MAR06-2005-005003

Abstract for an Invited Paper
for the MAR06 Meeting of
the American Physical Society

Trapped Ion Optical Clocks

PATRICK GILL, National Physical Laboratory

For the last fifty years, the international standard of time has been the caesium atomic clock, which is based on the 9.2 GHz microwave absorption in caesium-133 atoms. The recent Nobel Physics award to T W Haensch and J L Hall for their development of widespan femtosecond comb metrology has recognised the major role that femtosecond combs have made to the progress of optical frequency standards, and their use, going forward, as optical clocks. Such single trapped ion and cold atom optical clocks are now capable of challenging the best caesium fountain microwave clocks available. High accuracy frequency measurement of the single trapped ion optical frequency standards such as $^{199}Hg^{+}$ [1], $^{88}Sr^{+}$[2], and $^{171}Yb^{+}$ [3] by means of femtosecond combs referenced to the primary caesium fountain standard has now resulted in uncertainties at the 10^{-15} level. These measurements are close to being limited by the caesium standard itself. Looking forward, it now becomes attractive to reverse the "directionality" of accuracy provision by referencing the comb to the optical frequency standard itself, and this concept has already been demonstrated [4]. The optical clock so formed can then deliver full accuracy of the optical standard to about a million comb modes across the visible and near infra-red, and, through the comb repetition rate frequency, to the microwave and rf regions. This presentation will review recent results and expected future capabilities of these optical clocks, particularly in respect of the single cold $^{88}Sr^{+}$ ion quadrupole and $^{171}Yb^{+}$ ion octupole clock transitions.
[1] J C Bergquist et al 2005, submitted to Nature [2] H S Margolis et al. Science **306** 1355 (2004) [3] T Schneider et al Phys. Rev. Lett. **94** 230801 (2005) [4] S A Diddams et al. Science **293** 825 (2001)