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Cross-correlation spin noise spectroscopy of interacting multi-component spin systems LUYI YANG, DIBYENDU ROY, SCOTT CROOKER, NIKOLAI SINITSYN, Los Alamos National Laboratory — Interacting multi-component spin systems are ubiquitous in semiconductor spintronics; *e.g.* carrier-mediated ferromagnetism in magnetic semiconductors, or electronic spin coupling to nuclear spin baths. Traditionally, inter-species spin interactions are studied by experimental methods that are necessarily perturbative: *e.g.*, by intentionally polarizing or depolarizing one spin species and detecting the response of the other(s). Here, we show that multi-probe spin noise spectroscopy can reveal interspecies spin-spin interactions – under conditions of strict thermal equilibrium – by cross-correlating the stochastic fluctuation signals exhibited by each of the constituent spin species. We develop a theory for such noise cross-correlations in thermal equilibrium. As a proof of principle, we compare the results with an experimental study of a well-understood interacting spin system – a mixture of warm Rb and Cs vapors – by applying a new type of *two-color* spin noise spectroscopy [1,2]. Noise correlations directly reveal the presence of inter-species spin exchange interactions. Such non-invasive and noise-based techniques should be generally applicable to any multi-component spin system in which the fluctuations of the constituent components are detectable.

[1] D. Roy, L. Yang, S.A. Crooker, N.A. Sinitsyn, arXiv:1408.5399 (2014).
[2] L. Yang *et al.*, Nat. Comm. **5**:4949 (2014).

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