JOHANN WOLFGANG GOETHE
UNIVERSITÄT
FRANKFURT AM MAIN

Physikalisches Kolloquium

WS2005/2006

Ort: Max-von-Laue-Str. 1
60438 Frankfurt
Großer Hörsaal, Raum 0.111

Zeit: Mittwochs, 17.15 Uhr

26.10.2005
Antrittsvorlesung
J. Wachtveitl, Universität Frankfurt

Femtosekundenspektroskopie in der Biophysik: Ein Blick auf molekulare Tempolimits

Femtosekunden-zeitaufgelöste Spektroskopie erlaubt die Beobachtung und Kontrolle schnellster molekularer Dynamik von funktionellen Einheiten in weiten Bereichen der Biologie, Chemie und Physik. Von besonderem Interesse ist dabei die Reaktionsdynamik molekularer Systeme, wie z.B. optischer Schalter, natürlicher und artifizieller photosynthetischer Systeme oder bioaktiver Modellsysteme zur Peptid- und Proteinfaltung d.h.das Aufspüren von Tempolimits der zugrunde liegenden fundamentalen Prozesse, wie z.B. Photoisomerisierung, Energie- und Elektrontransfer, Konformationsdynamik von Biomakromolekülen oder Reaktionsdynamik an Grenzflächen. Dazu werden moderne Methoden der Quantenoptik zur Erzeugung von spektral abstimmbaren Femtosekunden-Lichtimpulsen mit maßgeschneiderten Pulsformen im sichtbaren und infraroten Spektralbereich entwickelt und eingesetzt. Experimente mit photoschaltbaren Peptiden, die eine Untersuchung schnellster Faltungsvorgänge ermöglichen, werden vorgestellt. Die Grundidee basiert hierbei darauf, einen optischen Schalter kovalent als Rückgratelement in ein Protein einzubauen. Damit können ausgeprägte Strukturänderungen im Protein auf der Zeitskala molekularer chemischer Reaktionen (fs-Bereich) mit Licht ausgelöst und mittels Ultrakurzzeitspektroskopie über den gesamten Zeitbereich der Faltungsreaktion beobachtet werden. Neue Anwendungsmöglichkeiten zeigen sich, die den jetzigen Einsatz von molekularen Lichtschaltern bis hin in die Biomedizin erweitern.

2.11.2005
Antrittsvorlesung
K. Peters, Universität Frankfurt & GSI:

Hadronenspektroskopie - Ein Streifzug von gestern bis übermorgen

Nicht zuletzt die Symmetrien des Spektrums von Hadronen, d.h. subnuklearen Teilchen wie dem Proton, dem Neutron oder dem Pion haben Wissenschaftler Ende der 1960er Jahre das Quarkmodell zu postulieren. Dieser zu einer Quantenfeldtheorie ausgebaute und in das Standardmodell der Teilchenphysik integrierte Ansatz hat aussergewöhnliche Konsequenzen für die Beobachtbarkeit der Konstitutenten (Quarks) und der Berechenbarkeit der uns umgebenden Natur andererseits.
Besonders der fehlende numerische Abgleich zwischen Experiment und Theorie, d.h. der vergebliche Suche nach einem sinnvollen Satz von Freiheitsgraden, welche die Physik der Hadronen beschreibt, treibt die Forschung in diesem Feld an. Wie die Masse des Protons etwa zustande kommt ist qualitativ verstanden aber berechnen lässt es sich nicht.
Um hier auf der experimentellen Seite substantiell vorwärts zu kommen werden hochbrilliante Strahlen von Hochstrombeschleunigern wie etwa bei FAIR an der GSI benötigt um sehr hohe oder exotische Anregungen der gebundenen Quarksysteme zu erzeugen und im Detail zu vermessen.

