

Ion beam and level population dynamics in Mg⁺ laser spectroscopy at CRYRING@ESR

Wednesday, June 1, 2022 4:40 PM (5 minutes)

We want to continue laser spectroscopy experiments at CRYRING@ESR with Mg⁺ ions in order to study population dynamics in the ions as well as electron-cooler ion beam dynamics. Synchrotron oscillations in bunched beam operation lead to fast hyperfine level pumping of all velocity classes within a few revolutions. This surprising behaviour shall be further studied using laser intensity modulation to vary laser-ion beam interaction times. Moreover, optical pumping using Lambda-transitions in coasting beam operation will be investigated, to have similar conditions as in the lithium experiment at the ESR where optical pumping was supposedly observed.

In our first E148 beamtime with Mg⁺ ions at CRYRING@ESR we found laser spectroscopy to be a sensitive monitor for the dynamics in electron cooling of low-energy ion beams, which requires very precise control of the cooler and ring parameters. A damping and subsequent re-excitation of synchrotron oscillations was observed utilizing the laser-excited fluorescence of the ion beam. This re-excitation was caused by a slight misalignment of the electron beam with respect to the ion beam. The position-dependent potential well of the electron beam and the dispersive coupling between the horizontal and longitudinal degrees of freedom lead to a positive feedback and enforced the oscillations. A closer inspection of these effects as well as of the electron beam space charge on the ion energy is planned.

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Session Classification: Cryring@ESR