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Spin wave spectrum in $CeRhIn_5$ under applied magnetic fields

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The phase diagram of $CeRhIn_5$ is in many ways a prototypical example of a heavy fermion superconductor; it is a heavy fermion antiferromagnet that can be tuned to a quantum critical point (QCP) via pressure, around which unconventional superconductivity emerges. Closer inspection reveals unusual behavior however; the interplay between magnetism and unconventional superconductivity is atypical, and electrical transport behavior and changes in the Fermi surface at the QCP are not in agreement with the prototypical spin-density-wave-type scenario. This is supported by our previous measurements of the spin wave spectrum at ambient pressure replicated by a simple frustrated $J_1 - J_2$ model based on localized Ce $4f$ electrons. We show that the addition of magnetic anisotropy and Zeeman terms to our Anisotropic Next-Nearest Neighbor Ising (ANNNI) model Hamiltonian quantitatively describes the spin wave spectrum under the application of magnetic field as obtained by neutron scattering, and reproduces the experimental magnetic phase diagram. Finally, this model predicts that the magnetic ordering vector should change logarithmically as a function of temperature across the high-field incommensurate-to-commensurate phase boundary, in agreement with our latest neutron diffraction results.

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