9.11.2005
L. Molenkamp, Universität Würzburg:

Nanostrukturen für die Spintronik

Semiconductor spintronics has now reached a stage where the basic physical mechanisms controlling spin injection and detection are understood. Moreover, some critical technological issues involved in the growth and lithography of the magnetic semiconductors have been solved. This has allowed us to explore the physics of spintronic nanostructures.
As examples of such devices, I will discuss resonant tunneling diodes (RTDs) fabricated from paramagnetic II-VI semiconductors that can be operated as a voltage controlled spin-switch. A quantum dot version of these RTDs exhibits, unexpectedly, remanent magnetism at zero external fieldm which we interpret as resulting from tunneling through a single magnetic polaron.
In the ferromagnetic semiconductor (Ga,Mn)As we have observed a very large spin valve effect due to domain wall pinning at sub-10 nm sized constrictions. Furthermore, we have found a novel magnetoresistance effect in this material, dubbed tunnel anisotropic magnetoresistance (TAMR), which is due to the strongly (magneto-)anisotropic density of states in a ferromagnetic semiconductor. The effect leads to the observation of a spin valve-like behavior in tunnel structures containg a single ferromagnetic layer and also dominates the spin-valve signal obtained from structures containing two (Ga,Mn)As layers, where the effect may cause resistance changes of five orders of magnitude.

16.11.2005
H. Rieger, Universität des Saarlandes:

Tumor-induced angiogenesis: A physicists view on vascular network remodeling in tumors

Tumor induced angiogenesis is the formation of new blood vessels around the tumor microenvironment for supporting the expansion of the tumor mass, which strictly depends on adequate supply of oxygen. The mathematical modelling of this process is a highly challenging task and still the macroscopic effects of the microscopic interaction between tumor and vasculature remain purely understood. Here we present and discuss a theoretical model based on the molecular interactions between a growing tumor and a dynamically evolving blood vessel network, which describes the transformation of the regular vasculature in normal tissues into a highly inhomogeneous tumor specific capillary network. The emerging morphology, characterized by the compartmentalization of the tumor into several regions differing in vessel density, diameter and necrosis, is in accordance with experimental data for human melanoma. We find that the geometric structure of tumor vasculature bears fractal aspects reminiscent of percolation clusters: Vessel collapse due to a combination of severely reduced blood flow and solid stress exerted by the tumor, leads to a correlated percolation process that is driven towards criticality by the mechanism of hydrodynamic vessel stabilization. Our results also suggest that microvascular density (MVD), regarded as an important diagnostic tool in cancer treatment, does not necessarily determine the tempo of tumor progression. Instead the MVD of the original tissue as well as the metabolic demand of the individual tumor cell plays the major role in the initial stages of tumor growth.

23.11.2005
Y. Demkov, Universität St. Petersburg:

Mendeleev and the hundred years long history of the periodical law

The periodical law is the greatest achievement in chemistry of the XIX-th century. Several people participated in the discovery but Mendeleev was the first who used the law as a tool to predict new elements and their properties, change their positions in the table etc.
The explanation of the table lasted for about a century and is connected with brilliant works of Bohr and his theory of the hydrogen atom and, on this basis, the constitution of all elements. Then Fock explained the internal symmetry of the hydrogen atom and proposed the Hartree-Fock method which allowed to explain the table quantitatively.
Madelung (1928) proposed a new scheme which explains almost ideally the filling of the states in the table based on an (N=n+l, n) rule instead of the (n, l) hydrogen-like Bohr rule. The other chain of discoveries started with the Maxwell “Fish-Eye” problem. Extended by Lenz and considered quantum-mechanically by Demkov and Ostrovsky it was possible to explain several properties of the table. Some problems remain unsolved and it is fun to follow this century-long saga which unexpectedly united famous people, and to participate in it.

30.11.2005 – entfällt-

7.12.2005
Prof. Dr. Markus Arndt, Institut für Experimentalphysik, Universität Wien

Philosophische und angewandte Aspekte des Welle-Teilchen Dualismus grosser Moleküle

Das Konzept von Materiewellen ist so alt wie die Quantentheorie selber und Materiewellen aus Elektronen oder Neutronen sind heute Standardwerkzeuge z.B. in der Materialphysik. Doch trotz ihres großen Erfolges steht die Idee der Materiewelle scheinbar in Konflikt zu unserem naiven Verständnis von Realität und unserer Erfahrung von Lokalität in der klassischen Welt. Wir werden eine Reihe von Experimenten am Übergang von der Quantenwelt in die klassische Physik diskutieren. Dazu wird zunaechst der Welle-Teilchen Dualismus mit verschiedenenartigen, großen Molekülen nachgewiesen und dann durch eine kontrollierterte Kopplung zwischen Molekuelen und Umgebung der scheinbare Verlust ihrer Quantennatur studiert. Die Experimente dienen vor allem der experimentellen Beleuchtung grundlegender Phänomene der Quantenphysik und der Klaerung der Frage warum unsere Welt so "normal" erscheint, wenn doch die Quantentheorie universell gültig ist.

