Plenary Talk PV I Mon 8:30 HSZ 01

Molecules at surfaces: From atoms to complexity — •Gerhard Ertl — Fritz Haber Institut der Max Planck-Gesellschaft, Faradayweg 4-6, 14195 Berlin

Free and condensed matter meet each other at surfaces. The interaction of molecules with solid surfaces forms, among others, the basis for important technological applications such as heterogeneous catalysis. The mechanisms underlying these interactions may be investigated with well-defined single crystal surfaces in microscopic detail. Open systems of this kind may under continuous flow conditions exhibit a rich variety of phenomena of spatio-temporal self-organization as described theoretically in the framework of nonlinear dynamics. The discussed principles will be illustrated by experimental examples.

Plenary Talk (SAMOP) PV II Mon 9:15 HSZ 02

Pairing in Unusual Places - Stretching the Realm of Superconductivity — •Randall Hulet — Rice University, Houston, TX 77005, USA

Ultracold atoms are emerging as a powerful new tool for exploring fundamental physics, particularly in condensed matter. They are clean and well-characterized systems, for which the interaction strength, temperature, density, and dimensionality are readily tunable. These attributes, especially in combination with optical lattices, provide opportunities to uncover unexpected new physics.

I will discuss experiments on the pairing of 6Li, a composite fermion, under extreme conditions. The interaction strength can be tuned to the unitary limit, where the pairing transition temperature as a fraction of the Fermi energy is higher than any other known superconductor or superfluid. While BCS theory expects equal densities of spin-up and spin-down particles, we have investigated two-component Fermi gases where the spin populations are unequal. Such a scenario corresponds to a magnetized superconductor. In three-dimensions (3D), we find phase separation between a fully paired core and the surrounding unpaired atoms. A surprising metastable state is found in elongated trap geometries which favors pairing, even for large population imbalances. We have also determined the phase diagram of a spin-imbalanced Fermi gas in 1D, which is predicted to exhibit the elusive FFLO modulated superfluid state. The FFLO state accommodates the imbalance in spin population by forming pairs with non-zero momentum. This momentum should be directly detectable in a time-of-flight measurement.

Plenary Talk (SKM) PV III Mon 9:15 HSZ 01

Linear and non-linear mechanics of biopolymer networks — •David A. Weitz — Dept. of Physics, Harvard University, USA

This talk will explore the mechanical properties of reconstituted networks of biopolymers that make up the cytoskeleton of the cell. Both linear and non-linear mechanics are essential in fully describing the behavior. In addition, comparisons to the mechanical properties of cells will also be discussed.

Prize Talk PV IV Mon 13:30 HSZ 01

Brownian motion and thermodynamics in special relativity — •Jörn Dunkel — Department of Applied Mathematics and Theoretical Physics, Centre for Mathematical Sciences, University of Cambridge, Wilberforce Road, Cambridge CB3 0WA, UK — Laureate of the Gustav-Hertz-Prize

The generalization of Brownian motion and thermodynamics within Einstein's theory of relativity poses a number of interesting conceptual challenges. In the first part of the talk, we will consider the question of how to construct Langevin models of Markovian diffusion processes in special relativity [1]. The second half will be dedicated to the unification of relativity and thermodynamics, a topic that has stirred considerable debate over the last 100 years. Part of the difficulty with relativistic thermodynamics lies in the fact that thermodynamic variables are nonlocal quantities that single out a preferred class of hyperplanes in spacetime. Moreover, there exist different, seemingly equally plausible ways of defining heat and work in relativistic systems. These ambiguities led, for example, to the various competing proposals for the Lorentz transformation law of temperature. From a more general perspective, however, traditional isochronous formulations of relativistic thermodynamics seem neither theoretically satisfactory nor experimentally feasible. We will discuss how these deficiencies can be resolved by defining thermodynamic quantities with respect to the backward-lightcone of an observer [2].

