of Colorado at Boulder JOHN KITCHING, *Time and Frequency Division, National Institute of Standards and Technology* SVENJA KNAPPE, *Time and Frequency Division, National Institute of Standards and Technology* LI-ANNE LIEW, *Electromagnetics Division, National Institute of Standards and Technology* VISHAL SHAH, *Time and Frequency Division, National Institute of Standards and Technology and Department of Physics, University of Colorado at Boulder* JOHN MORELAND, *Electromagnetics Division, National Institute of Standards and Technology* LEO HOLLBERG, *Time and Frequency Division, National Institute of Standards and Technology* We are developing a MEMS-fabricated chip-scale atomic clock that uses all-optical excitation to interrogate the hyperfine splitting of cesium. To date, we have constructed several clock physics packages that include a laser, micro-optics package, cesium vapor cell, and photo diode. A recent physics package had a fractional frequency instability of $3*10^{-10}$ at one second, had a volume of 9.5 mm^3, and used 75 mW of power. We are working to decrease power consumption of physics package to 15 mW and to integrate control electronics and a local oscillator, such that the entire clock will be 1 cm^3 in size and use 30 mW of power, allowing battery operation. Because of the MEMS fabrication techniques employed, frequency references of this type could be assembled at the wafer level, enabling low-cost mass-production of thousands of identical units with the same process sequence, and easy integration with other electronics.

8:48

S4 5 Polarizing 3He for neutron spin filters W.C. CHEN, T.R. GENTILE, *NIST* D. HUSSEY, X. TONG, Y. YAN, W.M. SNOW, *Indiana University* E. BABCOCK, T.G. WALKER, *University of Wisconsin - Madison* J. BAKER, F. DIAS, L. KUTUA, A. YUE, G.L. JONES, *Hamilton College* The large spin dependence of the cross section for neutron absorption by 3He gas provides a method for constructing neutron "spin filters" for applications in both neutron scattering and nuclear physics. These devices have particular utility for pulsed neutrpn sources such as the upcoming Spallation Neutron Source. In contrast with electron scattering and polarized gas MRI applications of polarized 3He gas, neutron spin filters typically require moderate gas thicknesses for large diameter beams. In some cases cells are polarized remotely and transported to the neuton beam line, making long gas relaxation times of particular concern. We are pursuing both spin-exchange and metastability-exchange optical pumping of 3He for this application. A survey of the current status will be presented, including application to neutron scattering and weak interaction physics, fundamental and practical issues in spin-exchange optical pumping, development of compression methods for polarized gas, and issues in obtaining long relaxation times.

9:00

S4 6 Electron transport through atomic and molecular chains length effects P. S. KRSTIC, X.-G. ZHANG, J. C. WELLS, M. D. BARNES, *Oak Ridge National Laboratory* Quantum transport and tunneling of electrons in an electrically biased, open quantum system is a nearly adiabatic, correlated, electron-molecule scattering process, with the Bloch wave boundary conditions of the metal leads applied to the scattering states. We generalize the tight-binding approach and, applying the methods of computational chemistry, we study the quasilinear transport of electrons through pi-conjugated organic polymer systems (oligo phenylene-vinylene) as well as through monoatomic nanowires as function of the system length. We demonstrate that the proper placement of the electrostatic potential relative to the electrodes is important even for small bias voltages. We acknowledge support from the US DOE through ORNL, managed by UT-Battelle, LLC under contract DE-AC05-00OR22725.

9:12

S4 7 Vortex Buckyball BHARAT KHUSHALANI, *University of Southern California* Buckminsterfullerene, C60, is a molecule with perfect symmetry made up of 60 carbon atoms arranged in the shape of a soccer ball and resembling a geodesic dome. The hexagonal and pentagonal patches making up the soccer ball are sewn together such that there are exactly 60 vertices with 3 edges intersecting at each vertex. Geometric structure of the C60 molecule is that of a truncated icosahedron with a single carbon atom occupying each vertex. Such a structure is obtained from an icosahedron by truncating each of the 12 vertices, resulting in a 5-membered ring at the location of each vertex and a 6-membered ring corresponding to each icosahedral face. In this paper, it will be shown that 60 point vortex atoms corresponding to the buckyball configuration undergo spontaneous clustering, each cluster undergoing periodic motion with characteristic frequency proportional to number of co-orbiting vortices. Generalizing the frequency relation for an isolated ring, the interacting clusters are shown to modify the ring frequencies such that the latter can be scale-fitted by an r^{-a} relation where r is the radius of the periodic orbit and "a" is a constant.

9:24

S4 8 Cumulant Dynamics of Quantum Accelerator Modes R. BACH, *Center for Theoretical Physics, Polish Academy of Sciences, 02-668 Warsaw, Poland* M.B. D'ARCY, *Atomic Physics Division, National Institute of Standards and Technology, Gaithersburg, Maryland 20899-8423* S.A. GARDINER, *JILA, University of Colorado and National Institute of Standards and Technology, Boulder, Colorado 80309-0440* K. BURNETT, *Department of Physics, University of Oxford, Oxford OX1 3PU, United Kingdom* We formulate a general method for the study of semiclassical-like dynamics in stable regions of a mixed phase-space. This involves determining stable Gaussian wavepacket solutions, and then propagating them using a cumulant-based formalism. We apply our method to the problem of quantum accelerator modes in an atom-optical system, determining their relative longevity under different parameter regimes, and obtaining good qualitative agreement with exact wavefunction dynamics.

