department of Physics, Technion

We use optical tools to study the retina, the light sensitive tissue of the eye. At the back of the retina lies a layer of sensor cells, the photoreceptors, made up from rods and cones. Incident light must pass up to 400 microns of nerve fiber layers to reach these cells. Scattering and refraction from these layers thus cause loss of light and loss of resolution. Outside the fovea (the central retina) there are many Muller or glial fibers: radial cells that span the entire depth of the retina, from the vitreous humor to the photoreceptors attached at the bottom. Since these fibers are transparent, they enable the passage of light from the retinal surface to the photoreceptor cells, winding through the intermediate scattering layers. To understand the optical effects of the complex structure of these cells, we employed a simulation based on a beam propagation method. We show how the cell structure, narrowing from top to bottom, improves considerably the capture of light. We also find that the distance between neighboring cells does not allow mode coupling, so as not to reduce the resolution. Moreover the intensity of light guided through the cells and onto the photoreceptors is shown to drop as they arrive from the ocular pupil center outwards. This varying intensity is in good accordance with the experimental results of the Stiles-Crawford effect.

Leibovitch Guy

Category #01-2

Bean-Livingstone barrier enhancement on nodal surface of the d-wave superconductor YBa2Cu3O7-x

G. Leibovitch R.Beck A.Kohen and G.Deutscher

Tel-Aviv University

Vortex entry into (110) oriented YBa2Cu3O7-x films has been studied by tunneling into Andreev - Saint-James bound states, whose energy is shifted by surface currents. At low temperatures, the characteristic field for vortex entry has been found to increase up to values several times higher than that of the Bean-Livingston entry field for conventional superconductors, in agreement with recent theoretical predictions.

Are large bound objects easy to study? - not for sure!

Doron Lemze, Rennan Barkana, Tom Broadhurst, Yoel Rephaeli

Tel-Aviv University

Clusters of galaxies are the largest bound objects in the universe. Therefore, their fundamental features such as their mass and temperature should be accurately known. However, this is not the case. There are various discrepancies between estimations from different data sets, and other discrepancies among estimations from analytic calculations, simulations and observations. We will give a few examples and possible solutions for these discrepancies.

Levi Daniel

Category #04-1

Enhancement of disordered metastable vortex states in $Bi_2Sr_2CaCu_2O_{8+x}$ crystals by columnar defects

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Institute of Superconductivity, Department of Physics, Bar-Ilan University
Ramat-Gan 52900, Israel

A high-speed magneto-optical system was employed to image the creation of disordered metastable vortex states in heavy-ion irradiated and pristine parts of the same $Bi_2Sr_2CaCu_2O_{8+x}$ crystal. Flux penetration from the edges into the sample was observed to create metastable states with significantly longer lifetime in the irradiated part as compared to the pristine part. This result clearly show that columnar defects enhance the disordered metastable states in the sample, contrary to the expectation that columnar defects stretch the entangled vortices of the metastable disordered states and thus assist their annealing. Further analysis of the metastable states injected into the irradiated part from the pristine part, suggests that in presence of columnar defects disordered metastable states may be created in the bulk, in addition to being injected from the edges.

Levy Roi

Category #03-2

Quantum Hall Insulator

R. Levy and Y. Meir

Department of Physics, Ben-Gurion University of the Negev, Beer Sheva 84105 Israel

Experimental studies showed that the transition from the last quantum Hall plateau in the integer quantum Hall effect terminates with a unique insulating phase. This phase is characterized by the divergent of the longitudinal resistivity with decreasing temperature, while the Hall resistivity remains quantized to its value in the last plateau. This is in contradiction to the predictions of the non-interacting electron theory. Therefore, it was suggested that this quantum Hall Insulator phase may be related to incoherent scattering events. We show that by including rare incoherent scattering events the quantum Hall insulator becomes a stable phase. The theory predicts a non-monotonic dependence of the Hall resistance on system size or temperature. Other aspects of the experiments are studied within our approach.

Category #04-1

Electric properties of a MOS structure containing nano-crystalline Ge imbedded in a thick SiO_2 film

Itamar Baron[1], Shai Levy[1], Issai Shlimak[1], Avraham Chelly[2], Zeev Zalevsky[2], and Tiecheng Lu[3].

[1]Physics Department Bar-Ilan University
[2] Engineering Department Bar-Ilan University
[3] Physics Department Sichuan University, P.R. China

MOS structure containing Ge nanocrystals (nc-Ge) imbedded inside the SiO_2 layer was studied for its electrical characterization. The nc-Ge were introduced into the structure by implantation of Ge^+ ions into an amorphous SiO_2 film which was subsequently annealed. The experimental characterization included an investigation of the C-V dependences measured at room temperature and in response to external optical illumination; in addition I-V measurements along the nc-Ge plane were conducted at different temperatures. It is shown that the capacitance of samples containing Ge nanocrystals depends on the applied voltage and has U-shape characteristics (with minimum capacitance at low voltages) which are strongly affected by external illumination and exhibit a hysteresis which indicates memory retention properties. The explanatory model for the observed phenomena is presented, based on the assumption that charge carriers trapped in nc-Ge are delocalized in response to a strong electric field or under light illumination.

Electric properties of a MOS structure containing nano-crystalline Ge imbedded into a thick SiO_2 film

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Category #03-2

Dynamics of the particle-hole pair creation in suspended graphene

Meir Lewkowicz[1], Baruch Rosenstein[2]

[1]*Physics Department, Ariel University Center of Samaria, Ariel*
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The process of coherent creation of particle - hole excitations by an electric field in graphene is quantitatively described. We calculate the evolution of current density, number of pairs and energy after switching on the electric field. In particular, it leads to a dynamical visualization of the universal finite resistivity without dissipation in pure graphene. We show that the DC conductivity of pure graphene is π/2 e^2/h rather than the often cited value of 4/π e^2/h. This value coincides with the AC conductivity calculated and measured recently at optical frequencies. The effect of temperature and random chemical potential (charge puddles) are considered and explain the recent experiment on suspended graphene. A possibility of Bloch oscillations is discussed within the tight binding model.

Pairing interaction in ultra-small nano-particles

Ze'ev Lindenfeld , Eli Eisenberg , Ron Lifshitz

Raymond and Beverly Sackler School of Physics and Astronomy, Tel Aviv University

We explore the possibility of a BCS-like pairing interaction in ultra-small isolated nano-particles within the framework of a simplified model. We start with the wave functions of free electrons in an infinite spherical well potential, while the phonons of the nano-particle are considered as the quantized normal modes of vibration of a stress-free elastic sphere. The interaction between the electrons and the phonons is evaluated explicitly, and the phonon mediated electron-electron interaction is estimated by means of a canonical unitary transformation. A reduced pairing Hamiltonian is obtained and its effects on the electron spectrum are evaluated and discussed.

Novel 3D Tethered Particle Motion (TPM)

Moshe Lindner, Guy Nir and Yuval Garini

Physics Department & Institute of Nanotechnology and Advanced Materials, Bar Ilan University, Israel.

Many intra-cellular processes are attributed to DNA-protein or RNA-protein interactions. Most of the studies on such interactions were done on ensembles of many molecules. Lately, however, single molecule detection methods were developed and provide few advantages over the ensemble methods.
We developed a system for single molecule detection by observing the motion of the entity in three-dimensions (3D). The method is based on tethered particle motion (TPM).
In TPM, one end of a macro-molecule (such as DNA or RNA) is linked to a surface, while the other end is linked to a small particle (sub-micrometer). The sample is placed in a fluidic cell and moves randomly (Brownian motion) while the bead moves in a constrained volume limited by the DNA length. By tracking the particle position, one can find the DNA end-to-end vector distribution, and thus its biophysical characteristics.
In order to track the particle's motion in the Z direction, we developed an optical setup with dark-field and total internal reflection microscopy (TIRM). The field above the surface is called evanescent field and its intensity decreases exponentially with the distance from the surface. After calibrating the system, the height of the bead can be extracted from its scattered light intensity.
We use gold nanobeads that have few advantages compared to the use of fluorescent probes which are more common: 1. There is no photobleaching and the experiment can last for long time. 2. Because the bead is small, it does not effect the DNA motion, and 3. The intensity of scattered light from gold nanobead is high compared to the intensity of fluorosphere and therefore the signal to noise of the measurement is high, as well as the precision of the analyzed data.
We will present the system that combines dark field and TIRM, data measured on double stranded DNA (both Z-axis and XY plane distributions) and comparison to simulations. We will also discuss the calibration issues as well as future plans.

Vortex quantum dynamics of two dimensional lattice bosons

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We study hard core lattice bosons in a magnetic field near half filling. The strong periodic potential scatters the vortices by units of reciprocal lattice momenta, enhancing their mobility and modifying their effective Magnus field. The bare vortex hopping rate on the dual lattice is extracted by exact diagonalizations of square clusters. We deduce quantum melting of the vortex lattice above vortex density of 0.0065 per lattice site. The Hall conductivity, which reflects the vortex Magnus dynamics, reverses sign abruptly at half filling. The characteristic temperature scale of the Hall conductivity vanishes at the transition point. We prove that at half filling, each vortex carries a spin half quantum number (`v-spin'). Experimental implications of these results are relevant for diverse systems of current interest, e.g. cold atoms on rotating optical lattices, arrays of Josephson junctions and underdoped cuprate superconductors.

http://arxiv.org/abs/0810.2604

A novel atom trap based on a carbon nano-tube

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Atom chips are devices for trapping, manipulating and measuring ultra cold atoms for quantum technology and fundamental studies. Typically, atoms are trapped microns from the chip by magnetic fields originating from current carrying wires fabricated on the chip’s surface. So far, these wires were made of pure metals. In order to suppress hindering effects induced by the surface, such as decoherence and potential corrugations, new conductors need to be found. Here we present an atom chip where the metal conductors have been replaced by single wall carbon nano-tubes (CNT). We describe the advantages and disadvantages of CNTs, and present the characterization of CNT atom chips.

