New Regimes of Nuclear Resonance Excitation and Detection with XFELs

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Accelerator driven sources of X-rays had a profound impact on the applications of the Mössbauer effect in all natural sciences. The enormous brilliance of X-rays delivered by synchrotrons enabled access to smallest amounts of materials under extreme conditions and allowed for studies with time resolution and polarization sensitivity that were virtually impossible in the lab. In this way it was even possible to transfer concepts of quantum optics into the regime of hard X-rays.

This science field gained a further momentum by the advent of X-ray lasers. These sources deliver radiation pulses with peak brightness values to enter qualitatively new regimes in the interaction of light and matter. In this talk I will present the results of recent experiments at the European X-ray free electron laser (EuXFEL) in which we studied the Mössbauer effect under multiphoton excitation conditions. Moreover, we were able to excite the sharpest nuclear resonance line in the regime of hard x-rays, the 12.4 keV transition in ^{45}Sc as a potential candidate for a nuclear clock.

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