High-Quality Level-Crossing Resonances in a Cesium Vapor Cell for Applications in Atomic Magnetometry

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One of the simplest and most robust techniques in quantum magnetometry is based on zero-field level-crossing resonances (LCRs) in alkali-metal vapors. A standard scheme involves a single circularly polarized probe wave, while a transverse magnetic field is scanned to observe LCR in the vapor cell transmission. This scheme has successfully been implemented in miniature magnetic-field sensors for biomedical applications.

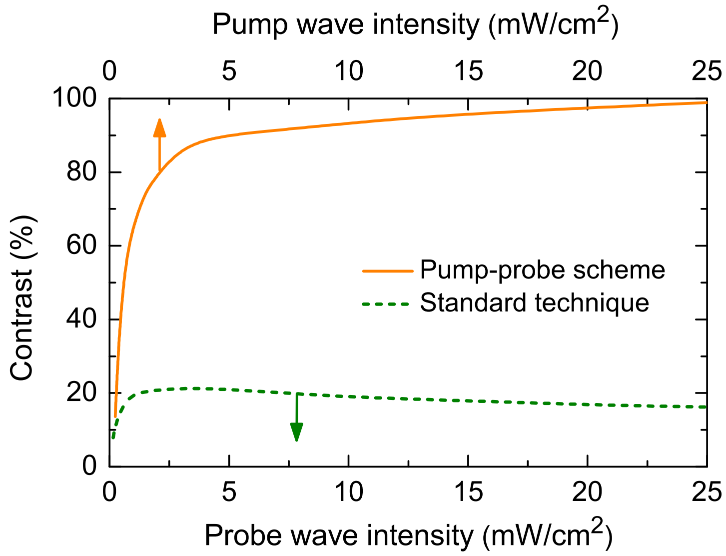

Figure 1: Contrast of level-crossing resonances in the standard Hanle single-beam configuration (dashed) and in the proposed pump-probe scheme (solid). $T_{\rm cell} \approx 60°$C, $d_{\rm beam} \approx 3$ mm.

Here we report on a scheme composed of pump and probe waves with opposite circular polarizations, exciting the level $F_g = 4$ in the Cs D$_1$ line. Besides the cesium vapors, a $5{\times}5{\times}5$ cm^3 cubic glass cell is also filled with neon as a buffer gas (130 Torr). A distinctive feature of the scheme is the observation of high-quality LCRs under the cell temperature that is much lower than in many other schemes ($\leq 60°$C). The comparison provided in the figure reveals the benefits of using the proposed pump-probe configuration against the standard one. The results can be applied in atomic magnetometry for developing low-power high-performance sensors. The work was supported by RFBR (20-52-18004) and Bulgarian National Science Fund (KP-06-Russia/11). We also thank Russian Science Foundation (17-72-20089).