[1] J. Dunkel and P. Hänggi, Phys. Rep. 471(1): 1, 2009

[2] J. Dunkel, P. Hänggi and S. Hilbert, Nature Physics 5: 741, 2009

Plenary Talk PV V Tue 8:30 HSZ 01

Status, Progress, and Future of the Green Semiconductor Laser — •Shuji Nakamura — Materials Department, University of California, Santa Barbara, CA 93106, USA

Blue/green LEDs and laser diodes have been developed and commercialized by using c-plain (polar) GaN. Due to the Quantum Confined Stark Effects (QCSE), the improvement of the Internal Quantum Efficiency of polar emitting devices is considered to be difficult. We have worked for nonpolar/semipolar GaN plains to develop high efficient emitting devices by minimizing the QCSE. Recently we developed the high efficient semipolar blue LED with the external quantum efficiency (EQE) of 53% and semipolar green LED with the EQE of 29%. Also, we developed the semipolar bluish green laser diodes with a lasing wavelength of 516 nm under pulsed operation. Soraa Inc., (US company) announced true green laser diodes with the lasing wavelength of 520 nm and the output power of 60 mW under CW operations using non-c-plain GaN. The latest performance of Nitride-based blue/green LEDs and laser diodes are described.

Plenary Talk (GP) PV VI Tue 9:15 HSZ 04

Physik vor dem Eisernen Vorhang — •Walter Thirring — Universität Wien

Die Republik Österreich befand sich als politisch neutraler Staat direkt an der Grenze zwischen den beiden Machtblöcken. In der Nachkriegszeit war Österreich ähnlich wie Deutschland in vier Besatzungszonen unterteilt. Mit der Unterzeichnung des Staatsvertrages unter der Bedingung politischer Neutralität erhielt Österreich seine volle Souveränität zurück. Was es für Wissenschaftler bedeutete direkt am Eisernen Vorhang zu forschen, darüber soll der Vortrag in einer persönlichen Rückschau Auskunft geben und dabei u.a der Frage nachgehen, warum man in Wien, als einem intellektuellem Zentrum Mitteleuropas, den Eisernen Vorhang psychologisch nie verkraftet und ihn nur als historisches Faktum hingenommen hat. Dabei wurde er beständig angeknabbert und man freute sich, wie sich kleine Risse zu Spalten erweiterten. Der gänzliche Zusammenbruch kam aber dann doch plötzlich und wir waren gefordert, die Gunst der Stunde zu nutzen. Was gelungen ist – und wir nicht vorhersehen konnten – wird im Vortrag ebenfalls diskutiert werden.

Plenary Talk (SAMOP) PV VII Tue 9:15 HSZ 02

Interactions of ions, atoms, and photons with surfaces and capillaries — •Joachim Burgdörfer — Institute for Theoretical Physics, Vienna University of Technology

Atomic collisions with extended systems such as solid surfaces represent a considerable challenge to theory in view of the multi-scale nature of the problem and the large number of degrees involved. In turn, they provide an ideal testing ground for the description of many-body systems at the quantum to classical crossover. The latter results from both the small de Broglie wavelength and the presence of strong decoherence in open large quantum systems. We will discuss recent developments with the help of a few illustrative examples. They include the probing of ab-initio surface potentials for metals and insulations by grazing-incidence scattering, quantum diffraction in fast atom-surface scattering, time-resolved photoemission from surfaces, nanostructuring of surfaces by highly charged ions, and ion guiding by nano-capillaries.

Plenary Talk (SKM) PV VIII Tue 9:15 HSZ 01

Computational Design of New Multifunctional Materials: From Magnetoelectronics to a Theory of Everything. — •Nicola Spaldin — Department of Materials, ETH Zurich, Switzerland

Modern computational methods are proving to be invaluable in the first-principles design of new materials with specific targeted functionalities. I will illustrate their utility with two examples from the field of multiferroics: First, the design of new materials for electric-field control of magnetism, and second, testing extensions to the Standard Model by searching for the electric dipole moment of the electron.

