From electromagnetically induced transparency to Autler-Townes splitting with x-rays

Xiangjin Kong\(^1\), Jörg Evers\(^1\), Johann Haber\(^2\), Cornelius Strohm\(^2\), Lars Bocklage\(^2\), Kai Schlage\(^2\), Rudolf Rüffer\(^3\), Ralf Röhlsberger\(^2\), Adriana Pálffy\(^1\)

\(^1\)Max Planck Institut for Nuclear Physics, Heidelberg, Germany  
\(^2\)Deutsches Elektronen-Synchrotron DESY, Hamburg, Germany  
\(^3\)European Synchrotron Radiation Facility, Grenoble, France

Coherent control of light interacting with matter is one of the ultimate goals of optics and quantum physics. The key role is played by resonant interactions, with control often refined within a resonance by the use of a second field coupling to neighboring levels of a multi-level system. This can lead for instance via Fano interference effects to electromagnetically induced transparency (EIT)- the medium is rendered transparent over a narrow spectral window within an absorption line. A different route can be achieved via Autler-Townes splitting (ATS), where a single resonance line is replaced by a doublet structure in the absorption profile by pumping with a strong second field.

Here we investigate the transition between EIT and ATS in the x-ray regime using thin-film x-ray cavities with two layers of resonant nuclei, see Fig. 1. In such planar cavities, the incidence angle can be used as tunable parameter to observe either of the two processes [1,2]. We use the Akaike Information Criterion [3] to evaluate the experimental data and discern which of the two mechanisms is dominant. Our results confirm the observation of EIT and ATS in thin-film x-ray cavities.

Fig. 1. Thin-film planar cavity setup with x-ray grazing incidence. The cavity consists of a sandwich of Pt and C layers with two thin layers containing \(^{57}\text{Fe}\). Inset panel: \(^{57}\text{Fe}\) level scheme.