INIS-mf--13358

THE WEIZMANN INSTITUTE OF SCIENCE
DEPARTMENT OF PHYSICS

ISRAEL PHYSICAL SOCIETY
1992
ANNUAL MEETING

PROGRAM AND ABSTRACTS

BULLETIN OF THE ISRAEL PHYSICS SOCIETY
VOL. 38, 1992

THE WEIZMANN INSTITUTE OF SCIENCE
DEPARTMENT OF PHYSICS

ISRAEL PHYSICAL SOCIETY
1992
ANNUAL MEETING

PROGRAM AND ABSTRACTS

BULLETIN OF THE ISRAEL PHYSICS SOCIETY
VOL. 38, 1992

הועדה המארגנת מקבלת את כל באי כנס החברה הישראלית לפיסיקה וכנס האגודה הישראלית לואקום בברכת ברוכים הבאים ובתקוה כי הכנסים יהיו מענינים ומועילים. בכנסים ייוצגו רוב שטחי הפיסיקה הפעילים וכן תהיה הרצאה כללית על מצב המים בארץ. מארגני הישיבות השתדלו למצוא מרצים מקרב אלו אשר הצטרפו אלינו לאחרונה. לפיכך ניתן יצוג יחסית גדול לעולים ולישראלים צעירים.

אני מודה לחברי הועדה המארגנת והאתראים לישיבות השונות על המאמץ שהשקיעו ולסגל מזכירות הפיסיקה על הטפול המסור.

יוסף אמרי

The organizing committee welcomes all participants of the IPS and Vaccuum Society meeting and wishes them interesting and useful meetings. Most active branches of Physics will be represented and a general lecture on the water situation in Israel will be given. The session organizers tried to find lecturers among recent newcomers to Israel. Olim and young Israelis are thus relatively well represented in the program.

I thank the members of the organizing committee and those responsible for the sessions for their efforts and the staff of the Physics Faculty for their help and devotion.

Yoseph Imry

General Information

We are happy to welcome you to the Weizmann Institute to participate in the annual IPS Meeting.

The following is for your information.

The conference desk will be open in the lobby of the Wix Auditorium from 08:30-10:00a.m. for registration. You are requested to pay the membership fee, IS 30.-(for retired members and for students IS 20.-) to the Israel Physical Society at the time of registration.

The plenary sessions will be held at the Wix Auditorium and the parallel sessions at various Lecture Halls, as indicated in the program.

The poster session will be held in the lobby (1st and 2nd floor) of the Physics Building. It is recommended that posters be displayed as early as possible. Please stay near your poster during the poster session (3:30-4:45 p.m.).

Abstracts presented orally appear in order of presentation and the rest of them are arranged in this bulletin in alphabetical order, in each session.

Participants are welcome to visit our newly established Sub-micron Center. Organized tours of the Center during the lunch and afternoon coffee break will be arranged. Please register at the conference desk if you are interested in this tour.

A three course meal will be available at the San Martin Cafeteria for IS 10. Sandwiches and cold drinks will be sold on the lawn of the Wix Auditorium (IS 1.50 for sandwich, and IS 0.50 for a drink). You are requested to buy tickets at the desk during registration, for the meal of your choice.

COUNCIL

Prof. I. Tserruya - president - Weizmann Institute
Prof. S. Gurvitz - secretary - Weizmann Institute
Prof. D. Rappaport - treasurer - University Bar-Ilan
Prof. D. Shaltiel - Hebrew University
Prof. G. Shaviv - Technion
Prof. S. Mordechai - Ben-Gurion University
Dr. B. Svetitsky - Tel-Aviv University
Dr. Y. Barak - Atomic Energy Comm. Yavne
Dr. T. Bar-Noy - Atomic Energy Comm. Dimona
Dr. D. Falik - RAFAEL
Prof. C. Kuper - Annals representative - Technion

MEMBER ORGANIZATIONS

Bar-Ilan University
Ben-Gurion University
Hebrew University
Israel Atomic Energy Authority
Technion - Israel Institute of Technology
Tel-Aviv University
Weizmann Institute

ORGANIZING COMMITTEE - Weizmann Institute

Y. Imry, Chairman
I. Bar Joseph
Y. Gefen
M. Hass
M. Kugler
I. Maron
M. Magaritz
M. Milgrom
S. Safran
U. Smilansky
I. Tserruya
G. Hodes, Representative of Vacuum Israeli Society

Table of Contents

Israel Physical Society - Annual Meeting

The Weizmann Institute of Science, Rehovot
15 April 1992

PROGRAM

08:30 Registration (Wix Auditorium)

09:30 Opening Session (Wix Auditorium)
Formal Opening: Yoseph Imry, Chairperson, Organizing Committee
Welcoming Remarks: Haim Harari, President, Weizmann Inst.
Presentation of Prizes: Itzhak Tserruya, President of IPS

09:50 Plenary Session (Wix Auditorium)
Yossi Nir, Weizmann Inst.
"Recent Developments in the Physics of Neutrinos."

10:35 Coffee Break

11:00-12:30 Parallel Session I (see detailed program)

12:30-14:00 Lunch Break

14:00-15:30 Parallel Session II (see detailed program)

15:30-16:45 *Poster session + coffee break*

16:30-16:45 Business Meeting

16:45-18:15 Plenary Session (Wix Auditorium)
Chairperson: Y. Yacoby, Hebrew University

16:45 Dan Zaslavsky, Water Commissioner
"The Water Situation in Israel and Challenges in Research."

17:30 Yosef Yeshurun, Bar-Ilan Univ.
"Review of High Temperature Superconductors: Oxides and Fullerenes."

Morning Parallel Sessions

Each lecture time includes 5 minutes for discussion

Non-linear Dynamics
Lec. Room A (Physics)

Chairperson: S. Fishman, Technion

Invited Lectures

11:00 R. Zeitak, Weizmann Inst.
"Vectorial Correlations on Fractal paths: Applications to Random Walks and Turbulence."

11:30 Y. Zarmi,Desert Research, Ben-Gurion Univ.
"Renormalization in Classical Nonlinear Systems."

12:00 I.S. Aranson, Hebrew University
"Stability Limits of Topological Defects and Spatio-Temporal Chaos in Nonequilibrium Media."

Solid State (I)
Weissman Auditorium
Chairperson: D. Zamir, Soreq Nucl. Res. Center

Invited Lectures

11:00 A. Finkelstein, Weizmann Inst. & Landau Inst.
"Magnetic Properties of Electron Liquids with Disorder."

11:30 A. Palevsky, Tel Aviv Univ
"Electronic Transport in Coupled Quantum Wells."

Oral Presentations:

12:00 D. Eger, Soreq Nucl. Res. Center
"Blue Laser Light Emission by SHG in Periodically Segmented Waveguides"

12:15 O. Cohen, Hebrew Univ.
"1/f Noise and Incipient Localization."

Particles and Fields
Lec. Room B (Feinberg)
Chairperson: S. Nussinov, Tel Aviv Univ.

Invited Lecture

11:00 D. Gepner, Weizmann Inst.
"Fusion Field Theories"

Oral Presentations

11:30 E. Nirsimov, Ben-Gurion Univ.
"Induced W_∞ Gravity as a WZNW Model on the Deformed Group of Area-Preserving Diffeomorphisms."

11:45 M. Spiegelglass, Technion
"Stringy Monodromies and a Black Hole Geometry."

12:00 A.E. Faraggi, Weizmann Inst.
"Deriving the Standard-Model from the Superstring."

12:15 A. Hanany, Weizmann Inst.
"Quark Solitons as Constituents of Hadrons."

Environment
Lec. Room B (Physics)
Chairperson: A. Nir, Rehovot

Invited Lectures

11:00 M. Fuchs, ARO, Volcani Center
"Radiation Exchange and Microclimate in Vegetation Canopies."

11:30 Y. Yoseph, Tel Aviv Univ.
"Global Warming? - A dilemma for the Scientist."

12:00 E. Tziperman, Weizmann Inst.
"Studying the Oceans by combining General circulation Models and Oceanographic data."

Oral Presentation

12:30-12:35 D. Loewenthal, Tel Aviv Univ.
"Dual Field Theory in Layered Media."

Plasma Physics
San Martin Lec. Room
Chairperson: B. Arad, Soreq Nucl. Res. Center
18 minutes each lecture, including discussion

Invited Lectures

D. Ofer, Nuc. Res. Centre, Negev
"Numerical Analysis of Nonlinear Mode-Mode Interactions in the Rayleigh-Taylor Instability."

A. Zigler, Hebrew Univ.
"Ceneration of High Intensity X-ray Radiation by Intense subpicosecond laser".

A. Rosenberg, RAFAEL
"Studies of High Power Nonresonant Virtual Cathode Oscillator."

M. Foord, Weizmann Inst.
""High-resolution Spectroscopic Studies of an Imploding Z-Pinch Plasma"

R. Boxman, Tel Aviv Univ.
"The Momentum Flux from Cathode Spot Plasma Jets : Interaction with Macroparticles and Background Gas, and Influence on Anode Spot Development."

Note: During part of the afternoon coffee break (15:45-16:30), Dr. A. Wolf, Nucl. Res. Centre, Negev, will conduct, in the same lecture room a discussion group on Free Electron Lasers

Science Teaching

Lec. Room D (Feinberg)

Chairperson: U. Ganiel, Weizmann Inst.

20 minutes each lecture, including discussion

Invited Lectures

M. Feingold, Technion
"Physics of Technological Systems: A Course for Weaker Students."

B. Eylon and Z. Geller, Weizmann Inst.
"Bridging the Gap between Electrostatics and Electrodynamics in the Teaching of DC Circuits."

M. Ronen, Weizmann Inst.
"A Computerized Learning Environment for Geometrical Optics."

M. Meidav, Tel Aviv Univ.
"A Teachers' Teacher Perspective."

Statistical Physics and Complex Fluids
Lec. Room A (Physics)
Chairperson: D. Mukamel, Weizmann Inst.

Invited Lectures

14:00 C. Knobler, UCLA
"Phase Transitions and Domain Structures."

14:30 D. Levine, Technion
"Some Peculiarities of Granular Materials."

15:00 D. Andelman, Tel Aviv,
"Modulated phases of Vesicles and Membranes."

Solid State II
Weissman Auditorium
Chairperson:Y. Avishai, Ben-Gurion Univ.

Invited Lectures

14:00 E. Akkermans, Technion
"Conduction and Statistical Properties of Metallic Spectra."

14:30 B. Laikhtman, Hebrew Univ.
"Current-Voltage Instabilities in Superlattices."

Oral Presentations

15:00 S.A. Gredeskul, Ben-Gurion Univ.
"Extended States on the Landau Levels with Disorder."

15:15 N. Hass, Tel Aviv Univ.
"Sharp Gap Edge and Determination of the Fermi Velocity in $Y_1Ba_2Cu_3O_{7-\delta}$ by Point Contact Spectroscopy."

Nuclear Physics
San Martin Lec. Room
Chairperson: E. Friedman, Hebrew Univ.

Invited Lectures

14:00 Y. Birenbaum, Nucl. Res. Centre, Negev
"Evidence for Nonstatistical Contribution to the Photoneutron decay of Lead, Bismuth and Terbium."

14:30 M. Hass, Weizmann Inst.
"The 'mystery' of the K=I=25 Isomer in ^{182}Os."

15:00 B. Svetitsky, Tel Aviv Univ.
"Bubbles in the Quark-Gluon Plasma."

Astrophysics
Lec. Room B (Physics)
Chairperson: J. Bekenstein, Hebrew Univ.

Invited Lectures

14:00 O. Regev, Technion
"Chaotic Phenomena in Astrophysical Fluids"

14:30 D. Eichler, Ben-Gurion Univ.
"Gamma-Ray Bursts"

Lasers and Optics
Lec. Room A (Feinberg)
Chairperson: R. Shuker, Ben-Gurion Univ.

Invited Lectures

14:00 A. Lewis, Hebrew Univ.
"Near-Field Optics: The Manipulation and Application of Light Beyond the Diffraction Limit."

14:30 M. Rosenbluh, Bar-Ilan
"Coherence, Optical Pumping and Atomic Orientation."

15:00 M. Orenstein, Technion
"Pseudo Guiding and Coupling of 2D Vertical Cavity Semiconductor Lasers - Patterns in the Second Dimension."

Medical Physics
Lec. Room D (Feinberg)
Chairperson: S. Akselrod, Tel Aviv Univ

Invited Lectures

14:00 B. Ehrenberg, Bar-Ilan Univ.
"The Mechanism and Efficiency of Second Generation Photosensitizers for Photodynamic Therapy of Cancer"

14:20 J. Karin, Tel Aviv Univ.
"Fetal Heart Rate Detection from a Combined Fetal-Maternal ECG"

Oral Presentations

14:40 E. Hirshowicz, M. Lewkowicz, S. Akselrod, Tel Aviv Univ.
"Effect of Radial Activation on LV-Mechanics."

14:50 R. Wallach-Kapon, S. Akselrod, A. Katzir, Tel Aviv Univ.
"Formation of Cavities in Liquids using a CO_2 Laser."

Y. Linnenberg, R. Wallach-Kapon, A. Katzir, S. Akselrod, Tel Aviv Univ.
15:00 *"Estimation of the Effect of Vapor and Plasma Formation on the Intensity of the CO_2 Laser Beam during Laser Irradiation."*

15:10 V. Khutorsky, S. Lang, Ben-Gurion Univ.
"Influence of Moisture on Pyroelectric Properties of Bone."

G. Peleg, A. Lewis, Hebrew Univ.
15:20 *"Retinal Dynamics using Laser Interference with a Pulsed MED Infrared Source."*

הכנס חשנתי ח-גג של האגודה הישראלית לואקום

יום ד', יב' בניסן תשנ"ב, 15 באפריל 1992
אולם שמידט, מכון ויצמן למדע, רחובות

תכנית

8.30-9.20		הרשמה והתכנסות מול האולם.
9.20-9.30		יורם שפירא, נשיא - דברי פתיחה
9.30-10.50		**מושב A**
9.30- 10.10	*	Buckminsterfullerenes: interacting elctrons on spherical molecules א. ארבך, הטכניון
10.10-10.50	*	Optical films with graduated refractive index י. לובצקי, רפא"ל
10.50-11.10		הפסקת קפה
11.10-12.10		**מושב B**
11.10-11.25	**	LEED-AUGER, EELS and work function study of the clean and the caesium deposited CdTe(100) surface ת. גורדון, הטכניון
11.25-11.40	**	Characterization of metal-dielectric films for IR hollow waveguides ר. דאהן, אוניברסיטת ת"א
11.40-11.55	**	Improved types of SAW directional couplers ע. חרובי, אוניברסיטת ת"א
11.55-12.10	**	Solid phase epitaxial growth of Sb implanted in $Si_{1-x}Ge/Si(100)$ structures ז. עצמון , הטכניון
12.10-12.25		Diamond films י. אביגל, הטכניון
12.25-13.35		ארוחת צהריים
13.35-14.30		תצוגת פוסטרים (על יד אולם ההרצאות)
14.30-15.00		אסיפת האגודה + חלוקת פרסים
15.00-18.00		**מושב C**
15.00-15.40	*	Semiconductor quantum dots ג. הודס, מכון ויצמן
15.40-16.20	*	Surfaces of comets ע. בר-נון, אוניברסיטת ת"א
16.30-18.00		הרצאות פלנריות יחד עם הכנס השנתי של החבי הישראלית לפיסיקה, שיתקיימו באולם ויקס:
16.30-17.15	*	The water situation in Israel and challenges in research ד. זסלבסקי, הטכניון
17.15-18.00	*	Review of High-Tc superconductors: oxides and fullernes י. ישורון, אוניברסיטת בר-אילן

דמי השתתפות בכנס: חבר האגודה -.20 שקל; סטודנט -.10 שקל; לא חבר באגודה -.45 שקל.

---

* הרצאה מוזמנת

** הרצאת סטודנט במסגרת תחרות המאמר או הפוסטר המצטיינים

המזכירות: מכון ויצמן למדע, המחלקה לחומרים ופני שטח, ת.ד. 26, רחובות 76100
The Secretariat: Weizmann Institute of Science, Dept of Materials & Interfaces, P.O.B. 26, Rehovot 76100, Israel
Phone: (08)343353 :טלפון • Telex: 381300 :טלקס • Fax: 972(8)344137 : פקס.

Plenary Lectures

Recent Developments in the Physics of Neutrinos

Yossi Nir
Department of Physics
Weizmann Institute of Science
Rehovot, Israel

Within the Standard Model, the known left-handed neutrinos are exactly massless. But there is no symmetry principle which prevents them from acquiring masses in the presence of new physics effects which go beyond the Standard Model. For a certain range of neutrino mass parameters, a reduction in the flux of neutrinos from the sun is predicted. A series of experiments that measure the solar neutrino flux find that it is significantly smaller than theoretical predictions for massless neutrinos. This may provide us with the first evidence for physics beyond the Standard Model.

Review on High-Temperature Superconductors: Oxides and Fullerenes

Y. Yeshurun
Department of Physics
Bar Ilan University

In this talk I review the experimental data on high-temperature superconductors (HTSC) with special emphasis on their magnetic properties. The field-temperature (H-T) phase diagram for these materials is rich in information on thermodynamic characteristics as well as on metastable and irreversible features. Irreversible magnetic properties are not only of utmost importance to application but also affect reliable determination of thermodynamic quantities. The common wisdom was that bulk defects are responsible for irreversible behavior. Recently, however, surface barriers were discovered to be the dominant mechanism for irreversibility at high temperatures. I also describe new experiments which aim at "improving" HTSC and discuss recent ideas and concepts related to these experiments. The major part of my talk is devoted to the (almost) mature field of oxide HTSC. I also review briefly the magnetic properties of the newly discovered fullerenes and compare their properties with that of the oxides.

Parallel Sessions

1. Non-linear Dynamics

Invited Lectures

Vectorial Correlations on Fractal Paths: Applications to Random Walks and Turbulence

Reuven Zeitak
Department of Chemical Physics
Weizmann Institute of Science
Rehovot, Israel

The vorticity-vorticity correlations on two possible models of turbulence are calculated, i.e. vortex tube tangles that form Brownian curves and the self avoiding random walk. The results can be transformed to velocity correlations via an exact relation which allows to rule out these models of fractal turbulence.

Renormalization in Classical Nonlinear Systems

Peter B. Kahn
Physics Department, SUNY, Stony Brook, NY 11794

and

Yair Zarmi
Center for Energy & Environmental Physics
The Jacob Blaustein Institute for Desert Research
Ben-Gurion University of the Negev
Sede Boqer Campus, 84993

The freedom of choice of the zero order term in the perturbation expansion of solutions to oscillatory systems that are perturbed by a small nonlinearity is utilized within the framework of the method of normal forms. It is shown that in the planar case a judicious choice of the zero order term converts the, usually, infinite perturbation series for the updated frequency in conservative problems into a finite sum of terms. In simple problems, such as the Duffing oscillator, the perturbation series degenerates to its first order term.

In dissipative problems that exhibit a limit cycle, the radius of the "limit circle" becomes a constant which can be calculated at the onset of the bifurcation, and does not vary with the change in the small perturbation parameter.

In problems out of the plane (e.g., a few nonlinearly coupled oscillators) It has been shown that at least second order corrections can be eliminated by an appropriate choice of the zero order approximation.

It is shown how the freedom of choice of the zero order term is intimately related with the structure of higher order terms.

Stability Limits of Topological Defects and Spatio-Temporal Chaos in Nonequilibrium Media

Igor S. Aranson

Racah Institute of Physics, Hebrew University of Jerusalem,
91904 Jerusalem, Israel

Lorenz Kramer and Andreas Weber

Physikalisches Institut der Universität Bayreuth,
8580 Bayreuth, Postfach 101251, Fed. Rep. Germany

We show that the Eckhaus instability for traveling waves is of convective nature and does not lead directly to absolute instability because the shocks between different structures absorb the perturbations. As a consequence spiral waves and hole solutions remain stable in a larger range than expected previously and the transition to spatio-temporal chaos can be delayed in some parameter range even beyond the Benjamen-Feir limit. We calculate the onset of absolute instability using the complex Ginzburg-Landau equation ($CGLE$) and verify the results by detailed simulations.

For the 1d CGLE we show that the stable localized oscillating hole solutions exist in the regions of the parameters preceding the appearance of spatio-temporal chaos. These solutions oscillate in the depth of the hole and in the coordinate of the center as well. They can be described in terms of a supercritical Hopf bifurcation of the stationary hole solutions. The analytical results have been verified numerically by direct simulations of the $CGLE$.

Abstracts

Novel interfacial patterns in a confined critical binary mixture subjected to a temperature gradient

Michel Assenheimer and Victor Steinberg

Weizmann Institute of Science
Department of Nuclear Physics
Rehovot 76100, Israel

Abstract

Novel cellular polygon like, and bubble like steady patterns in a binary mixture at its critical composition have been observed. They formed when a thin fluid layer was heated from below with the top temperature, T_t, below the consolute temperature T_c. The patterns are not related to Rayleigh-Bénard convection. We associate them with interfacial phenomena occurring in the two phase region of the critical binary fluid in a confined geometry. The average area of the cellular pattern varies strongly with $T_c - T_t$ and ΔT across the fluid layer, whereas the mean area of the bubble like pattern changes just slightly.

On Thermodynamically Consistent Extensions of the Classical Stefan Problem

Ch. Charach, I. Rubinstein, B. Zaltzman
CEEP - Blaustein Institute for Desert Research,
Sede-Boqer Campus 84993, Israel
also Physical and Mathematical Departments of the
Ben Gurion University, Beer-Sheva 84105, Israel

The classical Stefan problem, that provides s simplest continuum description of the first-order phase transition is reexamined within the irreversible thermodyanmical scheme of Caroli et al.[1]. The boundary conditions at the moving interface that account for the interface kinetics and for the fluid flow in the liquid are formulated. Asymptotic solutions describing the onset of planar solidification are presented incorporating these effects. Transition to the classical Stefan solutions at large times is shown explicitly for the problem with equal solid and liquid densities.

1. B. Caroli, C. Caroli and B. Roulet, J. Crystal Growth, **66**, 578 (1984), **71**, 235 (1985).
2. Ch. Charach and I. Rubinstein, J. Appl. Phys., **71** (in press).
3. Ch. Charach, I. Götz, B. Zaltzman (in preparation).

Disorder Parameter for Hamiltonian Chaos

Itzhack Dana
Physics Department, Bar-Ilan University, Ramat-Gan 52900

A disorder parameter is introduced to characterize chaos in kicked-rotor Hamiltonians with an anti-symmetric force function. This parameter, $\Delta\nu$, is defined at *fixed* winding number (frequency) ν for unstable periodic orbits (UPOs) approximating the chaotic region. It measures the deviation of a UPO from an ordered periodic orbit (topologically conjugate to an integrable rotation), in terms of the *type* of the UPO, i. e., the sequence of resonances visited by the UPO: $\Delta\nu$ is the R.M.S. deviation of the winding numbers of these resonances from ν.

The parameter $\Delta\nu$ is calculated in the case of the tent map (piece-wise linear force function), for ensembles of UPOs of given value of ν and periods $\leq T$. The function $\Delta\nu(S)$, where S is the action of a UPO per iteration, appears to be much more well-behaved than $\sigma(S)$, the Lyapunov exponent. In particular, near $\Delta\nu = 0$, $\Delta\nu(S)$ is always monotonously increasing, in consistency with known results concerning ground-state configurations for the corresponding Frenkel-Kontorova model. The new parameter $\Delta\nu$ may thus be used in several interesting applications, e. g., in a systematic re-summation of Gutzwiller trace formula for semi-classical quantization.

General field of research: Classical Hamiltonian Chaos.

Transition from confined to extended travelling waves in a convective binary mixture

Eran Kaplan and Victor Steinberg
Department of Nuclear Physics
Weizmann Institute of Science
Rehovot 76100, Israel

Abstract

Experimental evidence of two distinctive mechanisms of transition from localized (LTW) to extended (ETW) travelling waves in convecting binary mixtures is presented. Both are related to the convectively unstable nature of LTW, and reflect its different manifestations. In short cells the mechanism which is responsible for the LTW instability is related to the transition from convective to absolute instability. In long cells and negative enough values of the separation ratio ψ, transition from LTW to ETW occurs due to the interaction of convectively growing perturbations and LTW. Crossover between the two mechanisms is demonstrated.

FLOWS AND MAGNETIC FIELDS IN THE EKMAN-HARTMANN BOUNDARY LAYERS OF TWO CONCENTRIC COAXIALLY ROTATING SPHERES

Nathan Kleeorin and Igor Rogachevskii

Racah Institute of Physics, Hebrew University of Jerusalem

Despite a number of previous investigations of the Ekman-Hartmann boundary layers, the study of flows and magnetic fields inside the layers with various geometry and different conditions remains important in view of numerous applications in geophysics and planetary physics as well as in various engineering devices.

We have found the flow velocity and magnetic fields for the Ekman-Hartmann boundary layers of two concentric spheres, coaxially rotating with different angular velocities. We considered interactions between the conductive fluid and solid boundaries with variable conductivity. The magnetic fields, generated inside the Ekman-Hartmann layers result in the electromagnetic relaxation of the differential rotation of the fluid. At the same time, the magnetic fields, generated outside the boundary layers excite the differential rotation of the fluid. A new kind of the electromagnetic coupling due to a modification of the viscous force by the magnetic field is pointed out. We have shown that the properties of an additional cylindric boundary layer circumscribing the inner sphere are significantly modified by the magnetic field, generated inside the layer and it changes the dynamics of rotation.

The results discussed in this report are applied to the problem of the low-frequence variations in the rotation of the Earth. The liquid part of the Earth core occupying a shell between the solid core and the rock mantle can be considered as a fluid shell between two rotating spheres. An MHD model explaining the origin of the length-of-day variations is proposed.