Immune Holography: System-Level Analysis of Immunological States

Asaf Madi[1], Sharron Bransburg- Zabary[1,2], Inbal Hecht[2,3], Yifat Merbl[4], Adi Pick[2], Merav Zucker-Toledano[1,5], Francisco J. Quintana[4], Alfred I. Tauber[6], Irun Cohen[4] and Eshel Ben-Jacob[2,3]

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The recent Antigen Chip technology allows probing the immune state by parallel reactivity measurements of hundreds of antibodies. Here we present a new approach, Immune Holography, guided by the concept of viewing the immune system as a complex adaptive system. In such systems the ways in which the agents are related to one another is flexible to afford adaptability and survival - it is from these connections that the patterns are formed and the feedback disseminated. Thus, properties of the relationships between the antibodies are as important as the properties of the antibodies themselves. Thus, we characterize the immune state by analyzing normalized matrices of antigen-reactivity correlations or of subject-response correlations. The analysis comprises collective normalization, dimension reduction and feature selection. We show results of analyzing data of 10 pairs of mothers and newborns. For all cases, the data include the response of the IgM and IgG isotypes of 305, mostly autoimmune, antibodies. We found that the newborns share a universal innate IgM state, in contrast to diverse, person-specific mature profiles for the mothers. Analysis of the IgG isotypes revealed strong clustering between each mother and her newborn. We have also discovered that for the maternal IgM isotype there are subgroups of antibodies with special functional relations: they share a similar reactivity profile for the different mothers. Such subgroups do not exist for the newborns - implying that the maturation process of the immune system goes along with the formation of a multi-level structural organization of the immune network.

Polymorphism data may reveal the origin of species abundance statistics. Is it natural selection? or genetic drift?

Yosef Maruvka and Shenrb Nadav

Bar Ilan University

What is the underlying mechanism beyond the fat-tailed statistics observed for species abundance distributions? The two main hypotheses in the field are the adaptive (niche) theories, where species abundance reflects its fitness, and the neutral theory that assumes demographic stochasticity as the main factor that determines community structure. Both explanations suggest quite similar species-abundance distributions, but very different histories: niche scenarios suggest that a species population in the past was similar to the observed one, while neutral scenarios are characterized by strongly fluctuating populations. As the genetic variations within a population depend on its abundance in the past, we suggest here a way to discriminate between the theories using the genetic diversity of noncoding, haploid DNA. A statistical test, based on the Fu-Li method, has been developed and enables such a differentiation. We have analyzed the results gathered from individual-based simulation of both types of histories, and obtained clear distinction between the Fu-Li statistics of the neutral scenario and that of the niche scenario. Our results suggest that data for 10-50 species, with about 30 sequenced individuals for each species, may allow one to decide between these two theories.

http://yosi.maruvka.googlepages.com/untb

Meidan Dganit

Category #03-2

Superconductor insulator transition in thin films driven by an orbital parallel magnetic field effect

Dganit Meidan[1], Yuval Oreg[1]

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We study theoretically orbital effects of a parallel magnetic field applied to a disordered superconducting film. We find that the field reduces the phase stiffness and leads to strong quantum phase fluctuations driving the system into an insulating behavior. This microscopic model shows that the critical field decreases with the sheet resistance, in agreement with recent experimental results. The predictions of this model can be used to discriminate spin and orbital effects. We find that experiments conducted by A.~Johansson \textit{et al.} are more consistent with the orbital mechanism.

Fluctuations of the superconducting order parameter as an origin of the Nernst effect

Karen Michaeli and Alexander M. Finkel'stein

Department of Condensed Matter Physics, The Weizmann Institute of Science, Rehovot 76100, Israel

We show that the strong Nernst signal observed recently in amorphous superconducting films far above the critical temperature is caused by the fluctuations of the superconducting order parameter. We demonstrate a striking agreement between our theoretical calculations and the experimental data at various temperatures and magnetic fields. Besides, the Nernst effect is interesting not only in the context of superconductivity. We discuss some subtle issues in the theoretical study of thermal phenomena that we have encountered while calculating the Nernst coefficient. In particular, we explain how the Nernst theorem (the third law of thermodynamics) imposes a strict constrain on the magnitude of the Nernst effect.

Category #03-1

High-field vortices in dense chains of 0 and \pi shifted Josephson junctions

M. Moshe and R.G. Mints

Raymond and Beverly Sackler School of Physics and Astronomy, Tel Aviv University, Tel Aviv 69978, Israel

Chains of interchanging 0 and \pi shifted Josephson junctions are treated both theoretically and experimentally in the superconductor-ferromagnet-superconductor heterostructures, asymmetric grain boundaries in YBCO films, and zigzag YBCO/Nb junctions. In this talk, we demonstrate the existence of Josephson vortices in applied field, which is much higher than the Josephson penetration field. These high-field Josephson vortices exist in narrow field intervals located around an equidistant set of applied fields. When the applied field is in any of these intervals the flux per junction divided by the flux quantum is an integer. The high-field vortices are much longer than the lengths of the 0 or/and \pi fragments in the chain. As a result, the field generated by the high-field vortices is much lower than the background field. High-field vortices carry one flux quanta or half flux quanta and are free to move, unlike the semi-fluxons in the low field region. In the presence of a transport current across the junction, the high-field vortices are moving periodically from one side of the chain to the other and back. This periodic motion of flux generates a constant voltage across the chains with resonances similar to the zero-field steps.

Plasma-Lined Linac of Super-High Acceleration Gradient

Felix Tselnik and Jonathan Molcho

Ben Gurion University

Conventional high energy RF LINACs are long (sometimes – very long), because their acceleration gradient is limited to ~20MeV/m by breakdown of the accelerating RF field. The cause of breakdown is an RF-power-absorbing-cloud of plasma in the accelerating cavity beginning with field emission or multipactor generation of avalanches of electrons followed by heating, evaporation and ionization of the wall material. We propose to radically increase the accelerating gradient of the RF LINAC (>100MeV/m) by using “plasma-against-plasma”. The "good" plasma, in the form of a thin shell lining the resonator walls will: a. Protect the cavity surfaces against discharge by virtue of its high dielectric constant b. Protect the acceleration region against breakdown by ionizing debris from the wall (if residual discharge still occurs) and sweeping the ionized debris away.

Category #04-2

Perturbing GaN/AlN quantum dots with uniaxial stressors

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We have studied the effect of uniaxial stress on the optical polarization properties of GaN/AlN quantum dots (QDs) grown on Si(111) substrates. Microcracks form as a result of a mismatch of the thermal expansion coefficient between the GaN/AlN layers and the Si(111) substrate. We show that such microcracks serve as an excellent stressor through which the strain tensor of the GaN/AlN QDs can be modified for studies of strain-induced changes in the optical properties using a spatially and temporally resolved probe, such as with cathodoluminescence (CL) imaging and spectroscopy. CL measurements of the ground-state excitonic transition of vertically stacked GaN/AlN quantum dots (QDs) exhibited an in-plane linear polarization anisotropy in close proximity to microcracks, consistent with the presence of uniaxial stress. The spatial dependence of the polarization anisotropy and CL decay time in varying proximity to the microcracks were studied as a function of temperature in order to assess the influence of thermal stress variations on the oscillator strength between electrons and holes. Some aspects of the carrier relaxation kinetics are inferred from the temperature dependence of the lifetime and the integrated CL intensity.

Neutrino Signatures of Dark Matter Annihilation in the Galactic Disc

Zacharia Myers and Adi Nusser

Department of Physics, Technion, Israel Institute of Technology

Weakly interacting massive particles (WIMPs) are a viable candidate for the relic abundance of dark matter (DM) produced in the early universe. So far, WIMPs have eluded direct detection through interactions with baryonic matter. Neutrino emission from accumulated WIMP annihilations in the solar core has been proposed as a signature of DM, but has not yet been detected. These null results may be due to small-scale DM density fluctuations in the halo with the density of our local region being lower than the average (0.3 GeV cm−3). However, the accumulated neutrino signal from WIMP annihilations in the Galactic stellar disc would be insensitive to local density variations. Inside the disc, DM can be captured by stars causing an enhanced annihilation rate and therefore a potentially higher neutrino flux than what would be observed from elsewhere in the halo. We estimate a neutrino flux from the WIMP annihi- lations in the stellar disc to be enhanced by more than an order of magnitude compared to the neutrino fluxes from the halo. We offer a conservative estimate for this enhanced flux, based on the WIMP–nucleon cross-sections obtained from direct-detection experiments by assuming a density of 0.3 GeV cm−3 for the local DM. We also compare the detectability of these fluxes with a signal of diffuse high-energy neutrinos produced in the Milky Way by the interaction of cosmic rays with the interstellar medium. These comparative signals should be observable by large neutrino detectors.

Naftalis Netanel

Category #04-2

Anisotropic magnetoresistance and planar Hall effect in Manganites: The role of crystal symmetry effects

N. Naftalis[1], Y. Bason[1], J. Hoffman[2], X. Hong[2], C. H. Ahn[2] and L. Klein[1]

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Changes in magnetic orientation are known to induce in magnetic films variations both in the longitudinal resistivity ρ_{xx} (anisotropic magnetoresistance effect - AMR) and transverse Resistivity ρ_{xy} (planar Hall effect - PHE) and they are commonly described with the simple equations: $\rho_{xx} = \rho_\perp + (\rho_{||} - \rho_\perp)\cos^2\varphi$ and $\rho_{xy} = (\rho_\perp - \rho_{||})\cos\varphi\sin\varphi$, where $\rho_{||}$ and $\rho_\perp$ are the resistivities parallel and perpendicular to the magnetization, respectively, and φ is the angle between the current J and the magnetization M. Since these equations consider only the angle between J and M and ignore their orientation relative to crystalline axes, they are expected to strictly apply only to amorphous magnetic films and not to magnetic crystals. Nevertheless, these equations appear to describe AMR and PHE in various epitaxial magnetic films, including manganites and therefore special effort is required to demonstrate qualitative and quantitative deviations from the mentioned simple equations. To take into consideration crystalline contribution, we expanded the resistivity tensor using both α (the angle between M and <100>) and θ (the angle between J and <100>) and found new longitudinal and transverse resistivities [1]:

$$\rho_{xx} = A\cos(2\alpha - 2\theta) + B\cos(2\alpha + 2\theta) + C\cos(4\alpha) + D$$

$$\rho_{xy} = A\sin(2\alpha - 2\theta) - B\sin(2\alpha + 2\theta)$$

[1] Y. Bason, J. Hoffman, C. H. Ahn and L. Klein [arXiv:0810.4679v1]

Studying gamma-ray bursts with the Fermi observatory

Ehud Nakar

Tel-Aviv University

The Fremi observatory (formerly known as GLAST) is a large area gamma-ray telescope, which observes the GeV sky with unprecedented sensitivity. Fermi was successfully launched six months ago and already provided us with surprising discoveries. One of the observatory goals is to explore the GeV emission from gamma-ray bursts (GRBs). This poorly explored territory can potentially hold the key to some of the most important open questions in GRB study, such as resolving the physical parameters at the radiating source. I will give a brief review of the potential for studies of gamma-ray bursts with the Fermi observatory and discuss some of its recent observations.

