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Scandium-45 nuclear-clock isomer driven by X-ray laser

Tuesday 27 August 2024 15:45 (30 minutes)

Precise timekeeping is indispensable in everyday life, science, and technology. It relies on reference oscillators with stable frequencies. Atomic clocks – the most precise time-measurement devices at present – use spectrally very narrow resonant transitions between electronic states in atoms as their reference oscillators [1]. With the advent of hard x-ray FELs, the use of extremely narrow resonant transitions in atomic nuclei as reference oscillators for ultra-high-precision clocks is now within reach. Nuclear oscillators are naturally more stable and more resilient to external perturbations than their atomic counterparts.

Resonant excitation of an ultra-narrow transition in Scandium-45 nuclear isomer with hard x-rays became recently possible [2] due to the high spectral photon flux delivered by the European XFEL in self-seeded high-repetition-rate mode [3]. In this talk, the results of the Scandium-45 experiment [2] will be presented along with discussion of further developments of hard X-ray FELs required for ultra-high precision nuclear clocks in particular and for nuclear resonance studies in general.

[1] Ludlow, A. D. et al. Optical atomic clocks. Rev. Mod. Phys. 87, 637–701 (2015).
[2] Shvyd'ko, Yu. et al. Resonant x-ray excitation of the nuclear clock isomer 45Sc. Nature 622 (2023) 471.
[3] Liu, S. et al. Cascaded hard X-ray self-seeded free-electron laser at MHz-repetition-rate. Nature Photon. 17 (2023) 984–99/1.

I plan to submit also conference proceedings

No

Primary author: SHVYD'KO, Yuri (Argonne National Laboratory)

Presenter: SHVYD'KO, Yuri (Argonne National Laboratory)

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