Prize Talk PV IX Tue 13:30 HSZ 03

Honey, I shrunk the laser! — •Martina Hentschel — MPI für Physik komplexer Systeme, Nöthnitzer Str. 38, 01187 Dresden — Laureate of the Hertha-Sponer-Prize

The miniaturisation of well-known devices for nanophotonic or optoelectronic applications is now feasible, thanks to the tremendous progress in the fabrication, experimental control, and theoretical investigation of mesoscopic systems over the past two decades. With sizes

typically in the micrometer range, quantum dots, optical microcavities, and graphene are too big for a full quantum mechanical description, yet small enough to see quantum signatures such as interference effects: this opens up an ideal playground for basic research. The focus of this talk will be on interference phenomena associated with the existence of the boundary in optical and electronic mesoscopic systems. Boundary effects induce deviations from well-known macroscopic behaviours, for example in the many-body response that determines the photoabsorption cross section of quantum dots vs. metals. Unexpectedly, we observe violations of Snell's law and ray path reversibility which call for wave-inspired corrections to the naive ray model. Even without this, the far-field emission characteristics of optical microcavities depends sensitively on the resonator geometry. So, while I did not shrink the laser (nor Wayne's kids from the 1989 movie) myself, experimentalists have already been able to build lasers smaller than 100 micrometer cavity size that emit almost unidirectionally, based on our predicted shapes. The near future will show us whether this concept is also suitable to reach the nanoscale.

Prize Talk PV X Tue 14:00 HSZ 03

Theoretical progresses in off-equilibrium behavior — •Giorgio Parisi — Dipartimento di Fisica, Universita' di Roma La Sapienza, Rome, Italy — Laureate of the Max-Planck-Medal

Many systems approach equilibrium very slowly: the equilibration time becomes macroscopic, and sometimes it is so large that it cannot be measured.

Strong progresses have recently done in understanding the collective phenomena that are at the basis of their behavior.

This talk will contain:

a) A mini introduction to structural glasses and spin glasses.

b) A theoretical framework for interpreting these phenomena.

c) Aging in structural glasses and spin glasses (theoretical predictions, experimental and numerical results).

d) Generalized fluctuation dissipation relations and the definition of a scale dependent temperature.

Plenary Talk PV XI Tue 17:00 HSZ 01

Information and the Foundations of Quantum Mechanics: From Einstein's Spook and Schroedinger's Cat to Quantum Information Technology and back — •Anton Zeilinger — Faculty of Physics, University of Vienna — Institute of Quantum Optics and Quantum Information, Austrian Academy of Sciences

Experiments in quantum information science, having emerged from philosophically motivated experiments testing the foundations of quantum physics, are giving rise to both a new information technology and to a renewed debate about just these foundations. Most notably entanglement, while dismissed as "spooky" by Einstein, and epitomized in Schroedinger's cat paradox who also called it "the characteristic trait of quantum mechanics", emerged both as a central fundamental concept and as crucial for many procedures in quantum information technology including quantum teleportation. Recent results include tests of quantum cryptography networks and the realization of many protocols in quantum computation including quantum simulation.Today entangled states have achieved a technological maturity which again opens up possibilities for new fundamental experiments. The emerging picture is that information itself plays a fundamental role in the foundations of quantum mechanics.

Plenary Talk PV XII Wed 8:30 HSZ 01

Structural dynamics of condensed matter mapped by femtosecond infrared and x-ray probes — •Thomas Elsaesser — Max-Born-Institut für Nichtlineare Optik und Kurzzeitspektroskopie, 12489 Berlin, Germany

The study of ultrafast structural dynamics in condensed matter has developed into an exciting area of modern physics. Presently, there are strong efforts to unravel transient structures on atomic length and femtosecond time scales in order to understand the microscopic interactions governing phase transitions, chemical reactions and other structural changes. Powerful experimental techniques such as multidimensional nonlinear spectroscopies in a wide spectral range and femtosecond x-ray diffraction have been developed to observe such phenomena in real-time. This talk gives an overview of recent work on ultrafast structural dynamics in condensed matter. After a brief introduction into two-dimensional (2D) vibrational spectroscopy and femtosecond x-ray diffraction with table-top laser sources, recent results on structural dynamics of hydrogen-bonded systems will be presented. 2D infrared spectroscopy gives insight into structural fluctuations and interactions in liquid water and hydrated biomolecules while chemical processes in hydrogen bonded ionic crystals are mapped by femtosecond x-ray powder diffraction.

