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THESIS DEFENSE: Cavity-enhanced non-destructive measurements of atomic magnetism

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In this work we propose and demonstrate cavity-enhanced polarization rotation to detect magnetic effects in transparent media with greater sensitivity at equal optical disturbance to the atomic medium. We use the Jones calculus to compute the effective polarization rotation effect in a cavity containing a magnetic medium. We include the losses due to enclosure window or other sources. The results show that to measure polarization rotation collecting the transmitted light has advantages in terms of linearity and simplicity with respect to collecting the reflected light. We show also the description of a ``commensurate lattice'', to position the atoms at the anti-nodes of the probing light: this increases the atom-light coupling and therefore the cavity enhancement. The trapping light is also used to stabilize the cavity.

Then we describe the experimental realization of the cavity and we demonstrate the theory described by measuring the Faraday rotation in a Rb-87 atomic ensemble in the single-pass and cavity enhanced geometries. We observe the
enhancement given by the cavity in good agreement with the theoretical predictions. We also demonstrate shot-noise-limited operation of the enhanced rotation scheme in a small angle regime.

We conclude with the expected squeezing effect given by the cavity in a cold and ultra-cold ensembles. The cavity tested gives a measurement squeezing 5 dB larger with respect to the SP case.

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