A physical model of cellular "feet"

Moshe Naoz

Weizmann Institute of science, Chemical physics department.

Cells produce a variety of protrusions through polymerization of actin filaments near the membrane. Many of these protrusions also contain adhesive proteins that together with the actin filaments organize in a fairly similar way in most adhesive protrusions and act as "feet" (and "hands"). I will present a simplified physical model that attempts to explain the structure and behavior of such protrusions. In this model, actin activity level depends on membrane curvature as indicated by recent experimental evidence. This dependence can account for some special features observed in these protrusions.

Detecting the first generation of galaxies through their 21-cm signature

Smadar Naoz and Rennan Barkana

Tel Aviv Universuty

Over the next few years, new observations in the 21cm wavelength, will unfold the chapter in cosmic history at the era of the first galaxies and re-ionization. We predict the signature on the 21-cm signal of the early generations of galaxies. We calculate the 21-cm power spectrum including two physical effects that were neglected in previous calculations. The first is the redistribution of the UV radiation from the first galaxies due to their scattering on the neutral hydrogen, which results in an enhancement of the 21-cm signal. The second is the presence of an ionized hydrogen bubble near each source, which produces a cut-off at observable scales. We show that the resulting clear signature in the 21-cm power spectrum can be used to detect and study the population of galaxies that formed just 200 Myr after the big bang.

Strong field photodissociation control of H_2^+ with chirped laser pulses

A. Natan [1], V. S. Prabhudesai [1], U. Lev [2], O. Heber [2], B.D. Bruner [1], D. Strasser [2], D. Zajfman [2], Y. Silberberg [1]

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Ultrashort laser pulses have become the preferred tool for studying and controlling atomic and molecular processes due to their high peak intensity and short time duration. In particular, photodissociation processes are studied and controlled using such pulses. Recent studies suggested that photodissociation processes are mostly affected by the temporal envelope of the pulse, rather than its spectral content [1].
Here we show that varying the spectral phase of the pulse affects photodissociation of H_2^+ although the temporal envelope remains unchanged. We found a significant difference in the kinetic energy release (KER) spectra from positively and negatively chirped pulses, indicating that the spectral content of the pulse affects the probability of dissociation from specific vibrational levels.

[1] K. Sandig, H. Figger, and T. W. Hansch, Phys. Rev. Lett. 85, 23 (2000).

Modeling community-level properties of vegetation in a water limited system.

Jonathan Nathan[1], Assaf Kletter[2] and Ehud Meron[1,2]

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[2]Ben Gurion University

The broad diversity of species in the world is an ever-lasting source for questions such as: What are the mechanisms that allow coexistence of different species, what processes determine species diversity, and how species diversity affects biological productivity. We will present a model framework for water-limited plant communities, that allows studying the effects of various mechanistic processes, including vegetation pattern formation, on community-level properties such as species richness, abundance and composition. The model framework is an extension of a spatially explicit vegetation model to include a trait space that spans the the community of plant species under consideration. We applied this framework to the context of a plant community whose species differ in their resource allocation to roots versus above ground biomass. Numerical integration of the model for a spatially uniform system yields pulse-like solutions in the trait space. The pulse shape contains information about species richness (pulse width), abundance (pulse height) and composition (pulse location along the trait axis). Using this approach we studied how species richness is affected by rainfall variations, competition for light and grazing. We further confronted the results with available experimental data, obtaining a good qualitative agreement. We will conclude by presenting preliminary results related to species succession and spatial community organization.

Studying the interactions of a single enzyme and DNA using tethered particle motion method (TPM)

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HU is the most abundant nonspecifically binding protein in the nucleoid of all prokaryotes and some organelles in eukaryotes. The structure of the HU dimmer is associated with the DNA minor groove and induces flexible bends into DNA. Measurements of DNA bend angles generated by HU dimmers range from roughly 70°-140° for DNA's containing unpaired bases. The variability of bend angles suggests that the HU-DNA complex is able to accommodate a range of DNA bending.

HU's DNA bending activity is central to its role in a number of higher-order nucleoprotein complexes in bacteria. Previous studies of HU-DNA complexes using single DNA micromanipulation in E.coli have shown a bimodal behavior as a function of protein concentration. In the cell itself, however, there are no applied pressures on the DNA. We are therefore interested to peruse the HU protein implication on the DNA persistence length without the use of external forces.

We perform our experiments using the Tethered Particle Motion (TPM) method to follow a single DNA molecule. In TPM, a nanobead is attached to one end of the DNA while the other end is attached to a glass surface. The DNA molecule is almost free to diffuse and to perform Brownian motion while we observe the scattering from the gold nanobead. After constructing the optical system, developing the fluidic cell and optimizing the protocols, we are now able to test the effect of protein concentration on the DNA and follow a single DNA molecule for many hours. We observed dramatic fluctuations in the persistence length of a single DNA molecule. The method, system and results on the persistence length of the DNA as a function of the HU protein will be discussed.

LHC: A theorist's perspective

Yossi Nir

Weizmann Institute

Particle physics is entering a new era. The Large Hadron Collider (LHC) will accelerate protons to a very high energy, and the ATLAS and CMS detectors will observe the results of collisions between these protons. I will describe the questions that have been answered by experiments in the last decade, as well as the open questions waiting to be answered in the LHC era.

Enhancing Synchronization of Chaotic Fiber Lasers

Micha Nixon,Vardit Eckhouse, Moti Fridman, Nir Davidson, and Asher A. Friesem

Weizmann institute of science

New configurations for enhancing the synchronization between two chaotic fiber lasers are presented. Experimental and theoretical results reveal that the synchronization efficiency can be higher and synchronization time significantly shorter with a configuration that includes intra-cavity losses.

Category #05-1

Approximate analytical model for two-dimensional photonic crystal

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We present an analytical model for two-dimensional photonic crystal, consisting of periodic variation of rectangular dielectric rods, embedded in another dielectric material. Useful analytical formulas, for calculating the dispersion relation and the electromagnetic field, are developed. By comparing with accurate numerical calculations, we show that our analysis provides a good description of the physical properties for this type of photonic crystals. The presented approach and derived expression not only provide fast way of calculating photonic band structure but also yield a physical insight into the problem.

Category #08-2

An Algorithm For The Detection Of Transiting Circumbinary Planets

A. Ofir

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Transiting planets manifest themselves by a periodic dimming of their host star by a fixed amount. On the other hand, light curves of transiting circumbinary (CB) planets are expected to be neither periodic nor to have a single depth while in transit. These propertied make the popular transit-finding algorithm Box Least Squares (BLS) almost ineffective so a modified version of BLS for the identification of CB planets was developed – CB-BLS. We show that using this algorithm it is possible to find CB planets in the residuals of light curves of eclipsing binaries that have noise levels of 1 per cent and more – quality that is routinely achieved by current ground-based transit surveys. We also present improvements to the original implementation and results of blind-tests to CB-BLS. Detecting transiting CB planets is expected to have significant impact on our understanding of exoplanets in general, and exoplanet formation in particular. Using CB-BLS will allow to easily harness the massive ground- and space-based photometric surveys in operation to look for these hard-to-find objects.

Category #09-1

Correlated diffusion of membrane proteins and their effect on membrane viscosity

Naomi Oppenheimer and Haim Diamant

School of Chemistry, Raymond & Beverly Sackler Faculty of Exact Sciences, Tel Aviv University

Biological membranes contain a high concentration of embedded mobile proteins. While the Brownian motion of single membrane proteins has been studied in detail, the dynamic correlations between proteins, as mediated by flows within the membrane and in the surrounding liquid, has received little attention. We account for the correlated motion of membrane proteins, along with the effect of protein concentration on that correlation and on the response of the membrane to stresses. Expressions for the coupling diffusion coefficients of protein pairs and their concentration dependence are derived in the limit of small protein size relative to the inter-protein separation. Membrane viscosity has an additional role as determining the characteristic length scale for membrane response. This dependence leads to unusual concentration effects at large separation—the transverse coupling increases with protein concentration, whereas the longitudinal one becomes concentration-independent.

Ovadia Maoz

Category #04-2

The superconductor-insulator transition: is there a new insulating state?

Maoz Ovadia, Benjamin Sacepe, Dan Shahar

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We present nonlinear conductivity measurements on the insulating side of the superconductor-insulator transition in amorphous indium oxide. The results agree with previous data^{1,2}, and show conductance jumps at welldefined voltage bias thresholds. The current in the sample changes by as much as a factor of 10$^ {6}$ at the threshold, from our noise floor of 3x10^{-14}A to over 10^{-8}A. The jumps disappear above a magneticfield- dependent temperature T*, which is 0.11K or lower. The threshold voltage changes from 20μV to over 0.2V (4 orders of magnitude) by application of a magnetic field. \paragraph{} We ask whether a true zero conductance state exists in our samples. DC measurements reveal pseudo-exponential I-V characteristics, which can be extrapolated to find the high Ohmic resistance of these samples at low temperatures. The extrapolated R (T) curves typically show a sub-activated trend at low T. Our results suggest that our samples have zero conductance only at the absolute zero of temperature. \paragraph{} (1) Sambandamurthy et al. PRL 92, 107005 (2) Baturina et al. Nature Letters 452, p613

Panich Alexander

Category #04-2

73Ge nuclear spin decoherence and germanium-based quantum computer

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Owing to the well-developed technology, isotopic engineering of Si and Ge semiconductors permits to control the density of nuclear spins and vary the spin coherence time, a crucial parameter in spintronics and quantum computing where nuclear spin is used as a qubit. We report on the first NMR study of 73Ge nuclear spin decoherence in germanium single crystals with different abundance of the 73Ge isotope. Our measurements [1] show that Hahn and solid echo decays are caused by two different decoherence processes. The fast decay at the beginning of the relaxation process is caused by the quadrupole interaction. Then this process proceeds to slowly decaying, long-lived spin echoes that are caused by dipole-dipole interaction among nuclear spins, reflecting the fundamental decoherence process in the spin system. This slow decay is elongated by means of 73Ge spin dilution. We show that the corresponding decoherence time in the existing highly spin-diluted crystals could be elongated up to ~ 20 s, which is encouraging for application of this material for a nuclear-spin-based quantum computer. Our experimental findings are supported by the calculations of Hahn and solid echo decays in the germanium crystals. Good agreement between the theory and experiment is demonstrated.

