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Testing relativistic time dilation with a two-velocity ion clock in a storage ring G. GWINNER, University of Manitoba, Winnipeg, Canada, H. BUHR, S. REINHARDT, G. SAATHOFF, D. SCHWALM, A. WOLF, Max-Planck-Institute for Nuclear Physics, Heidelberg, Germany, G. HUBER, S. KARPUK, C. NOVOTNY, University of Mainz, Mainz, Germany, T.W. HÄNSCH, R. HOLZWARTH, T. UDEM, M. ZIMMERMANN, Max-Planck-Institute for Quantum Optics, Garching, Germany — We report on a new, improved test of time dilation in special relativity via the relativistic Doppler-effect. We use an optical transition with rest-frequency ν in $^7Li^+$ ions, stored at two different speeds of $\beta_1 = 0.064$ and $\beta_2 = 0.03$, respectively, in the TSR heavy-ion storage ring in Heidelberg. The Doppler-shifted excitation frequencies ν_p and ν_a for laser beams travelling parallel and antiparallel with respect to the ions are measured simultaneously using saturation spectroscopy in separate measurements at β_1 and β_2. The resonance conditions $\nu = \gamma(1-\beta)\nu_p$ and $\nu = \gamma(1+\beta)\nu_a$ yield the relation $\nu_{1p}\nu_{1a} = \nu_{2p}\nu_{2a}$, if $\gamma = 1/\sqrt{1-\beta^2}$, as predicted by SR. Deviations, e.g. caused by the existence of preferred frames, are parametrized by $\gamma = \gamma_{SR}(1+\alpha\beta^2+...)$. We have established a preliminary new limit of $|\alpha| < 9 \times 10^{-8}$, a 25× improvement over non-storage-ring techniques. We will also review the progress towards a measurement at $\beta = 0.34$ at the ESR storage ring at GSI in Darmstadt, which will be key to reducing the limit on α even further.

G. Gwinner
University of Manitoba

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