9:36

S4 9 Nonlinear dynamics with trapped charged particles* IAN GARRICK-BETHELL, *MIT Center for Space Research* THOMAS CLAUSEN, REINHOLD BLUMEL, *Wesleyan University* The dynamic Kingdon trap, essentially a rectilinear wire with applied dc and ac voltages, is one of the simplest charged particle traps that exhibits chaos and nonlinear effects on the single-particle level. Although already studied for many years, we recently discovered unexpected instabilities of the trap, which occur at well-defined settings of the voltages applied to the trap. Analogous instabilities were also found to exist in the two-particle Paul trap. These instabilities are explained as manifestations of well-known bifurcation phenomena of two-dimensional area-preserving mappings. The results of recent numerical studies of the thermodynamic properties of large ion clouds in a Paul trap are also presented.

*supported by NSF under grant number PHY-9984075

9:48

S4 10 Field quantization in dielectrics MICHAEL CRENSHAW, *US Army RDECOM* The quantum electrodynamic model of a dielectric consists of the quantized vacuum field and discrete quantized oscillators. Starting from the classical electromagnetic energy of continuum electrodynamics, macroscopic quantization of the field in dielectrics produces a less complex quantum theory that is based on a diagonal effective Hamiltonian and dressed field operators. I derive the effective macroscopic Hamiltonian from the microscopic quantum electrodynamical model of a linear medium. Based on this derivation, the limits and approximations that are embodied in the macroscopic treatment are identified and used to relate the macroscopic quantum theory of optical phenomena to the microscopic basis. The phenomenological Maxwell equations are derived and related to the microscopic and macroscopic quantum theory of linear media.

10:00

S4 11 Absolute Phase Measurement of Ultrashort Pulses by Asymmetric Ionization ANDRE D. BANDRAUK,* *Université de Sherbrooké* STEPHANE CHELKOWSKI, *Universite de Sherbrooke* Numerical solutions of the time-dependent Schroedinger equation, TDSE for a 3-D H atom in an intense (10**13-10**14 W/cm2) ultrashort (3-5 fs) 800nm laser pulse with linear polarization are used to propose a new experimental method to measure the absolute phase of such pulses based on the asymmetry of the ionization produced by such pulses. It will be shown that the asymmetry follows a "universal" shape when plotted as a function of intensity or pulse length. This universality exists only in the tunnelling region and cannot be reproduced by standard SFA (Strong Field Approximations) which neglect Coulomb potential effects.It is therefore shown that Coulomb potential effects cannot be neglected in the tunnelling ionization region for short pulses as we have emphasized in other contexts (Phys Rev Lett 89, 283903 (2002); 84, 3562 (2000)).

*Canada Research Chair

10:12

S4 12 Time Resolved Fano Resonances M. WICKENHAUSER, *Institute for Theoretical Physics, Vienna University of Technology* J. BURGDOERFER, *Institute for Theoretical Physics, Vienna University of Technology* F. KRAUSZ, *Photonics Institute, Vienna University of Technology* M. DRESCHER, *Faculty of Physics, University of Bielefeld* Recent experiments have succeded in tracing the time evolution of an Auger decay with a decay time of 8 fs with attosecond resolution. We investigate the feasibility to implement the same pump probe technique to study time-resolved Fano resonances. A time-resolved resonance process is initialized by a short XUV-pump pulse with energies of 50 - 100 eV in the presence of a synchronized probe laser pulse (1.6 eV). Excitation with the pump pulse opens two interfering paths from the ground state to to continuum. The time evolution of the coherent superposition of resonant state and continuum is mapped onto a modulation of the electron spectrum as a function of the time delay between pump and probe pulse. Without probe laser the spectrum shows the typical Beutler-Fano profile. In the presence of the probe pulse periodical fluctuations and sidebands in the energy spectrum provide information about the time evolution of the autoionization process. Possible candidates to test our predictions are (Super-) Coster Kronig transtions with lifetimes of the order of 500 as. This method holds the promise to resolve complex atomic dynamics on the attosecond scale. Work supported by the Austrian FWF, proj. No. SFB016

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10:30

T1 1 Atoms and the basic laws of physics.

NORVAL FORTSON, *University of Washington*

For decades, from the birth of quantum mechanics to the triumph of quantum electrodynamics, the study of atoms was central to uncovering the laws of physics. Today, remarkably sensitive techniques enable atomic physics to continue probing fundamental interactions. For example precise measurement of atomic parity violation together with major improvement in atomic theory have helped elucidate the nature of the electroweak force. What can we expect in the future? Cherished laws will come under increasing scrutiny as atomic physicists draw a narrower bead on QED, gravity, Lorentz invariance, and CPT symmetry. The search for a permanent atomic electric dipole moment may well reveal new forces that violate time reversal symmetry; such forces are expected to exist at measurable levels on the basis of supersymmetry and other favored theories of new physics. And advances in atomic clocks will inspire new experiments for realizing a long-held dream, detecting a possible variation of the fine structure constant with time. One thing seems certain: a variety of exquisite atomic techniques will continue to pose questions at the boundary of our understanding of the laws of nature.