Spin noise spectroscopy of a spin one system in and out of equilibrium

Joseph Delpy[1], Shikang Liu[1,2], Pascal Neveu[1], Fabien Bretenaker[1], Fabienne Goldfarb[1]

[1] Université Paris-Saclay, CNRS, Ecole Normale Supérieure Paris-Saclay, CentraleSupélec, LuMIn, Orsay, France

[2] East China Normal University, State Key Laboratory of Precision Spectroscopy, Shanghai, People's Republic of China

The optical spectroscopy of angular momentum fluctuations in atomic vapors, called spin noise spectroscopy (SNS), has been shown to reveal in a non-invasive manner the energy structure and part of the dynamics of the atomic ground-states [1,2]. However, atoms are usually treated as spins 1/2. We thus investigate the richer variety of spins dynamics occuring in spin-1 systems by performing SNS in a metastable helium vapor. In addition to the traditional Faraday rotation measurements, we record the ellipticity fluctuations of the probe beam. This allows to isolate additional degrees of freedom [3], revealed by extra features in the spin noise spectra (see fig.1(a)). We eventually show how out-of-equilibrium SNS in such systems can reveal the coupling of atoms and external fields (see fig.1(b)), with potential applications to the analysis of fluctuating magnetic fields.

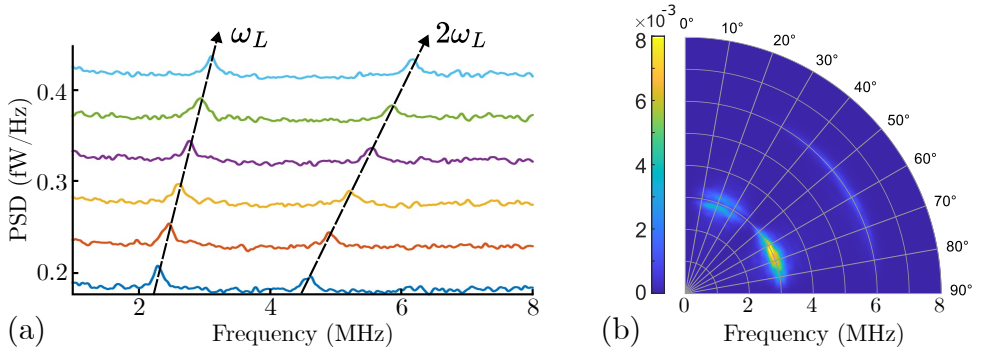

Figure 1. (a) Example of ellipticity noise spectra obtained near the D_0 transition of metastable Helium. The peak at twice the Larmor frequency ω_L is the signature of higher-order tensorial spin arrangement typical of spin-1 systems. (b) Simulated spin noise spectra driven by a randomly fluctuating magnetic field. The angular coordinates correspond to the direction of the light polarization with respect to the magnetic field.

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