X-ray science with atomic nuclei: When materials science meets quantum optics

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Abstract

The remarkable development of accelerator-driven light sources such as synchrotrons and X-ray lasers with their highly brilliant X-rays has brought quantum and nonlinear phenomena at X-ray energies within reach.

X-ray photonic structures like cavities and superlattices are employed as new laboratory to realize quantum optical concepts at X-ray energies. The prime candidates to be chosen as atomic emitters in this field are Mössbauer isotopes. Their extremely small resonance bandwidth facilitates to probe fundamental phenomena of the light-matter interaction like the observation of single-photon superradiance and the collective Lamb shift as well as electromagnetically induced transparency with nuclei.

Employing higher-order coherences of X-ray fields in the spirit of Glauber could even lead to novel concepts for quantum imaging at X-ray energies.