# Spin dynamics and magnon linewidth in the long wavelength limit in diluted magnetic systems

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Spin wave excitations in disordered magnetic systems has been one of the most widely studied fields in condensed matter physics for several decades now. However, a careful and extensive search reveals a longstanding controversy on one important aspect, which is the wavevector dependence of the spin wave intrinsic linewidth. Many different theories have predicted this dependence to be as varied as $\mathbf{q^3}$ to $\mathbf{q^7}$, but no general agreement has prevailed till now. We give here a detailed analysis of the low-temperature spin wave excitations in disordered (diluted) ferromagnetic systems and show that in the long wavelength limit the linewidth is in fact proportional to $\mathbf{q^5}$. This is in agreement with some previous theoretical studies on Heisenberg ferromagnets, which predicted a $\mathbf{q^{d+2}}$ dependence (d is the dimensionality). The linewidth is extracted from a proper finite size analysis of the magnon spectral functions, taking into account the effects of disorder and spin fluctuations. One of the primary difficulties in extracting the correct wave-vector dependence is the fact that the $\mathbf{q^5}$ behavior holds only for sufficiently small $\mathbf{q}$ values. This possibly explains the failure to observe this behavior experimentally, where it is often impossible to reach such small $\mathbf{q}$ values. In addition, we also demonstrate that evaluating the linewidth from the moments associated with the magnon spectral density is incorrect, as it leads to a linear dependence in $\mathbf{q}$.