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Spin noise spectroscopy to probe quantum states of ultracold fermionic atom gases BOGDAN MIHAILA, SCOTT CROOKER, KRASTAN BLAGOEV, DWIGHT RICKEL, Los Alamos National Laboratory, PETER LITTLEWOOD, Cavendish Laboratory, Cambridge University, UK, DARRYL SMITH — Physical systems are often studied by measuring their response to an external perturbation. Measuring the intrinsic noise of a physical system can provide the same information as measuring its response to a perturbation, but noise spectroscopy measurements often disturb the physical system less strongly and scale more favorably with system size reduction. For quantum systems at very low temperature, noise from quantum fluctuations in the ground state of an observable that does not commute with the Hamiltonian can be used as a probe of the system properties. We describe the use of electron spin noise spectroscopy to probe the quantum states of ultracold fermionic atomic gases. The electron spin is not a good quantum number of the atomic gases and fluctuations of electron spin can be measured using optical Faraday rotation. We show that electron spin noise spectroscopy gives unique signatures for different models describing the interatomic interactions in the ultracold fermionic gases, can be used to probe the BCS/BEC crossover in these systems, and weakly disturbs the atomic gases. Measurements of spin noise in classical Boltzmann gases of alkali atoms are used to estimate the expected signal strength for spin noise measurements in ultracold atom systems and to show that these measurements are tractable.

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