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Effect of Temperature Step Size on Calculating the Magnetic Entropy Change

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The magnetic entropy change, Δ*s*, is a key parameter in magnetocaloric research. The magnetic entropy change dictates the amount of heat a material may absorb or release upon a magnetic field change. This property may be characterised by indirect[1] or direct methods[2]. One of the indirect methods is the field integration of the derivative of magnetisation with respect to temperature. This calculation is based on a Maxwell relation $(\mathrm{d}s/\mathrm{d}H)_T = (\mathrm{d}M/\mathrm{d}T)_H$, where *s*, *H*, *T* and *M*, are entropy, magnetic field, temperature and magnetisation, respectively. However, due to the finite resolution of temperature and field in real experiments, this calculation will rely on a numerical approximation, which gives the equation $\Delta s(T_j,\Delta H_i) = \mu_0 \; \Sigma_i \; (M(T_{j+1},H_i) - M(T_{j-1},H_i)) \; / \; (T_{j+1} - T_{j-1}) \; \Delta H_i$, where μ_0 is the vacuum permeability. We have observed, in recent publications, e.g. [3,4], the lack of concern for the implications of this approximation. In this context, we study the effect of the temperature step, $\mathrm{d}T = T_{j+1} - T_j$, on the calculated Δ*s* for 3 different materials: Gd, $La_{0.67}Ca_{0.33}MnO_3$ and $La(Fe,Mn,Si)_{13}H_y$. We evaluate it by means of magnetisation measurements at different values of d*T*. We observe, for $La(Fe,Mn,Si)_{13}H_y$, that with a d*T* as large as 3.0 K $\Delta s_{max}(T,\Delta H=0.75\text{ T})$ may be ~25 % smaller than the one calculated from d*T*=1.0 K. This effect decreases for materials with smoother transitions, such as $La_{0.67}Ca_{0.33}MnO_3$ and Gd (~11 % and ~0.8 %, respectively), and for increasing fields.

Key Words: Magnetic entropy change, Maxwell relation.

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