Magnetic excitations in the random-exchange Ising system (Fe-Zn)F2 near the percolation threshold

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The diluted antiferromagnet (FexZn1-x)F2 has been extensively studied in the past as an ideal system for the studies of three-dimensional random-exchange Ising model. Previous neutron scattering studies of magnetic excitations of this system have revealed the following [1, 2]. For x=0.59 the spin-wave-like energy spectrum observed near q=0 changes to a form of localized excitations as q increases. The overall energy width and position of the spectrum at the zone boundary can be described by the local mean field (LMF) model. The spectrum from x=0.40 at q=0 consists of four evenly spaced excitation peaks. However, the overall structure is higher in energy than the predicted excitations of the LMF theory.

In order to clarify the total property of magnetic excitations of this system including the percolation threshold region (xp=0.24), we made high-energy-resolution inelastic neutron scattering measurements.

Two single crystals of x=0.25 (total weight 4.1g) were aligned with the c-axis vertical to the horizontal scattering plane. Measurements were performed using a horizontally-focusing analyzer on C1-1 spectrometer. The energy resolution varies from 0.08meV (FWHM) to 0.17meV as the energy transfer increases from 0 to 7meV with the final neutron energy fixed at Ef=3.1meV.

Figure 1 shows inelastic scattering intensity vs energy for x=0.25 measured at T=0.7K and various value of q. For all q values (from the zone center to the zone boundary) well resolved 6 peaks were observed. The position of each peak does not move with increasing q.

These features strongly suggest that the observed spectrum is attributed to the excitations of individual spins with various local environment. The bottom panel of Fig.1 shows the excitation spectrum of individual spins based on the LMF theory.

At T=10K no appreciable change was observed in the spectra. As increasing temperature the peaks gradually broaden and finally fade into a broad spectrum.
This shows that the system ”freezes” below T=10K.

[1] C. Paduani et al., Phys. Rev. B 50 (1994) 193.

[2] Y. W. Rodriguez et al., J. Mag. Mag. Mater. 310 (2007) 1546.

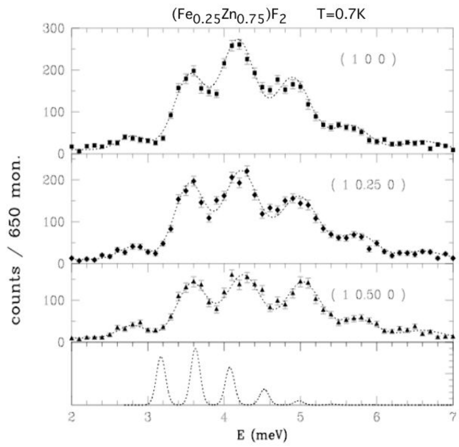

Fig. 1. The scattering intensity vs energy at T=0.7K measured at various q. The bottom panel is the LMF prediction.