Es stellt sich aber ueberdies heraus, dass der im Experiment verwendete Aufbau auch interessante Moeglichkeiten eroeffnet für die Deposition von grossflaechigen molekularen Nanostrukturen und für Präzisionsmessungen an grossen Molekülen.

14.12.2005
K. Schulten, Universität Illinois

What is life? An answer sought from photosynthetic bacteria

Since Schrödinger asked the question, “What is Life”, much information has been amassed about living systems. Yet, the question is even more pressing today than it was sixty years ago as the information gained still does not answer how biological cells and organisms achieve life, a state in which they maintain themselves and proliferate. The living state emerges from the integration of: (1) an a priori cell body or organism; (2) the activity of biopolymers; (3) energy consumption; (4) instructions written in the genome. Present knowledge pertains mainly to (1) – (4) separately; the integrating principles, for their most part, still need to be discovered. One path to discovery pieces together small, yet significant units of life forms, e. g., major cellular units or even entire cells, from (1) – (4) components, treating the stated systems like puzzles for which all pieces are first collected and then properly connected into a functioning whole. Solving such multi-component puzzles is the domain of physicists who have studied emergent forms of innate matter, revealing the principles that make the whole more than the sum of its parts. Biological physics seeks to explain likewise living matter. This lecture will introduce biological physics as it seeks the integration principles of life forms. It will take photosynthetic bacteria as an example, describing the individual components of their photosynthetic apparatus and how thousands of components are integrated into a functioning light energy converter. In doing so the lecture will outline the scientific methods and concepts used for revealing integration principles acting in living cells.

21.12.2005
P. Voss-de Haan, Freier Wissenschaftsjournalist und Mitarbeiter des BKA:

Physik auf der Spur

11.1.2006
M.J.J. Vrakking, AMOLF, Amsterdam:

Strongly driven electrons in the development and application of attosecond lasers

In my talk I will discuss how strongly driven electrons are at the basis of the generation of attosecond laser pulses as well as a model system where applications of attosecond laser pulses can be explored.

In the first part of the talk, experiments will be discussed where electron dynamics is studied under the influence of electric fields that vary over a wide range of timescales (from DC electric fields to laser fields at optical frequencies). Experiments on photoionization in DC fields will illustrate the importance of electron trajectories, while experiments in the radio frequency domain will illustrate the importance of the optical cycle of the light source[. Combining the two, it can be rationalized how high harmonic generation leads to the formation of attosecond laser pulses. Results will be presented from angle-resolved photoelectron imaging experiments that serve to characterize the attosecond pulses, as well as experiments that show that attosecond pulse trains can be used to map out the electronic wavefunction of an atom or molecule.
In the second part of the talk, several avenues towards the application of attosecond pulses will be explored. Experiments will be discussed where attosecond pulses are used to probe strongly driven electron dynamics in molecules, as well as experiments on dissociative ionization of D2, illustrating the ability to control the dissociation with the carrier envelope phase of a phase-stabilized few-cycle laser pulse

18.1.2006

T.Salditt, Universität Göttingen:

X-ray optics to illuminate the nanoworld

25.1.2006
S. Dreizler, Universität Göttingen:

Die Suche nach Planeten ausserhalb unseres Sonnensystems

1.2.2006
Antrittsvorlesung:
P.. Hülsmann, GSI:

Hochfrequente Wakefelder in supraleitenden TESLA-Resonatoren bei FEL-Betrieb

8.2.2006
Antrittsvorlesung
C. Gros, Universität Frankfurt:

Physik dotierter Mott-Hubbard Isolatoren und die Hoch-Temperatur Supraleiter

15.2.2006
W. Mathis, Universität Hannover:

Quanteneffekte von nanostrukturierten CMOS-Bauelementen und Schaltungen