47.65.+a ; 91.25Cw ; 91.10.Nj

Harmonic generation by one-dimensional systems*†

J G Leopold‡
The Fritz Haber Molecular Dynamics Research Centre
The Hebrew University, Jerusalem, 91904, Israel
and
D Richards
Mathematics Faculty, The Open University, Milton Keynes MK7 6AA, England

The radiation of an atomic system by an intense periodic field can produce emitted radiation containing many harmonics of the applied field. This phenomenon of Harmonic Generation has been observed experimentally and in both classical and quantal numerical computations[1]. All studies of this phenomenon deal with low frequency fields, by which we mean that the field frequency, Ω, is significantly less than the frequency of the transition between the initial and adjacent states, ω. One of the main observations is that for weak fields the magnitude of the radiated harmonics decay exponentially, but for stronger fields there is a plateau ending at about $k\omega/\Omega \approx 1$ after which the magnitudes decay exponentially. In this paper we present a simple analytic explanation of this phenomenon. At very low frequencies both classical and quantal dynamics are very simple as the principle of adiabatic invariance is valid.

In the adiabatic limit the motion is multiply periodic with two basic frequencies. The average over initial conditions removes the frequency associated with the unperturbed motion so that the mean dipole moment becomes a simple periodic function with frequency equal to that of the driving field, with the amplitude of the spectral line at $k\Omega$ decreasing exponentially for large $|k|$. In the adiabatic limit this is true both classically and quantally, though tunnelling may modify the quantal spectrum.

A non-adiabatic correction term contributes more combination frequencies to the classical motion and the average over initial conditions does not remove all the frequencies associated with the unperturbed motion, but predominantly leaves two sets of harmonics, one set, $k\Omega$, overlaps with those produced in the adiabatic limit, but there is a new set close to $\omega \pm k\Omega$, with the amplitudes decaying exponentially for $k > k_{crit}$, with k_{crit} being a well defined function of the system parameters. We also examine the effect of this term on the quantum dynamics when only two states are coupled together and show that now the classical and quantal spectra of the dipole moment are different.

*PACS No 42.65Ky 32.80-t 42.50Hz
†Submitted toJ Phys B
‡Permanent address: Department of Applied Physics, Rafael Labs POB 2250 Haifa, Israel
[1] L'Huillier A Schafer K J and Kulander K C 1991 J Phys **B24** 3315-41

Noise modulated propagating pattern in a convectively unstable system

Avraham Tsameret and Victor Steinberg
Department of Nuclear Physics
Weizmann Institute of Science
Rehovot, 76100, Israel

Abstract

Existence and properties of noise modulated propagating Taylor vortices (PTV) in convectively unstable regime of Couette-Taylor flow with a superimposed axial flow was studied. This noise-sustained and noise-modulated structure, predicted theoretically, differs drastically in its power spectrum and in the temporal behaviour of the interface from PTV in an absolutely unstable regime where it has a single sharp peak in the power spectrum and stationary interface. Interaction of external noise with the interface causes an amplitude modulation of the vortex velocity near the front and its phase modulation close to the outlet. Dependence of the interface location on the control parameter leads to an identification of the mechanism responsible for the PTV existence.

2. Solid State

Invited Lectures

Magnetic Properties of Electron Liquids with Disorder

A. Finkelstein
Landau Institute for Theoretical Physics
Chernogolovka, Russia
and
Department of Physics
Weizmann Institute of Science
Rehovot, 76100, Israel

Disordered electron liquids reveal essential magnetic properties which are important for the identification of their nature. As examples, disordered conductors near the metal insulator transition and high-T_c superconductors with substituted Cu ions will be discussed.

Electronic Transport in Coupled Quantum Wells

A. Palevski

School of Physics and Astronomy

Tel Aviv University, Tel Aviv 69978, Israel

Abstract

The problem of a particle in two identical quantum wells (QWs) separated by a thin, finite height barrier has a well known solution: the degeneracy of the states in wells is removed and the energy spectrum forms a series of doublets. The amplitudes of the wavefunctions corresponding to the doublet are equal in both wells, i.e. the electron at a given state is equally shared between two wells. However, the ratio of the amplitudes is extremely sensitive to asymmetry of the potential profile. For highly asymmetric QWs, these amplitudes are very different, i.e. electrons are essentially localized in one of the wells.

This quantum mechanical phenomenon strongly influents electronic transport along the system of 2 coupled QWs. Variation of the symmetry between the wells causes a drastic change in the electrical resistance of the system, namely resistance has a maximum value for symmetric wells and decreases when the potential profile becomes asymmetric. The appearance of the maximum depends on the ratio of electronic mobilities in each well. The value of the resistance peak increases with the ratio of the mobilities.

Experimentally a system of coupled QWs is realized by Molecular Beam Epitaxial (MBE) growth of GaAs-AlGaAs heterostructures. The electrons are introduced into each well using a standard technique of modulation dopping of AlGaAs. Different electronic mobilities in QWs are achieved by introducing extra scatterers into one of the wells during the growth of the structure. The variation of the symmetry between QWs is obtained by application of an external electrical voltage to the top and the bottom surfaces of the structure. The resistance peak is observed experimentally at low temperatures. The analysis of the data indicates that the size of the observed effect is consistent with a simple theoretical model.

Conductance and statistical properties of metallic spectra

Eric Akkermans
Department of Physics
Technion, Haifa

We consider the connexion between statistical properties of the energy spectrum of metals and the dissipation. This problem was first considered by Thouless who argued that the electrical conductance can be related to the sensitivity of the energy spectrum to a change of the boundary conditions.

This relation between a transport quantity and a property of the equilibrium spectrum is not obvious. On the one hand, the conductance g_d is the dissipative quantity given by the Kubo formula. On the other hand, we characterize the sensitivity of the energy levels as follows. Let the wave function ψ obeys the general boundary conditions, $\psi(x+L) = \psi(x)e^{i\phi}$. Then at small ϕ the energy levels move quadratically. The individual level curvature at the origin (ϕ=0) is easily found from perturbation theory. For a metallic system, i.e in the presence of disorder, this curvature is a random quantity, and we denote by g_c its typical value measured in units of the mean level spacing.

The fundamental relation $g_d = g_c$ beteween g_d and g_c describing an equilibrium quantity is known as the Thouless formula. Its derivation uses one important assumption which is that the energy levels are uncorrelated. This is not the case in metallic systems.

We are going beyond the above approximation to derive this relation in the metallic regime. In addition, we show that this problem is related to the transition between universality classes of random matrices in the presence of time reversal symetry breaking. We proposed moreover a new expression of the dissipative conductance based on scattering theory and compare it to the Kubo formula.

Current-Voltage Instabilities in Superlattices.

Boris Laikhtman
Physics Dept., Hebrew University, Jerusalem

In 1970 Esaki and Tsu suggested that an insulator-semiconductor superlattice can have a negative differential resistance at relatively small electric field. In experiments, however, complicated I-V characteristics were measured which were explained by an instability of a uniform electric potential distribution with respect to the formation of high field domains. Although a physical reason for such an instability was suggested after the first experimet no theory existed until recently. The developed theory not only gave quantitative estimates for instability threshold, its characteristic time, and structure of high field domains. It predicted also that specifically designed superlattices can show new nonstationary phenomena such as high field domains moving against the direction of the electron flow and S-shape I-V characteristic.

Oral Presentations

Blue laser light emission by SHG in periodically segmented waveguides.

D. Eger, M. Oron and M. Katz

Solid State Physics Department

Soreq Nuclear Research Center, Yavne 70600, Israel

There is a strong technological need for compact blue lasers. In this work we developed non linear optical waveguides to convert infrared to blue laser light. The ion exchange process was used to produce periodically segmented waveguides in Z-cut $KTiOPO_4$ crystals [1].

The periodic structure provides phase matching between the fundamental and second harmonic waves.

Over 3mW of 425nm light was obtained from 100mW infrared at 850nm. The relative high efficiency is probably related to the periodic reversal of the ferroelectric domains induced during the waveguide fabrication process.

[1] C. J. Wan der Poel, J. D. Bierlein and J. B. Brown
Appl. Phys. lett. 57 (270), 1990.

1/f Noise and Incipient Localization

O. Cohen Z. Ovadyahu and M. Rokni

The Racah Institute of Physics

The Hebrew University, Jerusalem 91904

We report on measurements of 1/f noise in the resistance of In_2O_{3-x} films and ZnO accumulation layers as a function of disorder. For metallic samples ($4 \geq K_F l \geq 1$), it is found that the noise level increases with static disorder by 6 orders of magnitude. Here K_F is the fermi wave-vector and l the elastic mean-free-path. When $K_F l \rightarrow 1$, the noise level reaches values that are eleven orders of magnitude higher than that typical of "good" metals (having $K_F l \geq 10$). Further increase of the static disorder has only a small effect on the relative noise. The steep dependence of the resistance fluctuations on disorder is interpreted as a precursor of the Anderson transition.

Extended States on the Landau Levels with Disorder

S. a. Gredeskul,[a] Y. Avishai[a] and M. Ya. Azbel'[b]

[a] Department of Physics, Ben Gurion University of the Negev, Beer Sheva 84120, Israel

[b] Raymond and Beverly Sackler Faculty of Exact Sciences
School of Physics and Astronomy, Tel Aviv University
Ramat Aviv, Tel Aviv 69978, Israel

We study an electron in a two dimensional system of random point scatterers placed on the sites of a regular square lattice subject to a perpendicular magnetic field B. When the energy equals the Landau energy $\epsilon_n(B)$ ($n = 0, 1, ...$) above a certain magnetic field B_n (which corresponds to the presence of $n + 1$ flux quanta $\Phi_0 = hc/e$ per an elementary square) we find analytically disorder independent extended eigenstates.

SHARP GAP EDGE AND DETERMINATION OF THE FERMI VELOCITY IN $Y_1Ba_2Cu_3O_{7-\delta}$ BY POINT CONTACT SPECTROSCOPY

Nir Hass, D.Ilzycer* and G.Deutscher
School of Physics and Astronomy
Raymond And Beverly Sackler Faculty of Exact Sciences
Tel Aviv University, Ramat Aviv, Tel Aviv Israel

G.Desgardin and I.Monot
Centre des Materiaux Supraconducteurs
ISMRA Bd Marechal Juin 14032 CAEN Cedex France

M.Weger
The Racah Institute of Physics
The Hebrew University, Jerusalem, israel

We report point contact spectroscopy measurements on $YBa_2Cu_3O_{7-\delta}$ thin films and textured bulk ceramics. The I(V) curves measured along the Copper-Oxygen (ab) plane direction are characteristic of the Andreev reflection phenomenon, with a sharp break at the gap edge. This allows a rather precise determination of the (in plane) gap, Δ = 20 meV. Subgap structure suggests the existence of a smaller gap for some orientations in the (ab) plane, of the order of 12 meV. The ratio of the zero bias conductance to the normal state one, in the ab direction measurements, enabled us to set a lower bound to the Fermi velocity in $YBa_2Cu_3O_{7-\delta}$ in this direction $v_F \geq 7\times10^7$ cm/sec. The value of v_F has a crucial importance in the determination of the theoretical explanation for superconductivity in the High Temperature Superconductors. For out of plane measurements, only a weak zero bias anomaly is observed at energies up to 5meV.

Abstracts

Semiclassical Analysis of Spectral Correlations in Mesoscopic Systems

Nathan Argaman Yoseph Imry and Uzy Smilansky

Department of Nuclear Physics, The Weizmann Institute of Science, Rehovot 76100, Israel.

We consider the recently developed semiclassical analysis of the quantum mechanical spectral form factor, which may be expressed in terms of classically definable properties. When applied to electrons whose classical behavior is diffusive, the results of earlier quantum mechanical perturbative derivations, which were developed under a different set of assumptions, are reproduced. The comparison between the two derivations shows that the result depends not on their specific details, but to a large extent on the principle of quantum coherent superposition, and on the generality of the notion of diffusion. The connection with classical properties facilitates application to many physical situations.

Buckminsterfullerine: Interacting Electrons On A Spherical Molecule

Assa Auerbach
Department of Physics, Technion-IIT, Haifa 32000.

We study a simplified model of buckminsterfullerine, where the π electrons move freely on the surface of a sphere. The total energy in the presence of an adjustable repulsive interaction is computed by first and second order perturbation theory. Second order results yield an effective attraction (pair binding) between electrons which are added above a closed angular momentum shell. For different regimes of interaction parameters, we find an L=0 singlet and an L=1 triplet ground state. Pair binding occurs at larger couplings for longer range interactions. We estimate the third order corrections, and define the region where the second order predictions are expected to hold. The relevance of this model to superconductivity and ferromagnetism in doped fullerenes is discussed.

Session: High Temperature Superconductivity

Quantum Particle in a Random Potential: Exact Solution and its Implications

M. Ya. Azbel

Raymond and Beverly Sackler Faculty of Exact Sciences
School of Physics and Astronomy, Tel Aviv University
Ramat Aviv, Tel Aviv 69978, Israel

I accurately solve the Schrödinger equation in a magnetic field B in an arbitrary set of two-dimensional point potentials. When $B = 0$, they yield a mobility edge. When $B \neq 0$, all states are localized below a certain energy $E_c(B)$. Above $E_c(B)$, they are extended at the Landau energies. At other energies the localization length is a discontinuous function of B at every rational value of eBd^2/ch, where d is an average interpotential distance.

Irregular Edge Spectrum, Diamagnetic Oscillations, and Phase Transitions

Mark Ya. Azbel

Raymond and Beverly Sackler Faculty of Exact Sciences
School of Physics and Astronomy, Tel Aviv University
Ramat Aviv, Tel Aviv 69978, Israel

I consider edge states of a quasi-one-dimensional Bloch electron in a magnetic field. They have irregular energy gaps and lead, at progressively low temepratures, to increasingly higher resolution of chaotic quantum oscillations and phase transitions. This situation is characteristic of open-orbit edge states in any dimensionality.

Evaporation: Local Quasimelting, Pseudotunneling, and Temperature Inversion

M. Ya. Azbel

Raymond and Beverly Sackler Faculty of Exact Sciences
School of Physics and Astronomy, Tel Aviv University
Ramat Aviv, Tel Aviv 69978, Israel

I map evaporation onto a thermodynamic phase diagram. I demonstrate that when temperature increases, the evaporation rate may decrease, have a *maximum* and *minimum*, and change almost discontinuously. Some of these features are in agreement with recent data on the escape of two-dimensional electrons from a bulk-helium surface; the others call for new specific experiments.

Charge Transfer in Liquids and Gases and Instantaneous Localization

Mark Ya. Azbel, R. Mints

Raymond and Beverly Sackler Faculty of Exact Sciences
School of Physics and Astronomy, Tel Aviv University
Ramat Aviv, Tel Aviv 69978, Israel

We demonstrate that in a simple model localization positions change adiabatically little when scatterers move on distances comparable with their average spacing.

Bloch Electron in Magnetic Field in a Periodic Point Potential

Mark Ya. Azbel, R. Mints

Raymond and Beverly Sackler Faculty of Exact Sciences
School of Physics and Astronomy, Tel Aviv University
Ramat Aviv, Tel Aviv 69978, Israel

We numerically study the electron spectrum in magnetic field, in a two dimensional system of point scatterers on a square lattice.

Landauer Formula in a General Case

M. Ya. Azbel

Raymond and Beverly Sackler Faculty of Exact Sciences
School of Physics and Astronomy, Tel Aviv University
Ramat Aviv, Tel Aviv 69978, Israel

I derive the Landauer formula in a general many-body case in the presence of magnetic field.

A SEMICONDUCTOR MAY DISTINGUISH LEFT FROM RIGHT

Mark Ya. Azbel

Raymond and Beverly Sackler Faculty of Exact Sciences
School of Physics and Astronomy, Tel Aviv University
Ramat Aviv, Tel Aviv 69978, Israel.

I predict the exponential dependence of the a.c. resistance R on frequency ω and the resistor length L in a new type of skin-effect. It is related to the left-right symmetry breaking. The measurement of $R(\omega,L)$ provides information on the instantaneous hopping probabilities. If experiments yield $R \propto L$, they prove (with the exponential in L accuracy) a new fundamental relation between these probabilities. Otherwise they may imply a glassy behaviour of a resistor.

Elevator Resonance Activation

by

M. Ya. Azbel

Raymond and Beverly Sackler Faculty of Exact Sciences
School of Physics and Astronomy, Tel Aviv University
Ramat Aviv, Tel Aviv 69978, Israel

I consider a quantum particle transmission through an opaque static barrier in an adiabatic alternating potential. I prove the activation energy is significantly less than the particle energy increase, and is zero if the alternating potential strength exceeds a certain critical value.

Non-local Einstein Relation

M. Ya. Azbel

Raymond and Beverly Sackler Faculty of Exact Sciences
School of Physics and Astronomy, Tel Aviv University
Ramat Aviv, Tel Aviv 69978, Israel

I derive accurate non-local relations between conductivity and diffusion (the Einstein formula), current density and local voltage, local voltage and total current. These relations provide a complete description of charge transfer. Their non-locality is due only to density-density correlation function.

Exact Eigenstates of a Finite Two Dimensional System in Magnetic Field

M. Ya. Azbel'

Raymond and Beverly Sackler Faculty of Exact Sciences
School of Physics and Astronomy, Tel Aviv University
Ramat Aviv, Tel Aviv 69978, Israel

I study an electron in a model of a finite two dimensional system of random point scatterers in magnetic field. I find extended states; the bulk ones are singular functions of coordinates.

Gas Phase Synthesis of Diamond Films

Ezra Bar-Ziv and Zamir Gavra
Nuclear Research Center - Negev
P.O. Box 9001, Beer-Sheva

The special properties of diamond, suitable for a large variety of applications motivated the search of methods for synthesis methods of diamond. Following a discovery about a decade ago, that diamond films can be grown on solid substrates from gas phase reactions at low pressures and temperatures, an intensive research and development activity has been established. In the last five years this activity has been even further enhanced and many methods of gas phase synthesis of diamond films have been developed. In all methods a gas mixture containing a hydrocarbon is flown through a source of energy that is capable of pyrolyzing the hydrocarbon molecules. Many methods have been recently developed for growing diamond films, they are based on: mw-plasma, rf-plasma, dc-plasma-arc-jet, hot filament, glow discharge, flame, and laser pyrolysis. The narrow range of parameters at which diamond polycrystallites grow are the substrate temperature, the concentration of the hydrocarbon, and the residence time of the gas mixtures at the high temperature.

Flame synthesis of diamond films is a unique and simple method. Specifically, atmospheric flames of oxyactylene were found capable of generating diamond films. The simplicity of the method have motivated many researchers to investigate and develop this concept. Besides its simplicity, the flame method was proven to generate diamond films at rates as high as 100 mm/hr.

Using an oxyactylene flame, we have carried out about a hundred experiments from which over eighty were found to generate diamond polycrystallites. The others generated soot due to unsuitable acetylene to oxygen ratio. It was found that the size of the diamond polycrystallites are strongly dependent upon the above parameters as well as the growth time. Most diamond films were deposited on silicon wafers and recently molybdenum substrates were also used. The diamond deposits generated were characterized by the following techniques: X-ray diffraction, X-ray fluorescence, SEM, and Raman spectroscopy. It was found that the main structure in these experiments is sp3 and only in several runs a mixtures of sp2 and sp3 was obtained. The lattice parameter was found to be 3.5667 A, very close to the reported value for diamond. Octahedron polycrystallites oriented with (111) faceting and 100-120 mm particles of cubo-octahedron structure with no evidence to secondary or amorphic nucleation.

In all experiments no pretreatment to the substrates was carried out. On the silicon wafers diamond polycrystallites of up to 150 micron in size were generated but no uniform films were created. On the molybdenum substrates uniform films of 30-50 micron polycrystallites were generated. Operation at conditions of absence of nitrogen enhanced the purity of the diamond produced.

Evidence for Glassy Behavior in the Field Effect of Anderson Insulators

M. Ben Chorin, Z. Ovadyahu and D. Kowal
Racah Institute of Physics, The Hebrew University

Investigation of the low temperature field effect in insulating indium oxide films reveals an anomalous feature: The conductance increases for both gate voltage polarities. The minimum in the conductance as a function of gate voltage is centered around the value at which the sample was cooled. Application of a fixed gate voltage causes a rapid increase in the conductance which then decays slowly to its initial value. In addition, the minimum in the conductance shifts towards the fixed gate voltage. Both these effects have a time scale of a few hours and exhibit a non-exponential time dependence. Similar relaxation effects are observed when the sample is excited optically. These findings suggest that the conductance of an insulating sample increases when it is removed from equilibrium. The non-exponential relaxation and its long time scales, which exceed the Maxwell relaxation time ε_0/σ by orders of magnitude, are characteristic of many glassy systems.

A New Method for Calculating the Bulk Effective Dielectric Constant of a Composite with a Periodic Microgeometry

David J. Bergman
School of Physics and Astronomy
Raymond and Beverly Sackler Faculty of Exact Sciences
Tel Aviv University, Tel Aviv 69978
and
K. J. Dunn
Chevron Oil Field Research Co.
P. O. Box 446, La Habra, CA 90633-0446, USA

A new method is presented for calculating the bulk effective dielectric constant $\varepsilon_e(\varepsilon_1, \varepsilon_2)$ of a two-component composite with a periodic microstructure, along with some representative examples of its usage. The method is based on a Fourier space representation of an integral equation for the electric potential, which is used to produce a continued fraction expansion for the dielectric constant. The method enabled us to include a much larger number of Fourier components in the calculation - up to 2×10^5 different values of reciprocal lattice vectors - than some previously proposed Fourier methods. Consequently our method provides for the first time the possibility of performing reliable calculations of the dielectric constant of periodic composites which are neither dilute nor low-contrast, and are not restricted to arrays of non-overlapping spheres.

The reason why we can include so many components in the Fourier expansion of the field is that we do not attempt to solve the non-sparse system of (linear) equations for them. Instead we use the matrix of those equations, which is *almost* of the Töplitz form, to produce an expansion for ε_e in powers of $\varepsilon_1 - \varepsilon_2$. This expansion is then transformed into a continued fraction that *converges everywhere* except where ε_e is actually singular. When properly terminated, the continued fraction can provide very accurate information (e.g., exact bounds) on ε_e for the case when its value is real, as well as for the case when it is complex.

The method can easily be extended to other bulk moduli like the elastic stiffness tensor.

Condensed Matter Physics. PACS Nos. 77.90.+k, 03.50.Kk, 05.60.+w

A novel technique for the stabilization of the second sound velocity in superfluid helium at very small reduced temperatures

Hananel Davidowitz
Department of Physics
Weizmann Institute of Science
Rehovot 76100, Israel

Abstract

A novel method for achieving high stability of the second sound velocity near the lambda point is described. It is based on the strong temperature dependence of the second sound phase at small reduced temperatures as a means of detecting temperature fluctuations. It is particularly useful at small reduced temperatures and is more sensitive as the lambda point is approached.

A New Method for Measurement of Thermal Conductivity Anisotropy in Thin Films. The case of $Y_1Ba_2Cu_3O_7$

L. Kornblit, N. Gluzman, M. Auslender, I. Shter
Ben-Gurion Unversity of the Negev, Beersheva

A new method to measure thermal conductivity of essentially anisotropic materials is proposed. It is applicable to any material which can be characterized by two thermal conductivity coefficients, one λ_x being connected to heat conduction in a symmetry plane, say (x,z), and other, λ_y, to that in the direction y perpendicular to the plane. In order to define both components of the λ tensor the measurements are performed with the aid of two different samples. In both versions the sample is a thin film on a thick substrate with a rectangular (x,y) cross section. In the first one the thin film has the form of a strip directed along z-axis. On this film a silver heater strip of the same width is deposited. Close to the film a silver strip thermometer of $2\mu m$ width is placed.This geometry allows the determination of λ_y through the temperatures of the heater and thermometer which are characterized via measurement of their electrical resistances. In the second version the thin film covers the whole substrate in the plane (x,z). Here the heater and thermometer are two similar silver strips directed along the z-axis. In both versions the width of the heaters and termometers and the separation between them are much smaller than the z-dimension. They are deposited from the vapour phase and are electrically isolated from the thin film by a very thin layer of SiO_2 (thickness about $0.005\mu m$). For the second structure the heat conduction problem with appropiate boundary conditions was solved and an explicit formula was obtained for $\Delta\Theta(x,y) = \Theta(x,y) - T_0$ where $\Theta(x,y)$ is the temperature in the film and T_0 is the temperature of the back of the substrate. The essence of the method consists in measurement of $\Delta\Theta(x,y)$ on the thin film surface $y = 0$ and using the formula to extract λ_x. To check the reliability of the method calculations for a thin film of $Y_1Ba_2Cu_3O_7(\lambda_y = 20mW/cmdeg)$ on a substrate of MgO $(\lambda = 367mW/cmdeg)$ were performed. We have calculated $\Delta\Theta$ assuming the film thickness $h = 0.5\mu m$ and that of the substrate $H = 0.5mm$, the width of the heater was chosen to be $\delta = 2\mu m$. We also suppose that the power of the heater per unit length is $1mW/cm$ and that the separation between the thermometer and center of the heater is $3\mu m$. Good performance of the method is illustrated by the table:

λ_x/λ_y	1.5	3.	5.	6.
$\Delta\Theta, 10^{-3}deg$	102	66	37	34

Resonant Donor Level of Chromium in Mercury Selnide

N. Gluzman
Ben-Gurion University of the Negev, Beer-Sheva

N. Lerinman, L. Sabirzyanova, I. Tsidil'kovski
Institute of Metal Physics,
Ural Division of the Academy of Science of Russia, Ekaterinburg.

A new zero-gap semimagnetic semiconductor $HgFeSe$ is currently attracting attention. The $Fe^{2+}(3d^6)$ ions have a narrow donor level in the conduction band of $HgSe$ and this level is located at $\approx 0.21eV$ from the bottom of the band. A whole spectrum of 'anomalous' properties is exhibited by $HgFeSe$ and these, as is usual, are governed by the Coulomb correlation between the Fe^{3+} ions formed as a result of preionization of the Fe^{2+} ions.

