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Towards the test of local Lorentz invariance with $^{172}Yb^{+}$ ion Coulomb crystals

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We report on our progress of an improved test of local Lorentz invariance (LLI) in the electron-photon sector using the highly sensitive meta-stable electronic F-state of the $^{172}Yb^{+}$ ion [1].

The Zeeman structure of the F-state contains two orthogonally oriented orbitals which gives us access to test LLI violation. To suppress the magnetic field noise during the measurement, we mix the Zeeman substates via dynamical decoupling [2]. This method allows us to profit from a long coherence time and high spatial homogeneity of the radio-frequency source used for interrogation, which enables easy up-scaling of the ion number.

In preparation of this measurement, we demonstrated the first coherent excitation to the F-state via the highly forbidden electric octupole (E3) transition with a reduced uncertainty of less than 10 Hz [3], improving on earlier measurements [4] by about 5 orders of magnitude. Recently, we observed a coherence time of 1.5 s when applying the dynamical decoupling sequence in the electronic ground state of Yb^{+}.

With these results, we are ready to perform the first test of LLI with a single Yb^{+} ion, after which we will scale it up to $\approx$ 10 ions to improve on the current best upper bound [5].

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