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Quantum optics and nonlinear physics with x-rays

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Nonlinear effects in the light-matter interaction arise when the optical properties of the medium are modified due to the presence of photons. The key quantity that determines these effects is the photon degeneracy, i.e., the number of photons per mode of the radiation field. At very high photon numbers, the light modulates the microscopic charge distribution, leading to phenomena like high-harmonic generation, frequency mixing, up- and down-conversion and more. With the advent of x-ray lasers it becomes appealing to explore these effects at wavelengths comparable to interatomic spacings, a situation that has not been encountered before.

Quantum optical and nonlinear effects, however, do not require a high photon degeneracy, but can be observed at the single-photon level if the mode structure of the vacuum is modified, e.g., in a cavity. I will show that effects like electromagnetically induced transparency can be observed by employing Mössbauer isotopes as two-level systems embedded in planar x-ray waveguides. Perspectives for experiments at existing and future light sources will be discussed.

Please specify the session

XFEL Experiments in Condensed Matter

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