Determination of Exchange Integrals J_1 and J_2 and Magnetic Surface-Anisotropy Energy in EuS from Standing-Spin-Wave Resonance(Physics)

Determination of Exchange Integrals J_1 and J_2 and Magnetic Surface-Anisotropy Energy in EuS from Standing-Spin-Wave Resonance

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The standing-spin-wave absorption spectrum in thin EuS films has been measured in the temperature interval 1.3-4.2 K. The dependence of the magnetization on temperature has been determined from the ferromagnetic-resonance field and compared with spin-wave theory. The results are well described by the exchange-parameter combination $(J_1+J_2)/k_B=(0.096\pm0.003)$ K. The temperature dependence of the exchange stiffness parameter $D(T)$ has been calculated including the contribution of a nonzero internal field. The experimental results have been analyzed taking the surface boundary conditions into account and correcting for the temperature and field dependence of H_1. The results show that the apparent temperature dependence of $D(T)$ arises almost entirely from the surface-anisotropy energy. The small observed variation $\Delta D(T)/D_0$ has been analyzed yielding $J_2/J_1=-0.57\pm0.05$. The results, expressed as $J_1/K_B=(0.214\pm0.026)$ K, $J_2/k_B=-(0.122\pm0.025)$ K are in essential agreement with the inelastic-neutron-scattering determination of Passell *et al.* but in marked disagreement with Swendsen's Green's-function theory and its application to the calculation of the ferromagnetic and paramagnetic Curie temperature. A comparison with other experimental determinations of J_1 and J_2 is made.

Effect of Magnetic Field on Sound Propagation near Magnetic Phase Transition Temperatures

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The anomalous ultrasonic attenuation and velocity variation caused by the critical fluctuation of spins near the Curie and Néel temperatures are theoretically investigated and found to be strongly affected by an application of magnetic field. In the random phase approximation, the attenuation coefficient is expressed in terms of a sum of the two terms; a cross term of the static spin polarization and the two-spin correlation function, and a product of the two-spin correlation functions. In the magnetic field, the former term has a positive contribution to the attenuation, since this term has a finite value only when the static spin polarization exists. The latter term decreases in the field, owing to the suppression of spin thermal fluctuations due to the magnetic field. The magnitude of the contributions from these terms depends upon temperature, the strength of magnetic field and the nature of the exchange interaction in magnetic materials. The theory explains various types of the field dependence of the attenuation observed in magnetic materials including MnP, Dy and MnF_2. A new attenuation peak found recently by Hirahara et al. in the paramagnetic phase of MnP under a magnetic field is