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A laser-cooled 40Ca+ ion and a 40Ca+ - 40Ca+ ion crystal for systematic investigations of motional quantum metrology

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At the Ion Traps and Lasers Laboratory of the University of Granada we have built a linear Paul trap apparatus as an assisted ion-trap system for a high-magnetic-field Penning trap experiment. The goal of this experiment is to generate and manipulate a qubit via the "clock"S1/2 -> D5/2 transition of 40Ca+ to read out motional frequencies of a 40Ca+ - 40Ca+ crystal in the ground state of motion and to study metrological protocols to perform experiments beyond the standard quantum limit. The trap is fully characterized and, in 2021, a 729 nm laser system locked to a high-finesse cavity has been installed (measured finesse of 280000). The on-going work is devoted to properly address the S1/2 -> D5/2 transition in order to prepare the ion and ion crystal in their respective motional ground states and perform the first experiments on both systems in a very low magnetic field.

In this contribution, we will present the status of the linear Paul trap apparatus. We will underline the technical achievements of the experiment so far and describe the first experiment on a single ion and on the balanced ion crystal. The results are crucial for the measurements envisaged in the Penning trap apparatus and will allow for studies of systematic effects of such crystals in a high magnetic field.

Authors: Mr DOMÍNGUEZ, Francisco (Universidad de Granada (ES)); Mr ALTOZANO, Emilio (Universidad de Granada (ES)); Mr BERROCAL, Joaquín (Universidad de Granada (ES)); Dr CERRILLO, Javier (Universidad Politécnica de Cartagena (ES)); Prof. RODRÍGUEZ, Daniel (Universidad de Granada (ES))

Presenter: Mr DOMÍNGUEZ, Francisco (Universidad de Granada (ES))

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