This correlation results in ordering of the Fe^{3+} ions, i.e. it creates a localized Wigner crystal consisting of charged ions. It is desirable to determine whether iron is the only ion, that has a donor level in $HgSe$. With this in mind we investigated the main transport properties of chromium-doped $HgSe$ crystals. Were investigated $Hg_{1-x}Cr_xSe$ ($5 \cdot 10^{-5} \leq x \leq 10^{-2}$) crystals by determination of the Hall coefficient and of the electrical resistivity at temperatures $1.4 \leq T \leq 300K$ as well as by recording the Shubnikov-de Haas oscillations of the transverse magnitoresistance at $T = 1.4 - 30K$ in magnetic fields up to $60kOe$. The investigated dependences $n(N_{Cr}), \mu(N_{Cr}), T_D(N_{Cr})$ (electron density, electron mobility, Dingle temperature on the concentration of Cr atoms N_{Cr}), $\mu(T)$ and $n(T)$ were mainly similar to the corresponding dependences reported for $HgFeSe$ crystals. The constancy of n on increase in N_{Cr} above $\approx 5 \cdot 10^{18} cm^{-3}$ led to the conclusion that ,as in the case of $HgFeSe$, the Fermi level ε_F was pinned to the donor level of chromium. Our estimates showed that $\varepsilon_{Cr} = 0.14eV$, i.e. that the chromium level is much closer to the band edge than the iron level. This in agreement with the Hund rule, predicting that the chromium level should lie below the iron level.

The experimentally observed increase in mobility as a result of chromium doping of $HgSe$ confirmed that chromium, like iron formed a donor level against the background of the conduction band. The Coulomb correlation between the Cr^{3+} ions was responsible for thei ordering, which reduced the electron scattering probability. Fax:057-75919; PASC number 7220M; poster.

Normal ordering for deformed boson operators

Jacob Katriel
Department of Chemistry, Technion - Israel Institute of Technology, Haifa
and **Maurice Kibler**
Institut de Physique Nucléaire de Lyon, IN2P3-CNRS et Université Claude Bernard, F-69622 Villeurbanne Cedex, France

The normally-ordered form of a power of the boson number operator[1] involves expansion coefficients which are the well-known Stirling numbers of the second kind.

In the context of recent interest in quantum groups and their realization, three types of deformed boson operators have been introduced.[2-4] These operators are usually specified in terms of the commutation relations $a\,a^\dagger - q\,a^\dagger\,a = 1$, $a\,a^\dagger - q\,a^\dagger\,a = q^{-\hat{n}}$ and $a\,a^\dagger - q\,a^\dagger\,a = p^{\hat{n}}$, defining the M-type, P-type and G-type bosons, respectively.

The normally ordered expansion of a power of the number operator for deformed bosons other than the M-type bosons differs in a significant respect from that for conventional bosons. Demanding $[\hat{n}]_G^m = \sum_{k=1}^m (a^\dagger)^k\,\hat{S}(m,k,\hat{n})\,a^k$ we obtain the recurrence relation $\hat{S}(m+1,k,\hat{n}) = q^{k-1}\,\hat{S}(m,k-1,\hat{n}+1) + \hat{S}(m,k,\hat{n})\,[k]_G\,p^{\hat{n}}$, from which it follows that the generalized q-Stirling numbers thus introduced are in general operator-valued. The only exception are M-type bosons, for which we obtain the scalar-valued q-Stirling numbers,[5] which for $q = 1$ reduce to the integer-valued Stirling numbers. The marked difference between the M-type bosons and all the others has already been noted before, in the context of the extension of the Campbell-Baker-Hausdorff formula for products of exponential operators.[6]

References

1. Katriel J 1974 *Lett. Nuovo Cimento* **10** 565
2. Macfarlane A J 1989 *J. Phys. A: Math. Gen.* **22** 4581
3. Biedenharn L C 1989 *J. Phys. A: Math. Gen.* **22** L873
4. Chakrabarti R and Jagannathan R 1991 *J. Phys. A: Math. Gen.* **24** L711
5. Wachs M and White D 1991 *J. Combin. Theory Ser. A* **56** 27 and references therein.
6. Katriel J and Solomon A I 1991 *J. Phys. A: Math. Gen.* **24** L1139

A High T_c Superconducting Bolometer

M. Katz, U.P. Oppenheim, and G. Koren
Physics Department, Technion-Israel Institute of Technology
Haifa 32000, Israel

Every superconductor has a transition temperature (T_c) at which the resistance drops to zero.The curve of resistance versus temperature has its steepest slope just above T_c. At this point a small change in temperature causes a large change in resistance. This property was used to fabricate a bolometric detector. A bolometer is a device which changes its resistance when it absorbs a certain amount of radiation. As a thermal detector it has the advantage of responding to a wide range of wavelengths. In this research a superconductor of $YBa_2Cu_3O_{7-\delta}$ (YBCO) was used. YBCO has a T_c of 90 K, a temperature which is higher than the boiling temperature of liquid nitrogen. Thin films of YBCO were deposited on $SrTiO_3$ by laser ablation . The samples were patterned by photolithography. Their sensitive area had a meandering shape.The motivation to use such a pattern was to raise the resistance and also the derivative of the resistance with respect to temperature. The sample was mounted in a suitable dewar which admitted IR radiation. The temperature of the bolometer was stabilized at 90 K in the middle of the transition . A chopped CW CO_2 Laser was used as a source of radiation. The a.c. output voltage was fed into a lock in amplifier. The response obtained was fully bolometric. The resulting detector had a response of 5 volt/watt and a D* of 10^8 cm $\sqrt{\text{Hz}}$/Watt.

The nature of sputtered negative carbon clusters and the isomerism of neutral small carbon clusters.

D. Kella[a], O. Heber[a], D. Majer[a], H. Feldman[a], D. Zajfman[a], Y. Grossman[a], Z. Vager[a], and R. Naaman[b].

[a] Dept. of Nuclear Physics, Weizmann Institute of Science, Rehovot , Israel.

[b] Dept. of Chemical Physics, Weizmann Institute of Science, Rehovot, Israel.

Since the pioneering work of Smalley[1], a vast amount of experimental information had been gathered on the structure of carbon clusters with less than ten atoms. The concensus was that only one isomeric structure exist for these clusters and that they are linear.

The first and only experimental evidence for isomers with a different structure and with very different electron affinities came from Coulomb-Explosion-Imaging (CEI) experiments which were performed at the Weizmann Institute[2]. Specifically, C_4, which was produce by photodetachment of C_4^- from a Cs sputter source, was found to have a rhombic shape with an electron affinity of about 2.1 eV, in agreement with several previous theoretical predictions.

Since then, careful experimental studies were carried out on spectra of photodetachment electrons from supersonically cooled laser sputtering sources of negative carbon clusters[3]. In these experiments, the treshoid for photodetachment of C_4^- was found to be much higher (3.88 eV) and to correspond to a linear $\rightarrow$ linear transition. The lower threshold isomer which was measured in our CEI experiments did not appear in the spectra of these experiments, nor in older experiments.

In the following, we propose a resolution to the above contradiction and present experimental results which support it. Moreover, these new data provide a basis for the understanding of sputtering from a graphite substrate.

The main argument of this note is that sputtering proccess, by laser or heavy ions, produces negative clusters which are mainly compact (i.e ring) rather than linear clusters. Without further 'cooling' collision proccesses, the ions maintain their compact structure and show low photodetachment thresholds consistent with the results reported by the CEI experiment[2]. Upon 'cooling' collisions, these negative ions equilibrate to a lower energy different isomeric structures of linear form. Thus, subsequent photodetachment measurements will miss compact structures which were destroyed by the cooling process.

Laser photodetachment depletion measurements of negatively charged carbon cluster beams using three different types of ion source (ion sputter, laser sputter, and supersonically cooled laser source) will be shown at the meeting. From these results, it is concluded that sputtering of carbon produce mainly compact clusters.

[1] S. Yang et al., Chem. Phys. Lett. **144**, 431, (1988).

[2] H. Feldman et al., J. Chem. Soc. Faraday Trans. **86**, 2469, (1990).

[3] D. W. Arnold et al., J. Chem. Phys. **95**, 8753, (1991).

Multivortex States in Large Pinning Centers

I. B. Khalfin , B. Ya. Shapiro
Physics Department, Bar-Ilan University, Ramat-Gan 52100, Israel

It is shown that Abrikosov vortex clusters appear in the superconductors with la inhomogeneity, λ is the London length) we obtain essentially different vortex configurations. The energies of these configurations decrease with vortex number for $a >> \lambda$, increase for $a << \lambda$ and become nonmonotonic for $a \simeq \lambda$. The temperature dependence of stabile configuration energy is obtained and it's shown that vortex structure transformes to the new one with another vortex numbers. The interaction between vortex cluster and external vortex is investigated. The potential barrier for this interaction depends both on the number of vortexes in the cluster and on the type of the vortex configuration. It is predicted that these multivortex states strongly influence on the irreversibility line in the high temperature superconductors and strongly affects on decay of magnetization.

Spin Wave Resonance in Thick YIG Films

I. Laulicht and J. T. Suss
Department of Physics, Bar-Ilan University
Ramat-Gan 52900, Israel.

J. Barak
Department of Solid State Physics
Soreq Nuclear Research Center, Yavne 70600, Israel

Standing spin wave modes across the thickness of magnetically ordered films are studied by their spin wave resonance (SWR) spectra. The resonances are expected at fields which are $D(\pi n/s)^2$ Oe below the uniform mode. D is the exchange parameter, s is the film thickness and n is the number of half-waves of the n-th mode. Hitherto SWR was observed only in thin films which had strong surface spin pinning. Even then only low n ($n<15$) value modes could be seen. In thick films only magnetostatic modes show up. The present SWR study is on thick YIG films ($s\geq 20\mu m$), grown by the LPE technique, which are expected to have weak pinning. To our surprise we were able to observe high (700 to 1000) n value modes with magnetic fields applied either parallel or perpendicular to the film plane. These lines are observed as long as the fields are strong enough to saturate the magnetization in the sample. The good agreement with the above quadratic law enabled extracting D, which is found to be $(5.8\pm0.1)\cdot10^{-9}$ Oe·cm^2 for the perpendicular field geometry and has a slightly smaller value for the parallel field one. These and other features of the thick film spectra will be discussed.

Clausius-Mossotti approximation for a family of nonlinear composites

Ohad Levy and David J. Bergman
School of Physics and Astronomy
Raymond and Beverly Sackler Faculty of Exact Sciences
Tel-Aviv University, Tel-Aviv 69978, Israel.

The Clausius-Mossotti (also known as the Maxwell-Garnett) approximation is one of the most widely used methods for calculating the bulk properties of linear composites. We discuss a generalization of this approximation to a family of nonlinear composites: materials that are composed of a linear host and spherical or ellipsoidal nonlinear inclusions. In the inclusions the constitutive relation $\vec{D} = \epsilon(|\vec{E}|)\vec{E}$ (or $\vec{J} = \sigma(|\vec{E}|)\vec{E}$) is local but otherwise quite arbitrary.

Explicit results are obtained for the bulk effective nonlinear constitutive relation $\left\langle \vec{D} \right\rangle = \epsilon_e(|\left\langle \vec{E} \right\rangle|)\left\langle \vec{E} \right\rangle$ in the case of strong as well as in the case of weak power law nonlinearities. In the case of strongly nonlinear inclusions (with β the exponent of nonlinearity) it is found that the type of macroscopic behavior which is observed depends on the strength of the applied electric field: For very weak fields the composite is weakly nonlinear with exponent β and the linear term corresponds to a linear composite with perfectly insulating inclusions. In the limit of very strong fields the composite is still weakly nonlinear but with a different exponent $-\frac{\beta}{\beta+1}$. The linear term corresponds to a composite with perfectly conducting inclusions. In the case of weakly nonlinear inclusions the bulk is also weakly nonlinear, with the same exponent and with a prefactor that is identical, to first order in the nonlinear conductivity, with the value found in a previous mean field approximation.

We also apply this approach to random resistor networks made of nonlinear resistors randomly distributed in an otherwise uniform linear network. This extension permits a comparison with results of computer simulations of such networks.

Resonance Tunneling with Coulomb Interaction

B. Malomed, M. Ya. Azbel

Raymond and Beverly Sackler Faculty of Exact Sciences
School of Physics and Astronomy, Tel Aviv University
Ramat Aviv, Tel Aviv 69978, Israel

We demonstrate a.c. generation by the resonant tunneling of an incident electron stationary plane wave in the presence of Coulomb interaction.

FINE STRUCTURE OF GOLD AND SILVER CRYSTALS SURFACE STUDIED BY SCANNING TUNNELING AND ATOMIC FORCE MICROSCOPY

S. MATLIS

Soreq Nuclear Center

A novel set of scanning microscopes - STM and AFM - are widely used now in order to study surface defects and changes of either solid or chemical and biological subjects. These microscopes allow non-destructive imaging with atomic resolution. STM and AFM provide complementary information - the map of local density of states and topographical structure of the surface, accordingly. The main goal of the present work was to perform comparative analysis of surface with both the STM and AFM.

Thin films of gold and silver deposited on mica nd silicon were studied. The STM and AFM observation were made on a scale ranging from 400 nanometer to 10 Angstrom in air at atmospheric pressure and room temperature.

The common and distinguishing features of surface reconstruction patterns imaged by two modes of microscopy were discussed.

Computer simulation of the $T = 0$ frustrated classical two dimensional XY model.

Ronen Meiri and Amnon Aharony
School of Physics and Astronomy
Raymond and Beverly Sackler Faculty
of Exact Sciences
Tel-Aviv University, Tel-Aviv 69978, Israel.

The magnetic properties of the CuO_2 planes in La_2CuO_4 and other high temperature superconductors are represented by the spin$-1/2$ antiferromagnetic Heisenberg model. Doping introduces localized holes on oxygens, which generate strong ferromagnetic bonds between the neighboring copper ions[1]. We capture some of the resulting frustrated behavior by studying the square lattice ferromagnetic classical XY model, with a concentration x of randomly placed strong antiferromagnetic bonds. To leading order, these bonds generate a canting of all the surrounding spins, which decays like a dipole potential. The energy of two such impurities is similar to the dipole-dipole interaction. We used this fact to identify the ground state configuration of the spins on these bonds, and then relax all the other spins. The resulting ground state configurations were used to calculate the cross section for neutron scattering, and the zero field NMR resonance. The cross section in the simulation showed a splitting of the ferromagnetic peak with insertion of impurities. This splitting is similar to the antiferromagnetic peak splitting seen in experiment[2]. The simulations also predict a broadening of the zero filed NMR resonance peak with insertion of impurities. The same qualitative behavior was seen in zero field NMR experiments [3].

[1] A.Aharony *et al.*, Phys. Rev. Lett. **60**,1330 (1988).
[2] T.R.Thurston *et al.*, Phys. Rev. B **40**,4585 (1989).
[3] P.Mendels *et al.*, Physica C **171**,429 (1990).

Condensed Matter Physics.

Peierls instability in a mesoscopic ring threaded by a magnetic flux

B. Nathanson,[1] O. Entin-Wohlman,[1] and B. Mühlschlegel[2]

[1]Raymond and Beverly Sackler Faculty of Exact Sciences,
School of Physics and Astronomy, Tel Aviv University, Tel Aviv 69978, Israel

[2]Institut für Theoretische Physik, Universität zu Köln
D-5000 Köln 41, Germany

Abstract

The effect of a magnetic flux threading a perfect mesoscopic one-dimensional ring upon the peierls instability is studied. Within the mean field approximation, the Peierls transition temperature oscillates with the flux, similar to the superconducting transition temperature oscillations in closed geometries, as long as the Peierls transition temperature is less than the level spacing at the Fermi energy. Fluctuations due to the finiteness of the ring, however, destroy this effect as they smear the phase transition. When the opposite effect is considered, i.e., the effect of the Peierls instability upon the oscillatory behavior of thermodynamic quantities of the ring with the flux (e.g., specific heat, persistent current), it is found that the amplitude of the oscillations is suppressed significantly even for a very small ring. In addition, the Peierls transition causes the approximate disappearance of all harmonics of the persistent current except the first one. The last two results are due to the equivalence between the effect of the Peierls gap parameter and that of the temperature in a Peierls insulator.

THE INTERACTION OF LIGHT WITH MATTER IN THE PHOTODEPOSITION PROCESSES FOR Cd AND Se COLLOID SYSTEMS

A. Peled*, V. Weiss and A.A. Friesem
Electronics Department, Weizmann Institute of Science,
Rehovot 76100, Israel

Photodeposition is a photon assisted process by which thin films can be formed on substrates immersed in colloidal solutions. Photodeposition occurs only in the irradiated zones and therefore ultimate imaging resolution is governed in principle by the size of colloid particles. Two systems were investigated so far with this process by which Se[1] and Cd[2] films were obtained from Se and CdS colloidal solutions. Here we describe the similarities and differences of the thin films growth kinetics in the two systems.

(1) A. Peled and A.A. Friesem, "CW Laser Photodeposition of a-Se Films", Thin Sol. Films (1992) submitted.

(2) A. Peled, V. Weiss and A.A. Friesem, "Photodeposition of Thin Films from CdS colloid solutions", Thin Sol. Films (1992) submitted.

* Permanent address: CTEH aff TAU, 52 Golomb St., Holon 58102, Israel

High Field Magneto-Transport in a Percolating Medium

Andrey K. Sarychev
Institute for High Temperature of the Russian Academy of Sciences
Moscow, Russia (permanent address), and
School of Physics and Astronomy
Raymond and Beverly Sackler Faculty of Exact Sciences
Tel Aviv University, Tel Aviv 69978
and
David J. Bergman and Yakov M. Strelniker
School of Physics and Astronomy
Raymond and Beverly Sackler Faculty of Exact Sciences
Tel Aviv University, Tel Aviv 69978

A discrete network model is used to discuss the critical behavior of magneto-transport in a percolating medium in the presence of a magnetic field H of arbitrary strength. The two-dimensional (2D) version of the model is shown to have the same critical behavior as real 2D composites by constructing an exact duality transformation. The three-dimensional version of the model for a metal-insulator mixture is studied by applying an appropriate real-space-renormalization-group transformation, and by simulations of large, randomly constructed samples of the model both at and away from the percolation threshold p_c. We find that the model has two fixed points: The one at $p = p_c$ and $H = 0$ is stable against a perturbation to $H \neq 0$, and the one at $p = p_c$ and $H = \infty$ is unstable against a perturbation to $H < \infty$. Thus there are two regimes of critical behavior, and the crossover between them is governed by a new, field dependent length ξ_H. In a real, percolating metal-insulator mixture, the resistivity ratio with and without a field $\rho(H)/\rho(0)$ is found to saturate as $p \to p_c$ at a value $\sim H^{0.5}$. It is also found to saturate when $p \neq p_c$ is fixed and $H \to \infty$, in marked contrast with the behavior predicted by the effective medium approximation. If the right materials are used, these findings can be tested experimentally without having to use excessively high magnetic fields.

Slave bosons treatment of the degenerate Anderson impurity with finite *on-site* Coulomb interaction

A. Schiller and V. Zevin
The Racah Institute of Physics
The Hebrew University of Jerusalem, 91904 Jerusalem, Israel

We discuss here thermodynamic properties and bremsstrahlung isochromat spectroscopy (BIS) spectra which are originated with degenerate Anderson impurities embedded in a metal. The finite on-site Coulomb interaction U on impurity sites is accounted within slave bosons formalism and diagrammatic Non Crossing Approximation. Due to the incorporation of the approximate scheme in which only spin fluctuations are considered and the consequent analytical treatment of the vertex correction, simple spectral functions for the empty, single and double occupied f-electron states are developed and f-occupancies, specific heat C_V and magnetic susceptibility χ are calculated as functions of the temperature for typical Ce^{3+} and Yb^{3+} parameters. The BIS spectral functions are also calculated. The computations are greatly reduced by our analytical approach. We show that $C_V(T)$ and $\chi(T)/\chi(T=0)$ as functions of the reduced temperature $T/T_0(U)$ are almost U independent ($T_0(U)$ being the Kondo temperature). The theory developed here has a good quantitative accuracy for $T \lesssim T_0(U)$ and it is convenient for analysis of experimental data. We propose here also an accurate analytical expression for the Kondo temperature $T_0(U)$. At zero temperature our theory fully reproduces the Gunnarsson - Schönhammer variational results.

BOND DEPENDENT SYMMETRIC AND ANTISYMMETRIC SUPEREXCHENGE INTERACTIONS IN La_2CuO_4

L. Shekhtman, Amnon Aharony and O. Entin-Wohlman
Raymond and Beverly Sackler Faculty of Exact Sciences
School of Physics and Astronomy, Tel Aviv University, Tel Aviv 69978, Israel

Abstract

A microscopic derivation of the effective spin Hamiltonian that describes the magnetic properties of La_2CuO_4 is presented. It is shown that although the one-bond superexchange interaction is *isotropic*, the observable magnetic properties of La_2CuO_4 are naturally accounted for by the microscopic theory of superexchange *alone*, without introducing phenomenologically the necessary anisotropies. Straightforward calculations show that the spin system of La_2CuO_4 is frustrated the principal axes of the symmetric parts of the one-bond "anisotropy" tensors are not the same for all the bonds. It is shown that the resulting mean-field spin Hamiltonian is identical to the Hamiltonian derived previously on a phenomenological basis to account for the magnetic properties of La_2CuO_4.

The Low Magnetic Field Hall Conductivity Of A Simple Cubic Lattice Of Identical Spheres

Roni Waldman and David J. Bergman
School of Physics and Astronomy
Raymond and Beverly Sackler Faculty of Exact Sciences
Tel Aviv University, Tel Aviv 69978

The effective Hall conductivity is calculated in a two-component composite model consisting of a 3D simple cubic array of identical spheres in a host having different Ohmic and Hall conductivities. The model assumes the effective Hall conductivity λ_e to be linear in the (low) magnetic field. Under the above assumption the normalized value $\Lambda \equiv (\lambda_e - \lambda_{host})/(\lambda_{sphere} - \lambda_{host})$ is given by: $\Lambda = \langle \nabla \phi_0^{(x)} \times \nabla \phi_0^{(y)} \rangle$ where $\langle\rangle$ designates the volume average over a sphere and $\phi_0^{(x)}$ is the potential created in the sample with *no magnetic field* when a uniform external electrical field is applied in the x direction. The two potentials $\phi_0^{(x)}$, $\phi_0^{(y)}$ are evaluated by expanding them in terms of the electric resonances of *a single sphere*, which are simple spherical harmonics. Those expansions are then used to evaluate Λ. Using this approach, we have been able to calculate the effective Hall (and also the Ohmic) conductivity over the whole range of volume fractions , p, for which the spheres do not overlap, and for all values of the contrast $k \equiv \sigma_{sphere}/\sigma_{host}$.

Particular attention was given to the situation of nearly touching spheres ($p \to p_c$) and high contrast ($k \to \infty$), where a *conductivity treshold* is approached. The results show a logarithmic critical behaviour for Λ:

$$\Lambda \sim \left(\frac{\sigma_{host}}{\sigma_{sphere}}\right)^{\alpha} \begin{cases} \log^{\beta}(p - p_c) & for \ \left(\frac{\sigma_{host}}{\sigma_{sphere}}\right) \ll (p - p_c) \ll 1 \\ \log^{\gamma}\left(\frac{\sigma_{host}}{\sigma_{sphere}}\right) & for \ (p - p_c) \ll \left(\frac{\sigma_{host}}{\sigma_{sphere}}\right) \ll 1 \end{cases}$$

with critical exponents $\alpha = 2, \beta \approx 2, \gamma \approx 3$. At the same time the effective Ohmic conductivity was also calculated, obtaining a similar behaviour for $\Sigma \equiv (\sigma_e - \sigma_{host})/(\sigma_{sphere} - \sigma_{host})$ with the following exponents: $\alpha = 1, \beta \approx 1, \gamma \approx 1.5$. Comparing the two critical behaviours we obtained an approximately quadratic dependence of Λ on Σ i.e.: $\Lambda = \Sigma^2$. This differs from the behaviour of a 3D *random* composite near percolation.

FERMI CORRELATIONS IN LANDAU-ZENER DYNAMICS

Aharon Weinstein[1], Yuval Gefen[1], Efrat Shimshoni[2] and Eshel Ben-Jacob[3]

1. The Weizmann Institute of Science
2. University of Illinois, Urbana, Champaign
3. Tel-Aviv University

Following the increased interest in the dynamics of mesoscopic systems, it has been realized that there is a large spectrum of phenomena beyond linear response, e.g., when Landau-Zener tunneling is introduced. The latter has been studied in the context of a single particle dynamics. Here we investigate the effects of Fermi correlation on Landau-Zener tunneling.

The correlation does not affect the evolution of single particle states in the system, of which the Slater determinant is composed. Thus it does not affect the expectation values of single body operators, but does affect the expectation values of n-body (*e.g.* two body) operators.

We use a simple model, giving rise to a periodic adiabatic spectrum, and first find the evolution of a single electron state. This toy scheme may elucidate certain issues associated with the dynamics of a small current biased tunnel junction, as well as a voltage biased quantum Hall effect system.

We define a 'voltage' for the correlated electron system. The expectation value of the voltage and its mean square fluctuation (at zero temperature) are shown to be oscillating in time, at frequencies which are harmonics of a basic frequency. The amplitude of these oscillations and the number of harmonics increase as the Landau-Zener tunneling probability is enhanced. For a finite temperature the oscillations are attenuated while quantum fluctuations increase.

This research was partially supported by the U.S.-Israel Binational Science Foundation and by the German-Israeli Foundation.

Phase Diagram of the Antiferromagnetic Heisenberg model with a Dzyaloshinsky-Moriya interaction in a Magnetic Field at zero temperature.

Yuval Yaish and Amnon Aharony
School of Physics and Astronomy
Raymond and Beverly Sackler Faculty of Exact Sciences
Tel-Aviv University, Tel-Aviv 69978, Israel.