[1] A. M. Panich, N. A. Sergeev, and I. Shlimak, Phys. Rev. B 76, 155201/1-8 (2007).

On the triple origin of blue stragglers

Hagai B. Perets

Weizmann Institute of Science

Blue straggler stars (BSSs) are stars observed to be hotter and bluer than other stars with the same luminosity in their environment. As such they appear to be much younger then the rest of the stellar population. Two main channels to produce such stars are (i) stellar collisions between stars in clusters or (ii) mass transfer between, or merger of, the components of primordial short-period binaries. Here we suggest a third scenario, in which the progenitor of BSSs are formed in primordial (or dynamically formed) hierarchical triple stars. In such configurations the dynamical evolution of the triples through the Kozai mechanism and tidal friction can induce the formation of very close inner binaries. Angular momentum loss in a magnetized wind or stel lar evolution could then lead to the merger of these binaries (or to mass transfer) and produce BSSs in binary (or triple) systems. We study this possibility and its implications and show that it could naturally explain many of the characteristics of the BSS population in clusters, most notably the large binary fraction of long period BSS binaries and their unique period-eccentricity distribution. We suggest that this scenario has a major (possibly dominant) role in the formation of BSSs in open clusters and give specific predictions for the the BSSs population formed in this manner.

Vibrational analysis of thermal oscillations of SWCNT

Polina Pine, Y.Yaish and Joan Adler

RBNI, Technion

The many potential applications of carbon nanotubes include ultra high mass, force and pressure sensors. These are based on monitoring the vibrational frequency shift as a result of attached mass or applied force. A detailed study of the vibrational frequencies of carbon nanotubes is thus important for further advancement in this field. We model the fundamental frequency of the thermal vibrations as well as their higher modes for nanotubes of varied length and radius. Atomistic Molecular Dynamics and Fourier analysis are used to test frequency dependence on the length and radius of the nanotube. Comparison with an analytic model and an explanation for the observed discrepancies in certain cases reveal the need for an improved analytic model.

http://phycomp.technion.ac.il/~pine

Space-frequency model for pulsed beam free-electron laser operating in the space-charge (collective) dominated regime

Y. Pinhasi and Yu. Lurie

Dept. of Electrical and Electronic Engineering, Ariel University Center of Samaria

Intense radiation devices such as microwave tubes, free-electron lasers (FELs) and masers, utilize distributed interaction between an electron beam and the electromagnetic field. In these devices the electron beam serves as the gain medium generating radiation, which is coupled out of the device through a transmission system. We developed a three-dimensional, space-frequency theory for the analysis and simulation of radiation excitation and propagation in electron devices and free-electron lasers operating in millimeter wavelengths and in the Tera-Hertz frequencies. The total electromagnetic field (radiation and space-charge waves) is presented in the frequency domain as an expansion in terms of transverse eigen-modes of the (cold) cavity, in which the field is excited and propagates. The mutual interaction between the electron beam and the electromagnetic field is fully described by coupled equations, expressing the evolution of mode amplitudes and electron beam dynamics. The approach is applied in a numerical particle code WB3D, simulating wide-band interaction of a free-electron laser operating in the linear and non-linear regimes. The model is utilized to study spontaneous and super-radiant emissions radiated by a an electron bunch at the sub-millimeter regime, taking into account three dimensional space-charge effects emerging in such ultra short bunches.

Backward Wave Excitation and Generation of Oscillations in Free-Electron Lasers in the Absence of Feedback—Beyond the High Gain Approximation

Yosef Pinhasi, Asher Yahalom, Yuri Lurie, and Gad A. Pinhasi

Ariel University Center of Samaria

Quantum and free-electron lasers (FELs) are based on distributed interactions between electromagnetic radiation and gain media. In an amplifier configuration, a forward wave is amplified while propagating in a polarized medium. Formulating a coupled mode theory for excitation of both forward and backward waves, we identify conditions, leading to efficient excitation of backward wave without any mechanism of feedback or resonator assembly. The excitations of incident and reflected waves are described by a set of coupled differential equations expressed in the frequency domain. The induced polarization is given in terms of an electronic susceptibility tensor. In quantum lasers the interaction is described by two first-order differential equations. In FELs, the excitation of the forward and backward modes is described by two coupled third-order differential equations. In our previous investigation analytical and numerical solutions of reflectance and transmittance for both quantum lasers and high-gain FELs were presented. In this work we extend the study to a general FEL without restriction of the high-gain approximation. It is found that when the solutions become infinite, the device operates as an oscillator, producing radiation at the output with no field at its input, entirely without any localized or distributed feedback.

[1] Yosef Pinhasi, Asher Yahalom, Yuri Lurie & Gad A. Pinhasi “Backward wave excitation and generation of oscillations in distributed gain media and free-electron lasers in the absence of feedback” IEEE Journal of Quantum Electronics, Vol. 43, No. 10, October (2007).

Polishook David

Category #08-2

Spin Rate Distribution of Small-Sized Main Belt Asteroids

David Polishook

Tel-Aviv University
Department of Geophysics and Planetary Sciences

Photometry of asteroids allows the derivation of their spins around their axis. Enlarging the statistics of asteroids' spins enables one to study physical mechanisms that affect the spin evolution of asteroids in correlation with their orbits, sizes and compositions. We conduct an extended campaign of asteroid photometry at the Wise Observatory using a wide-field CCD on a semi-automated telescope. With it, we succeeded to obtain results for a population that has hardly been measured by now – small Main Belt Asteroids (MBAs) in the size range of one to three km. We added our derived spin periods to data from the literature and compared the spin rate distributions of small MBAs with that of bigger asteroids and of similar-sized Near-Earth Asteroids (NEAs). We found that the spin rate distribution of small MBAs does not show the clear Maxwellian-shaped distribution as large asteroids do; rather they have a spin rate distribution similar to that of NEAs. This implies that non-Maxwellian spin rate distribution is primarily controlled by the asteroids' sizes rather than their locations.

http://xxx.lanl.gov/ftp/arxiv/papers/0811/0811.1223.pdf

Pugatch Rami

Category #05-2

Universal Spectra of Coherent Random Recurrence

R. Pugatch (1), O. Firstenberg (2), M. Shuker (2), and N. Davidson (1)

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(2) Dept. of Physics, Technion

The probability of a random walker to return to its starting point in dimensions one and two is unity, a theorem first proven by Polya. The recurrence probability $P(r = 0, t)$ to be found at the origin at a time t is a power law with a critical exponent $-d/2$ in dimensions $d = 1, 2$. We report an experiment that directly measures the Laplace transform of the recurrence probability in one dimension using Electromagnetically Induced Transparency (EIT) spectroscopy of coherent Rubidium atoms diffusing in a vapor-cell filled with buffer gas. We find a regime where the limiting form of the complex spectrum is universal and only depends on the effective dimensionality in which the random recurrence takes place. In an effective one-dimensional diffusion setting the measured spectrum exhibits power law dependence over two decades in the frequency domain with a critical exponent of -0.53 ± 0.03. Possible extensions to more elaborate diffusion schemes are briefly discussed.

Puller Vadim

Category #03-2

Breaking of Phase Symmetry in Non-Equilibrium Aharonov-Bohm Oscillations through a Quantum Dot

V. Puller and Y. Meir

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Linear response conductance of a two terminal AB interferometer is an even function of magnetic field, as dictated by Onsager-Buttiker relations. This "phase symmetry" is generally known to break beyond the linear response regime. In simple AB rings the phase of AB oscillations changes smoothly with voltage bias. We show that behavior of AB phase in voltage-biased quantum dot interferometers in cotunneling regime is strikingly non-monotonous: breaking of phase symmetry starts only after the onset of inelastic cotunneling, and becomes significant only when the contributions of different levels to the even component of AB oscillations nearly cancel out (e.g., due to different parity of these levels).

http://vpuller.googlepages.com/

Rappaport Shay.

Category #09-2

Model of DNA Bending by Cooperative Binding of Proteins

Shay M. Rappaport and Yitzhak Rabin

Department of Physics Bar-Ilan university

We present a model of non-specific cooperative binding of proteins to DNA in which the binding of isolated proteins generates local bends but binding of proteins at neighboring sites on DNA straightens the polymer. We solve the statistical mechanical problem and calculate the effective persistence length, site occupancy and cooperativity. Cooperativity leads to non-monotonic variation of the persistence length with protein concentration, and to unusual shape of the binding isotherm. The results are in qualitative agreement with recent single molecule experiments on HU-DNA complexes.

Delayed currents and interaction effects in mesoscopic capacitors.

Zohar Ringel, Y. Imry and O. Entin-Wohlman

Weizmann Institute Of Science

We propose an alternative derivation for the dynamic admittance of a gated quantum dot connected by a single-channel lead to an electron reservoir. Our derivation, which reproduces the result of Pretre, Thomas, and Buttiker, shows that at low frequencies, the current leaving the dot lags after the entering one by the Wigner-Smith delay time. We argue that the delayed current behavior is responsible for the universal resistance measured in such devices. We also compute the capacitance when interactions are taken into account only on the dot within the Hartree-Fock approximation and study the Coulomb-blockade oscillations as a function of the Fermi energy in the reservoir. In particular we find that those oscillations disappear when the dot is fully 'open', thus we reconcile apparently conflicting previous results.

Crossover from sub-diffusion to super-diffusion in a tilted washboard potential

Yael Roichman [1], Ke Xiao [2], and David G. Grier [2]

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A fluid-borne particle driven out of equilibrium by a constant force still undergoes normal diffusion in the co-moving frame with the same diffusion constant of a free particle. When the particle is driven over a periodic potential energy landscape its diffusion constant depends on the driving force and exhibits a giant enhancements when the driving force is comparable to the trapping force. Our experiments and simulations reveal that a small amount of quenched disorder in this system results in a broadening of the cycle time distribution of a particle in the periodic landscape. This, in turn, leads to a qualitative change in the diffusion nature. The effective diffusion constant is enhance even farther, and peaks when the particle's diffusion changes from subdiffusion to superdiffusion.

Rosenblatt Daniel

Category #04-2

Extraordinary Hall effect in thin Co-Pd multilayers

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Extraordinary Hall effect in materials with an out-of-plane anisotropy and room temperature hysteresis can be used in a new generation of nonvolatile magnetic memory devices. We report the study of thin Co-Pd multilayers that demonstrate rectangular room temperature hysteresis loops and coercive field varying linearly with the repetition number. The extraordinary Hall effect was found to reverse its polarity from positive to negative with an increasing number of layers while no changes were observed in the ordinary Hall component.

