Nuclear Quantum Optics Beyond the Linear Regime – Recent Progress in Theory and Experiment

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Mössbauer nuclei form a rich platform for the exploration of X-ray quantum optics and dynamics [1-3]. However, theory and experiment so far are focused on the linear low-excitation regime, owing to a restriction of the experimentally available resonant photon flux due to the narrow nuclear linewidths. This situation has changed with the availability of X-ray free electron lasers, which may provide a large number of photons within the nuclear linewidth per pulse [4]. Further progress towards the high-excitation regime recently became possible with high-repetition-rate self-seeded hard x-ray free electron lasers.

In this talk, I will discuss recent experimental and theoretical progress towards nuclear quantum optics beyond the linear excitation regime. After presenting first results on multi-photon excitation of ^{57}Fe at European XFEL, I will discuss methods to verify the excitation beyond the linear regime, and to enhance the nuclear excitation fraction.

References

[1] R Röhlsberger and J Evers, in: Y Yoshida and G Langouche (eds.), Modern Mössbauer Spectroscopy, Springer, Singapore, 2021, Vol. 137, pp. 105-171

[2] B W Adams, C Buth, S M Cavaletto, J Evers, Z Harman, C H Keitel, A Pálffy, A Picón, R Röhlsberger, Y Rostovtsev and K Tamasaku, J. Mod. Opt. **60**, 2 (2013)

[3] E Kuznetsova and O Kocharovskaya, Nat. Photonics. **11**, 685 (2017)

[4] A I Chumakov, A Q R Baron, I Sergueev, C Strohm, O Leupold, Y Shvyd'ko, G V Smirnov, R Rüffer, Y Inubushi, M Yabashi, K Tono, T Kudo and T Ishikawa, Nat. Phys. **14**, 261 (2018)