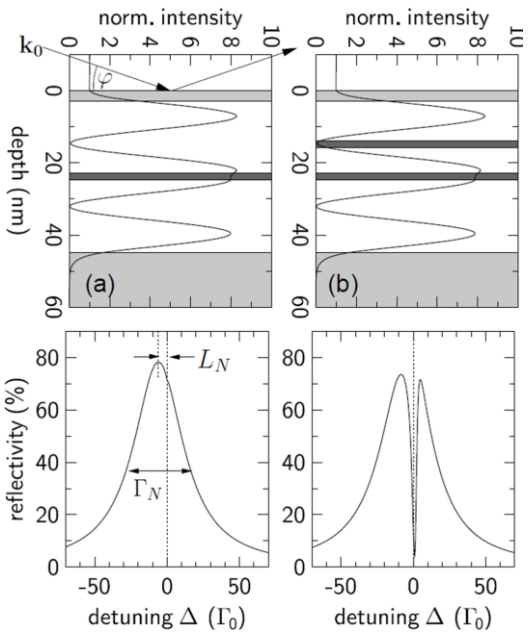
Electromagnetically Induced Transparency with Resonant Nuclei in a Cavity

R. Röhlsberger, H. C. Wille, K. Schlage, and B. Sahoo

Deutsches Elektronen Synchrotron DESY,Notkestr. 85, 22607 Hamburg, Germany

A planar cavity can be employed to prepare superradiant states of excited atoms that are coupled to the standing wavefield in a cavity mode. This principle has been applied recently to observe the collective Lamb shift L_N in single-photon superradiance from resonant ^{57}Fe nuclei that have been excited by pulses of 14.4 keV synchrotron radiation [1]. The ^{57}Fe atoms have been embedded as a single ~1 nm thick layer in the center of a cavity consisting of a carbon guiding layer sandwiched between two Pt layers acting as mirrors [2], see Fig. 1a.

Here we show that a planar cavity containing two ultrathin layers of resonant Mössbauer nuclei exhibits electromagnetically induced transparency (EIT) [3]. Nuclear resonant EIT occurs if the two layers are placed in a node and an antinode of the cavity mode, as shown in Fig. 1b. The interaction with the radiation field in the cavity lifts the radiative degeneracy of the nuclear levels: While the layer in the antinode exhibits strong superradiant enhancement of its decay width, the layer located in the antinode remains subradiant and thus corresponds to the metastable state in the three-level scheme of an EIT system. The radiation field in the cavity mixes these two levels and the resulting quantum interference eventually leads to a pronounced transparency at the exact resonance energy of the nuclei where the system is completely opaque otherwise.



We investigate nuclear resonant EIT for the 14.4 keV nuclear resonance of ^{57}Fe. First experimental results obtained at the PETRA III synchrotron radiation source at DESY (Hamburg, Germany) are presented [3].

References

[1] R. Röhlsberger, K. Schlage, B. Sahoo, S. Couet, and R. Rüffer, Science **328,** 1248 (2010).
[2] R. Röhlsberger, J. Mod. Opt. **57**, 1979 (2010).
[3] R. Röhlsberger, H.-C. Wille, K. Schlage, and B. Sahoo, Nature (accepted, 2011)