The noise spectra of a biased quantum dot

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The noise spectra associated with correlations of the current through a single level quantum dot, and with charge fluctuations on the dot, are calculated for a finite bias voltage. The results turn out to be sensitive to the asymmetry of the dot's coupling to the two leads. At zero temperature, both spectra exhibit two or four steps (as a function of the frequency), depending on whether the resonant level lies outside or within the range between the chemical potentials on the two leads. In addition, the low frequency shot-noise exhibits dips in the charge noise and dips, peaks and discontinuities in the derivative of the current noise. In spite of some smearing, several of these features persist at finite temperatures, where a dip can also turn into a peak.

Rotman Ziv

Category #02-2

Slow dynamics and glassiness in a lattice model

Ziv Rotman and Eli Eisenberg

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We study the supercooled liquid state of the hardcore N3 lattice gas model. Analysis of the Mayer cluster integral expansion predicts termination of the liquid branch at finite activity z_c with termination density lower than the closest packing density. We conduct a Monte Carlo study to provide evidence for jamming in the supercooled liquid phase, in agreement with a recent study of a similar kinetically constrained dynamical model. The movement of a trial particle shows a growing directional correlation, indicative of either caging or an increase in the probability of returning to the previous configuration. Such an increase was previously suggested as a mechanism leading to glass. These results hint at the possibility of N3 being a simple model that may give insight into glassy phenomena.

Category #11-2

Triggering and control of stick-slip friction

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Even regular stick slip frictional sliding always has some stochasticity associated to it. This stochasticity appears as uncertainty in the period between consecutive slip events. We show that once harmonic perturbations are introduced to the shear loading this picture changes significantly. Even relatively small perturbations can trigger the slip instability causing it to occur at a specific phase of the perturbation. This triggering either eliminates the stochastic element completely, or constrains it so that the stick-slip periods differ by discrete multiples of the period perturbation˜

Category #06-2

Luminosity Measurement at the International Linear Collider

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The linear collider community has set a goal to achieve a relative precision of 10^{-4} on the luminosity measurement at the International Linear Collider. This may be accomplished by constructing a finely granulated calorimeter, which will measure Bhabha scattering at small angles. In order to integrate the luminosity calorimeter in the proposed International Large Detector (ILD), the geometrical parameters of the calorimeter have been redefined. A dedicated clustering algorithm for the calorimeter has also been developed, which allows partial reconstruction of radiative Bhabha scattering events. In addition to the simulation studies, the current work includes the testing of silicon sensors, with the aim of participation in the construction of a calorimeter prototype within the FCAL collaboration.

http://alzt.tau.ac.il/~sadeh/pub/talkAbstract.pdf

Study of early spectral changes in cellular malignant transformation using FTIR-microspectroscopy

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Fourier transform infrared Microspectroscopy (FTIR-MSP) is potentially a powerful analytical methods for identifying the spectral properties of biological activity in cells [1]. The goal of the present research is the implementation of FTIR-MSP to study early spectral changes accompanying cellular malignant transformation. As a model for this purpose we used cell cultures infected with Murine Sarcoma Virus (MuSV) which induce malignant transformation. In order to follow the transformation’s progress as a function of time, it was necessary to find and validate consistent and significant spectral parameters [2] (biomarkers), which can clearly distinguish between normal and cancerous cells. Our results point out that the first spectral signs of malignant transformation were observed on the 1stand 3rd day of post infection (for NIH/3T3 and MEF cell cultures respectively), while the first visible morphological alterations were observed only on the 3rd and 7th day respectively [2]. These results strongly support the potential of developing FTIR microspectroscopy as a simple, reagent free method for early detection of malignancy.

Acknowledgement

This research work was supported by the Israel Cancer Association (ICA).

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[2] E. Bogomolny, M. Huleihel, Y. Suproun, R. K. Sahu, S. Mordechai, J. of Biomed. Opt. 12(2) (2007).

* the article has been also selected for the April 1, 2007 issue of Virtual Journal of Biological Physics Research

Diffuse time tomography of random heterogeneous materials

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Although the most attention in physics textbooks is devoted to the homogeneous or perfectly ordered materials, the physical world around us is mainly disordered. A great variety of random heterogeneous materials are encountered in nature and synthetic products. In many instances, the microstructures should be characterized only statistically. Therefore, instead of reconstructing the image of the sample, we can confine ourselves to measuring only the microstructure statistics (a "poor man's tomography"), say, a two-point correlation function of a relevant constitutive parameter (e.g., permittivity). In principle, this problem can be solved by means of a "soft field", probing the medium by microwave or optical radiation. In this work we derive, from the first principles, an original model of wave propagation in strongly scattering random structures. The basic quantity we evaluate here is the two-frequency mutual coherence function [1,2], which is an important quantity in itself, but primarily due to the fact that being properly normalized, and then Fourier transformed, it gives the impulse response function (photon time-of-flight distribution). Calculating then the first temporal moment, namely, the mean arrival (or diffuse) time of a short narrowband pulse, we show that its value is presented as a linear integral transform of the medium's power spectrum. Moreover, the integral transform relating the diffuse time to the microstucture statistics appears to be invertible, which allows one, in principle, to reconstruct the power spectrum of a heterogeneous medium by measuring the angular distributions of the diffuse time for waves of different frequencies.

[1] G. Samelsohn and E. Gruzdev, Phys. Rev. E 78, 036601 (2008).
[2] G. Samelsohn, V. Freilikher, and M. Haridim, Phys. Rev. E 78, 066602 (2008).

Category #07-2

Antihydrogen formation and trapping

Eli Sarid

NRCN, Israel and the ALPHA collaboration, CERN

The first cold antihydrogen atoms were produced in CERN in 2002 by the ATHENA and ATRAP experiments, using nested Malmberg-Penning traps to capture and mix positrons with antiprotons from the CERN AD (Antiproton Decelerator). The ALPHA collaboration continues the work of ATHENA, facing the next big challenge: trapping antihydrogen atoms. By adding multipole magnetic fields we produce a minimum-B trap that can trap cold neutral antihydrogen atoms through the interaction between the inhomogeneous magnetic field and the magnetic moment of the neutral atoms. In this presentation I will describe the design and operation of the ALPHA apparatus, the most recent results from the ALPHA experiment and the prospects for antihydrogen trapping. *This work is supported by the ISF, Israel.

Thermal evolution of planetesimals beyond the "snow-line"

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The early thermal and structural processes that affect planetesimals have strong implications for planet formation scenarios. The record for the evolution of these “building blocks” may be interwoven in the profiles of nowadays cometary bodies of various sizes, compositions, and presumed source regions. Modeling the internal evolution of cometary bodies takes into account various heat sources, such as insolation, crystallization, collisional effects and radioactive elements. In terms of composition, these models deal with a composition of dust and a mixture of volatiles, this may be either in solid or gaseous state. In terms of structure, the negligibility of self-gravity is taken as a general rule for all cometary bodies. As a result of the above assumptions, the equations that govern the structure and evolution are those of mass and energy conservation. A prescribed density profile usually replaces the demand for momentum conservation. In large enough bodies (~100 km and larger) self-gravity is not necessarily negligible, at least not for the entire body. Hydrostatic balance may play an important role in the evolution of internal structure in large bodies, affecting compaction and the continuous re-distribution of pore sizes. We combine in our models the thermal processing of volatiles, due to radionuclides (predominantly, 26Al and 60Fe) and insolation (which is negligible for orbits far enough from the “snow-line”), with a hydrostatic scheme for the solid matrix. We present some preliminary results and considerations, regarding the thermal and structural state of bodies occupying the region where the outer planets were formed and accreted. Emphasis is put on the emerging structure, amorphous-to-crystalline ice transition, and possible volatile retention.

Methane and ice water retention in large Kuiper belt objects

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Tel Aviv University

Recent observations have revealed that many large (>~1000 km in diameter) Kuiper belt objects exhibit features of crystalline water ice in their surface spectra. Some may even exhibit amorphous ice features. In addition, some of these objects show distinct spectral features of volatile ices, such as Methane and Ethane. The presence of such features of volatile ices could be explained as a consequence of atmospheric escape of these compounds. The crystalline ice features on the surface suggest a thermal processing history, which would increase the rate of volatile lose. An interesting question is how to get mixed reservoirs of water and volatile ices close to the surface, so it can be either observed directly, or be subjected to a thermal escape mechanism. We combine in our models the thermal processing of ices, due to radioactive heating, insolation (may be negligible for surface compositions in the outer Solar System and Trans-Neptunian region) and crystallization of amorphous to crystalline ice (as a triggered source of internal energy). We show that under certain thermochemical conditions, layers of crystalline water ice, amorphous water ice and CH4 ice can co-exist, for relatively long time scales (~100 Kyr). These layers, which are a part of an overall semi-stratified internal structure, may also exist ‘close enough’ to the surface. This means that deep depression features may easily arise on surfaces of KBOs (either as primordial topography or as impact cratering), exposing water and volatile ice spectral signatures. The fraction ratios deduced from irradiative surface models, may indicate the mass fraction of ices exposed and the physical characteristics of the depression feature.

Sela Itamar

Category #01-2

Quantum Stirring of electrons in low dimensional devices

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The simplest one-dimensional model for the studying of non-trivial geometrical effects is a ring shaped device which is formed by joining two arms. We explore the possibility to model such a system as a two level system (TLS). Of particular interest is the analysis of quantum stirring, where circulating current is induced in the Fermi sea by integrating a quantum pump into the closed circuit. The induced current may have either the same or the opposite sense with respect to the ``pushing" direction of the pump. We work out explicit expressions for the associated geometric conductance using the Kubo-Dirac monopoles picture and discuss whether the topology is properly reflected within the framework of the TLS modeling.

Transport properties of Ar^{+} irradiated $SrTiO_3$

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Irradiation of single crystal samples of insulating $SrTiO_3$ with Ar^{+} yields electron doped conductors with carrier mobility similar in its magnitude and temperature dependence to that obtained when other methods of electron-doping are used. Recently, we have reported [1] that some transport properties are time-dependent. In particular, the sheet resistance increases with time at a temperature-dependent rate, suggesting an activation barrier on the order of 1 eV, attributed to diffusion of oxygen vacancies.

