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Understanding Schottky spectra of stored laser-cooled bunched ion beams - simulations & recent experimental results from the CSRe

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Laser cooling of O5+ ion beams with an energy of 275.7 MeV/u was successfully achieved at the storage ring CSRe in Lanzhou, China. *The longitudinal momentum spread of the laser-cooled O5+ ion beams measured by the Schottky resonator reached Δp/p ≈ 2×10−6, which is limited by the resolution of the Schottky diagnostics for bunched ion beams. To interpret the experimental observations, a multi-particle tracking method has been developed to simulate the longitudinal Schottky spectra of bunched ion beams.*
*We systematically studied the dependence of the Schottky power on the number of stored ions. The Schottky power of the central peak is proportional to the square of the number of ions and coherently enlarged only when the observation frequency is an integer multiple of the bunching frequency. Otherwise, the Schottky power of the central peak and sidebands is proportional to the number of ions. Therefore, the greatly enhanced central peak, caused by the 'coherent effect', has been fully interpreted. Besides, we propose a novel method to extract the momentum distribution from the Schottky spectrum of the bunched ion beams by calculating the envelope of the total Schottky power of each sideband. Unlike the previously used methods**, this is a very simple and precise way for real-time monitoring of the momentum distribution during beam cooling experiments at the storage rings. We will present these results at the COOL'25 Workshop.

Footnotes

- W. Q. Wen, et al., PRA 110 (2024) L010803. ** M. Bussmann, Proceedings of COOL 2007, 226-229; K. Lasocha, PRAB 23 (2020) 062803; V. Balbekov, Proceedings of EPAC 2004, Lucerne, Switzerland.

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