We investigate the phase diagram of an Antiferromagnetic (AF) Heisenberg model in the presence of a magnetic field and a Dzyaloshinsky-Moriya (DM) interaction at zero temperature ($T = 0$). The Hamiltonian is

$$\mathcal{H} = \sum_{(nn)}^{N} J_1 \vec{S}_i^1 \vec{S}_j^1 + J_2 \vec{S}_i^2 \vec{S}_j^2 + J_3 \vec{S}_i^3 \vec{S}_j^3 - \sum_{(nnn)}^{N} (G_1 \vec{S}_i^1 \vec{S}_j^1 + G_2 \vec{S}_i^2 \vec{S}_j^2 + G_3 \vec{S}_i^3 \vec{S}_j^3) + \sum_{(nn)}^{N} \vec{D}_{i,j} \cdot (\vec{S}_i \times \vec{S}_j) + \sum_{i}^{N} \mu \vec{H} \cdot \vec{S}_i \quad ,$$

where ($J_1 > J_2, J_3 > 0$) and ($G_1 > G_2 = G_3 > 0$). The DM vector $\vec{D}$ points along the axis **2**, and is perpendicular to the easy axis **1**. The magnetic field $\vec{H}$ may be directed in any direction in the **1-3** plane.

We concentrate on two cases:

a. For $J_2 = J_3$, we find Fig. 1*a*, with a "*shelf*" of first order phase transitions between the AF and the "*Spin-Flop*" (SF_3) phases.

b. For $J_2 > J_3$, we find a new phase (SF_2), which has a spin component along the **2** direction. There is a surface of first and second order phase transitions between this phase and the others which exist in the former case. A *tricritical* line is found on that surface which ends at two ***bicritical*** points. See Fig. 1*b*. The results may apply to *orthorhombic* La_2CuO_4, with our axes **1-2** in the CuO_2 planes.

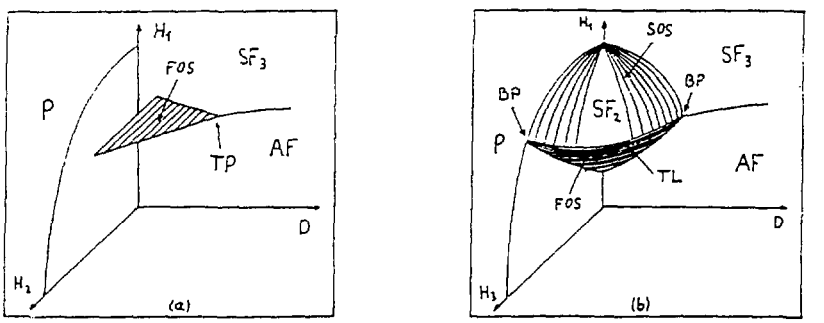

Fig. 1. The Phase Diagrams for the two cases. AF=AntiFerromagnetic, SF= SpinFlop, P=Paramagnetic, FOS=First Order Surface, SOS=Second Order Surface, BP=Bicritical Point, TP=Tricritical Point, TL=Tricritical Line.

NONLINEAR ELECTRICAL RESPONSE AND BREAKDOWN OF SEMICONTINUOUS METAL FILMS

Yoad Yagil and Guy Deutscher

Department of Physics and Astronomy, Raymond and Beverly Sackler Faculty of Exact Sciences, Tel Aviv University, 69978 Tel - Aviv, Israel.

The breakdown current of a percolating system is measured, for the first time, on real materials. In contrast to the commonly used fuse model, we find a power law relation between the breakdown current I_c and the nonlinear electrical response, determined by third harmonic generation. A new breakdown current criteria is suggested, defined as the current at which a hot spot reaches the melting temperature of the metallic grains. The local geometry is then modified, reducing the local power dissipation; the local resistance may either increase to infinity (fuse like) or decrease, as found experimentally. The hot spot modelling yields a power law $I_c \propto B^{-x}$, $B = V_{3f}/I^3$ where the upper and lower bounds of x are respectively 0.5 (continuum percolation upper limit) and 0.36 (lattice percolation lower limit), in excellent agreement with the measured data which gives $x = 0.48$ and 0.41 for the Ag and Au films respectively.

3. Particles and Fields

Invited Lecture

D. Gepner, Weizmann Inst.

"Fusion Field Theories"

Abstract not available

Oral Presentations

Induced $\mathbf{W}_\infty$ Gravity as a WZNW Model on the Deformed Group of Area-Preserving Diffeomorphisms

E. Nissimov and S. Pacheva

Department of Physics
Ben-Gurion University of the Negev
Box 653, 84105 Beer Sheva, Israel
E-mail : emil@bguvms , svetlana@bguvms

I. Vaysburd

Racah Institute of Physics
Hebrew University
Jerusalem 91904, Israel
E-mail : igor@hujivms

ABSTRACT

We derive the explicit form of the Wess-Zumino quantum effective action of chiral $\mathbf{W}_\infty$-symmetric system of matter fields coupled to a general chiral $\mathbf{W}_\infty$-gravity background. It is expressed as a geometric action on a coadjoint orbit of the deformed group of area-preserving diffeomorphisms on cylinder whose underlying Lie algebra is the centrally-extended algebra of symbols of differential operators on the circle. We present a systematic derivation , in terms of symbols, of the "hidden" $SL(\infty;)$ Kac-Moody currents and the associated $SL(\infty;)$ Sugawara form of energy-momentum tensor component T_{++} as a consequence of the $SL(\infty;)$ stationary subgroup of the relevant $\mathbf{W}_\infty$ coadjoint orbit. Also, a brief discussion is given of the classical Yang-Baxter equation, the r-matrix and the Knizhnik-Zamolodchikov type equations.

Stringy Monodromies and a Black Hole Geometry

Mordechai Spiegelglas
Department of Physics and Astronomy, Tel-Aviv University, Israel.

The angular variable in the Euclidean version of the stringy black hole solution is found to have a double set of winding, through an investigation of the $U(1)$ zero modes in the $SL(2,\mathbb{R})_k/U(1)$ and $SU(2)_k/U(1)$ conformal coset theories. Region II, between the Horizon and the Singularity, is $SU(2)_k/U(1)$ with the cut structure of its parafermionic amplitudes entailing the doubling. This monodromy is given a space-time interpretaion and derived for other string compactifications. The implications for string thermodynamics, quantum statistics and quantum mechanical phases are discussed.

Deriving the Standard–Model from the Superstring

Alon E. Faraggi
Department of physics, Weizmann Institute of Science
Rehovot 76100, Israel

ABSTRACT

In this lecture I present the first elaborate attempt to derive the Standard Model from the superstring. This attempt is made possible by unique computer programs which I wrote for the analysis of free fermionic models. I present the results of a detailed study of superstring standard–like models in the four dimensional free fermionic formulation. This formulation is chosen because of its unique properties. First it is formulated directly in four space–time dimensions. Second it is an exact conformal field theory which give us the advantage of using the powerful calculational tools of conformal field theory, yielding highly predictive models. Finally, it is formulated at the self–dual point in the compactified space, which enhances space–time gauge symmetries from $U(1)$ to $SU(2)$.

The study focuses on the construction of superstring standard–like models [1]. This focus is motivated by consideration of proton decay. In the minimal supersymmetric model proton decay is mediated by dimension four operators. The superstring standard–like models are the only superstring models in which proton decay from dimension four and dimension five operators is naturally suppressed due to gauged $U(1)$ symmetries. The superstring standard–like models have remarkable properties. They have exactly three generations of chiral fermions. There are no extra generations and mirror generations, which presumably get massive at a high scale. The free fermionic standard–like models explain the heaviness of the top quark relative to the lighter quarks and leptons. At the trilinear level of the superpotential only the top quark gets a non vanishing mass terms while the lighter quarks and leptons obtain their mass terms from non renormalizable terms. This property of standard–like models follows from the requirement of a supersymmetric vacuum at the Planck scale. This requirement is a strong constraint on the allowed models, yielding a unique class of highly predictive models. The standard–like models predict the top quark to be in the mass range $m_t \sim (140 - 180) GeV$. and the correct mass relation for $\frac{m_b}{m_\tau}$. Preliminary studies of non renormalizable terms in these models reveal that construction of realistic mass matrices is possible. The standard–like models predict the existence of small gauge groups in the hidden sector. This feature of the standard–like models is desirable for understanding gauge and supersymmetry breaking in these models. To conclude, we have made the first steps on the way toward a standard superstring model.

References

1. Alon E. Faraggi, construction of realistic superstring standard–like models in the four dimensional free fermionic formulation, WIS–92/16/FEB–PH, and references therein.

Quark solitons as constituents of hadrons

John Ellis[a]
CERN – Geneva

Yitzhak Frishman and Amihay Hanany[b]
Department of Physics, Weizmann Institute of Science
76100 Rehovot, Israel

and

Marek Karliner[c]
Raymond and Beverly Sackler Faculty of Exact Sciences
School of Physics and Astronomy
Tel-Aviv University, 69978 Tel-Aviv, Israel.

We exhibit static soliton solutions of multi-flavour QCD in two dimensions that have the quantum numbers of baryons and mesons, constructed out of quark and anti-quark solitons. In isolation the latter solitons have infinite energy, corresponding to the presence of a string carrying the non-singlet colour flux off to spatial infinity. When N_c solitons of this type are combined, a static, finite-energy, colour singlet solution is formed, corresponding to a baryon. Similarly, static meson solutions are formed out of a soliton and an anti-soliton of different flavours. The stability of the mesons against annihilation is ensured by flavour conservation. The static solutions exist only when the fundamental fields of the bosonized lagrangian belong to $U(N_f \times N_c)$ rather than to $U(N_f) \times SU(N_c)$. Discussion of flavour symmetry breaking requires a careful treatment of the normal-ordering ambiguity. Our results can be viewed as a derivation of the constituent quark model in QCD_2, allowing a detailed study of constituent mass generation and of the heavy quark symmetry.

Research field: Quantum Field Theory.

Abstracts

Nonstrange Isovector Two-Body Decay Modes of Heavy Mesons Sensitive Tests for Annihilation Contributions and Final State Interactions

Harry. J. Lipkin

Department of Nuclear Physics
Weizmann Institute of Science
Rehovot 76100 ISRAEL

and

School of Physics and Astronomy
Raymond and Beverly Sackler Faculty of Exact Sciences
Tel Aviv University
Tel Aviv 69978 ISRAEL

The experimentally observed enhancement of the $\pi\eta'$ and $\rho\eta'$ decays relative respectively to $\pi\eta$ and $\rho\eta$ suggests interference between the dominant tree amplitude and a small annihilation amplitude, which is linear in the small amplitude and has opposite signs for the η and η' final states. The analysis is supported by the absence of η' enhancement in corresponding $D^{\pm}$ decays, where the analogous interference has the same sign for η and η'. General relations testing different weak decay models are derived for charmed meson decays into isovector two-body final states emphasizing the role of linear interference effects as a much more sensitive test for small amplitudes than quadratic direct contributions. Simple relations between D_s decays into $\pi\phi$, $\pi\eta$, $\pi\eta'$ $\rho\phi$, $\rho\eta$ and $\rho\eta'$ modes follow from two assumptions: (1) these decays are all dominated by the same tree diagram at the quark level, $c \to s\bar{u}d$ and (2) strong final state rescattering is expected to be small because of the OZI rule.

ELECTROMAGNETIC MATRIX ELEMENTS IN BARYONS
Needed - Data for Electromagnetic $\Sigma \rightarrow \Sigma^*$ Transitions

Harry. J. Lipkin

Department of Nuclear Physics
Weizmann Institute of Science
Rehovot 76100 ISRAEL

and

School of Physics and Astronomy
Raymond and Beverly Sackler Faculty of Exact Sciences
Tel Aviv University
Tel Aviv 69978 ISRAEL

ABSTRACT

Some simple symmetry relations between matrix elements of electromagnetic operators are investigated and their implications for hyperon beam experiments are discussed.

Implications of EMC and G_A/G_V for Baryon Structure

Harry. J. Lipkin

Department of Nuclear Physics
Weizmann Institute of Science
Rehovot 76100 ISRAEL

and

School of Physics and Astronomy
Raymond and Beverly Sackler Faculty of Exact Sciences
Tel Aviv University
Tel Aviv 69978 ISRAEL

Surprising conclusions about proton spin structure have arisen from an analysis [1] combining data from polarized deep inelastic electron scattering and weak baryon decays. The EMC experiment measures neutral current matrix elements related directly via the Bjorken sum rule to the contributions to the proton spin of the u, d and s - flavored current quarks and antiquarks respectively to the spin of the proton conventionally denoted by $\Delta u(p)$, $\Delta d(p)$ and $\Delta s(p)$. Semileptonic weak decays measure charged current matrix elements which are related in the analysis to neutral current matrix elements by the use of symmetry assumptions whose validity has been questioned. [2]. [3].

Interesting information about baryon structure is obtained from semileptonic decay data by direct use of the charged current matrix elements without symmetry assumptions. An apparent inconsistency exists between the excellent agreement of the experimental value $G_A/G_V = -0.340 \pm 0.017$ for the $\Sigma^- \rightarrow n$ decay with the SU(6) prediction of -1/3 and the well-known serious disagreement of the experimental value 1.261 ± 0.004 for the neutron decay with the SU(6) prediction of 5/3.

References

1. Stanley J. Brodsky, John Ellis and Marek Karliner, Phys. Lett. 206B, 309 (1988)
2. Harry J. Lipkin, Phys. Lett. B230 (1989) 135
3. Harry J. Lipkin, Phys. Lett. B214 (1988) 429

Bose-Einstein Correlations for Mixed Neutral Mesons

Harry. J. Lipkin

Department of Nuclear Physics
Weizmann Institute of Science
Rehovot 76100 ISRAEL

and

School of Physics and Astronomy
Raymond and Beverly Sackler Faculty of Exact Sciences
Tel Aviv University
Tel Aviv 69978 ISRAEL

January 29, 1992

ABSTRACT

The Bose-Einstein correlations observed between identical charged pions or charged kaons in experiments leading to multiparticle final states are a consequence of quantum mechanics and give no information about the underlying dynamics. The situation is different when states of mixed neutral mesons are considered. In the particular case of inclusive production of $B^o - \bar{B}^o$ pairs created in a hadronic collision process, the pairs are in an incoherent mixture of states which are even and odd under CP. In the kinematic region where Bose-Einstein correlations occur, the even CP states will be enhanced and the odd CP states will be suppressed. This can be of practical importance in experiments which search for CP violation by observing lepton asymmetries in correlated decay modes[4,5,6], where one B decays into a CP eigenstate and the other into a leptonic mode. In an experiment with no time measurement the result gives only a time integral of the lepton asymmetry. Only the asymmetry from the even CP state survives the time integration; the asymmetry from the odd CP state averages to zero and gives a symmetric background[7]. Thus an enhancement by a factor of two of the lepton asymmetry above background should be observed in the kinematic region where the Bose-Einstein correlations occur.

ISOSPIN, SHMISOSPIN, CP AND CPT IN HEAVY MESON DECAYS
How Different Partial Widths Combine to Give Same Total Widths

Harry. J. Lipkin

Department of Nuclear Physics
Weizmann Institute of Science
Rehovot 76100 ISRAEL

and

School of Physics and Astronomy
Raymond and Beverly Sackler Faculty of Exact Sciences
Tel Aviv University
Tel Aviv 69978 ISRAEL

ABSTRACT

Many physicists have been perplexed by way that CP violation can give rise to different partial widths for charge-conjugate exclusive channels in heavy meson weak decays, while all these different partial widths mysteriously add up to give the same total widths as required by CPT. A simple argument unravels the mystery and shows how this works, as well as defining the specific conditions which must be satisfied in order to obtain an observable CP-violation asymmetry in a particular pair of exclusive channels.

PAIR PRODUCTION IN A STRONG ELECTRIC FIELD

Yuval Kluger

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

With a view towards the flux tube model of particle production in the central rapidity region, we have studied pair creation in QED from spatially homogeneous strong electric fields in 1+1 dimensions. Solution of the semiclassical field equations shows particle creation followed by plasma oscillations. We compare our results with a model based on a relativistic Boltzmann–Vlasov equation with a pair-creation source term related to the Schwinger mechanism. The time evolution of the electric field and the current obtained from the Boltzmann–Vlasov model is surprisingly similar to that found in the semiclassical calculation. We display curves for electric field and current as functions of time, and for the momentum distribution of the produced particles.

4. Environment

Invited Lectures

Radiation Exchange and Microclimate in Vegetation Canopies

Marcel Fuchs, Agricultural Research Organization, Volcani Center, Bet Dagan

Solar and terrestrial radiation supplies the energy used in vegetation. It warms or cools plant tissues, drives transpiration or condensation. These processes generate the microclimate in the space occupied by vegetation. Solar radiation is also the source of photons activating photosynthesis and other light sensitive chemical reactions

Investigation of links between radiative input and microclimate inside vegetation relies largely on experimentation and measurements. These studies reveal the large horizontal heterogeneity of the downward radiation flux focussing the problems on the statistics and instrumentation requirement for a representative characterization of the radiation inside a vegetation canopy. For a long time the prevailing view has been that the salient feature of the radiation penetration is its vertical profile. Horizontal heterogeneity was treated as the noise in the system. In parallel, models, inspired from flux-gradient theories developed for the atmospheric surface layer, appeared in the literature. They aimed at predicting the vertical distribution of energy fluxes (radiation, latent and sensible heat) and vertical profiles of the state variables (temperature, humidity and wind speed) inside the vegetation.

New concepts originating from two different disciplines altered this idealized view of the energy transfer in canopies. The first contribution comes from remote sensing that invokes the effect of leaf angular distribution on the horizontal variability of radiation to explain the directional components of scattered flux. The second change came from studies of turbulent flow in vegetation, evidencing apparent counter-gradient fluxes and coherent structures of eddies.

The stomates on the leaf epidermis limit the rate of vapor transport from the plant to the atmosphere. Radiation interception in the photosynthetic range of the spectrum regulates their degree of opening. The resulting vapor diffusion resistance rules the partition between sensible and latent heat. Stomatal behavior is only partially known. Biological and environmental factors create a wide uncertainty range for this vapor transport variable.

Variability is thus the common denominator of all attempts to characterize the microclimate within the canopy. Despite the apparent complex nature of this variability, simple heat balance principles determine the energy flux densities and their associated state variables inside the canopy. Codification of these principles in a parametric model predicts the variability of the microclimate inside vegetation. This paper describes the essential features that the model must include, and illustrates how radiative and convective transport determines foliage temperature and its distribution.

"Global Warming? - A scientist's dilemma"

Joachim H. Joseph

Department of Geophysics and Planetary Sciences
Tel Aviv University

Global warming has become a much debated issue in the last few years. The debate is in several environments - the political debate centers on the actions to be taken to counteract the warming that is assumed to occur and have a variety of effects on global and regional living conditions. The public interest centers on dangers in the near future and their possible effects on society. The two debates feed on one another and both use information supplied by the scientific community. The measures that have to be taken in both the near and the more remote future to preclude the effects of the possible warming would have serious social and economic repercussions on both the developed and the developing nations.

Politicians and specialists investigating societal, economic and political impacts therefore need a strong back-up from scientists implying that warming is real. However, analysis of the available statistical data by experts does not conclusively prove that any warming due to CO_2 is occurring. Modellers agree that the increase in the atmospheric CO_2 may lead to some heating on a global basis, if it is unopposed by any other climatic agent or feedback. The possible opposing effects, are not modelled adequately. On the other hand, some recent computer experiments in which the CO_2 was increased gradually over a period of 100 years show that the reaction of the climate system to the increase of CO_2 may be highly non-linear and that an increase in global temperature may lag much behind that of the concentration of the greenhouse gases. Nothing may be said with any degree of accuray on regional effects.

The dilemma confronting the - much pressed - scientists involved in climate research is about crying "wolf". If one cries without being convinced, one is either naive or has ulterior motives. If political, economical and social actions are taken which will have serious immediate and future effects on the basis of a warming which later turns out to be unjustified, the scientists have not fulfilled their duty to society and also lost credibility for future pronouncements. If the specialist community does not issue a warming where it thinks it is justified, even on the basis of incomplete knowledge and a warming with severe impacts does occur, the scientists again have not fulfilled their duty to society and will probably be blamed for it.

Studying the Oceans by combining general circulation models and oceanographic data.

Eli Tziperman
Environmental Sciences, Weizmann Institute of Science

The world ocean is one of the main components of the climate system. It plays an important role by absorbing about one half of all the CO_2 released into the atmosphere by human activity, and by controlling the heating of the atmosphere due to the ocean's huge heat capacity. It is clearly crucial, therefore, for any climate study to be able to understand and predict the behavior of the oceans in any scenario of climate change.

The study of the oceans' physics, however, is complicated by the difficulty of making detailed observations at sea. Many of the oceanographic quantities of interest, such as the air-to-sea fluxes of heat and various greenhouse gases are difficult or impossible to measure directly. On the other hand, there is a wealth of oceanic data of other types which we should be able to use in order to calculate the unobservable parameters. These include, for example, satellite data, current meter data, temperature and salinity data and many more. The main tool for predicting climate evolution are computer models of the atmosphere and the oceans, known as general circulation models (GCM). But these models require as input exactly those parameters for which we have very little data, such as the air to sea fluxes of heat, or the poorly known forcing of the oceans by the atmosphere by wind stress.

Thus one of the major challenges confronting physical oceanographers today is to analyze large quantities of oceanographic data of many types with the aid of complex numerical general circulation models, and to relate existing observations to quantities of interest for which only incomplete observations are available. This, however, is a fairly difficult problem due to both the complexity of the models and the large quantities of data.

A novel nonlinear optimization method in oceanography, based on "optimal control" ideas, that aims at combining complex 3D general circulation models and large oceanographic data sets will be presented. Both simulated data and real data from the North Atlantic ocean and from the global ocean will be used to discuss the possibilities and difficulties in combining the GCMs and data into a consistent picture of the oceanic circulation. It is hoped that this methodology will enable answering questions concerning the global heat budget of the ocean and other problems of interest to climate studies, therefore advancing our understanding of the role of the oceans in the climate system.

Classification: Earth Sciences, Physical Oceanography, General Circulation Models, Inverse Methods.

Oral Presentation

Dual Field Theory in Layered Media

Dan Loewenthal

Raymond and Beverly Sackler Faculty of Exact Sciences
Department of Geophysics and Planetary Sciences
Tel Aviv University, Ramat Aviv 69978, Tel Aviv, Israel

In most basic physical phenomena, the laws governing motion can be looked at as the relation between two fields which are continuous in time and space. They are activiated simultaneously by the same source. The relations of these dual fields can be casted through two symmetric first order partial differential equations. By substituting one of the dual equations by the other, it follows that both dual field obey the wave equation. Pressure and particle velocity as well as electric and magnetic pairs are shown to be such dual fields.

Acousto-elastic and electromagnetic propagation is characterized by movement with small scattering or absorption of wavelets. Gravity propagation can be characterized as movement of objects in empty space with small scattering or absorption. A unified formulation of such mechanical acousto-elastic and electromagnetic nondisperive and nondissipative motion is presented.

The observed dual fields above and below a weakly reflecting boundary are shown to be related by Lorentz Einstein transformation where the propagation velocity is not necessarily the speed of light but that of the gravity wavelet propagation inside the layer containing the source. Our theory does not exclude the possibility of velocities higher than the velocity of light in empty space.

5. Plasma Physics

Invited Lectures

Numerical Analysis of Nonlinear Mode-Mode Interactions in the Rayleigh-Tayler Instability

D. Ofer, J. Hecht, D., Shvarts
Physics Dept., Nuclear Research Centre Negev
Z. Zinamon
Nuclear Physics Dept., Weizmann Institute of Science
S.A. Orszag
Applied and Computational Math, Princeton Unversity

Rayleigh-Tayler (RT) instability results when a low density fluid accelerates a heavier fluid or supports it against gravity. Recent interest in the nonlinear evolution of this instability has been stimulated by work in areas as diverse as intertial confinement fusion and stellar evolution.

We study the interaction of a small number of modes in a two fluid RT instability at relatively late stages of development i.e. the highly non-linear regime, using a two dimensional hydrodynamic code incorporating front tracking scheme. We find that the interaction of modes can greatly affect the amount of mixing and may even reduce the width of the mixing region. This interaction is both relatively long range in wave number space and also acts in both directions, i.e.: short wavelengths affect long wavelengths and visa-versa. We have identified three distinct stages of interaction, including substantial interaction among modes some of which may still be in their classical (single mode) "linear" regime.

A three dimensional hyrdo-code with interface tracking has recently developed, enabling us to conduct RT simulations in three dimensions. We have begun comparing the RT phenomenon in 3D with our 2D results, including comparison of single-mode, two-mode and multi-mode cases. Although we have found quantitative differences between both cases, it seems that the qualitative behaviour in 3D is similar to 2D in most cases.

Generation of high intensity x-ray radiation by intense subpicosecond laser

Professor A. Zigler, Hebrew University

The use of recently developed high brightness subpicosecond lasers for the study of the interaction of solid matter is leading to the production of powerful incoherent x-ray sources associated with dense plasma environments. The use of these intense pulsed x-ray sources will enable the production of extremely high densities and levels of electronic excitation in materials while leaving the system kinetically cold during the interaction. This general condition is conducive to the amplification of short wavelength radiation. In the discussion we will summarize the recent experimental finding on x-ray produced by intense subpicosecond laser sources and future developments.

STUDIES OF A HIGH POWER NONRESONANT VIRTUAL CATHODE OSCILLATOR

A. Rosenberg, C. Leibovitz, C. Lindenbaum, B. Mandelbaum, J. Shiloh
RAFAEL
P.O.Box 2250, Haifa, Israel

In recent years, Virtual Cathode Oscillators have been demonstrated to emit short pulses of very high power microwaves, ranged up to several gigawatts. The mechanism for the emission of the radiation has been attributed to both space and time oscillation of the virtual cathode and the oscillation of electrons in the potential well between the real and virtual cathode (reflexing electrons). Simulations show that both mechanisms occur simultaneously. A clear separation between these mechanisms has never been made experimentally.

