Tuesday Afternoon, October 21, 2008

IPF 2008 Frontiers in Imaging: from Cosmos to Nano
Room: 312 - Session IPF-TuA

Frontiers in Physics

Moderator: F. Dylla, AIP

1:40pm **IPF-TuA1 Nano-Circuit Developments**, ***J. Gordon***, IBM Almaden Research Center **INVITED**

2:20pm **IPF-TuA3 Proton Cancer Therapy**, ***J. Flanz***, Massachusetts General Hospital **INVITED**

4:00pm **IPF-TuA8 Optical Atomic Clocks**, ***J. Ye***, National Institute of Science and Technology and University of Colorado **INVITED**

Quantum state engineering of ultracold matter and precise control of optical fields have allowed accurate measurement of light-matter interactions for the development of best atomic clocks. State-of-the-art lasers now maintain optical phase coherence over one second. Optical frequency combs distribute this optical phase coherence across the entire visible and infrared parts of the electromagnetic spectrum, leading to direct visualization and measurement of light ripples. An the same time, ultracold atoms confined in an optical lattice of zero differential a.c. Stark shift between two clock states allow us to minimize quantum decoherence while strengthen the clock signal. For ^{87}Sr, we achieve a resonance quality factor >2 x 10^{14} on the $^1S_0$ – $^3P_0$ doubly forbidden clock transition at 698 nm.[1] The uncertainty of this new clock has reached 1 x 10^{-16} and its instability approaches 1 x 10^{-15} at 1 s.[2] These developments represent a remarkable convergence of ultracold atoms, laser stabilization, and ultrafast science. Further improvements are still tantalizing, with quantum measurement and precision metrology combining forces to explore the next frontier.

[1] M. M. Boyd, T. Zelevinsky, A. D. Ludlow, S. M. Foreman, S. Blatt, T. Ido, and J. Ye, "Optical atomic coherence at the one second time scale," Science Vol. 314, pp. 1430 – 1433, 2006.

[2]A. D. Ludlow, T. Zelevinsky, G. K. Campbell, S. Blatt, M. M. Boyd, M. H. de Miranda, M. J. Martin, J. W. Thomsen, S. M. Foreman, J. Ye, T. M. Fortier, J. E. Stalnaker, S. A. Diddams, Y. Le Coq, Z. W. Barber, N. Poli, N. D. Lemke, K. M. Beck, and C. W. Oates, "Evaluation of a Sr lattice clock at 1x10-16 via remote optical comparison with a Ca clock," Science Vol. 319, pp. 1805 – 1808, 2008.

4:40pm **IPF-TuA10 Diamond Circuitry**, ***M. Lukin***, Harvard University **INVITED**

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Bold page numbers indicate the presenter