Here we explore the nature of conductivity in Ar^{+}-irradiated $SrTiO_3$ by exploring its magnetoresistance in a wide range of temperatures and for different field orientations.

[1] M. Schultz and L. Klein, Appl. Phys. Lett. **91**, 151104 (2007).

Shafir Oren

Category #04-2

Electromagnetic radiation emanating from the molecular nanomagnet Fe8

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Photons emitted by transition between the discrete levels of single molecular magnets have an interesting property: their wave length can be similar to that of the sample size. This is the elementary condition for Dicke's super-radiance. In this radiative process a short intense pulse of light from a molecular system appears as a result of enhanced spontaneous emission rate due to interactions via the electro-magnetic field. Consequently, several investigators have been looking for this type of radiation in the molecular magnet Mn12, where energy bursts were reported after magnetic avalanches. We investigate the same phenomenon in the Fe8 molecule. Unlike in Mn12 we found energy bursts each time there is a jump in the magnetization, confirming their quantum nature. A series of tests indicated that photons carry out the energy. These photons obey the elementary conditions for super-radiance.

Rotational Properties of the Maria Asteroid Family

Alon Shaham

Tel Aviv University

Asteroid families represent results of natural experiments in which single asteroids were fragmented due to a high energy impact. The resulting debris of such an event are the asteroid family members. In our research we investigated the Maria Asteroid Family, a small group of roughly 70 members, and examined the light curves of some of its most prominent members. We expect to derive quantitative properties of the parent body at the completion of the analysis.

Shahmoon Ephraim

Category #01-2

Qubit Coherent Control with Squeezed Light Fields

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Quantum control fields that operate on a qubit in a single quantum gate may become entangled with the qubit and thus contribute to the gate error. Here, we study the use of squeezed light for qubit coherent control and compare it with the more standard coherent light state control field. We calculate the entanglement between a short pulse of resonant squeezed light and a two-level atom in free space during the π pulse operation and the resulting operation error. We find that the squeezing phase, the phase of the light field and the superposition phase, all determine whether atom-pulse mode entanglement and the gate error are enhanced or suppressed. These results are explained intuitively by using the Bloch sphere picture and quantitatively by quantum interference effects in the evolution of the atom-pulse quantum state. It is found that, although reduced for certain qubit initial states, when averaged over all possible states the minimal gate error is comparable to that with coherent light fields. In fact, in most cases the average error increases as a result of the enhancement of atom-pulse entanglement by squeezing. We discuss the possibility of measuring the increased gate error as a signature of this entanglement.

Category #09-1

Fast readouts mechanisms in the Central Nervous System: The temporal-Winner-Take-All

Maoz Shamir

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In recent years there has been a growing interest in temporal coding. In particular, spike-time latency has been shown to encode information about external stimuli. Here we study the accuracy of a temporal generalization of the Winner-Take-All (WTA) readout: the temporal- Winner-Take-All (tWTA). The tWTA accuracy is sudied in a framework of a statistical model for the dynamic response of a cell population responding to an external stimulus. Every cell is characterized by a preferred stimulus, a unique value of the external stimulus for which it responds fastest. The tWTA estimate for the stimulus is the preferred stimulus of the cell that fired the first spike in the entire population. We ask: What are the essential features in the tuning of the cell dynamic response to the stimulus to which the tWTA is sensitive? How does the tWTA accuracy depend on the population size? And what is the effect of noise correlations on tWTA accuracy? Our analysis reveals that response latency is the essential feature to which the tWTA is sensitive. We find that tWTA sensitivity to the stimulus grows algebraically fast with the number of cells in the population, N. This result is in contrast with the logarithmic-slow scaling of the conventional rate-WTA sensitivity with N. Noise correlations in the time-to-first-spike of different cells can limit the accuracy of tWTA readout, even in the limit of large N, similar to the effect that has been observed in population coding theory.

Shelukhin Victor

Category #04-1

Induced magnetization due to inverse proximity effect in S/F bilayers

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The transport and optical studies of the inverse proximity effect in superconductor ferromagnetic bilayers are presented. We have measured magnetoresistance of a e-beam lithographically patterned 200 nm thick Pb discs with diameters in the range 2-5 microns, deposited on the top of a 5 nm Ni film. The magnetoresistance curve exhibits relatively strong anomalous hysteresis (15 G wide).The direction of the hysteresis coincides with the direction of magnetization in Ni, indicating that the field induced in Pb has opposite direction to Ni magnetization, and it is a result of the magnetization induced in Pb. The hysteresis increases as the diameter of the superconductor (Pb) disc decreases. This is expected since the demagnetization factor is reduced when the ratio of the height of the disc to its diameter is decreased.
Magneto-optical measurements of the polar Kerr effect using a zero-area-loop Sagnac magnetometer on Pb/Ni and Al/(Co-Pd) proximity-effect bilayers show unambiguous evidence for the "inverse proximity effect," in which the ferromagnet (F) induces a finite magnetization in the superconducting (S) layer [1]. To avoid probing the magnetic effects in the ferromagnet, the superconducting layer was prepared much thicker than the light's optical penetration depth. The sign (diamagnetic) and size of the effect, as well as its temperature dependence agree with recent theoretical predictions [2] and they are consistent with our transport studies.

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Curved inclusions surf membrane waves.

R. Shlomovitz and N. S. Gov

The Weizmann Institute of Science, Department of Chemical Physics.

In this work we describe how membrane inclusions that have a spontaneous curvature, will be convected on the membrane due to the propagation of membrane waves. We calculate the Stokes' drift of such particles and the effect on their overall density field. We solve analytically for a uniform sinusoidal wave in the absence of diffusion, and numerically for the more realistic case of decaying waves with diffusion. In the latter case we provide some good analytic approximations. A variety of such membrane waves that propagate over a significant proportion of the cell surface exist in living cells, and we therefore show that they can play a role in transporting membrane proteins.

Category #04-2

Field induced resistivity anisotropy in $SrRuO_3$ films

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$SrRuO_3$ is an itinerant ferromagnet with orthorhombic structure and uniaxial magnetocrystalline anisotropy – features expected to yield resistivity anisotropy both above and below its Curie temperature (T_C). Nevertheless, thin films of $SrRuO_3$ exhibit rather small anisotropy which is difficult to characterize by comparing resistivity measurements taken on patterns with current flowing along different directions relative the crystallographic axes, since uncertainties related to geometrical factors of the compared patterns would considerably affect the results. For this reason, when we have determined the zero field anisotropy of epitaxial films of this compound, we have looked for a different method and used measurements of the planar Hall effect. Using this effect provides with a single measurement information on the local anisotropy and thus it serves as a very useful tool for accurate and reliable determination of resistivity anisotropy. Furthermore, as a consistency check the PHE was measured for different patterns having their current paths along different crystallographic orientation where all patterns were fabricated on the same sample. Using this method we were able to fully characterize the zero field resistivity anisotropy between 2-300 K and we could identify both magnetic and non-magnetic origin of the observed anisotropy [1]. Here, we apply a similar method to explore how changing the magnitude and orientation of the magnetization at a given temperature affects the resistivity anisotropy.

[1] Isaschar Genish, Lior Klein, James W. Reiner and M. R. Beasley, Phys. Rev. B 75, 125108 (2007).

Category #08-2

Searching For and Studying Transiting Extrasolar Planets

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Transiting extrasolar planets are unique astrophysical objects. They allow the measurement of their mass and radius, thus putting to the test theory of planetary structure and composition. Moreover, the discovery of a transiting planet enables several detailed follow-up studies, including searching for additional bodies in the star-planet system. I will present the primary steps and difficulties in searching for these rare objects, and also the results of a follow-up study of an interesting planet.

http://wise-obs.tau.ac.il/~shporer/homepage/

Two-Photon Polymerization of Polydiacetylene

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We show that visible light can polymerize diacetylene monomers into polydiacetylene (PDA) in a two-photon process. We monitor the process by measuring Raman intensities of PDA using a Raman laser at 633 nm with variable intensity I and show that the Raman cross section at short times increases as 3 I , corresponding to a two photon process. The process generates a relatively stable blue phase PDA, in contrast with UV polymerization that leads to a fast blue to red phase transformation.

Vortex annihilation effect on ac magnetic response in type-II superconductors

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In this work we show that the presence of the zero-field lines ($B=0$) in a superconducting sample can dramatically affect the flux motion and the ac response of high-temperature superconductors. The same lines can be called annihilation lines, since (in the slab geometry) these are the places where the Abrikosov vortices of different polarity annihilate each other. Such a annihilation line changes significantly the distribution of currents in the sample and have a retardation effect on the flux motion in the whole sample. The effect is more prominent if the frequency ω of the external field is relatively high, such that $1/\omega$ is of the same order or smaller than the characteristic relaxation time of vortices in the sample, in the flux-flow regime. In this limit the Bean model can no longer be used for the description of vortex motion in the sample [1], and therefore the equation of flux diffusion has to be solved numerically [2]. One of the results of the retardation effect of the zero-field lines is the appearance of two maxima (per one half of the period of the external magnetic field) in the voltage associated with the flux motion. The previously observed (usual) maximum is in phase with the external field, the other is out of phase with the field (about $\pi/4$ shift) and its position is determined by the zero-field lines appearance in the sample. The presence of two maximums have been recently found out experimentally [3], and our analysis forms a theoretical basis for understanding the effect. We study the dependence of the effect on the amplitude of the magnetic field, its frequency as well as on the value of the transport current flowing in the sample and get quite encouraging agreement between the experimental data and theoretical analysis.