Plenary Talk (SAMOP) PV XIII Wed 9:15 HSZ 02

Dynamics of Ground and Excited Electronic States from First Principles — •Todd J. Martinez — Department of Chemistry Stanford University, Stanford, CA

The ab initio multiple spawning (AIMS) method is now a quite mature method to describe dynamics including quantum effects of both the electrons and the nuclei from first principles. AIMS is specifically focused on the description of nonadiabatic effects, i.e. breakdown of the Born-Oppenheimer approximation. We discuss the role of conical intersections in excited state nonadiabatic dynamics, as determined from AIMS simulations and validation to experiments. The role of condensed phase environments (solvent and/or protein) is discussed. We highlight the new ability, by leveraging consumer videogame technology (graphical processing units or GPUs), to carry out fully first principles dynamics calculations of solvated proteins and we use this to investigate the validity of mixed quantum mechanical/molecular mechanical (QM/MM) descriptions. A number of applications are used to demonstrate the diversity of behaviors in excited state dynamics, ranging from photoinduced cis-trans isomerization to excited state proton transfer.

Plenary Talk (SKM) PV XIV Wed 9:15 HSZ 01

Emergent Electromagnetism in Solids — •Naoto Nagaosa — Department of Applied Physics, The University of Tokyo, Tokyo 113-8656, Japan

The electromagnetic responses constitute the essential part of the physical properties of the materials. Recently, it is gradually recognized that the gauge fields analogous to the electromagnetic field exist in condensed matter systems as an *emergent phenomenon* resulting form restriction of the Hilbert space in the low energy sector. This subspace is usually curved characterized by the connection and curvature corresponding to the vector potential and magnetic field, respectively. Two examples are the U(1) Berry phase analogous to the electromagnetism and the non-Abelian SU(2) gauge field describing the spin-orbit interaction. In this talk, I will try to present a unified view on the gauge structure of the electronic states in solids with several concrete examples of phenomena such as topological Hall effect in Skyrmion crystal state, optical Hall effect, and spin Hall effect.

Prize Talk PV XV Wed 13:30 HSZ 01

What is the structure of the thiol/gold interface in self-assembled monolayers? — •David Woodruff — University of Warwick, Coventry, UK — Laureate of the Max-Born-Prize

Perhaps the most archetypal of all self-assembled monolayer systems on surfaces are those formed by n-alkanethiolates ($CH_3(CH_2)_{n-1}S$-) on the Au(111) surface, and these have been subjected to a vast number of studies in the last 20 years or so. Despite this, the structure of the interface remains in doubt. Early theoretical (mainly density functional theory) calculations favoured a structure in which the S head-group atom bonds to a two- or three-fold coordinated bridging or hollow site on an unreconstructed substrate, but more recently a wide range of experiments have shown that the S atoms occupy local atop sites. The solution to this dilemma appears to be that the thiolates induce a reconstruction of the substrate, plucking out Au atoms from the substrate to form Au-thiolate moieties; it is these moieties that 'self-organise' on the underlying Au(111) surface. There remains, however, controversy as to the exact nature and structure of these Au-thiolate species: specifically, are they Au-monothiolates or Au-dithiolates? In this short review I will describe the background to this problem and the experiments being conducted to resolve this controversy and provide a definitive solution to the structure of this interface.

