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Magnetic resonance linewidth of alkali-metal atoms and systematic error of comagnetometer

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The investigation of magnetic-resonance linewidth is of fundamental importance in the field of magnetic-resonance physics and its diverse applications. Previous research has predominantly focused on the linewidth of alkali metal atoms within two distinct regimes: the spin-exchange relaxation-free (SERF) regime near zero magnetic field, and strong magnetic fields where Zeeman resonances are clearly resolved due to the quadratic Zeeman effect. However, the linewidth behavior in the unresolved-Zeeman-resonance (UZR) regime, which is commonly encountered in various magnetometer and comagnetometer applications, remains unclear.

By solving the master equation for alkali metal atoms under the rotating-wave approximation and weak-driving conditions, we reveal that the linewidth in the UZR regime is significantly influenced by the mutual coupling of quantum coherence between different Zeeman sublevels[1]. Leveraging this understanding of the linewidth, we present our recent findings on the systematic error in comagnetometers induced by small changes in the Rb resonance linewidth[2,3]. These results are expected to be highly beneficial in enhancing the long-term stability of comagnetometers.

References:

1. Tang, F. & Zhao, N. Magnetic-resonance linewidth of alkali-metal vapor in the unresolved Zeeman-resonance regime. *Phys. Rev. A* **111**, 013103 (2025).
2. Gao, G. *et al.* Stability improvement of nuclear magnetic resonance gyroscope with self-calibrating parametric magnetometer. *Phys. Rev. Applied* **21**, 014042 (2024).
3. Zhang, X., Hu, J., Xiao, D.-W. & Zhao, N. Frequency shift caused by nonuniform field and boundary relaxation in magnetic resonance and comagnetometers. *Commun Phys* **8**, 93 (2025).

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