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Low-Energy Magnetic Excitations in the Itinerant Quantum Ferromagnet $ZrZn_2$ STEPHEN HAYDEN, EDWARD YELLAND, University of Bristol — High resolution de Haas-van Alphen measurements offer a powerful method to probe the low energy magnetic excitations in ferromagnets. Here we report measurements of the temperature dependence of the exchange splitting $\Delta(T)$ in the weak itinerant ferromagnet $ZrZn_2$ (Curie temperature $T_c = 28\,\mathrm{K}$) using the de Haas-van Alphen (dHvA) effect. Quantitative comparison with the magnetic moment $M(T)$ shows that longitudinal or 'Stoner' excitations dominate, in strong contrast with observations on metallic ferromagnets like Fe and Ni, where spin-waves dominate at low T. We ascribe the difference to the proximity of a quantum critical point (QCP) in $ZrZn_2$. The results are discussed in terms of a phenomenological Ginzburg-Landau model which includes effects of thermal fluctuations and enhanced fluctuations due to the nearby quantum critical point. We find that the model accurately predicts both the rate of collapse of $M(T)$ with T and the relative reduction of $\Delta(T)$ and $M(T)$. We suggest a picture for the evolving nature of magnetic excitations within the ferromagnetic state as the QCP is approached.

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