Prize Talk PV XVI Wed 14:00 HSZ 01

How crystals melt and glasses form in two dimensions — •Georg Maret — Universität Konstanz, Fachbereich Physik, Konstanz, Germany — Laureate of the Gentner-Kastler-Prize

The nanoscopic processes responsible for melting of crystals, crystallisation and glass transition belong to the most important and largely open issues in solid state physics. Suspensions of microscopic particles (so-called colloids) at high packing densities have turned out ideal model systems to study the underlying structural and dynamic

changes with high accuracy because individual colloids can easily be tracked at all relevant time and length scales by real time video microscopy. This talk focuses on a two dimensional system of superparamagnetic colloids with knob-tuneable pair interactions free floating near a planar air-water interface. Using monodisperse such particles large 2D hexagonal crystals can be made and their melting quantitatively verifies the 2D melting scenario predicted by KTHNY. Binary mixtures form 2D-fluids or -glasses and provide detailed information about the mechanism driving the structural arrest near the glass transition; it involves dynamic heterogeneities correlated with structural heterogeneities caused by different types of nanocrystallites responsible for a widely varying energy landscape.

Evening Talk PV XVII Wed 20:00 HSZ 01

Photovoltaik - Strom aus der Sonne — •Karl Leo — Institut für Angewandte Photophysik, TU Dresden und Fraunhofer-IPMS, Dresden

Photovoltaik, die direkte Erzeugung von elektrischer Energie aus Licht, ist ein faszinierender physikalischer Effekt und scheint eine ideale Lösung für die Energieversorgung der Menschheit zu sein. Es bedarf aber noch großer wissenschaftlicher und ökonomischer Anstrengungen, dieses Potential zu nutzen. In meinem Vortrag möchte ich einige wichtige Fragen diskutieren: Liefert denn die Sonne genügend Energie für alle ? Wie funktioniert Photovoltaik überhaupt? Warum liefern Solarzellen nur etwa 15% Wirkungsgrad und nicht 80%? Braucht die Produktion von Solarzellen nicht mehr Energie, als sie erzeugen? Ist das nicht alles viel zu teuer?

Plenary Talk PV XVIII Thu 8:30 HSZ 01

Pushing the Envelope in Biological Imaging — •Eric Betzig — Janelia Farm Research Campus, Ashburn, VA 20147 USA

Optical microscopy has been instrumental in studies of the structure and function of biological systems for centuries. However, many questions at the forefront of molecular, cellular, and neurobiology remain beyond its current capabilities. Here I will summarize our efforts to extend these capabilities as follows: fluorescence imaging beyond the diffraction limit with photoactivated localization microscopy, deep tissue imaging with two-photon adaptive optics, and high speed volumetric cellular imaging with Bessel beam plane illumination microscopy.

Plenary Talk (SAMOP) PV XIX Thu 9:15 HSZ 02

Precision spectroscopy using quantum logic — •Piet O. Schmidt — QUEST Institute for Experimental Quantum Metrology, Physikalisch-Technische Bundesanstalt, Braunschweig — Leibniz Universität Hannover, Hannover

During the past years, tremendous progress has been made in optical precision spectroscopy, culminating in a recent frequency ratio measurement of two optical clocks with an accuracy of 18 digits. This has become possible by using quantum logic techniques developed for quantum information processing with trapped ions. A logic ion is simultaneously trapped with the spectroscopy ion to provide sympathetic cooling, state initialization and detection. I will present two experiments, in which previously inaccessible atomic ions are investigated using this technique. In the first experiment, we plan to use quantum logic spectroscopy to build a portable optical clock based on a single aluminium ion that is controlled via a calcium logic ion. In the second experiment, we combine quantum logic spectroscopy with direct frequency comb spectroscopy to perform precision spectroscopy of atomic and molecular ions with a complex level structure. Such measurements provide a means to test fundamental theories beyond the standard model, e.g. by probing possible temporal changes in fundamental constants.