In this paper we present detailed studies concerning the operation of a nonresonant Virtual Cathode Oscillator with currents close to the critical current for pinching condition. The measurements were carried out in the S-band using a mildly relativistic electron beam (0.5 - 1MV, 30-50 kA and pulse length of 50 nsec). Various techniques were used to measure the power and frequency of the microwave radiation. A high resolution pressurized calorimeter has been developed and used for measurements of the microwave power output. The calorimeter high sensitivity (50mV/J) and excellent signal to noise ratio make it a very efficient tool for measurements of high power microwave. Maximum output power between 200-300 MW was achieved when the cathode surface design, charge voltage and anode-cathode gap are arranged to simultaneously maximize the diode voltage, satisfy magnetic insulation and avoid nonuniform and unstable electron emission.

Frequency measurements using a heterodyne mixer clearly indicate that the virtual cathode oscillates at a single frequency (~3 GHz) with a narrow bandwidth (<2%). The customary chirping behavior exhibited by a nonresonant vircator oscillator is absent in these measurements. The central frequency follows roughly the beam plasma frequency, and can be perfectly tuned by varying the diode voltage and anode-cathode gap. The microwave-induced gas breakdown was used as a diagnostic of the operating mode of the vircator. The radiation patterns observed indicate clearly that the dominant waveguide mode is TM_{01} mode.

High-resolution Spectroscopic Studies of an Imploding Z-Pinch Plasma

M.E. Foord, G. Davara, L. Gregorian and Y. Maron
Weizmann Institute of Science
Physics Department, Rehovot, Israel.

The spectral line emisson in the uv-visible wavelength region from a gas puff z-pinch plasma is investigated. The plasma is formed by injecting a 4 cm diameter annular gas shell between the anode and cathode which are separated by 1.4 cm. A 35 kV, 16 μF capacitor bank provides a current of 480 kA with a rise time of 1.2 μs. Measurements indicate that the injected gas profile is uniform resulting in reproducible stable pinching of the plasma shell.

A 1-m spectrograph coupled to a twelve channel PMT detector system having spectral sensitivity between 2000 Å–8000 Å, and 4 ns temporal and 0.06 Å spectral resolution is used to determine spectral line-shapes and intensities during a single shot. Strong line-emission from various ions of different charge states is observed during the collapse of the plasma shell as well as a burst of soft and hard x-rays at the time of the pinch. Various gases such as Ar and CO_2 are used to allow a comprehensive study of the absolute and relative level populations of excited states which emit in the uv-visible wavelength regime.

Time-dependent line profiles of singly and triply charged ions of carbon and oxygen from emission in the radial direction are being investigated. Certain line profiles are found to be dominated by the Doppler shift of the imploding shell and the spread in the radial velocity distributions. Radially velocities near 5 cm/μs have been measured and interesting differences between CIV and OIV velocities are observed which are not yet understood. Other phenomena will be discussed such as zippering and particle injection from the electrode which are apparent from transverse scans along the z-direction.

The Momentum Flux from Cathode Spot Plasma Jets: Interaction with Macroparticles and Background Gas, and Influence on Anode Spot Development

R.L. Boxman and S. Goldsmith
Tel Aviv University
Electrical Discharge and Plasma Laboratory

The cathode spot of the vacuum arc emits a jet of highly ionized metallic vapor plasma. These jets convect with them a high momentum flux, as known from Tanberg's pendulum deflection experiments 60 years ago. In this talk quantitative expression for the momentum flux are developed based on modern measurements of the ion energies for both collimated and uncollimated plasma jets. The momentum flux is used to explain the interaction of the plasma jets with macroparticles present in the plasma, and with background gases and vapors.

Visual observations indicate that the metallic vapor plasma is confined in a hemisphere whose radius varies as a function of the ratio between arc current and background pressure. The radius can be predicted by equating the momentum flux with the background gas pressure. The ion current extracted from collimated plasma jets decreases steeply around a critical pressure which can likewise be predicted.

Under appropriate conditions the anode is heated by the vacuum arc sufficiently that it emits a vapor plume. Under marginal conditions the plume is confined to the vicinity of the anode. With heating sufficient to obtain a vapor pressure greater than the cathodic momentum flux, the plume can propagate into and dominate the interelectrode region.

Abstracts

TRAVELING-WAVES FREE ELECTRON MASER (TWFEM) EXPERIMENTS

Eran Agmon, Arhel Golombek, and Eli Jerby
Department of Physical Electronics
Faculty of Engineering
Tel Aviv University

The TWFEM (1) is an hybrid devices which combines the TWT and the FEL structures. Consequently, both interactions occur in the TWFEM device, in addition to a synergistic interaction of a new kind. Thus, the TWFEM produces a higher gain and requires a lower electron beam energy comparing to the TWT and FEL interactions in the same conditions. In this paper we describe an experimental implementation of this concept. The goal of our TWFEM experiment is to prove the existance of the hybrid TWFEL interaction component. The experiment is operated in the microwave regime with a low energy (10-20 keV), low current (0.5-1 A) electron beam. A first TWFEM operation is expected in this summer.

(1) E. Jerby, "Traveling waves free electron laser", Physical Review A, 44 (1991) 703.

Interaction between slow electromagnetic waves and an electron beam in an unmagnetized plasma

M. Botton
RAFAEL, P.O. Box 2250, Haifa 31021, Israel

Intense relativistic electron beams usally require a strong axial magnetic field to enable their propagation. The magnetic field affects also the interaction between the electron beam and slow electromagnetic waves by inducing transverse cyclotron motion in the beam. This effect may degrade the efficiency of energy transfer from the beam to the waves.

In this work we analyze the interaction between slow electromagnetic waves and and electron beam which is guided by a channel of a neutral plasma without the presence of an axial magnetic field. It was demonstrated that high intensity beams can travel through metallic tubes, when the space-charge is neutralized by an unmagnetized plasma. In the absence of an axial magnetic field, the time independent stationary state of the beam is determined by the energy and density of the beam and the density of the background plasma.

An analysis of the electrostatic modes of the combined beam-plasma system shows that their properties are affected by the absence of the axial magnetic field. The long wavelength plasma modes interact with the slow space-charge modes of the beam, and an instability of the beam-plasma type is obtained. The spectrum and growth rates of this electrostatic instability strongly depend on the density of the low-energy plasma electrons. With an axial magnetic field the instability is found only for beam and plasma densities higher than threshold values.

The interaction between the longitudinal slow electromagnetic waves and the electron beam is less affected by the absence of the guiding magnetic field and the presence of the background plasma. The growth rates of the electromagnetic instability are weakly dependent on the density of the plasma electrons. However, at higher densities of plasma electrons, the growth rate of the electrostatic modes may dominate the growth rate of the electromagnetic mode.

The possibility of using plasma-guided electron beam without an axial magnetic field as the basis of a radiation source is also discussed.

Space-Charge Limited Ion Flow and Electric Field Screening in an Ionizing Magnetized Plasma.

R.E. Duvall, C. Litwin, and Y. Maron,
Department of Physics,
Weizmann Institute of Science,
Rehovot, 76100, Israel.

Several theoretical models are currently being used to study the problem of space-charge limited ion flow through a layer of weakly ionized plasma and the resulting plasma buildup and screening of electric fields. The plasma is immersed in a magnetic field which confines electrons while ions remain unmagnetized. This configuration is relevant to the magnetically insulated ion beam diode (MID) experiment at the Weizmann Institute. It has been suggested that an ionizing neutral layer near the anode surface makes a major contribution to the initial plasma buildup in this experiment[1]. Our analysis indicates that electron flow to the anode would play a crucial role in the electric field time evolution for this plasma. Comparison to measurements of the electric field in the MID will therefore allow us to estimate the dominant mechanisms of electron flow from the plasma. Comparisons between theory and experiment also provide an estimate of the initial neutral layer density, which is compared with that value inferred from the measured electron density in the fully ionized plasma.

Magnetic field evolution, flux penetration and energy dissipation in (almost) collisionless short duration plasmas

A. Fruchtman and K. Gomberoff
Physics Department, Weizmann Institute of Science, 76100 Rehovot, Israel

Fast magnetic field evolution driven by the Hall field, and the associated flux penetration and energy dissipation, are discussed. This evolution is of much interest since it is expected to occur for times (between the electron and ion cyclotron periods) and for lengths (between the electron and the ion skin depths) that are characteristic of plasmas in pulsed-power devices, such as the Plasma Opening Switch (POS). The first mechanism for fast magnetic field evolution can result either from density nonuniformity[1] or from magnetic field curvature[2]. When electrons decelerate due to their motion from a low-density region to a high-density region, or from a small radius to a larger radius in the cylindrical geometry of a POS configuration, the magnetic field grows in time. On the other hand, if the electrons accelerate due to a density gradient or cylindrical geometry, the magnetic field does not increase in the plasma. Moreover, in this latter case if the plasma was initially permeated by the field, that field can be spontaneously expelled[2]. In the case in which the magnetic field does increase in the plasma, a shock-like propagation ensues, accompanied by a large deviation from the frozen-in law (large flux penetration) and a large energy dissipation (large resistance), even if the plasma is almost collisionless. The energy in the shock downstream is equally divided between magnetic field energy and electron thermal energy. A direct relation is shown between the heating of an electron along its orbit and the deviation from the frozen-in law[3]. The presence of conductors at the radial boundaries in the POS configuration is shown to result in a large energy dissipation in their vicinity[4]. It is demonstrated that a magnetic field can penetrate even into an initally homogeneous plasma, where a density gradient along the current lines arises due to magnetic pressure in the 2D flow. Such a penetration occurs without volume dissipation and the shock structure is determined by the electron inertia[5]. The second mechanism for fast magnetic field evolution is the propagation of the field as a whistler wave along a background magnetic field[6]. This mechanism could be used to control the magnetic field evolution in the POS.

References

1. K.V. Chukbar and V.V. Yan'kov, Sov. Phys. Tech. Phys. **33**, 1293 (1988).
2. A. Fruchtman, Phys. Fluids **B3**, 1908 (1991).
3. A. Fruchtman and K. Gomberoff, Phys. Fluids **B4**, 117 (1992).
4. A. Fruchtman, "Power dissipated during rapid magnetization or demagnetization of plasmas", Phys. Rev. A, in press.
5. A. Fruchtman and L.I. Rudakov, in preparation.
6. A. Fruchtman and Y. Maron, Phys. Fluids **B3**, 1546 (1991).

Spatial Coherence in refractive media

G. Hazak[a], O. Zahavi[b] and Z. Zinamon[b]
a) Nuclear Research Center-Negev, P.O. Box 9001, Beer-Sheva, 84105, Israel
b) Department of Physics, Weizmann Institute of Science, Rehovot, 76100, Israel

A study of spatial coherence properties of radiation from an extended aperture of uncorrelated sources is presented. This is done in the geometrical optics approximation, using ray-tracing method. In this method, the inclusion of inhomogeneity in the refractive medium, through which the radiation propagates, is shown to be quite natural. For a general class of refractive index profiles, the refraction of the radiation is shown to merely introduce a new scaling factor in the well-known expression for the spatial coherence in free space. The application of this result to amplified spontaneous emission systems, such as x-ray lasers, is discussed.

NEGATIVE MAGNETIC PRESSURE IN A PLASMA WITH ADVANCED MHD TURBULENCE

Nathan Kleeorin and Igor Rogachevskii

Racah Institute of Physics, Hebrew University of Jerusalem

The effects, nonlinear in the large-scale magnetic field, of modifying the magnetic force by an advanced small-scale MHD turbulence are considered. Generation of magnetic fluctuations at the expense of hydrodynamic pulsations results in a decrease of the total (hydrodynamic plus magnetic) turbulent pressure. It can noticeably lower the elasticity of the large-scale magnetic field, and under certain conditions, the effective magnetic pressure can change sign.

This effect excites an instability of the large-scale magnetic field due to the energy transfer from the turbulent pulsations. The mechanism of the instability is the following. An isolated tube of the magnetic field lines, moving upward against the direction of gravity turns out to be lighter than the surrounding plasma, since the fall of the magnetic field in it , due to the tube expansion, is accompanied by an increase of the magnetic pressure inside the tube. Since the effective magnetic pressure is negative, this increase leads to a decrease of the density inside the tube and to appearance of a buoyancy force. It results in formation of inhomogeneities of the magnetic field.

To investigate the MHD turbulence at the large magnetic Reynolds number we used both the high order closure procedure and the renormalization group method.

The instability due to the negative magnetic pressure probably acts as a mechanism of the large-scale magnetic ropes formation in the solar convective zone and spiral galaxies.

EFFECT OF EXCITATION-AUTOIONIZATION PROCESSES ON FRACTIONAL ABUNDANCES OF HIGHLY IONIZED KrI-LIKE TO NiI-LIKE HEAVY ELEMENTS IN CORONAL PLASMAS

D. Mitnik, P. Mandelbaum, J.L. Schwob,
Racah Institute of Physics, The Hebrew University of Jerusalem, Israel

J. Oreg, A. Bar-Shalom,
The Nuclear Research Center of The Negev P.O.Box 9001, Beer Sheva, Israel

and W. Goldstein
Lawrence Livermore National Laboratory P.O.Box 808, Livermore, California 94550

Excitation of an inner-shell electron followed by autoionization (EA - Excitation Autoionization) constitutes an alternative channel to electron impact direct ionization, and can lead to an enhancement of the total ionization rate. Recent studies have shown that this process becomes very significant for ions in isoelectronic sequences having few electrons in the n=4 outer shell, through $3d^{10}$...-$3d^{9}$..4d and 4f inner-shell excitations.

In the present work based on these new data, effects of EA on fractional ion abundance of KrI to NiI-like ionization states of heavy elements at coronal equilibrium condition are studied. For the CuI-, ZnI-, GaI-, BrI- and KrI-like ions, the results of detailed computations involving the 3d-4d and 3d-4f inner shell excitations are introduced.

For other sequences involving a higher number of levels an approximate computation method of EA rates has been developed by introducing a mean branching ratio toward autoionization for the whole inner-shell excited configuration.

The coronal ionization rate equations for the successive ionization stages have been solved for various elements. Results for Pr (Z=59) and Dy (Z=66) obtained with and without taking into account EA processes are compared.

A general consequence of the introduction of EA process rates is a drastic shift of the maximum fractional ion abundance occurring for some ions toward low temperatures, in some cases by more than 25%. The dependence of this effect upon Z is discussed.

High resolution investigations of a plasma formed over a dielectric surface

L. Perelmutter, G. Davara, L. Troyansky, and Y. Maron

Department of Physics, Weizmann Institute of Science, Rehovot, Israel

The formation of plasmas near electrically stressed surfaces is common to insulator breakdown phenomena and to various plasma wall interactions. In order to understand the behavior of such plasmas the particle densities at the immediate vicinity of the surface, the particle flow to and from the surface into the plasma, the plasma temperature and density near the surface, and the electric fields prevailing there have to be experimentally investigated.

We developed techniques based on laser-absorption and laser-induced-fluorescence and utilized them, together with seeding of the plasma with various species, to obtain high-spatial-resolution measurements, required for studying such nonuniform plasmas. The laser absorption technique has additional advantages that are particularly useful for these studies. It lacks the uncertainties resulting from optical thickness effects that affect measurements based on spontaneous emission. It also enables direct determination of densities and spectral line profiles.

Using these techniques[1], we measured the particle density and velocity distributions at the immediate vicinity of the dielectric-anode surface in a magnetically insulated ion diode. The densities of the ground states and of low-lying levels for a few species: MgII, LiI, HI, and CII were measured directly as a function of distance from the anode surface. The spectral profile of the absorption line yielded the particle velocity distribution. A spatial resolution of 30 μm near the anode surface was achieved. The MgII Doppler broadened absorption profiles gave an MgII temperature $\simeq$15 eV within $\simeq$30 μm from the anode surface. We thus conclude that most of the MgII velocities previously observed in the anode plasma[2] are acquired by the ions within $\simeq$30 μm from the anode surface. This suggests ion acceleration by electric fields $\geq$5 kV/cm near the surface. In addition, our experimental procedure enabled us to observe, for the first time, high density gradients near the anode surface for many of the observed species. The measured density dependences on the distance from the surface for the various ions were compared to those determined from a ballistic model that describes the flow in the plasma of particles ejected from the surface into the plasma with the observed velocity distribution. Together with time dependent collisional-radiative calculations, the data are used to estimate the electron density and temperature within approximately 50 μm from the anode surface. These estimates are also supported by measurements of the density ratio between the MgII ground and first excited states near the anode surface. The electron density and temperature are compared with those farther from the anode surface, determined in previous studies[2] from spontaneous emission spectroscopy. The significance of the results for the investigation of plasma-wall interactions in pulsed-power systems is discussed.

1)L. Perelmutter, G. Davara, and Y. Maron, Proceedings of the XIVth International Symposium on Discharges and Electrical Insulation in Vacuum, Santa Fe, New Mexico, U.S.A., p. 318, Sept. 1990.

2)Y. Maron, E. Sarid, O. Zahavi, L. Perelmutter, and M. Sarfaty, Phys. Rev. **A39**, 5842 (1989); Y. Maron, M. Sarfaty, L. Perelmutter, O. Zahavi, M.E. Foord, and E. Sarid, Phys. Rev. **A40**, 3240 (1989).

Spectroscopic Investigations of a Plasma Opening Switch using a Novel Gaseous Plasma Source

M. Sarfaty, Ya. Krasik, R. Arad, A. Weingarten, Y. Maron and A. Fisher*
Physics Department
Weizmann Institute of Science
Rehovot, 76100, Israel

We are investigating the plasma behavior in a cylindrical Plasma Opening configuration in the 100-ns time scale. To this end we developed a gaseous plasma source that injects plasma radially outward from inside the inner conductor to the spacing between the two conductors. The source gas released from a gas valve expands down a cylindrical tube and then propagates into radial capillaries drilled in the wall of that tube. A volume discharge inside the tube followed by discharge of the gas in the capillaries cause the plasma injection from the capillaries outward through the inner-conductor.

Using floating probes, biased charge collectors, fast photography and spectroscopy the electron density and temperature in the switch region were found to be 5×10^{13} cm^{-3} and $\simeq$20 eV, respectively. The plasma injection velocity is $\simeq$5 cm/μsec. The plasma reproducibility in r, θ and z directions were found to be $\simeq \pm 20\%$. The inner conductor plasma source system is connected to the high voltage output of a 300 kV, 1Ω, 90 ns generator.

The operation of the POS for positive polarity for various plasma parameters is being examined. Eight $\dot{B}$ loops and two Rogowsky coils are used to measure the current upstream and downstream. Plasma switch characteristics, voltage, current, impedance, energy and power in conduction and opening phases will be given. Ion current extracted from the plasma was measured simultaneously by two arrays of four collimated Faraday cups placed on both sides of the plasma switch. Results of these measurements during switch conduction and opening will be discussed. Spectroscopic observations of high spatial and spectral resolutions of various particle velocities in the plasma have been made. Line intensities and levels population at various radial locations will be analyzed using time dependent collisional-radiative calculations. The spectroscopically observed results will be checked in comparison with various POS models.

---

* Naval Research Laboratory Washington DC.

THE EFFECT OF NON-MAXWELLIAN ELECTRONS PENNING AND CHARGE EXCHANGE PROCESSES ON THE SOFT X-RAY AND VUV SPECTRA OF LOW CHARGE STATES OF Al (Z=13), Zn (Z=30) and Y (Z=39) EMITTED FROM A REFLEX DISCHARGE (PID) PLASMA

D. Stutman, M. Finkenthal, O. Marinov, S. Kovnovich, I. Pinchas, J. L. Schwob

Racah Institute of Physics, The Hebrew University, Jerusalem

and

A.K. Bhatia

Goddard Space Flight Center, Greenbelt, Maryland 20771

ABSTRACT

Spectra of one to three times ionized Al, Zn and Y have been recorded in the 100-3000Å range using a 2m grazing incidence Schwob-Fraenkel spectrograph and a scanning Minuteman monochromator equipped with photoelectric detection. A Penning ionization discharge with open anode configuration has been operated with magnetic fields ranging between 1 and 4 kG using He, Ne and Ar as buffer gas. The gas pressure was varied from a few mtorr to several torr, at discharge currents of 0.5-1 A and anode cathode potentials of 1-2 kV.

The fast electron produced Y IV and Al III spectra at 100-350Å, the influence of Penning ionization on the spectra of Y II and Al II and the charge exchange produced Zn II emission between 800 - 2200 Å, are presented and discussed.

6. Science Teaching

Session on **Physics Education**

Physics in High School- Research and Development

Chairman: U. Ganiel

Lecturers:

M. Feingold (Technion) :
Physics of Technological Systems: A Course for Weaker Students

B. Eylon and Z. Geller (The Weizmann Institute of Science):
Bridging the Gap between Electrostatics and Electrodynamics in the Teaching of DC Circuits

M. Ronen (The Weizmann Institute of Science):
***RAY**- A Computerized Learning Environment for Geometrical Optics*

M. Meidav (Tel-Aviv University):
Summary: A Teachers' Teacher Perspective

Session on **Physics Education**

Physics in High School- Research and Development

Chairman: U. Ganiel

Invited Lecturers:
M. Feingold (Technion)
B. Eylon (The Weizmann Institute of Science)
Z. Geller The Weizmann Institute of Science)
M. Ronen (The Weizmann Institute of Science)
M. Meidav (Tel-Aviv University)

Feingold will describe a physics curriculum developed for weaker students in vocational high schools.

An example of a research and development project for high school physics, in the area of electricity, will be described by Eylon and Geller. Studies of students' reasoning in the domain of electricity indicate that there is a missing link between electrostatics and electrodynamics in students' conceptions about dc circuits. We suggest that providing students with a qualitative model which emphasizes mechanisms, including the role played by surface charges on circuit elements, can provide this missing link. Experiments demonstrating the existence and effect of such surface charges will be demonstrated.

Ronen will demonstrate the "RAY" simulation- a computerized learning environment designed to facilitate the learning of geometrical optics. This example illustrates how technology can be integrated into the teaching/learning of physics.

The session will be summarized by Meidav, who will discuss the issues raised in this session, highlighting the perspective of teacher training.

7. Statistical Physics and Complex Fluids

Invited Lectures

Phase Transitions and Domain Structures in Langmuir Monolayers

X. Qiu, J. Ruiz-Garcia and C. M. Knobler
Dept. of Chemistry and Biochemistry
UCLA
Los Angeles, CA 90024

A variety of recent measurements have shown that the phase diagrams of monolayers at the air/water interface are remarkably complex. The structures of the phases can be related to those of smectic liquid crystals. When the monolayers are examined by fluorescence microscopy defect structures can be observed that demonstrate long-range order of the molecular tilt azimuth and support the view that the "liquid- condensed" monolayer phases are hexatics.

Some Peculiarities of Granular Materials

Dov Levine
Dept. of Physics
Technion, Haifa, Israel

The physics of granular materials, such as sand, is quite different from the physics of solids and liquids per se, sometimes behaving like the former, sometimes like the latter, and sometimes like neither. I will summarize some of the peculiarities of such systems, review recent work, and present some new results on the flow of granular materials and on the segregation of multicomponent granular systems.

MODULATED PHASES OF VESICLES AND MEMBRANES

David Andelman
School of Physics and Astronomy, Tel Aviv University
Ramat Aviv 69978, Tel Aviv, Israel

Amphiphiles such as phospholipids manifest a strong tendency to *self assemble* and form membranes in water. Membranes exist either as a stack of *lamellae* or as closed-form vesicles. We consider here vesicles and unilamellar membranes which are composed of two *different* species. We show that *modulated phases* are stabilized in some cases. The modulation periodicity is selected by a competition between two opposing interactions of different spatial range. Analogies to ferromagnetic films, ferrofluids and co-polymers are drawn with an emphasis on *universal* features of the different physical phenomena. Calculation of vesicle shapes yields a strong coupling between the local relative composition and the vesicle shape. Strong deviation from a spherical shape — characteristic of a single-component closed-form vesicle — are found and analyzed. For a single membrane (unilamella), phase transitions are calculated between homogeneous phases and modulated phases which exhibit periodic out-of-plane undulations as well as periodic variation in the relative composition of the two components.

Abstracts

Surface Modification and Freezing

R. Bar-Ziv and S.A.Safran
Dept. of Materials and Interfaces
Weizmann Institute of Science
Rehovot,Israel 76100

Recents experiments have shown that surfactant monolayers at the liquid-air interface can prevent supercooling of the liquid, inducing nucleation of the solid. The nucleation process appears to be very sensitive to the structural match between the ordered clusters in the monolayers and the underlying solid. Our theoretical approach is to understand the instability of the liquid/ordered monolayer system to nucleation of the solid as a function of temperature and the extent (size) and crystallinity of the surface monolayer. We use a generic model to describe a liquid in a metastable state near a first order phase transition which includes the effects of spatial inhomogeneity to model the variation of the crytallinity from the surface to the bulk. When the monolayer lattice is (i) well-matched to the solid and (ii) well ordered, the monolayer/supercooled liquid system may be unstable to small perturbations, resulting in nucleation of the solid. However, partial coverage of the surface can stabilize the system against crystallization, allowing supercooling. We predict the critical domain size as a function of temperature and monolayer crystallinity.

Roughening Transitions on the HCP Lattice

Gideon Baum, Joan Adler and S. G. Lipson
Department of Physics, Technion, Haifa, 32000, Israel.

Helium crystals have an HCP lattice structure and exhibit equilibrium roughening transitions on three different crystal facets. We have developed an HCP model based on a mapping into a three-dimensional Ising model. The three facets are constrained by appropriate boundary conditions and the roughening phase transitions are obtained by simulations. Lower bounds for the roughening temperatures are obtained by measuring the transition temperatures of three different two-dimensional Ising models. Our model required the development of special algorithms to handle simulations on the non-Bravais HCP structure. All previous high quality numerical studies of roughening transitions were made for cubic systems and thus ours are the first that can be compared with the experimental data for the relative locations of the three transitions. We are also able to investigate the effect of further neighbour interactions on the existence of additional roughening transitions.

