Phase transitions of sympathetic cooling of HCI ions

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An ion cloud confined in a linear RF-quadrupole trap is an example of a non-neutral plasma, a plasma consisting of particles with a single sign of charge. When laser-cooled, the trapped ions form ordered structures, called Coulomb crystals [1]. The morphology of these crystals depends on the ratio of the axial and radial motional frequencies associated to the effective harmonic potentials that form the RF linear trap. Particles of different charge-to-mass ratio, e/m can be trapped and allow to create multi-species crystals. Coulomb crystals are ideal candidates for the study of structural transitions, of particular interest is the second order phase transition associated to the morphological change from one chain to a zig-zag [2].

At this 47th EGAS conference, we will present a numerical study, performed using molecular dynamics simulations, concerning the phase transition of Highly Charged Ions (HCI) sympathetically cooled by laser-cooled simple atomic ions in a multispecies crystal. Due to the different charge-to-mass ratio, the HCI are located in the centre of the crystal. The screening introduced by the surrounding ions is expected to modify the behaviour of the chain to zig-zag transitions. While the present study is purely numerical, recent experimental work has demonstrated first evidence for the feasibility of such systems [3].

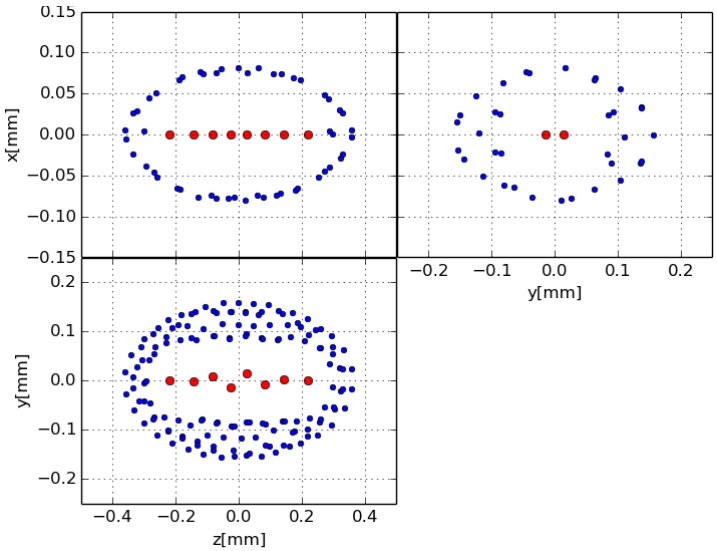

Figure 1: *Sympathetically cooled Ar^{13+} (5 ions) by laser cooled Be^{+} (256 ions). The HCI are in a zig-zag structure while the Be ions form a 3D crystal around.*

References

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