Plenary Talk (SKM) PV XX Thu 9:15 HSZ 01

Towards a quantitative understanding of high-temperature superconductivity — •Bernhard Keimer — Max Planck Institute for Solid State Research, Stuttgart, Germany

Twenty-five years after the discovery of high-temperature superconductivity in the copper oxides, we are rapidly approaching a quantitative understanding of this phenomenon. Using a combination of inelastic neutron scattering and resonant inelastic x-ray scattering, we have developed an essentially complete experimental description of the magnetic excitation spectrum in the model compound $YBa_2Cu_3O_{6+x}$. [1] A numerical solution of the Eliashberg equations based on the experimental spin excitation spectrum of $YBa_2Cu_3O_7$ reproduces its superconducting transition temperature within a factor of two, strongly supporting magnetic Cooper pairing models. [1] We also present evidence that an analogous mechanism is responsible for the recently discovered superconducting state in iron arsenides. [2] In the underdoped regime of $YBa_2Cu_3O_{6+x}$, this theoretical description breaks down due to vertex corrections, and we experimentally observe an "electronic nematic" state that competes with superconductivity. [3] Finally, we will briefly discuss possible signatures of competing electronic order in conventional, elemental superconductors. [4]

[1] M. Le Tacon et al., to be published. [2] D. S. Inosov et al., Nature Phys. 6, 178 (2010); P. Popovich et al., Phys. Rev. Lett. 105, 027003 (2010). [3] D. Haug et al., New J. Phys. 12, 105006 (2010); V. Hinkov et al., Science 319, 597 (2008). [4] P. Aynajian et al. Science 319, 1509 (2008); P. Aynajian, N. Munnikes et al., to be published.

Prize Talk PV XXI Thu 13:30 HSZ 01

Scanning probe microscopy of molecules on insulating films: From orbital imaging to molecular structure determination — •Gerhard Meyer — IBM Research Zurich, 8803 Rüschlikon, Switzerland — Laureate of the Robert-Wichard-Pohl Prize

Ultrathin insulating films on metal substrates are unique systems to use the scanning tunneling / atomic force microscope to study the electronic and structural properties of single atoms and molecules, which are electronically decoupled from the metallic substrate. In the case of STM of molecules the electronic decoupling allows the direct imaging of the molecular frontier orbitals [Repp et al, Science 312, 1196 (2006)]. In combination with atomic/molecular manipulation this opens up the possibility to study elementary processes related to charge state control, molecular switching and electrical contact formation. Detailed structural and charge state information can be attained by Atomic Force Microscopy which leads to the direct imaging of the molecular geometry [L. Gross et al, Science 325, 1110 (2009)]. The required high lateral resolution is achieved by specific AFM tip terminations (for example CO transferred to the tip by atomic manipulation) to tune the interaction of the tip with the adsorbed molecule. It will be shown that this technique has the prospect to determine the molecular structure of an unknown molecule [L. Gross, Nature Chemistry 2, 821 (2010)].

Evening Talk PV XXII Thu 20:00 HSZ 01

Redlichkeit in der Wissenschaft — •Siegfried Hunklinger — Kirchhoff-Institut für Physik, Universität Heidelberg — von-Laue-Lecture

Vor einigen Jahren wurde eine spektakuläre Fälschung von wissenschaftlichen Daten aufgedeckt. Dieser Vorfall gab Anlass zur Diskussion in der Wissenschaft und in der Öffentlichkeit. Unter der Federführung der DFG wurde daraufhin eine Empfehlung mit dem Titel „Sicherung der guten wissenschaftlichen Praxis“ erarbeitet, die mit kleinen Änderungen von den Universitäten und den Forschungseinrichtungen übernommen wurde. Zusätzlich wurde der „Ombudsman für die Wissenschaft“ (früher „Ombudsman der DFG“) als Ansprechpartner eingerichtet, der nun seit mehr als 10 Jahre tätig ist.