Effect of Bimodal Molecular Weight Distribution on the Configurations of Terminally Anchored Chains

N.Dan* and M. Tirrell
Dept. of Chemical Engineering and Material Science
University of Minnesota
Minneapolis, MN 55455, USA

We investigate the equilibrium properties of terminally anchored polymer chains with a bimodal molecular weight distribution. The chain configurations are calculated using a numerical solution to a self consistent field model. We find that the longer chains stretch through the inner layer of the shorter chains, so that vertical segregation ensues. Stratification persists even under strong compression, as evident from segment density and chain end distribution.

* Present address: Department of Materials and Interfaces, Weizmann Institute of Science, Rehovot 76100,Israel.

OPTICAL STUDY OF SURFACE MELTING ON ICE

M. Elbaum(1,2), S.G. Lipson(2), M. Schick(1), J.G. Dash(1).....
(1) Physics Dept. Univ. of Washington, Seattle, WA USA
(2) Physics Dept. Technion - IIT, Haifa, ISRAEL

Surface melting is the phenomenon by which melting of a bulk solid material at its triple point (T_{TR}) is initiated by the formation of a thin liquid film on the surfaces at lower temperatures. We have conducted a study of surface melting on ordinary water ice. Single crystals were grown in situ from vapor, and examined by optical means at temperatures approaching 0 °C. Polarized reflectometry provided sensitivity on the level of tens of Angstroms, while interference microscopy displayed the surface morphology on the scale of the wavelength of light. Evidence was found for a pre-melted liquid film on ice in some crystallographic orientations. Under pure vapor conditions the thickness of this film did not diverge at the triple point. Instead, droplets of very low contact angle were observed. In analogy to the nomenclature of wetting, we have called this observation incomplete surface melting. Thus the surface may have liquid-like properties near T_{TR}, but bulk melting must still be nucleated elsewhere. The introduction of air to the chamber caused a change to complete wetting. In addition, we have analyzed the surface melting of ice in terms of Lifshitz theory of dispersion forces, and found a similar result: surface melting of ice is incomplete.

Crystal stucture and flowability: smectic B liquid crystal model

Hersht Igor
Physics Department, Bar-Ilan University, Ramat-Gan 52900

We study the role of higer-order gradient terms in the elastic energy of layered smectics and show that crystal order can coexist with a shear instability. On this basis a new model of smectic B phase is proposed where the structure possesses long range translational order in all directions. The interlayer shear modulus decreases at lower frequencies of applied strain and tends to zero in the static case [1]. The crystal-smectic B phase transition is considered.

[1] I. Hersht and V.K. Pershin *J. Phys. (Fr.)* **51** (1990) 1769.

Three phenomena observed in high-temperature specific heat

Yaakov Kraftmakher
Department of Physics, Bar-Ilan University, Ramat-Gan 52900

The aim of the paper is to attract attention to three phenomena observed earlier in high-temperature specific heat of metals. An unexpected premelting anomaly in the specific heat of Pt and Pt-Rh alloy is observed with modulation measurements on thin wire samples, 0.02 to 0.1 mm thick. The anomaly consists of a rapid and deep decrease of the specific heat and is probably related to a metastable (superheated) state near the melting point[1]. Temperature fluctuations in thin tungsten wires, 0.003 mm thick and 1 mm long, were observed using photosensors. They depend on isochoric specific heat while temperature oscillations caused by modulation depend upon isobaric specific heat. The temperature fluctuations, with spectral density of the order of 10^{-11} K^2/Hz, were compared with the oscillations caused by noise modulation. The ratio of the isobaric and isochoric specific heats at 2200 and 2400 K was found to be 1.4 which is an unexpectedly high value [2].

A relaxation phenomenon in the specific heat of W and Pt caused by equilibration of point defects has been observed. Temperature oscillations of low and high frequencies were created in the samples simultaneously, and the specific heats corresponding to them were compared directly. In the both cases the defect origin of the nonlinear rise in specific heat was confirmed [3].

1. [1] Y.Kraftmakher. it 6th European Conf. Thermophys. Properties, Dubrovnik, 1978, paper 101; *Phys. Lett.* A **154** (1991) 43.
2. [2] Y.Kraftmakher and S.Krylov. *Teplofiz. Vysok. Temper.* **18** (1980) 317; *Fiz. Tverd. Tela* **22** (1980) 3157.
3. [3] Y.Kraftmakher. *Teplofiz. Vysok. Temper.* **19** (1981) 656; *Fiz. Tverd. Tela* **27** (1985) 235; *Phys. Lett.* A **149** (1990) 284.

ON THE NATURE OF EXCITATIONS IN LIQUID ^{4}He

Yu.A. Nepomnyashchy

Physics Department, Technion, Haifa, Israel

Exact microscopic considerations provides answers to the questions which have been discussed for a long time in the literature: (i) The existence of zero sound (ZS) (see e.g. [1]) and of quadratic single-particle (SP) branch in HeII. Both branches are proved to be excluded. (ii) The origin and interrelation of phonons and rotons: We prove that they form a unified spectral branch of SP origin caused by the condensate. Independently of the strength of interaction the condensate leads to suppression of the ZS, to transmission of some properties of ZS to the SP branch and to "maxon-roton" non-monotonicity of the SP branch reflecting the "short-range order". (iii) The interrelation of phonons below T_λ and above T_λ: We prove that only the former have quantum hydrodynamic structure and only the latter correspond to the ZS. (iv) The relation of Bose gas to the real HeII: We show that in the both cases the phonons are qualitatively the same - the hybridization between particle, "hole" and "particle-hole" excitations leads to the elimination of ZS, to the formation and renormalization of Bogoliubov sound that acquires QHD structure and becomes independent of the condensate density. Our results essentially differ from those of Ref. [2].

PACS number: 6740

1. D. Pines, Quantum Fluids, edited by B.E. Brewer (Wiley, N.Y. 1966), p. 257.

2. H.R. Glyde and A. Griffin, Phys. Rev. Lett. **65**, 1454 1990.

ON THE THEORY OF DOPPLER SHIFT OF 4TH SOUND IN He II

Yu.A. Nepomnyashchy and M. Revzen

Physics Department, Technion, Haifa, Israel

The presence of two macroscopic motions and several sounds in a superfluid provides an unusual manifestation of the Doppler effect. The simplest situation corresponds to completely "locked" normal component: the Doppler shift of 4th sound in HeII. We develop the microscopic theory of this phenomenon, first investigated by Rudnick et al. [1]. We prove that the existing approximate description of the Doppler shift is inadequate. It is practically "kinematic": the center of the sound sphere moves with the velocity of liquid as a whole, i.e. of its center of mass. We show that the real situation is quite different. Our theory predicts some new physical effects: (i) At low temperature ($T \leq 0.4^{o}K$) the center of the sound sphere moves more quickly relative to fixed normal component than superfluid component itself (which seems paradoxical) [2]. (ii) The coefficient in the Doppler shift expression as a function of T has a sharp peak at $T \sim 0.6^{o}K$, which exceeds the "kinematic" prediction by factor nearly 25.

PACS number: 6740

1. I. Rudnick, H. Kojima, W. Veith and R.S. Kagiwada, Phys. Rev. Lett. **23**, 1220, 1969.

2. Ya. A. Nepomnyashchy and M. Revzen, Physics Letters **A161**, 164, 1991.

Elasticity and Concentration of Soft Two-Component Solids

P. Pekarskii and Y. Rabin
Physics Department, Bar-Ilan University, Ramat-Gan 52100, Israel

We present a recently developed theory of elasticity and concentration fluctuations in soft two-component solids such as rubbers and gels swollen in solvents [1]. The theory differs from classical theories of rubber elasticity in that it introduces a coupling between the strain and the local concentration of the elastic component and accounts for the concentration-dependence of the elastic coefficients. This leads to enhancement of concentration fluctuations in the direction of applied strain, in agreement with recent neutron scattering studies of these systems [2]. Our theory is also applied to the problem of swelling of polymer gels and the calculated dilation moduli are compared with experimental observations.

1. Y. Rabin and R. Bruinsma, submitted to *Europhys. Lett.*
2. E. Mendes, P. Lindner, M. Buzier, F. Boue and J. Bastide, *Phys. Rev. Lett.* **66**, 1595 (1991).

Simple explicit molecular-field expressions of one and two lattice magnetic crystals near Tc

S. Shatz and I. Laulicht
Department of Physics, Bar-Ilan University

Simple explicit molecular-field expressions are derived for the magnetization of one and two lattice magnetic crystals near Tc at moderate applied fields. Under these conditions, the magnetic energy is much smaller than the thermal one, and the magnetization equations can be expanded in terms of this small parameter, resulting a cubic equation. Using a computer-algebra system, the solutions are simplified, assuming that below Tc, at small external fields, the spontaneous magnetization is dominant, whereas at higher fields, or above Tc, the field-induced one dominates. The values obtained by applying these expression to Yttrium Iron Garnet (YIG), a two-lattice ferrimagnet, are in very good agreement with those obtained using the conventional graphical (numerically exact) methods. Ferromagnetic resonance anisotropy in EuS and YIG films (proportional to the magnetization) at Tc are analyzed using the above formulas. The calculated anisotropy agrees with the experimental value remarkably for YIG, and fairly well for EuS (where the above assumptions are less justified).

Animated Simulated Annealing

Amihai Silverman and Joan Adler
Department of Physics, Technion, Haifa, 32000, Israel.

We have deveolped a simple animated algorithm for visualizing the process of annealing. In our simulations of the annealing process we quickly obtain defect-free single crystals in model materials because the animated visualization helps gain insight into the annealing process. Simulated annealing has become a popular optimization method for minimizing multiparameter functions and our new algorithm enhances its power. Our animated techniques have already been applied to semiconductor modelling, adaptive optics and the determination of groundstates in complex systems such as quadrupolar models and plastic crystals.

Polarization Modulation By Chiral Polymers In Electrolyte Solutions

Olga Volanski
Physics Department, Bar-Ilan University, Ramat-Gan 52900

Recently it has been suggested that an ionic solution of chiral molecules exhibits a chiral polarization and potential instability that leads to a modulation of these quantities on a length-scale that depends on the Debye screening length and on the chirality parameter [1,2]. We have applied these ideas to the case of a chiral cylinder dissolved in an electrolyte-containing solvent. We find a helical modulation of the electrostatic potential and the polarization in the cylinder. The pitch of the helix is determined by the dielectric constants of the media inside and outside the cylinder, the concentration of electrolyte, the chirality constant and the diameter of the cylinder. Application of these results to DNA molecules in biological cells together with a reasonable choice of the magnitude of the chiral parameter gives a predicted pitch of the order of 30 Angstrems, in accord with experimental observations. The possibility of higher-order axes that can be realized in double-helix structures is also discussed [3].

[1] V.N. Bondarev *Pisma Zh. Eksp. Theor. Fis.* **43** (1986) 200.

[2] V.N. Bondarev *Phys. Lett.* A **136** (1989) 139;

[3] V.N. Bondarev and O.O. Volanski *Doklady Academii Nauk SSSR* **321** (1991) 1178.

8. Nuclear Physics

Invited Lectures

Evidence for Nonstatistical Contribution to the Photoneutron Decay of Lead, Bismuth and Terbium

Y. Birenbaum, Z. Berant, S. Kahane, R. Moreh and A. Wolf
Physics Department, Nuclear Research Center-Nevev
P.O.B. 9001, Beer-Sheva, Israel, 84190

Isolated (γ, n) transitions in PB, Bi and Tb were studied utilizing thermal neutron capture photons, and a high resolution neutron spectrometer. Differential and total cross sections were obtained. The results were compared with predictions of the Direct-Semi-Direct (SDS) model, and the compound nucleus (CN) model. The measured angular distributions are consistent, in general, with predictions of the DSD model, reflecting interference between the isovector giant dipole resonance and the isoscaler giant quadrupole resonance. The measured total (γ, n) cross sections are generally underestimated by the DSD calculations, and closer to the predictions of the Cn models. Some of the (γ, n_o) cross sections in ^{208}Pb are comparable to the total Giant Dipole Resonance cross section, reflecting local E1 strengths reported earlier. Evidence for such nonstatistical contribution was found also in some of the other nuclei investigated.

The "Mystery" of the K=I=25 Isomers in ^{182}Os

C. Broude, M. Hass* and G. GOLDRING

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

and

A. Alderson, I. Ali, D.M. Cullen, P. Fallon,
F. Hanna, J.W. Roberts, and J.F. Sharpey-Schafer

Oliver Lodge Laboratory, University of Liverpool
Liverpool L69 3BX, UK

ABSTRACT

The quadrupole moment of the $I = K = 25^+, T_{1/2} = 150$ ns isomer in ^{182}Os has been measured by observing the time-dependent quadrupole interaction pattern of the decay radiation from the isomer implanted in a single crystal of Os. The result of $|Q| = 4.2(2)$ eb is consistant with the predicted deformation of β_2=0.2 for ^{182}Os at $I = 25$ and $K = I$ for this isomer.

* Visiting Professor at NSRL, University of Rochester, Rochester, NY 14627.

BUBBLES IN THE QUARK-GLUON PLASMA

Benjamin Svetitsky

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

The MIT bag model gives an anomalously small surface tension between the high- and low-temperature phases of QCD. This smallness has been confirmed by lattice gauge theory calculations. In calculating the free energy of a bubble in the plasma, then, one is led to consider terms of higher order in $1/R$, beginning with the curvature tension. Both the bag model and lattice calculations show this term to be sizeable and negative, implying that the uniform plasma is *unstable* against the formation of these vacuum bubbles. One might be led to the conclusion that the high-temperature phase of QCD is a Swiss cheese of vacuum bubbles embedded in plasma, at least near the phase transition. Simple calculations, however, show that spherical bubbles are unstable against deformation, and that growth of long, narrow structures is favored. Thus the quark-gluon plasma possesses a rich structure.

Abstracts

Ultra-fast Secondary Emission X-ray Imaging Detectors

A. Breskin, R. Chechik, H. Acclander, A. Akkerman, V. Elkind, I. Frumkind and A. Gibrekhterman
The Weizmann Institute of Science, Rehovot, Israel

We present a new method for fast, high-resolution, digital imaging with X-rays, which can be very useful for on-line radiography in NDT application, in medicine and in HE physics for particle identification by Transition-Radiation. The method is based on a new radiation sensor composed of a thin convertor-foil couplied to a large area, low-pressure, position-sensitive gaseous electron multiplier. The image is reconstructed in real time using modern pixle read-out electronics.

The radiation detector has the following properties:
1. A parallax-free image produced in a solid convertor.
2. Fast time response of the order of 1 nanosecond.
3. Localization capability of the order of 200 μm or better.
4. Detection efficiency of a few percent.
5. Capability to handle very high radiation fluxes.

The solid converto. operation is based on the phenomenon of emission of slow secondary electrons under the impact of X-ray quanta. Such secondary electrons are very efficiently amplified and localized with the low-pressure electron multipliers. The position of the avalanche is very well correlated with the impact point of the incident radiation, providing images of very high quality.

We have operated prototype detectors with 10–40 Torr of CH_4, C_2H_6, i-C_4H_{10} or DME using X-ray photons of 6–60 keV, and convertor materials such as Al, Au and CsI. The last is by far superior in terms of quantum efficiency and localization properties, as will be presented. We present the results of our recent investigations with 8–60 keV photons and discuss the foreseen properties of the new detectors at high X-ray and γ-ray energies. The increase of the quantum efficiency and of the localization resolution by optimizing the geometrical arrangement (grazing angle incidence or stacking up of several detector layers) is presented. The possible applications of this type of detector for the imaging of Transition Radiation is being studied, in view of their implementation in future LHC experiments as a very fast particle identification device. The response of the detector for direct impact of relativisitc particles was studied.

Our studies are accompanied by mathematical modeling and Monte-Carlo simulations of the secondary emission process.

Field: Radiation detectors

INVESTIGATIONS OF PARITY VIOLATION IN NEUTRON RESONANCES.

S.A. Biryukov

CEEP, J.Blaustein Institute for Desert Research,
Ben Gurion University of the Negev, Sede-Boqer Campus, 84990,
Israel

V.I.Mostovoy, G.V.Muradyan
Kurchatov Institute of Atomic Energy, Moscow,
Russia

ABSTRACT

The recent work [1] contains an attempt to extract information about matrix elements of nucleon-nucleon weak interaction at low energies from statistical data on matrix elements of parity-violating nucleon-nucleus Hamiltonian in complex nuclei. A few cases of parity violation in low-energy neutron resonances of different nuclides were reported in [2,3] (transmission experiments).

Now a new experimental approach is developed: measurements of P-odd asymmetry in the resonance radiative-capture cross-section $\sigma_{n\gamma}$ by means of multisectional NaI(Tl) 4π-detector and polarized proton target as a source of longitudinally polarized resonance neutrons.

With the help of this method measurements of P-odd asymmetry in $\sigma_{n\gamma}$ on the ensemble of resonances up to neutron energies about 500 eV were performed. P-odd asymmetry value in p-wave resonance of ^{111}Cd (resonance energy E_p=4.53 eV) was found for radiative-capture process and its value was measured.

The first measurements on ^{111}Cd and ^{238}U demonstrate that such measurements, being performed at pulsed neutron source with flux $\sim 4\cdot10^{13}$ $(\text{sec}\cdot 4\pi)^{-1}$, can provide accuracy, comparable with the results of transmission measurements [4] of Los-Alamos group.

1. M.B.Johnson, J.D.Bowman and S.H.Yoo, Phys.Rev.Let.,1991, v.67, N 3, p.310
2. V.P.Alfimenkov et al. - Nucl. Phys.,1983, v.A398, p.93-106
3. S.A.Biryukov et al. - Sov.J.of Nucl.Phys., 1987, v.45, N6, p.937
4. J.D.Bowman et al. - Phys.Rev.Lett., 1990, v.65, N10, p.1192

Double Resonances in Pion Double Charge Exchange on ^{51}V , ^{115}In and ^{197}Au.

Y. Grof and I. Orion.
Ben-Gurion University of the Negev,Beer-Sheva, 84105,Israel

S. Mordechai
Ben-Gurion University of the Negev,Beer-Sheva, 84105,Israel
and University of Texas at Austin, Austin, Texas 78712-1081.

D. Binton, M. A. Kagarlis, H. T. Fortune and J. M. O'Donnell.
University of Pensylvania, Philadelphia, Pensylvenia 19104-6396.

C. L. Morris.
Los Alamos National Laboratory, Los Alamos, New Mexico 87545.

H. Ward, K. Johnson, G. Kahrimanis, D. Saunders and C. F. Moore.
University of Texas at Austin, Austin, Texas 78712-1081.

Resonances were observed in the continuum in pion induced double charge e xchange (at T_π=295 MeV) on ^{51}V at Q=−12.9, −31.6 and −48.1 MeV , on ^{115}In at Q=−24.2, −36.4 and −48.7 MeV and on ^{197}Au at Q=−30.8, −34.9 and −43.4 MeV . The three resonances have different characteristic angu lar distributions. Partial angular distributions were measured and observed to have $J^\pi=0^+$, 1^- and 2^+ shapes respectively. Based on their energies, angular distributions and cross sections we identify the three resonances as the double isobaric analog state, the giant dipole built on the isobaric analog and the double giant dipole resonance. The new observations are in close agreement with the gross features reported recently for these double resonances (i.e. resonance energies, widths and the A-dependence of the cross section). We will discuss the general features of these exotic nuclear states[1] as they have emerged from DCX experiments performed at LAMPF. This work is supported by the U.S.-Israel Binational Science Foundation, the Robert A. Welch Foundation, the U.S. Department of Energy, and the National Science Foundation.

[1] S. Mordechai and C. Fred Moore, Nature, Vol 352, 393-397 (1991).

SU3 Symmetry Breaking and the H Dibaryon

Harry. J. Lipkin

Department of Nuclear Physics
Weizmann Institute of Science
Rehovot 76100 ISRAEL

and

School of Physics and Astronomy
Raymond and Beverly Sackler Faculty of Exact Sciences
Tel Aviv University
Tel Aviv 69978 ISRAEL

The H dibaryon has been proposed as a candidate for an exotic hadron, with its binding primarily due to the color magnetic interaction between quark pairs. Effects of SU(3)-flavor symmetry breaking on the binding are investigated Two implications are noted of a possible repulsive interaction between two Λ's due to quark exchange: (1). The possible existence of metastable dibaryons; (2). The possible existence of doubly strange hypernuclei even though the H also exists as a stable bound state.

The Evidence for Production of the Superheavy Element with Z=112 via Secondary and Direct Heavy-Ions Reactions

A. Marinov.
Racah Institute of Physics, The Hebrew University, Jerusalem 91904.

The production of superheavy elements, via secondary reactions, in CERN W targets[1] irradiated with 24-GeV protons, has several basic advantages: a) A large variety of isotopes, both stable and radioactive are available as "projectiles". b) The second step of the reaction takes place at the most within $5x10^{-14}$ s after the fragment has been formed. During this short time, the fragment is still at high excitation energy and quite deformed. This may affect strongly the fusion cross section due to the subbarrier fusion phenomenon.

The evidence for production of element Z=112 consists of a) the observation of spontaneous fission activity, with half-life of several weeks, in Hg fractions which were separated from two W targets, and b) the measurements of the masses of the fissioning nuclei and the energy spectra of the fission fragments. It was proven that the fission fragments were not due to any actinide nucleus in general or a contamination of ^{252}Cf in particular. It was also proven that the fission fragments were not due to Hg itself. The measured masses of the fissioning nuclei were consistently interpreted in terms of 5 different molecules of element 112 with N≈160. The kinetic energy spectra of the fission fragments were found to be different from a normal binary fission process, and were consistently interpreted in terms of spontaneous fission into four fragments.

In principle the radiative capture process is possible in these experiments. The Q-value for a reaction like $^{88}Sr+^{184}W-->^{272}112$ is -282 MeV while the Coulomb barrier is around 285 MeV. It was shown that, due to the large expected deformation of the projectile (a fragment at high excitation energy) in these reactions, large fusion cross sections, in the mb region, are possible assuming an experimentally extrapolated extra-push energy of about 40 MeV. A smaller extra-push energy, which is possible when the projectile is a very deformed fragment, will yield even larger fusion cross sections.

The direct $^{88}Sr+^{184}W$ reaction has been studied using 5.1 MeV/u ^{88}Sr beam provided by the UNILAC accelerator in GSI. Indications for characteristic X-rays and α-particle of element 112 were observed in particle versus X-ray and particle versus particle coincidence measurements. The results are interpreted in terms of production of long-lived isomeric states in neutron-deficient isotopes of element 112 with A=271 or 272.

1) For a short summary see: A. Marinov, in "Intern. Symp. on Structure and Reactions of Unstable Nuclei", Niigata, Japan.

9. Astrophysics

Invited Lectures

CHAOTIC PHENOMENA IN ASTROPHYSICAL FLUIDS

O. Regev
Department of Physics
Technion, Haifa, Israel

Convective motions and turbulent flows abound in astrophysical systems and thus modern developments in the study of these phenomena, using dynamical systems theory, should have important impact on them. As the advances in this field are not yet conclusive, we do not deal with them here. Rather than that we discuss applications of nonlinear dynamics on a few more specific astrophysical problems.

We review briefly recent progress in understanding nonlinear stellar pulsation and irregular variability in accretion flows where temporal chaos was found in theoretical models. Attempts to analyze observational data from such systems in the search for chaos are also mentioned.

Recent theoretical attempts to model spatial complexity in extended astrophysical media are reviewed in more detail. It is found that a simple model of a thermally unstable medium with spatial coupling by heat diffusion gives rise to complex patterns of clouds in one and in two dimensions. These results may be applicable to recent observations of interstellar clouds, in which the existance of complex structures with fractal boundaries has been suggested.

D. Eichler, Ben Gurion Univ.

"Gamma-Ray Bursts"

Abstract not available

Abstracts

A MECHANISM OF MAGNETIC FLUX ROPES FORMATION IN THE IONOSPHERE OF VENUS

N.Kleeorin, I.Rogachevskii,
Racah Institute of Physics, Hebrew University of Jerusalem

A.Eviatar
Department of Geophysics and Planetary Science, Tel Aviv University

Magnetic field observations in the dayside ionosphere of Venus revealed the magnetic flux ropes (Russell and Elphic 1979). General properties of these small-scale magnetic field structures can be explained by the theory of magnetic fluctuations excited by random hydrodynamic flows of ionospheric plasma. The local spatial distribution of the magnetic field is intermittent: the field is concentrated within flux tubes separated by the regions with weak fields. A mechanism of amplification of the magnetic fluctuations was proposed by Zeldovich: an original loop of magnetic field is stretched, twisted and then folded. These non-trivial motions are three-dimensional.

A nonlinear theory of the flux tubes formation based on the Zeldovich's mechanism is proposed. The equation describing the evolution of the correlation function of the magnetic field is of the Schroedinger type with a variable mass. This nonlinear equation can be derived from the induction equation, the nonlinearity being connected with the Hall effect. The large magnetic Reynolds number limit allows an asymptotic study by a modified WKB method.

On the basis of this theory it is possible to predict the cross section of the flux ropes in the ionosphere of Venus and the maximum value of the magnetic field inside the flux tube and to explain why the flux tubes are not observed if there is a strong regular large-scale magnetic field due to the lowering of the ionopause.

References

C.T. Russell and R.C.Elphic , Nature, 1979, **279**, 616.

Radiation Pressure on Dust as a Mechanism of Acceleration of Circumstellar Envelopes

N. Netzer
ORT Braude College / Indiana University

Red giant stars, in a certain stage of their evolution lose copious amounts of mass. The mechanism that drives this mass outflow, has been believed to be radiation pressure on dust grains. In previous works, an important effect was ignored, namely that the dust moves through the gas supersonically. That leads to a reduction of the relative abundance of dust within the gas, and for low mass loss rate stars, where this effect is particularly strong, there is a low limit on the possible mass loss rate, namely $10^{-7} M_{\odot} y^{-1}$.