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Sonin Edouard

Category #01-2

Gauge-field rotation of electrically polarized Bose condensate due to Aharonov-Bohm effect

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It is shown that a condensate of electrically polarized bosons subject to a radial magnetic field must rotate due to the Aharonov-Bohm effect. As in mechanically rotated superfluids, rotation is accompanied by penetration of vortices into the condensate at some critical magnetic field. In the case of a Bose condensed exciton cloud in a double- quantum well a necessary electric polarization is provided with spatial separation of electrons and holes forming excitons. Penetration of vortices strongly affects the intensity and the angular distribution of photoluminescence from the exciton cloud. This effect can be used for an effective experimental manifestation of exciton Bose condensation.

http://arxiv.org/abs/0811.3296

Electronic level structure of semiconductor nanocrystals in 2D arrays and in core/shell heterostructures

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The electronic level structure of colloidal semiconductor nanocrystals (NCs) in two-dimensional arrays was probed using scanning tunneling spectroscopy (STS). Typically, the band gap is found to reduce compared to that of the corresponding isolated NCs. We found that the type and the degree of the reduction determined mainly by the density of the NCs inside the arrays and by the effective mass of the charge carriers. For InAs quantum dots (QDs) arrays, the electron ('conduction-band') ground state red shifts more than the hole ('valence-band') ground state. This is assigned to the much smaller effective mass of the electrons, resulting in stronger electron delocalization and larger coupling between electron states of neighboring QDs compared to the holes. This is corroborated by comparing these results with those for InAs and CdSe nanorods (NRs) assemblies, manifesting the effects of the electron effective mass and arrangement of nearest neighbors on the band gap reduction. In addition to the probing of the electronic level structure in NCs arrays, the STS method can be used to find local variations inside a single core/shell heterostructured NC. So far, no method was reported for direct measurement of the band-offsets in colloidal nanocrystals and only indirect information could be derived from optical measurements. Here we demonstrate that STS along with theoretical modeling can be used to determine band-offsets in such nanostructures. Applying this approach to CdSe/CdS quantum-dot/nanorod core/shell nanocrystals portrays its type-I band structure where both the hole and electron ground-state are localized in the CdSe core, in contrast to previous reports which predicted electron delocalization. The generality of the approach is further demonstrated in ZnSe/CdS nanocrystals where their type-II band alignment, leading to electron-hole separation, is manifested.

Imaging physical concepts: A review of Bose-Einstein condensation

Jeff Steinhauer

Technion -- Israel Institute of Technology

Since the experimental achievement of Bose-Einstein condensation in 1995, the field of ultracold atoms has been a cornucopia of fascinating studies, touching on a wide range of physical phenomena related to quantum and condensed matter physics. In many cases, the results are observed via images of atomic clouds, in which textbook equations and concepts become visual.

Is N=8 Supergravity Finite?

K. Stelle

Imperial College, London

Recent advances in computational technique have permitted the evaluation of higher loop divergences in super Yang-Mills and supergravity theories, up to three loops so far. This reveals supergravity cancellations that might not have been expected. We will consider this in the light of non-renormalization theorems and will try to judge whether these results constitute a cancellation "miracle" indicating possible all-loop-order finiteness of the maximal N=8 theory.

Category #06-2

Measurement of the energy dependence of the total photon-proton cross-section at HERA

Amir Stern

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The energy dependence of all hadron-hadron total cross sections can be described by a simple form. At the ep collider HERA, $\sigma_{\mathrm{tot}}(\gamma p)$ can be extracted from ep scattering at very low momentum transferred squared at the electron vertex, $Q^2 \simeq 0\ GeV^2$. Earlier measurements of the total γp cross section at HERA showed that the total photoproduction cross section has an energy dependence similar to that of hadron-hadron reactions. Taking advantage of the HERA running at different center-of-mass energies, an attempt is made to determine precisely the energy dependence of the total photon-proton cross-section using only data collected with the ZEUS detector.

Corrected Charged Black Strings

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In this work we find α' corrections to d-dimensional charged black holes which were formed by the collapse of highly excited fundamental strings. We calculate the changes in the black holes thermodynamic properties as caused by these corrections, including the changes in the black holes entropy and mass-charge ratio. Our results show that the entropy increases while the mass-charge ratio decreases. Lately, It has been conjectured that higher derivative corrections decrease the mass-charge ratio when added to (non-supersymmetric) extremal black holes. Since in this work we consider non-extremal black holes, our results indicate an important possible extension of the mass-charge ratio conjecture.

http://www.phys.huji.ac.il/~merav/CBS.ppt

Semilinear response for the heating rate of cold atoms in vibrating traps

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The calculation of the heating rate of cold atoms in vibrating traps requires a theory that goes beyond the Kubo linear response formulation. If a ``strong quantum chaos'' assumption does not hold, the analysis of transitions shows similarities with a percolation problem in energy space. We show how the texture and the sparsity of the perturbation matrix, as determined by the geometry of the system, dictate the result. An improved sparse random matrix model is introduced: it captures the essential ingredients of the problem, and leads to a generalized variable range hopping picture.

[1] A. Stotland, D. Cohen, N. Davidson, arXiv:0810.0360

http://physics.bgu.ac.il/~stotland/ARCHIVE/kbw_tlk.pdf

Category #03-2

Manipulating the optical transparency of meta-materials with a strong magnetic field

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We have conducted a theoretical and calculational study of the transmission of light through a sub-wavelength-perforated metal film [1,2], as well as through a homogeneous metal film [3], with Drude ac conductivity tensor in the presence of a static magnetic field [4]. Both perforated and homogeneous metal films are found to exhibit a magneto-induced light transparency and a decreasing of reflectivity due to cyclotron resonance (see extraordinary light transmission [5]). In particular, the cyclotron resonance and the surface plasmon resonance of a perforated metal film move to higher frequencies with increasing magnetic field, bringing about large changes in the extraordinary light transmission peaks predicted to occur in such a film. In the case of periodic microstructures, these phenomena depend not only on the magnitude of the applied in-plane magnetic field, but also on its direction. This is due to the nonlinear dependence of the local electromagnetic response on that field. The practical possibility of changing the sample transparency by application of a static magnetic field (e.g., a new type of magneto-optical switch) is discussed.

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Reactive-Wetting in Room Temperature: Bulk Spreading and Interface Kinetic Roughening

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We introduce a reactive-wetting system, the only known one in room temperature. It consists of small mercury droplets (150 microns in diameter) spreading on thin silver films (2000 – 4000 A). The process is monitored using an optical microscope. Using a new method, based on reflection DIC (Differential Interference Contrast) light microscopy, we reconstruct the dynamic three-dimensional shape of the spreading droplet from a planar top view thereof, with video time resolution. Following this reconstruction, we study the time dependence of the bulk droplet radius and its contact angle.

The kinetic roughening process of the triple line exhibits complex spatio-temporal patterns. We discuss the growth and roughness exponents of the propagating interface, the temporal interface width fluctuations during a single growth process, and the lateral correlation length along the triple line – all as a function of the silver substrate roughness and the temperature of the system. Using extreme value statistics, in particular the persistence measure, we demonstrate the difficulties to associate a given universality class to this complex system.

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Tamam Lilach

Category #09-1

X ray studies of Langmuir films of Chiral Molecules on Liquid Mercury

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The classical “Langmuir films” have been studied considerably over the last decades due to their importance for both basic and applied sciences [1] . Since the subphase-film interaction should play an important role in the determination of the structure of the film, we have explored the structure and thermodynamics of such films on the surface of liquid mercury, using surface-specific synchrotron X-ray techniques and surface pressure measurements. One advantage of this subphase is its high surface tension, as compared to that of water. This enhance the spreadability of films, allows spreading water soluble, hydrophobic and non-amphiphilic molecules, and other molecules not spreadable on water. More importantly, it provides a much different subphase-monolayer interaction than that available on an aqueous subphase. The high surface tension of liquid metals also provides a super-smooth surface, allowing surface-specific x-ray techniques to reach atomic resolutions, not achievable on aqueous subphases. In the present study we focus on the effects of molecular chirality on the structure of the Langmuir film. Chirality is an extremely important factor in biology. Serine, the chiral compound of the present study is of great interest because serine-serine interactions account for many biochemical processes [2] . We investigated the molecule structure and phase behavior of a monolayer of molecules consisting of a strearic acid moiety linked to a serine group by a peptide bond, on the surface of liquid mercury. At low coverages we find a laterally disordered layer of surface parallel molecules for both the hetro– and the homo-chiral films. As the coverage (and surface pressure) increases, a standing-up phase is formed, in which the molecules are oriented parallel to, or somewhat tilted from, the surface normal. In this phase we find a different order for the Hetro and Homo chiral films The behavior of these phases will be also discussed in comparison with similar amino acid on water [3] surface and with the corresponding alkane derivatives on mercury [4].

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Veksler Alexander

Category #02-2

Generalized fractional Fokker-Planck equation for anomalous diffusion

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The problem of anomalous diffusion is important for a variety of systems, such as fluids, glasses, polymers, proteins etc. It is characterized by a mean square displacement evolving in time as a power-law $\langle x^2 \rangle = 2D_0 t^\alpha$. However, a Fokker-Planck-like equation which could describe a stationary Gaussian process with anomalous-diffusion behavior, such as the one described by the Generalized Langevin equation, is still missing.

We propose a generalization for constant force to the fractional Fokker-Planck equation (fFP) [Metzler, R. and Klafter, J., Phys. Rep. **339** (2000), 1-77], based on a series expansion in spatial and fractional time derivatives and powers of the Fokker-Planck operator. The proposed equation, GfFP, recovers the generalized Einstein relation and leads to Gaussian distribution, in particular, for free particle diffusion.

We apply GfFP to 1-D first passage time problem. The long-time asymptote of the probability distribution behaves like $\exp(-t^\alpha)$. This contrasts with the power-law behavior of the corresponding solutions of the fFP. We further propose to generalize GfFP for treating other outstanding problems, such as the anomalous diffusion under an harmonic potential and the Kramers` escape problem.

Evolution of Nuclear Shape in the Light Radon Isotopes

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We have carried out Coulomb excitation of post-accelerated beams of $^{202,204}Rn$ from the REX-ISOLDE facility. The aim of this study is to expand our understanding of nuclear shape coexistence, which has been increasingly well-established in the light mercury and lead nuclei to these very heavy nuclei. Such an extension will provide stringent tests of nuclear models of collectivity and shape coexistence in a previously-inaccessible heavy mass region. REX-ISOLDE is the only facility worldwide at the present time which can provide accelerated beams of such heavy radioactive nuclei.

Inhomogeneous phases in a double-exchange magnet with long range Coulomb interactions

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We consider a model with competing double-exchange (ferromagnetic) and superexchange (antiferromagnetic) interactions in the regime where phase separation takes place. The presence of a long range Coulomb interaction frustrates a macroscopic phase separation and favors microscopically inhomogeneous configurations. We use the variational Hartree-Fock approach, in conjunction with Monte Carlo simulations, to study the geometry of such configurations in a two-dimensional system. We find that an array of diamond-shaped ferromagnetic droplets is the preferred configuration at low electronic densities, while alternating ferromagnetic and antiferromagnetic diagonal stripes emerge at higher densities. These findings are expected to be relevant for thin films of colossal magnetoresistive manganates.