In meinem Vortrag werde ich die Prinzipien der guten wissenschaftlichen Praxis erläutern und deren Bedeutung anhand realer Vorfälle diskutieren. Ich werde zeigen, dass Datenfälschung, Verweigerung der Koautorenschaft, Mobbing usw. im Institutsalltag durchaus vorkommen. Dabei möchte ich mit Hilfe von Beispielen die Arbeitsweise des Gremiums erläutern.

Plenary Talk PV XXIII Fri 8:30 HSZ 01

Quantum light: Synthesis of complex microwave photon states with superconducting qubits — •John Martinis — University of California, Santa Barbara, USA

Josephson qubits are one of the most promising approaches for solid-state quantum information processing. I will discuss recent experiments at UC Santa Barbara that demonstrate our ability to synthesize complex quantum states of microwave photons in superconducting resonators using phase qubits. I will review experiments that generate photon number (Fock) states up to 12 photons, as well as a protocol for arbitrary states and their measurement via Wigner tomography. The violation of Bell's inequality has also been demonstrated along with a closure of the measurement loophole. I will also discuss a recent experiment that shows complex entanglement of microwave photons in a pair of superconducting resonators. We use as a benchmark the generation of NOON states, with N photons in one resonator and 0 in the other, superposed with the state with the occupation numbers reversed. The resonator states are analyzed using bipartite Wigner tomography, which is required to distinguish entanglement from an ensemble of mixed states. These experiments have led to the development

of a new RezQu architecture that utilizes memory resonators for each qubit and a common coupling bus. With experimental demonstration of Bell-state memory, CNOT gates, C-phase gates for the quantum Fourier transform, and Toeffoli gates, I believe it is possible to operate 9 to 17 mode quantum processors in the immediate future.

Plenary Talk (SAMOP) PV XXIV Fri 9:15 HSZ 02

Coherent x-ray imaging for biomedical applications — •Franz Pfeiffer — Department of Physics (E17) and Institute of Medical Engineering (IMETUM), Technische Universität München, Garching/ Munich, Germany

Visible-light microscopy is a standard and widely used tool with a broad range of applications in science, industry and everyday life. Besides standard bright-field imaging, many more contrast mechanisms have been developed, and dark-field-imaging, phase-contrast, confocal and fluorescence microscopy are routine methods in today's light-microscopy applications. In x-ray microscopy, or more generally x-ray imaging, the development of a similar range of contrast modalities proceeded much more slowly and is still a very active field of research. This presentation will focus on our recent contributions to this field and discuss the development of several novel coherent x-ray imaging and microscopy methods and their application to biology and medicine on length scales ranging from the macromolecular to the macroscopic level.

Plenary Talk (SKM) PV XXV Fri 9:15 HSZ 01

Probing the energetics and dynamics of individual atomic spins on surfaces — •Andreas Heinrich — IBM Almaden Research Center

The scanning tunneling microscope has been an extremely successful experimental tool because of its atomic scale spatial resolution. In recent years this has been combined with the use of low temperatures, culminating in microvolt energy resolution. However the time resolution of typical STM experiments is limited to about one millisecond for spectroscopy on a single atom. In this talk we will discuss the use of inelastic tunneling spectroscopy with low-temperature STM for the study of spins, a technique coined spin-excitation spectroscopy. With this approach it is possible to measure the energy eigenstates of the quantum spin Hamiltonian that describes spins on surfaces with very high precision. We will briefly discuss its application to the measurement of the Zeeman energy and to magneto-crystalline anisotropy. We will focus on a new way of achieving fast time resolution based on an all-electrical pump probe spectroscopy. In this approach, a strong voltage pulse applied between tip and sample drives a spin out of thermal equilibrium (the pump pulse) [Nature Physics 6, 340 (2010)]. A short time later (typically a few nanoseconds) a smaller voltage pulse (the probe pulse) is applied which probes the state of the system. I will demonstrate this technique for the measurement of the spin relaxation time of individual magnetic atoms on a surface [Science 329, 1628 (2010)].