Further calculations show that there are differences in the patterns of acceleration between stars where oxygen is more abundant than carbon and those where the situation is opposite. In particular, there is also an upper limit on the possible mass loss rate. For carbon stars, it is several times $10^{-4} M_{\odot} y^{-1}$ while for oxygen stars it is higher.

Invited Lectures

Near-Field Optics: The Manipulation and Application of Light Beyond the Diffraction Limit

Aaron Lewis
Division of Applied Physics,
The Hebrew University of Jerusalem,
Jerusalem, Israel

Near-field optics is a method to circumvent the diffraction limit restricting the resolution of light focused by conventional lens-based methods. It involved bringing a point of light within the near-field of a surface and then interogating the sample in question with this spatially confined light probe. The recent explosive progess in the development of near-field optics will be focused on in this lecture. These developments are resolving, after a decade of effort, some of the crucial factors that have limited the wide applicability of this provocative approach to optical resolution. The advances that have led this progress have been in the area of new methods of creating extremely intense subwavelength light probes (microwatts in a 100nm diameter point) and in the area of integrating universal methods of feedback which allow the control of the light probe/surface separation to better than 0.1nm. With such a revolution in the creation manipulation of light in subwavelength dimensions a whole variety of unique applications are now possible. These applications include super-resolution light microscopy and spectrosocpy under ambient conditions, new realms of resolution in optical lithography and innovative approaches for resolving the standing problem of producing points of femtosecond light pulses with high spatial resolution.

Coherence, Optical Pumptin and Atomic Orientation

Y. Nafcha, M. Rosenbluh
Bar-Ilan University, Physics Department, Ramat Gan

Experiments which demonstrate complete atomic orientation within a beam of Cs atoms will be described. The direction of the orientation is laser frequency dependent and can have interesting consequences in near resonant atom-laser interactions such as those encountered in laser cooling of atoms. This new optical pumping method can also be used to establish strong coherences between atomic Zeeman sublevels. Such coherences have been predicted to lead to a variety on interesting new nonlinear effects.

Pseudo Guiding and Coupling of 2D Vertical Cavity Semiconductor Lasers - Patterns in the Second Dimension

Meir Orenstein
Department of Electrical Engineering
Technion, Haifa 32000, Israel

Vertical cavity semiconductor lasers (VCSELs) are one of the most attractive entities in the field of optoelectronics. They offer a significant contribution for many applications as well as very interesting device physics such as cavity quantum electrodynamics effects; very high speed carrier dynamics, etc.

The gain layer of a VCSEL is very thin (~30 atoms), thus the laser cavity quality is the most important parameter of such lasers. Using this fact we found out that starting from broad area verticle cavity laser we can prepare a large number of diverse oscillator arrays just by scratching the top mirror with a prescribed pattern. This spatial patterning of the reflectivity can generate arrays of e.g. independent laser oscillators if the scratch pattern is formed as multiple crossed stripes with 10μm strips center to center and 3μm strip width, but also arrays of strongly or weakly coupled laser oscillators according to the scratched pattern characteristics.

The typical lasing modes of these coupled laser arrays are characterized by having a zero field amplitude in the inter laser spacings (the lower reflectivity zones) in order to reduce the modal loss. But how these modes are generated? The VCSEL structure does not support guiding by index of refraction of by the gain profile. We demonstrate how the modes of each oscillator are generated via "aperture guiding" and what are the coupling mechanisms which enable the generation of phase locked arrays. We shall demonstrate the results of coupling of large number of VCSELs (~500).

Conventional edge emitting lasers can be coupled to give a 1D phase locked array. The two-dimensionality of the arrays of VCSELs has a crucial role in stabilizing the coherency over large areas and much better defect immunity relative to the 1D case. The second dimension also was instrumental for the design of radiation modes with special symmetries, taking into advantage symmetries in two dimensions. We shall demonstrate results of arrays based on rectangluar grid, annular grids, triangular grids and their special features.

Abstracts

STUDY OF EXCITON LOCALIZATION BY MICROWAVE ELECTRON HEATING IN GaAs/AlGaAs QUANTUM WELLS

B. Ashkinadze, E. Cohen, Arza Ron
Physics department and solid state Institute, Technion-Israel Institute of Technology, Haifa 32000, ISRAEL

L. Pfeiffer
AT& T Bell Laboratories, 600 Moutain Ave., Murray Hill, NJ 07974, USA

We studied the modulation of the photoluminescence (PL) and its excitation (PLE) spectra of undoped *GaAs/AlGaAs* multiple quantum wells (MQW) by microwave radiation in the temperature range of 2-10K.

The MQWs (well widths of 50-70A and x=0.34) are selectively excited and are simultaneaously irradiated by 35 GHz radiation with power levels of 10-200mW. The modulated PL spectrum consists of a negative part in the low energy tail of the (e1:hh1)1S exciton band and a positive part in the high energy exciton band. The modulated PLE spectra follow the exciton density of states. Both the modulated PL and PLE spectra are linearly dependent on the microwave power. We interpret these results by the following model:

The laser creates both excitons and free carriers even for excitation below the bandgap. The carriers are heated by the microwave field and subsequently impact the localized excitons.

This results in a decrease in their PL and in an increase in the (higher energy) delocalized exitons PL. The rate equations for transfer between these two types of excitons yield an estimate of the electron-exciton scattering parameters.

Acknowledgement: This work was supported by the IS-US Binational Science Foundation (BSF) and by the Technion Alexander Goldberg Memorial Research Fund. It was done in the Center for Advanced Opto-electronics Research.

Quantum Beats of Excitons and Bi-excitons in GaAs Quantum Wells

S. Bar-Ad and I. Bar-Joseph

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

Quantum beats spectroscopy is an evolving experimental technique for the determination of dephasing rates and small energy splitting. In this paper we report on new kind of absorption quantum beats, between excitons and bi-excitons, observed when oppositely handed circular polarizations for the pump and probe are used.

Our experiments were conducted at 4K, in a 5T magneto-optical cryostat, using a standard pump-probe setup with a time resolution of $\sim$ 1 ps. The differential absorption signal, for the case of oppositely handed circular pump and probe polarizations, tune to just below the heavy hole (hh) exciton energy, exhibits deep temporal oscillations. The observed oscillations have a period of 1.6 ps independent of small detuning and of laser intensity (0.3 to 30 W/cm^2). This observation rules out explanations related to optical nutation. The fact that the oscillations exist only for the case of pump and probe of opposite circular polarizations is an indication that they are of bi-excitonic origin. We proposed that excitons created by the pump renormalize the available states for absorption of the probe, from excitonic states to lower energy bi-excitonic states. The two energy terms in the resulting polarizability beat at the difference frequency, which is the bi-exciton binding energy. This interpretation gives a binding energy of 2.7 meV, in agreement with recent photoluminescence measurement in narrow QW, but larger than theoretical estimates and reported values for wide QW. A gradual suppression of the oscillations and increase of their period in a magnetic field of up to 4T, and their disappearance as the temperature is increased above $\approx$60K, further substantiate our interpretation.

In order that beating would be observed, phase coherence must be preserved. The fast damping of the oscillations, within $\sim$ 5 ps, therefore gives the dephasing rate between the excitonic and bi-excitonic states. This also implies that spin orientation should be preserved for the duration of the oscillations. Indeed, direct measurements of spin orientation have shown that no substantial spin relaxation occurs on this time scale. We cleary resolved two decay time constants, 50 ps and 120 ps, which we associate with the spin relaxation of hh and electrons, respectively.

IR FIBEROPTIC NON-UNIFORM TEMPERATURE DISTRIBUTION MONITORING

E.Belotserkovsky, A.Zur and A.Katzir

School of Physics and Astronomy, Tel-Aviv University,
Tel-Aviv,69978,Israel

The problem of non-uniform temperature distribution monitoring is very important in many applications. Infrared(IR) fiberoptic radiometry of thermal surfaces offers several advantages over refractive optics radiometry; it does not need a direct line of sight to the controlled thermal area and offers high accuracy with high resolution.

The developed theoretical model of non-uniform temperature distribution monitoring process allows to predict the sensor output functions and their dependence on fiber location relative to the controlled area and to determine the expected error. Theoretical analysis of the process showed that in order to obtain a more accurate determination of temperature and high resolution, the fiber must be situated as near as possible to the controlled thermal area.

We developed a fiberoptic radiometric system based on $AgBr_xCl_{1-x}$ fibers for monitoring of non-uniform temperature distributions. Silver halide fibers were chosen because they are highly transparent in the IR wavelength range of 2 to 20μm, flexible, non-toxic and insoluble in water. The system consisted of an IR detector, chopper, lock-in-amplifier and digital voltmeter. $AgCl_{0.5}Br_{0.5}$ fibers with the following parameters were used: refractive index n=2.0; diameter D=0.9mm; attenuation α=(0.2-0.3)dB/m. The distal end of the IR fiber faced an area with a non-uniform temperature distribution and could be displaced both parallel and perpendicular to it.

Glass and metal samples were non-uniformly heated(e.g. using a focused CO_2-laser beam) and the surface temperature distribution was monitored. Experimental results showed good agreement with the theoretical model. The developed system allows to monitor non-uniform surface temperature distribution with accuracy $\Delta T = \pm 0.1\,^{\circ}C$. This fiberoptic radiometer will be extremely useful for temperature scanning systems, laser material processing and laser surgery, and microwave heating.

Topic of research: Infrared Fibers, Fiberoptic Sensors.

Time of Flight Spectroscopy of Electron Transport in Superlattices - From Band Transport to Stark Localization

G. Cohen and I. Bar-Joseph

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

The application of an electric field normal to the layers of a superlattice (SL) breaks the continuous mini-band into a set of discrete levels, known as Stark ladder, and localizes the electron wave function, which is extended throughout the SL at zero field, into a limited number of neighboring sites. In this paper we use time resolved differential absorption spectroscopy to investigate the electron transport through a SL subjected to localizing electric field. We show that the traversal time through the SL increases at moderate fields and then decreases at large fields. We interpret this behavior as an evidence for a Wannier-Stark localization.

When a reversed biased p-i-n junction is illuminated by a short laser pulse - a strong differential absorption signal appears, which originates from a screening of the external electric field. The rise time of the signal is related to the arrival time of the electrons to the n electrode and the fall time to the diffusion of the voltage signal in the plane of the contacts. In our experiment we implement this technique to the study of vertical transport in a GaAs/AlGaAs SL. The sample we studied is composed of 100 undoped 30 $\AA$ GaAs wells separated by 30 $\AA$ $Al_{0.3}Ga_{0.7}As$ barriers which form the intrinsic region of a p-i-n junction. The wafer was processed to form mesas with electrical contacts, and the substrate was removed to allow transmission measurements. Clear Stark ladder peaks were observed in the absorption spectrum both at low and at room temperature. Various excitation energies were investigated with a time resolution of $\sim$ 1 ps.

The rise time of the signal at low voltage is $\approx$ 7.5 ps, implying an electron velocity $\sim 10^7$ cm/s, of the order of the saturation velocity in bulk GaAs. At higher voltages the rise time become longer, up to 13 ps. Transmission measurements show that at these voltages Stark localization takes place. At very high voltages the rise time becomes short again due to the finite height of the barrierswhich allows electrons to escape from the wells either by tunneling through the narrow tilted barriers or hopping above them.

Spatial Squeezing of Diffusive Light

N. Davidson and A.A. Friesem

Department of Electronics, Weizmann Institute of Science

Rehovot 76100, Israel

ABSTRACT

We present the spatial squeezing of diffusive light as a classical, ray optics, analog to the squeezed states of quantum theory. The squeezing is related to an uncertainty relation between the minimal spatial dimensions of the concentrated diffusive beam in two orthogonal directions, which is induced by the second low of thermodynamics. Our experiments with unisotropic diffusive light concentration confirms the possibility of such spatial squeezing.

DEPHASING OF LOCALIZED AND DELOCALIZED EXCITONS IN GaAs/AlGaAs MULTIPLE QUANTUM WELL STRUCTURES

A. Frommer, E. Cohen and Arza Ron, Solid State Institute, Technion, Haifa 32000, Israel.
and
L. Pfeiffer, AT&T Bell Laboratories, Murray Hill, NJ 07974, U.S.A.

We have studied the LO-phonon resonant Raman scattering (RRS) and the optical alignment of selectively excited excitons in undoped $GaAs/Al_xGa_{1-x}As$ multiple quantum wells (MQW). The wells were either 50 or 70$\AA$ wide and the barriers were 200$\AA$ wide with $x = 0.33$ or 1. The scattering is due to a strong enhancement by the (e1:hh1)1S excitons. The RRS profiles (scattering intensity vs exciting laser energy) are analyzed in terms of the inhomogeneously broadened exciton density of states and the energy dependent exciton damping. The profiles are well accounted for by using a damping function which is very small in the low energy tail of of the exciton band and increases abruptly near the center of the band. This result can be viewed as an indication for two regimes of exciton dephasing by in-plane scattering: A low-rate scattering for excitons localized by interface potential fluctuations and a high rate for delocalized excitons. The optical alignment results show that there are exciton states which scatter into lower energy states by acoustic-phonon emission processes which preserve the exciton phase. In addition, phase-preserving exciton relaxation between its 2S and 1S internal states is clearly observed.

Acknowledgment: The research at the Technion was supported by the U.S.- Israel Binational Science Foundation (BSF) Jerusalem, Israel and was carried out in the Center for Advanced Opto-Electronics Research.

INTERSUBBAND TRANSITIONS IN MODULATION DOPED GaAs/GaAlAs QUANTUM WELLS

Y. Garini, E. Cohen, E. Ehrenfreund and Arza Ron
Department of Physics and Solid State Institute
Technion-Israel Institute of Technology Haifa 32000, Israel

K-K. Law, J.L. Merz and A.C. Gossard
University of California, Santa Barbara, CA. 93106, U.S.A.

We studied a series of modulation-doped $GaAs/Al_{0.34}Ga_{0.66}As$ multiple quantum wells (MQW) by photo-induced, intersubband absorption (PIA) as well as by photoluminescence (PL) and its excitation (PLE).
The doping levels were 10^{10}, 10^{11}, 10^{12} electrons/cm^2 and undoped MQWs (all with a 55Å well width and 100Å barriers). At low temperatures, all doped MQWs show the e1-e2 intersubband transition of the electronic plasma. PIA between these subbands is observed only for the undoped and the $n = 10^{10}$ MQWs. The PIA dependence on the (interband) excitation energy and intensity is studied and compared with those of the e-h pair (exciton) radiative recombination.

The observed PIA spectra and their dependence on excitation power are analyzed in terms of the following model: The intersubband transition involving excitons (namely, the (e1:hh1)-(e2:hh1) transition) has a much higher oscillator strength than the bare electron (e1-e2) transition. Therefore, as long as excitons exist in the n-doped MQW, PIA is observed. For the n=10^{11} and 10^{12}, the excitons are completely screened out. We show that the photo-generated electrons in these highly doped MQW undergo fast relaxation processes from E_F into lower states in the Fermi sea, which are vacated by e-h recombination. The rate equations which are based on this model account well for observed PIA and PL dependence of excitation power.

Acknowledgment : This work was supported by the US-Israel Binational Science Foundation (BSF) and was done in the Center for Advanced Opto-Electronics Research.

Implementation of Bipolar Optical Neural Network using Feedback

O. Gila, A.A. Friesem and I. Shariv

Department of Electronics, Weizmann Institute of Science

Rehovot 76100, Israel

ABSTRACT

The fact that most neural networks models assign bipolar values to the interconnection weights and to the neurons causes difficulties in the optical implementation of neural networks. The common solutions to the problem involve dual channel architectures and electronic subtractions. These solutions generally lead to cumbersome and complicated architecture. We present a relatively simple implementation that involves only a single channel and no subtraction. The bipolar neurons are implemented by an array derived from a polarization modulating spatial light modulator, whereas the interconnects are realized as an array of subholograms. Our implementation method is sufficiently general, so it can be used for many neural network models. We illustrate it experimentally for a three layers, feed-forward, all-optical neural network.

PACS No. 42.80.V - Optical computing techniques.

Observation of Field-induced extra resonances

Nadav Horesh and Yehiam Prior

Department of Chemical Physics, Weizmann Institute of Science, Rehovot Israel, 76100

The interpretation of nonlinear spectroscopy, in general, and Four Wave Mixing (FWM) experiments in particular, is mostly done by using the perturbation expressions for the nonlinear susceptibilities derived in the early sixties by Bloembergen and coworkers, which were very successful in handling resonances lineshape. The perturbation expansion, however, holds only for a weak nonsaturating laser fields. Recently, a nonperturbative approach to FWM has been developed for arbitrarily strong input fields[1]. The theory predicts the existence of strong field induced extra resonances, and recovers the analogous pressure-induced resonances[2].

When a pump is strong, and the difference frequency between two input fields matches the excited state separation (coupled by a two-photon transition), an extra resonance is observed in addition to the ordinary resonances. The experimental results show how the field-induced resonances evolve from the Rabi side-bands induced by the pump, and as such, they are related to the Autler-Townes doublet. The resonances have been demonstrated, and several strong-field phenomena were identified: Stark shift of resonance position, saturation and other nonlinear effects. Several spectral feature are found to be in a qualitative agreement with the calculated results[1], while others are not fully understood.

The nonperturbative theory and experimental results will be discussed. The need for extension of the "ideal" theoretical model of strong field interactions to account for real systems will also be pointed out.

References

[1] A. M. Levine, N.Chencinsky, W. M. Schreiber, A. N. Weiszmann and Y. Prior, Phys. Rev. A**35**, 2550 (1987); N. Chencinsky, W. M. Schreiber, A. M. Levine and Y. Prior, Phys. Rev. A**43**, 2839 (1990)

[2] Y. Prior, A. R. Bogdan, M. Degenais and N. Bloembergen Phys. Rev. Lett.**46**, 111 (1981)

Fiberoptic Evanescent Wave Sensors

[1]A.Messica,[1]A.Katzir,[2]U.Schiessl,[2]M.Tacke,[3]R.Kraska,[3]K.Taga,[3]R.Kellner

1.School of Physics and Astronomy,Tel Aviv University,Tel Aviv 69978,Israel.
2.Fraunhofer Institute fuer Physikalische Messtechnik,Freiburg,Germany.
3.Institute for Analytical Chemistry,Technical university of Vienna,Austria.

Abstract

Key words | Evanescent wave,Attenuated total internal reflection,Infrared fibers,Tunable infrared Sources.

Fiberoptic evanescent wave sensors (FEWS) are based on the attenuated total internal reflection (ATR) mechanism. Infrared (IR) transmitting silver halides unclad fibers were used as direct sensors and as indirect sensors with different tunable IR sources.

Direct fiberoptic evanescent wave sensor is based on the interaction of guided IR radiation and a sample in contact with the surface of the fiber. Such a sensor - few centimeters long - was used to record spectra of liquids (such as amyl acetate) and gases (such as sulfur hexaflouride) and to monitor gas pressure changes in the range of 60 - 760 torr with a precision better than 5%. Tunable IR laser sources such as $PbS_{0.6}Se_{0.4}$ or $PbSn_{0.03}Se_{0.97}$ diode lasres or a CO_2 laser were incorporated with the above mentioned sensors.

Indirect fiberoptic evanescent wave sensor is a coated fiber where the interaction of the guided IR radiation with the sample takes place through the coating. We used a polyethylene coated fiber to measure concentrations of water pollutants. The coating served as a buffer which rejected water molecules from the vicinity of the fiber surface but attracted pollutant molecules to the region near the fiber surface , thus enhancing evanescent absorption.
A concentration of 5 ppm of Chlorobenzene in water was the sensor detection limit with a precision better than 10%. A Fourier Transform Infrared (FTIR) spectrometer was used as a tunable IR source with this sensor.

Silver halide based FEWS are water non soluble and non toxic,they feature IR wideband transparency and low intrinsic absorption. They are suitable for monitoring and controlling of processes in both science and industry. FEWS inherently posses a non destructive feature and thus may serve as an important testing tool in many applications.

OPTICAL STUDIES OF MIXED SILVER-HALIDES: SINGLE CRYSTALS, POLYCRYSTALLINE MATERIALS AND OPTICAL FIBERS.

L. Nagli, R. Chen, A. Katzir, N. Kristianpoller, L. Oster* and A. Shmilevich
School of Physics and Astronomy
Tel Aviv University, Ramat Aviv
Tel Aviv 69978, Israel

Recent studies have shown that mixed silver halides are useful for IR optical fibers, due to their optical and mechanical properties.[1]

Our present investigations have shown that the threshold of laser induced breakdown (LIB) is about $10^9 W/cm^2$ for certain compositions (x) of high-quality $AgCl_xBr_{1-x}$ single crystals, but decreases to $10^7 W/cm^2$ in polycrystalline fibers made from the same material. This decrease in the threshold of the LIB may be due to casual impurities and to defects induced by heating and pressure, applied to the crystals during preparation of the fibers by extrusion. Therefore effects of mechanical pressure and of thermal pretreatment as well as of impurities on optical properties on these materials were investigated. Methods of optical absorption and of luminescence were applied for these investigations.

Deformation induced by mechanical pressure at room temperature did not cause any noticeable changes in the absorption and luminescence properties of these crystals. These properties were, however, markedly affected by heating to above 200^0C in various atmospheres. Our results also show, that the luminescence of the mixed as well as of nominally pure AgBr crystals is strongly influenced even by the very small concentrations of impurity ions, which can not be detected by absorption measurements. Measurements of emission spectra showed that the luminescence of pristine $AgCl_{0.45}Br_{0.55}$ as well as of nominally pure AgBr crystals is dominated by emission bands which are attributed to iodide impurities. This was more pronounced in the photoluminescence (PL) than in the radioluminescence (RL).

Annealing of the mixed AgCl-AgBr crystals to 300^0C in a dry N_2 atmosphere caused the disappearance of the iodide emission band and the appearance of a different band, which is ascribed to an intrinsic process of radiative decay of a self trapped exciton in AgCl. This assumption is supported by our measurements of the temperature dependence of the emission as well as by the excitation spectra of the PL bands. These results appear to be of importance when preparing optical fibers from mixed AgCl-AgBr crystals by extrusion.

References

1. F. Moser, N. Barkay, A. Levite, E. Margalit, I. Paiss, A. Saar, I. Shnitzer and A. Kat zir, Proc. SPIE, 1228, 128, (1990).

Surface Plasmons in Multi-Layer Structures

Y. Noifeld, A.A. Friesem and D. Rosenblatt

Department of Electronics, Weizmann Institute of Science

Rehovot 76100, Israel

ABSTRACT

Surface plasmons can exist in metallic multi-layer structures. We have developed tools for solving the electromagnetic fields associated with these surface plasmons. For a structure with three layers there are two surface modes (plasmons), whereas for a structure with four layers there are three modes; these modes can be excited with the proper phase matching conditions. In these multi-layer structures, one of the modes is of potential practical interest because of its long propagation distance.

We present some dispersion relation curves for surface plasmons in the case of three and four layered structures and illustrate the coupling to there plasmons using grating.

INTERSUBBAND TRANSITIONS IN InGaAs/InP QUANTUM WELLS STUDIED BY PHOTOMODULATION SPECTROSCOPY

J. Oiknine-Schlesinger, D. Gershoni, E. Ehrenfreund
Physics department and solid state Institute, Technion-Israel Institute of Technology, Haifa 32000, ISRAEL

D. Ritter, M.B. Panish, and R.A. Hamm
AT& T Bell Laboratories, 600 Moutain Ave., Murray Hill, NJ 07974, USA

We report on a study of the infrared absorption and photoinduced absorption in unintentionnaly doped ($\simeq 10^{16} cm^{-3}$), lattice-matched $InGaAs/InP$ multiple quantum well structures. A clear intersubband absorption is observed and it is assigned to the n=1 to n=2 electronic transition.

For these unintentionally n-doped quantum wells, the oscillator strength for the transition observed in absorption is $\simeq 1$. The photoinduced absorption in this system saturates at excitation density which is comparable to the background impurities density within the quantum well plane, with an oscillator strength of $\simeq 1$.

We suggest that the CW measured photoinduced absorption in this doped system originates from long-lived photoelectrons trapped on impurity centers within the quantum well.

Acknowledgement: This work was supported by the IS-US Binational Science Foundation (BSF) and by the Technion Alexander Goldberg Memorial Research Fund. It was done in the Center for Advanced Opto-electronics Research.

Thermal image guide with bundled silver halide crystalline fibers

Idan Paiss and Abraham Katzir

Raymond and Beverly Sackler Faculty of Exact Sciences

School of Physics and Astronomy

Tel Aviv University, Tel Aviv, Israel 69978

Abstract

Flexible silver halide optical fiber bundles (multifibers) with 70 to 2000 guiding elements were fabricated by extrusion method. Such devices transmit in the mid-IR spectral region (4-20 μm), and thus suitable for room temperature thermal image delivery. These elements are useful for temperature mapping in areas difficult to access and they have potential uses in medical, industrial, scientific and military applications. The properties of these novel optical elements, their fabrication and their imaging capability are discussed.

RESONANT GRATING STRUCTURES

D. Rosenblatt, A. A. Friesem

Department of Electronics, Weizmann Institute of Science

Rehovot 76100, Israel

ABSTRACT

Zero order dielectric gratings have a period shorter than the wavelength of the incident light and have no diffracted orders that propagate in free space. Such gratings are essentially "transparent" to the incident wave, but under the proper conditions layered zero order grating structures exhibit a resonance phenomena in which the there is a sharp change in the reflectance of the structure as a function of wavelength. This resonance effect is due to a multiple scattering phenomena closely connected with the excitation of a guided mode in the layered structure. The origin of the multiple scattering phenomena and the relationship between the grating parameters and the wavelength dependance of the resonance will be described.

