Linear and nonlinear susceptibility effects in Y$_2$Fe$_{17}$ and Er$_2$Fe$_{17}$

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When an ac magnetic field is applied to a magnetic material, several information can be obtained from the response of the material to the different external parameters: temperature, ac field amplitude, frequency, bias dc magnetic field.

Moreover, if the ac field is small enough, the ac magnetisation of the material can be expanded in power series of the magnetic field as:

$$M = M_0 + \chi_0 h + \chi_1 h^2 + \chi_2 h^3 + ...$$

where $M_0$ is the spontaneous magnetisation, $\chi_0$ is the linear susceptibility and $\chi_1, \chi_2, ...$ are the nonlinear components of the ac susceptibility. While $\chi_1$ is usually detected in the presence of a bias dc field, the third order susceptibility $\chi_2$ displays a peculiar behaviour around the magnetic transition temperature, which characterizes, better with respect than to the fundamental ac susceptibility, the kind of magnetic order of the system investigated. So, it is possible (i) to distinguish whether the material is a simple spin-glass or a superparamagnetic system, (ii) to detect the correct transition temperature and also (iii) to observe the possible existence of micro-inhomogeneities within the sample [1].

In this work we present the thermal dependence of the linear and nonlinear ac susceptibilities of the ferromagnetic Y$_2$Fe$_{17}$ and of the ferrimagnetic Er$_2$Fe$_{17}$ intermetallic compounds investigated as a function of the amplitude and frequency of the applied ac field. In both compounds, the change of sign at $T_C$ and the behaviour below and above the ferromagnetic or ferrimagnetic transition temperature are well explained in terms of divergence of the nonlinear susceptibility. Low temperature transitions detected by real and imaginary components of the fundamental ac susceptibility are related to the coupling of domain-wall dynamics and mobility defects. The thermal behavior of the linear and third order susceptibilities has been tentatively divided in different regions with different relaxation phenomena. Moreover, nonlinear effects due to the annealing procedure have been analyzed and discussed [2].

![Fig.1 - Temperature dependence of the real and imaginary components of nonlinear ac susceptibility in Y$_2$Fe$_{17}$ in the whole temperature range.](image)

References