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Modulation Enhancement of a Laser Diode in an External Cavity

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High-frequency modulation of laser beams is important for various fields including atomic physics, metrology and optical communications. In particular, it is useful in generating two coherent phase-locked laser beams with a frequency difference of several GHz, corresponding to the hyperfine splitting of the ground state of alkali atoms, which are commonly used in cold atom experiments. We present experimental results demonstrating enhanced current modulation of an AR coated edge-emitting laser diode placed in an external cavity. By eliminating the internal cavity of the laser diode and matching the external cavity FSR to the modulation frequency, we have increased the modulation response by 3 orders of magnitude up to nearly complete carrier suppression. We intend to use this tool to manipulate the internal (hyperfine) state of isolated single atoms on atom chips including, for example, to prepare a superposition state and measure its coupling to the macroscopic environment via the dephasing observable.

Environment and Star Formation

Joanna Woo[1], Avishai Dekel[1], Kai Noeske[2], Aaron Dutton[3], Sandra Faber[3], et al.

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I will review recent studies on the correlation between environment and star formation (SF) in galaxies, and present my own results from the AEGIS field. I will show that the enviroment-SF correlation evolves with redshift, and depends on stellar mass (M*). However, I will also show that the correlations are very weak, and that environment is not a major contributer to the scatter in the SF-M* relation.

Yaakobi Oded

Category #11-2

Multidimensional, autoresonant three-wave interactions

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The theory of autoresonant three-wave interactions is generalized to more than one space and/or time variation of the background medium. In the most general case, the three waves propagate in a four-dimensional (4D) slowly space-time varying background, with an embedded 3D linear resonance hypersurface, where the linear frequency and wave-vector matching conditions of the three waves are satisfied exactly. The autoresonance in the system is the result of weak nonlinear frequency shifts and nonuniformity in the problem and is manifested by satisfaction of the nonlinear resonance conditions in an extended region of space-time adjacent to the resonance surface despite the variation of the background. The threshold condition for autoresonance is found and further discussed in application to stimulated Raman scattering in a 1D, time-dependent plasma case. Asymptotic description of the autoresonant waves far away from the resonance surface is obtained. The theory is illustrated and tested in 2D numerical simulations.

Category #02-4

In Random Multiplicative Environments – Charity Pays Off.

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We address two issues that puzzled scientific thinking since antiquity. The first of the puzzles is the emergence and selection fitness of altruist behavior in a world of self-reproducing individuals (or memes in general). The second is the sustainability of growth and the survival in a stochastic high risk though potentially gainful world. We show that the solution for each of these puzzles lies within the other one. It is known that in a multiplicative random process even if in the mathematical evaluation of the expected gain the wins overwhelm the losses, one is likely to face extinction. For example if the probability of a total loss event is arbitrarily small but finite, the measure of histories with non-vanishing gains approaches zero for asymptotic times. Thus the optimistic theoretical expectation is dominated by event chains whose probability is too small to happen in reality. We find that in those situations, there is a way to survive. The individuals can insure continuous, unlimited growth by sharing their gains$/$losses after each step of the random process. We compute the minimal necessary sharing group size N_{crit} for survival. In a group of N_{crit} individuals, defection by one individual leads automatically, thus credibly, to the ruin of the entire group (including the defector). Consequently sharing becomes the only stable survival strategy without the need of any additional enforcing mechanism. This implies the survival and thriving of "altruistic genes" for very long evolutionary periods.

http://www.phys.huji.ac.il/~guryaari/IPS.pdf

Non-Stationary Barotropic Magnetohydrodynamics as a Four Function Field Theory

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Variational principles for magnetohydrodynamics were introduced by previous authors both in Lagrangian and Eulerian form. In a previous work [1] we introduced a simpler Eulerian variational principles from which all the relevant equations of magnetohydrodynamics can be derived. The variational principle were given in terms of six independent functions for non-stationary flows and three independent functions for stationary flows. This is less then the seven variables which appear in the standard equations of magnetohydrodynamics which are the magnetic field $\vec{B}$ the velocity field $\vec{v}$ and the density ρ. In this work we will attempt to improve on our previous results thus reducing the number of functions needed even further.

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Yahalom Asher

Category #03-2

Covariant formulation of the dynamics in a dissipative quantum dielectric obtained from a simplified Lagrangian

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Equations of motion and energy–momentum tensors are obtained for a dissipative medium sustaining electromagnetic polarizations using a Lagrangian formalism. A previous work has been simplified by reducing the number of independent vector fields interacting with the sink modes. A relativistic formalism of the same is also suggested.

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The Geometrical Meaning of Time

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It is stated in many text books that the any metric appearing in general relativity should be locally Lorentzian i.e. of the type $\eta_{\mu\nu}$ = diag(1,−1,−1,−1) this is usually presented as an independent axiom of the theory, which can not be deduced from other assumptions. The meaning of this assertion is that a specific coordinate (the temporal coordinate) is given a unique significance with respect to the other spatial coordinates. In this work it is shown that the above assertion is a consequence of requirement that the metric of empty space should be linearly stable and need not be assumed.

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RF Transmission through multiple layers

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Development of a channel model for continuous RF frequencies enables the analysis of communications in an ultra wide band wireless network in indoor environment including a single transmitting and a single receiving antenna. In this work we will describe a model taking into account transmission through multiple layers which are a consequence of the inhomogeneity of the building materials our indoor environment is made of. Our model enables the analysis of a communication channel between adjacent and distant rooms, in those cases we take into account the wide band signal propagation through separating walls. The model developed is in the frequency domain and thus allows analyzing dispersive effects in transmission and reflection of ultra short pulses in UWB communications from building materials which the room is made of in accordance with their complex dielectric coefficients. For this purpose a library of material characteristics of various materials (concrete, reinforced concrete, plaster, wood, blocks, glass, stone and more) in the standard frequency domain for wireless networks was assembled. One of the important phenomena for UWB communications which our research has revealed is the in-wall multiple reflections resulting in echos of the narrow pulse transmitted.

Yarmolich David

Category #07-1

Phenomena of non-complete ferroelectric surface discharge

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The operation of ferroelectric plasma sources under the application of driving pulses with different amplitudes (4-40kV) was studied. It was found that the dense plasma formation during the fast fall (a few tens of nanoseconds) in the driving pulse is accompanied by the generation of a highly diverging ?1800 neutral flow with velocity ?7?107 cm/s and charged microparticles in addition to the electron/ion flows which were studied in earlier research. It was shown that the velocity and intensity of the generated neutral flow remained the same for different parameters of the driving pulse. A model of neutrals and microparticles emission based on Coulomb micro-explosions of ferroelectric ceramics is suggested. Application of ferroelectric plasma source and a promising micro-thruster is discussed as well.

Yigal Shamir

Category #06-2

Lattice gauge theory meets technicolor

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Gauge theories similar to QCD, except with more general gauge groups and fermion content, had been long in use in technicolor and similar extensions of the Standard Model. The methodology of lattice gauge theory allows us to study these theories with controllable errors. We have carried out numerical simulations of the SU(3) theory with two color-sextet fermions. Our first results for a discrete analogue of the beta function indicate an infrared fixed point that makes the massless theory conformal rather than confining. Spectroscopy away from the massless limit reveals a two-phase structure consistent with the existence of a fixed point.

Yochelis Arik

Category #11-2

Selection of periodic and localized states in Reaction-Diffusion-Advection systems

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Spatially periodic and localized states are theoretically studied in the context of reaction-diffusion-advection systems with mixed boundary conditions. The minimal requirement for emergence of nonuniform patterns is a two variable model with advection and only one diffusion term; this makes the pattern selection qualitatively different from the symmetric finite wave number Turing or Hopf instabilities. The key mechanism is coexistence of propagating or stationary nonuniform solutions, which are identified in a comoving reference. Consequently, stationary periodic states may stabilize if aperiodic boundary conditions are employed, since the translational symmetry which is essential for traveling waves, can not be preserved. In the same framework, we also explain propagation of traveling waves against the advective flow, and reveal the regime of excitable pulses.

http://arxiv.org/abs/0810.4690

Properties of superconducting $TiSe_2Cu_x$

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One of the known Charge density waves (CDW) material is $TiSe_2$. Recently, a new material, $TiSe_2Cu_x$, was discovered. A new aspect of this material is that by introducing more Cu in to the compound, one continuously suppresses CDW up to a point where a superconductive state emerges and further on, the CDW state vanishes. Further more, Thus, providing the first opportunity to study the "CDW to superconductivity transition" in detail, through an easily controllable chemical parameter. We have measured, using Muon Spin Rotation (μSR), the magnetic penetration depth (λ) for various samples with different Cu levels. We found that λ follows the transition temperature, T_c, that appears to increase as the Cu doping increases, up to an optimal doping point, after which it decreases for higher Cu levels.

Zinger Elad

Category #08-2

The Role of Gas Streams in the Formation and Structure of Galaxy Clusters

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In recent years it has become increasingly clear that mass accretion onto galactic systems does not occur in a quasi-spherical manner, but rather along well defined streams. This new scenario for mass accretion can have a marked effect on the structure and dynamics of clusters. By employing high resolution numerical simulations, I investigate the interplay between the internal structure of the intra-cluster gas and the streams along which mass accretes onto the cluster, in the hopes of better understanding some of the questions raised by observations of these systems.

Advanced Statistical Techniques Applied to FTIR spectra of human Colon Cancer and Polyps

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Colon cancer is a major public health problem, due to its large disease rate and death toll worldwide. FTIR microscopy (MSP) has shown encouraging trends in the field of cancer diagnosis in the last 20 years. We investigated the potential of FTIR-microscopy to define spectral changes between normal, polyp and cancer human colonic biopsies. The measured data base was divided into five groups: normal and cancer tissues as well as 3 benign colonic polyps, namely, mild, moderate and severe polyps, which are precursors of carcinoma. All biopsied tissue sections were classified by an expert pathologist including the polyp stages which constitute a gradual and acute model system. By applying the principal component analysis (PCA) model, we reduced the dimension of the original data size to 13 principal components. While PCA analysis shows only partial success in distinguishing between cancer polyp and normal tissues, Multivariate analysis shows a promising distinction even inside the subgroups of the polyps. Good classification accuracy was achieved between groups with approximately 85% success rate between Normal and Cancer. These results strongly support the potential of developing FTIR-micro spectroscopy as a simple, reagent-free viable tool for early detection of colon cancer in particular among the benign colonic polyps with increasing degrees of severity of dysplasia (mild, moderate, and severe). The malignant risk is correlated with the severity of the epithelial dysplasia.