QUANTUM WELL EXCITON DEPHASING - FREQUENCY AND TIME DOMAIN MEASUREMENTS

A. Sharon, H.H. Yaffe and Yehiam Prior
Department of Chemical Physics
Weizmann Institute of Science
Rehovot Israel, 76100

The problem of exciton dephasing in Quantum Wells has attracted attention over the last few years[1]. We report measurements of the dephasing rates for different exciton densities and wavelengths across the heavy hole exciton inhomogeneous absorption line in GaAs/AlGaAs Quantum Wells at 4.2 degrees Kelvin. The experimental techniques used are Nearly Degenerate Four Wave Mixing and Hole Burning in the frequency domain, combined with Time Delayed Four Wave Mixing in the time domain[2].

It is shown that the dephasing time is decreasing with the increase of the exciton energy through the absorption line, with a sharp decline near the middle. For low exciton density in the high energy side of the absorption line the transverse dephasing and spectral diffusion times are in the range of 1-2 psec, while the dephasing time of the 'bound' excitons in the low energy side is much longer $\sim$ 50 psec. For 'free' excitons the dephasing time was found to be identical to the spectral diffusion time, making the elastic scattering contribution negligible. Measurements for different exciton densities in the range $10^8 - 10^{10} \frac{excitons}{cm^2}$ are shown, shedding light on saturation effects, and on exciton exciton interactions. Strong saturation effects cause a drastic decrease in the dephasing time ($\sim$ 1.0 psec) of the 'bound' excitons in the low energy side of the exciton absorption line, while for the 'free' high energy excitons the saturation effect was less significant.

The short dephasing times are better measured in the frequency domain, while the longer ones may be extracted from the time domain echo signals. The relative convenience of the two methods, and practical limitations on their use are also discussed. The work is supported by the Israel Academy of Science, Fund for Basic Research.

1. M.D. Webb, S.T. Cundiff, D.G. Steel, Phys. Rev. Lett., 66, 934 (1991).
2. H.H.Yaffe, Yehiam Prior, J. Harbison and L. Florez, Exciton and Biexciton dephasing in GaAs QW's: Polarization effects, Phys.Rev.Lett. (submitted)

Field Correlations Measurements in Multi-Mode Diode Lasers

R.Zaibel and Yehiam Prior
Department of Chemical Physics, Weizmann Institute of Science, 76100 Rehovot, Israel

Stochastic processes in single mode diode lasers have been intensively studied in the last decade. In most cases the noise source is assumed to be δ correlated in time, and the resulting spectrum has a Lorentzian line-shape for the central component with Relaxation Oscillations side-bands at typical frequencies of a few GHz. In the theoretical treatment a Langevin noise source, is added to a set of coupled rate equations for the complex field and the charge density [1].

We report the measurement of Field Correlation Function (FCF) of a gain guided, temperature controlled, GaAs multi-mode diode laser . This was done using an interferometric technique in which the contrast of the interference pattern is recorded as a function of the relative time delay between the arms of the interferometer. These functions consist of sharp spikes modulated by a slower "envelope". The envelope reflects the field correlation of the individual modes, while the structures between spikes, are function of the intensity ratio of the modes. The functional form of the FCF obtained for any mode structure was *always* a Gaussian.

The non-exponential decay of the FCF is a signature of a non-Markovian noise process. In particular, a Gaussian function can be obtained under a correlated phase jump process [2]. The implication of this observation to diode laser theory is that the Langevin noise sources cannot be considered to be δ correlated, but they should have a finite correlation time.

In another set of experiments, we measure FCF of an index guided GaAs laser diode. Here, the number of modes affects the damping of the Relaxation Oscillations as predicted recently by Gray and Roy[3].

References

1 C.H.Henry ,IEEE J. **QE-19**, pp.1391, (1983).

2 A.G.Kofman, R.Zaibel, A.M.Levine and Yehiam Prior Phys.Rev.A, **41**, pp.6434, (1990).

3 George Gray and Rajarshi Roy Phys.Rev.A, **40**,pp.2452, (1989).

Resonant Raman Scattering by LO - phonons in $GaAs/Al_{0.32}Ga_{0.68}As$ Bragg Confining Structures

M.Zahler, E.Cohen, J.Salzman
Solid State Institute, Technion-Israel Institute of Technology, Haifa, Israel
and L.Pfeiffer, A.T.T Bell Laboratories Murray Hill, NJ 07974 U.S.A.

We studied the resonant Raman scattering (RRS) in undoped $GaAs/Al_{0.32}Ga_{0.68}As$ doubly periodic superlattices (SL) at T=2K. These structures consist of SL sections (5 periods) which are separated by spacers made of the same material as the SL barriers. In addition to the SL - confined e1, hh1 and lh1 subbands, there are subbands which correspond to Bragg confined (BC) e and h states in the spacer layers. The RRS profiles (scattering intensity vs. excitation energy) of the BC structures show pronounced peaks in the spectral range of the $(e_B : hh_B)$ exciton band. We compared this profile with that obtained for a SL which does not have the spacers and its period is identical to the BC SL sections. No RRS was observed in this spectral range for the regular SL. On the other hand, the RRS profiles of these two types of SLs are identical in the (e1:hh1) exciton spectral range. We analyze the RRS profile in terms of a strong excitonic enhancement in the $(e_B : hh_B)$ spectral range. The intensity of the RRS is dependent on the degree of Bragg confinement, and the profile is shown to reflect the exciton damping due to in-plane scattering processes. We also show that since the (e1:hh1) and $(e_B : hh_B)$ RRS arise from particles confined in different parts of the BC structure, their LO - phonon spectrum, observed by RRS, is distinctively characteristic of each part.

Acknowledgments: This work was supported by the US - Israel Binational Science Foundation (BSF), and was done at the Center for Advanced Opto - Electronics Research.

11. Medical Physics

Invited Lectures

THE MECHANISM AND EFFICIENCY OF SECOND GENERATION PHOTOSENSITIZERS FOR PHOTODYNAMIC THERAPY OF CANCER

Benjamin Ehrenberg, Adina Lavie, Leonid Roitman and Zvi Malik*

Departments of Physics and Life Sciences*
Bar Ilan University, Ramat Gan 52900.

Photofrin II (PF-II) and hematoporphyrin derivative (HPD) are used, experimentally, as selective photosensitizers of malignant cells. Their absorption of tissue-penetrating, long wavelengths, of light is weak, and there is a quest for sensitizers with strong absorption in the range 600-900 nm. We compared the photosensitization mechanism and kinetics of these sensitizers with our newly-introduced zinc and magnesium-tetrabenzoporphyrin, and with expanded-ring texaphyrins. These new sensitizers have much stronger absorption coefficients in the above-mentioned range, and can be sensitized with HeNe or diode lasers. The spectroscopic properties of these sensitizers and the energy conversion yields were determined. The sensitization of simple targets in homogeneous solutions, as well as of cells of various types were carried out. *In vivo* experiments also show good efficiency for the new sensitizers, and thus they are very promising for photodynamic therapy of cancer.

Fetal Heart Rate Detection from a Combined Fetal-Maternal ECG

J. Karin* M.Hirsch+ S.Akselrod*

***The Abramson Institute of Medical Physics, Sacler Faculty of Exact Sciences, Tel Aviv University and +Department of Obstetrics and Gynecology, Bellinson Medical Center.**

Detection of a single repetitive signal from data composed of multiple different repetitive signals is a common problem in the measurement of physical and physiological phenomena. Fetal heart rate is the primary non invasive indication of the fetal well-being before and during labor, and is of great importance to the medical expert. We have implemented an algorithm for the detection of fetal heart rate, which utilizes only two electrodes.

The electrical signal picked up by electrodes on the abdominal area of a pregnant woman is composed of three repetitive signals (maternal and fetal heart beats and maternal breathing activity), in addition to random noise from skeleton muscle activity and electrical interference from external sources. Since we have only one "true channel" of data, we had to use a variety of filters and derivatives of that data in order to separate specific components of the composed signal into different artificial channels.

The task of separating the fetal beats from the other components is performed via the use of first and second derivatives of the data simultaneously, and not with the original signal itself. We subtract the morphology of the maternal heart beat from the derivatives of the combined signal and filter out all frequencies above 25 Hz. The use of first and second derivatives in the subtraction process was motivated by two main reasons:

1. Elimination of low frequency variations originated from maternal breathing movements.
2. Splitting the data into two derivatives. This enabled us to process each derivative separately thus making the subtraction process of the maternal contribution less vulnerable to computation errors. If the subtraction in one channel is not exact, the second independent channel may compensate for this lack of accuracy.

A third channel, used to locate a maternal heart beat, is obtained by taking the second derivative and the use of a different filter. The data in that channel is used to point out the presence of a maternal beat and initiate the subtraction process in the other two channels.

The algorithm is currently implemented in an experimental system we use at the Medical Physics Center at TAU. It enables us to obtain a fetal ECG signal and an accurate fetal heart rate measurements.

Oral Presentations

Effect of Radial Activation on LV-Mechanics

Eran Hirshowicz[1], Meir Lewkowicz[2], Solange Akselrod[1]

1. School of Physics and Astronomy, Tel Aviv University, Tel Aviv 69978 Israel.
2. Department of Physics, Bar-Ilan University, Ramat-Gan 52900 Israel.

Employment of a fluid-fiber-collagen description of the myocardium has recently been successfully applied to yield the local behavior of the stress - and strain distribution, tissue pressure, etc, as well as global indices like LV pressure, systolic and diastolic pressure-volume relations, ejection fraction etc. The LV was treated as a thick-walled cylinder of finite length. The myocardial activation sequence was disregarded, and the whole myocardium was considered to be activated instantaneously.

In this work we consider the effect of the previously neglected radial activation. We investigate the case of a radial dependent conduction velocity of the activation wave. The analysis shows that introduction of the finite conduction velocity bears only a minor effect on LV-mechanics.

Another result found was that the myocardial fiber-tension near the endocardium is higher and of longer duration than at the epicardium, which might explain the higher and longer plateau of the action potential at the endocardium vs epicardium.

An analysis of radially distributed ischemiae with various depths showed that oxygen deficiency near the midwall is of more severity than near the inner or outer wall.

Formation of Cavities in Liquids using a CO_2 Laser

R. Wallach-Kapon, S. Akselrod and A. Katzir
Abramson Institute of Medical Physics, Sackler Faculty of Exact Sciences,
Tel Aviv University.

In a previous paper we described the formation of stationary cavities in water using pulsed laser radiation as a means of performing treatments in liquid environments. The depth of the cavity which is formed by the laser is determined by the balance between the processes which tend to fill the cavity and those which enlarge it. In the initial model no assumption was made concerning the actual process which is responsible for liquid removal. In a series of experiments we show that liquid escapes from the cavity site both in the form of vapor and in the form of small water droplets. This suggests that the process is a complex one which involves both rapid heating of the liquid and an acoustic process which is most likely secondary to the thermal one. The surface of the liquid can cool through diffusion, convection radiation and evaporation whereas liquid which is below the surface cannot evaporate thus causing a pressure build up under the surface. This pressure build up causes rapid expansion of the liquid which causes a bubble to be formed and explode. As the bubble explodes liquid emerges from the cavity in the form of water droplets and at the same time the bubble in the liquid expands, thus the energy which is required to remove a given volume of liquid is considerably less than that which would be required to evaporate the same mass of liquid. Measurement of the mass of escaping water droplets to escaping vapor shows that the ratio is highly dependent on the temporal shape of the pulse. As the pulses become "short and high" this ratio increases, which is consistent with the above description.

It is generally accepted that using trains of laser pulses of short duration and high peak power reduces the thermal damage caused to the volume surrounding the incision made by the laser. In another study we showed that irradiation of tissue under water reduces can further reduce this layer of thermally damaged tissue. Thus we conclude that using pulsed radiation of short pulse duration and high frequency to irradiate tissue which immersed in water is a simple means of reducing thermal damage caused to tissue during the irradiation process.

Estimation of the Effect of Vapor and Plasma Formation on the Intensity of the CO_2 Laser Beam during Laser Irradiation

Y. Linenberg, R. Wallach-Kapon, A. Katzir and S. Akselrod

Medical Physics, School of Physics and Astronomy, TAU

When tissue is irradiated by a CO_2 laser beam at energies higher than 25 J/cm^2, plasma starts to form, partly shielding the tissue. At lower energies, water vaporized from the tissue has similar effect. In the experiment hereby presented, water is irradiated under conditions which allow the cavity effect to occur. The cavity enables us to measure the effect of vapor on the intensity of the beam which crosses the water layer, in order to obtain an estimate of the intensity loss. Three effects were found while analyzing the cavity formation. The cavity is not steady but has a frequency of its own. This frequency is lower by an order of magnitude than the laser repetition rate. Finally, as the power per pulse increases, the effect of the vapor on beam intensity becomes stronger. The first two effects may be significant when choosing parameters for laser surgery under fluid. The estimate which was derived for the intensity loss due to vapor formation is to be included in our computerized model of laser-tissue interaction, which has been developed to allow the optimization of the ablation/damage ratio.

Influence of Moisture on Pyroelectric Properties of Bone

Vadim E. Khutorsky and Sidney B. Lang
Department of Chemical Engineering
Ben-Gurion University of the Negev, Beer Sheva, Israel

It is well-known that pyroelectricity is a universal property of all biological systems [1]. However, the source of pyroelectricity in biological tissue has not yet been determined, although it is assumed that it is based upon permanent polarization. The difference between the behavior of fresh and dried epidermal tissues in plants and animals was considered previously [2], but there have been no detailed investigations of the influence of moisture on pyroelectric properties of biological materials. Such a study has importance in determining the influence of moisture on mechanoelectric or piezoelectric transduction in bone [3], properties closely related to the polarization of the media.

In this work, the voltage and time dependencies of the pyroelectric properties of wet and dry bone (turkey femur) were investigated using the dynamic pyroelectric method of Chynoweth. The experiments used a periodically-modulated laser beam as an energy source and a lock-in amplifier to measure the pyroelectric response. The major results were as follows.

The pyroelectric current of virgin bone had both real and imaginary components. The magnitude of the response was almost the same, regardless of which sample electrode was irradiated with the laser beam, but the signs were opposite. Pyroelectricity was observed for samples cut with major surfaces either normal to or parallel to the longitudinal axis of the bone. The pyroelectric current increased up to several orders of magnitude when a bias dc electric field of 1000 V/cm was imposed. When the bias field was switched off, a pyroelectric current in the opposite direction with a relaxation time of tens of hours was measured. There was also a slow relaxation of a dc current with a polarity opposite to that of the bias field. In conductivity measurements, the dc current varied nonlinearly as the 1.5 power of the voltage.

When the samples were stored in vacuum at 100o C for one hour, they lost between 8 and 15% of their weight and both the pyroelectric coefficient and the dc conductivity decreased by several orders of magnitude. The dried samples showed a very small pyroelectric current external field dependence. The weight, pyroelectric current and conductivity were restored to approximately original values after storing the dried samples in water.

We conclude that the pyroelectric properties of bone depend strongly on the moisture content and that the polarization in wet bone is non-uniform. The polarization appears to be induced by an internal field at the interfaces of the solid matrix and the fluid which fills the pores. We believe that the behavior depends upon the solid-fluid interfaces which influence the electrical characteristics.

1. S.B. Lang, Ferroelectrics 34, 3 (1981).
2. M. Simhony and H. Athenstaedt, Biophys. J. 29, 331 (1980).
3. D.A. Chakkalakal, J. Mater. Res. 4, 1034 (1989).

Retinal Dynamics Using Laser Intereference With A Pulsed Infrared Source.

Gad Peleg , Aaron Lewis, Hadassah Laser Center, And Division Of Applied Physics, The Hebrew University, Jerusalem.

A low energy Nd:Yag laser at 1.064 micron, was used to produce inreference fringes from a cow's eye in vitro. The laser was run at a repetition rate of 30 Hz with a pulse width of 130 n.s. The fringes produced by this low energy laser are sensitive to the separation (distance) betweeen the cornea and the retina. Thus, our approach can provide information on the dynamics of the retinal layer, when frames from different laser pulses are compared for different conditions of the eye.

The short pulses of the Yag provide sufficient stability for dynamic measurement to be made. The near-infrared wavelength of the laser protects the photosensitive cells, and changes in the retina can be inspected at video rates.

12. General Physics

Abstracts

MEASUREMENTS, ERRORS, AND NEGATIVE KINETIC ENERGY

Yakir Aharonov
School of Physics and Astronomy, Tel-Aviv University and
Department of Physics, University of South Carolina,
Columbia, SC, U.S.A.

Sandu Popescu
School of Physics and Astronomy, Tel-Aviv University

Daniel Rohrlich
Racah Institute of Physics, Hebrew University of Jerusalem

Lev Vaidman
School of Physics and Astronomy, Tel-Aviv University

An analysis of errors in measurement yields new insight into the penetration of quantum particles into classically forbidden regions. In addition to "physical" values, realistic measurements yield "unphysical" values which, we show, can form a consistent pattern. An experiment to isolate a particle in a classically forbidden region obtains negative values for its kinetic energy.

Universality in Bacteria Growth

Mark Ya. Azbel

Raymond and Beverly Sackler Faculty of Exact Sciences
School of Physics and Astronomy, Tel Aviv University
Ramat Aviv, Tel Aviv 69978, Israel

I demonstrate that under certain assumptions the bacteria growth is proportional to t^{γ}, where t is time and $1 \leq \gamma \leq 2$. When a colony does not divide into subcolonies, $\gamma = 2$. The change in the number N of subcolonies is related to a phase transition, with the "life-death" transition when N becomes equal to zero.

Localization in History

Mark Ya. Azbel

Raymond and Beverly Sackler Faculty of Exact Sciences
School of Physics and Astronomy, Tel Aviv University
Ramat Aviv, Tel Aviv 69978, Israel

Specific aspects of evolution and human history are related to a density function with a hierarchy of time dependent localization lengths. Time dependence is related to different characteristic time scales.

NEW RESULTS ON QUANTUM NONLOCALITY

Avshalom C. Elitzur
Department of Chemical Physics
Weizmann Institute of Science

Sandu Popescu
School of Physics and Astronomy, Tel-Aviv University

Daniel Rohrlich
Racah Institute of Physics, Hebrew University of Jerusalem

An extension of Bell's inequality leads to the following conclusion: For any entangled state of two or more systems, quantum theory predicts experimental results that are inconsistent with local realism. Thus any entangled state leads to nonlocal correlations. We also consider violations of Bell's inequality in measurements on an ensemble of particle pairs; do they imply that each pair behaves nonlocally, or only the ensemble as a whole? Each pair in the ensemble behaves nonlocally when the particles are spins coupled in a singlet state. For spins in a non-singlet state, however, a model in which some pairs behave locally reproduces quantum predictions.

end

Generating Quasi-Exactly-Solvable (QES) Problems

Uzi Paz

School of Physics and Astronomy
Raymond and Beverly Sackler Faculty of Exact Sciences
Tel-Aviv University, Tel-Aviv 69978, Israel
e-mail: uzipaz@taunivm.bitnet

and

Physics Department
Faculty of Natural Sciences
Ben-Gurion University of the Negev
P.O.B 653, Beer-Sheva, 84105, Israel

Quasi-Exactly-Solvable (QES) problems, are (eigenvalue) problems (usually Schrödinger equations) for which part of the solutions can be found algebraically.

The problem of generating QES problems with a single exact solution is trivial. Here we discuss few equivalent (or almost equivalent) schemes for constructing QES problems [1-3] with N exact solutions ($N > 1$). Each of them leads to a different insight and implications.

References:

1. A.V. Turbiner, *Commun. Math. Phys.* **118** (1988) 467.
2. M.A. Shifman, *Int. J. Mod. Phys.* **A4** (1989) 2897.
3. U. Paz, *Direct Approach to Partial Algebraization* (Tel–Aviv U. preprint, 1992) **TAUP-1927-91-Rev.**

THE FINITE–TEMPERATURE ANOMALOUS CASIMIR EFFECT

Isaiah Paziashvili
Scool of Physics and Astronomy
Raymond and Beverly Sackler Faculty of Exact Sciences
Tel Aviv University, Tel Aviv 69978

The Poster presentation.

The original version of the Casimir effect determines the change in total vacuum energy between two parallel plates in contrast to the unbounded space. This change is physically observable as an attractive force between the plates and is only known effect of vacuum quantum fluctuations as a mechanical force.

We investigated the Casimir attraction of two plates in the presence of nonstationary, position-dependent sources of heat. We've got the expression for the propagator of a particle in a nonequilibrium nonuniform high–temperature medium and calculated the components of the energy-momentum tensor.

We found that in the force and in the pressure or the energy there appear additional contributions, which are modulated by external heat sources, and are proportional to the derivatives of temperature. In addition to the modification of the known effects, there appears a new one, the momentum flow through the plates, which is connected to the nondiagonal terms in the energy-momentum tensor. All these effects in principle can be measured and checked by the appropriate experiment.

Quantum Mechanical Interaction-Free Measurements

Lev Vaidman
Tel-Aviv University, Ramat Aviv.

I will report the results of the work performed in collaboration with Avshalom Elitzur from the Weitzmann Institute of Science. We have found a novel manifestation of nonlocality of quantum mechanics. We have shown that it is possible to ascertain the existence of an object in a given region of space without interacting with it. The method might have practical applications for delicate quantum experiments.

In particular, we give an answer to the following quantum puzzle: Consider a large stock of bombs with a sensor of a new type: if anything, even a single photon hits the sensor, the bomb explodes. Suppose further that some of the bombs in the stock are out of order: a small part of their sensor is missing so that photons pass through the sensor's hole without being affected in any way whatsoever, and the bomb does not explode. Is it possible to find out that a bomb out of the stock is good without exploding it?

מכון ויצמן למדע
המחלקה לפיסיקה

החברה הישראלית לפיסיקה
תשנ״ב
הכנס השנתי

תכנית ותקצירים
1992

מכון ויצמן למדע
המחלקה לפיסיקה

החברה הישראלית לפיסיקה

תשנ״ב

הכנס השנתי

תכנית ותקצירים
1992

הועדה המארגנת מקבלת את כל באי כנס החברה הישראלית לפיסיקה וכנס האגודה הישראלית לואקום בברכת ברוכים הבאים ובתקוה כי הכנסים יהיו מעניינים ומועילים. בכנסים ייוצגו רוב שטחי הפיסיקה הפעילים וכן תהיה הרצאה כללית על מצב המים בארץ. מארגני הישיבות השתדלו למצוא מרצים מקרב אלו אשר הצטרפו אלינו לאחרונה. לפיכך ניתן יצוג יחסית גדול לעולים ולישראלים צעירים.

אני מדה לחברי הועדה המארגנת והאחראים לישיבות השונות על המאמץ שהשקיעו ולסגל מזכירות הפיסיקה על הטפול המסור.

יוסף אמרי

The organizing committee welcomes all participants of the IPS and Vaccuum Society meeting and wishes them interesting and useful meetings. Most active branches of Physics will be represented and a general lecture on the water situation in Israel will be given. The session organizers tried to find lecturers among recent newcomers to Israel. Olim and young Israelis are thus relatively well represented in the program.

I thank the members of the organizing committee and those responsible for the sessions for their efforts and the staff of the Physics Faculty for their help and devotion.

Yoseph Imry

חועד

פרופ׳ יצחק צרויה, יו״ר - מכון ויצמן למדע
פרופ׳ שמואל גורביץ, מזכיר - מכון ויצמן למדע
פרופ׳ דניס רפפורט, גזבר - אוניברסיטת בר-אילן
פרופ׳ דוד שאלתיאל - האוניברסיטה העברית
פרופ׳ גיורא שביב - טכניון
פרופ׳ שאול מרדכי - אוניברסיטת בן-גוריון
ד״ר בנימין סבטיצקי - אוניברסיטת תל-אביב
ד״ר יוסף ברק - ממ״ג
ד״ר טוביה בר-נוי - קמ״ג
ד״ר דב פאליק - רפא״ל
פרופ׳ צירלס קופר - (נציג Annals) - טכניון

גופים חברים

אוניברסיטת בר-אילן
אוניברסיטת בן-גוריון
האוניברסיטה העברית
הועדה לאנרגיה אטומית
הטכניון - מכון טכנולוגי לישראל
אוניברסיטת תל-אביב
מכון ויצמן למדע

חועדה חמארגנת - מכון ויצמן

י. אמרי, יו״ר
י. בר-יוסף
י. גפן
מ. הס
י. מרון
מ. מילגרום
מ. מגריץ
ע. סמילנסקי
ש. ספרן
י. צרויה
מ. קוגלר
ג. הודס - נציג האגודה הישראלית לואקום

הוראות כלליות

אנו מקדמים בברכה את באי כנס החברה הישראלית לפיסיקה.

להלן מידע על הכנס, לידיעתכם:

דוכן ההרשמה לכנס יהיה בלובי של אולם ויקס מהשעה 08:30 עד 10:00 בבוקר. אתם מתבקשים לשלם דמי חבר בסך -30. שקל (גימלאי או סטודנט -20. שקל) לחברה הישראלית לפיסיקה בזמן ההרשמה.

ישיבות המל·אה תתקיימנה באולם ויקס והישיבות המקבילות באולמות אחרים, כמתואר בתכנית.

תצוגת הפוסטרים תהיה בלובי של בנין המחלקה לפיסיקה בקומה 1 ו- 2. מומלץ שהפוסטרים יוצגו מוקדם ככל האפשר ובעל הפוסטר יעמוד על ידו בין השעות 15:30-16:45).

משתתפי הכנס מוזמנים לבקר במרכז התת-מיקרוני החדש. סיור מודרך ייצא למרכז בזמן הפסקת הצהרים ובזמן הפסקת הקפה אחה"צ. אם הנך מעונין, נא להרשם לסיור בזמן ההרשמה.

תקצירים שיוגשו בע"פ יכללו בבולטין לפי סדר הצגתם. יתר התקצירים יופיעו לפי סדר א"ב בכל מושב.

ניתן לקבל ארוחת צהרים בת שלוש מנות בסן מרטין עבור -10. שקל, או סנדויצ'ים ושתיה קלה אשר ימכרו על הדשא לפני אולם ויקס עבור 1.50 שקל הסנדויצ'י ו- 0.50 שקל שתיה. בזמן ההרשמה עליכם לקנות תלושים לארוחה, לפי החלטתכם.