European XFEL Joint Theory Seminar

Thursday, 03 September 2026, 16:00 – 17:00 CET

European XFEL, XHQ / E1.173

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Mössbauer science at x-ray free-electron lasers — a theory perspective

Probing resonances in Mössbauer nuclei with x-rays or γ-rays is widely used to study structure and dynamics of matter with a remarkably high energy resolution. Mössbauer nuclei are also established as a powerful platform for x-ray quantum optics. So far, most experiments use radioactive or synchrotron radiation sources. Recently, Mössbauer science has been established at European XFEL in a series of experiments. The self-seeded XFEL radiation provides qualitatively new excitation conditions, and several new applications and research avenues have already been demonstrated [1,2].

In this talk, I will first introduce Mössbauer science and review the recent experimental developments at EuXFEL. Then, I will discuss the corresponding theoretical approaches, focusing on the modeling of the recent EuXFEL experiments [2] and on future perspectives for Mössbauer nuclei at EuXFEL [3,4,5].

[1] Y. Shvyd'ko et al., Resonant x-ray excitation of the nuclear clock isomer 45Sc, Nature 622 (2023) 471.

[2] M. Gerharz et. al, Single-shot sorting of Mössbauer time-domain data at X-ray free electron lasers, arXiv:2509.15833 [quant-ph].

[3] D. Lentrodt, C. H. Keitel, and J. Evers, Toward nonlinear optics with Mössbauer nuclei using x-ray cavities, Phys. Rev. Lett. 135, 033801 (2025).

[4] L. Wolff and J. Evers, Interferometric characterization of the relative phase between two x-ray free-electron laser pulses using long-lived Mössbauer resonances, arXiv:2607.01796 [quant-ph].

[5] M. Gerharz and J. Evers, Cumulant expansion approach to the decay dynamics of interacting Mössbauer nuclei after strong impulsive excitation, arXiv:2510.00970 [quant-ph].

Host: Ruslan Kurta

Virtual participation (via Zoom):

https://xfel.zoom.us/j/68250677785?pwd=LJUz9FBc0nabwENRq0NV1dqfZ0Bm9t.1

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