Influence of magnetic field on the critical behavior of $La_{1-x}Ca_xMnO_3$ (x= 0.2, 0.3, 0.4)

P. Zhang[d*], P. Lampen[c], T. L. Phan[a], S. C. Yu[a], T. D. Thanh[b],
N. H. Dan[b], V. D. Lam[b], H. Srikanth[c], M. H. Phan[c]

[a]Department of Physics, Chungbuk National University, Cheongju 361-763, South Korea
[b]Institute of Materials Science, Vietnam Academy of Science and Technology, Hanoi, Vietnam
[c]Department of Physics, University of South Florida, Tampa, FL33620, USA
[d]School of Electrical & Electronic Engineering, Hubei University of Technology, Wuhan, 430068, China

The properties of the ferromagnetic to paramagnetic transition in polycrystalline manganites $La_{1-x}Ca_xMnO_3$ (x= 0.2, 0.3, 0.4) is presented in detail. The first order transition in $La_{0.7}Ca_{0.3}MnO_3$ is bordered by second order transitions in the neighboring $La_{0.8}Ca_{0.2}MnO_3$ and $La_{0.6}Ca_{0.4}MnO_3$ compositions. Analysis of the Landau–Lifshitz coefficients obtained from Arrott plots showed that while b(T) is uniformly negative in $La_{0.7}Ca_{0.3}MnO_3$, it changes from positive to negative values in different magnetic field ranges for $La_{0.8}Ca_{0.2}MnO_3$ and $La_{0.6}Ca_{0.4}MnO_3$, indicating that the behavior cannot be described within a single model under the application of a strong field. The Kouvel–Fisher procedure performed on the samples with continuous transitions over different ranges of fitting field confirmed tricritical exponents in $La_{0.6}Ca_{0.4}MnO_3$ but revealed that the critical exponents obtained for $La_{0.8}Ca_{0.2}MnO_3$ depend strongly on the choice of field range, shifting from values consistent with short range (3D Heisenberg/3D Ising) interactions to those approaching the tricritical mean field model. This observation is attributed to the influence of magnetic field on the coexistence of energetically close double-exchange and super-exchange ferromagnetic interactions in $La_{0.8}Ca_{0.2}MnO_3$.

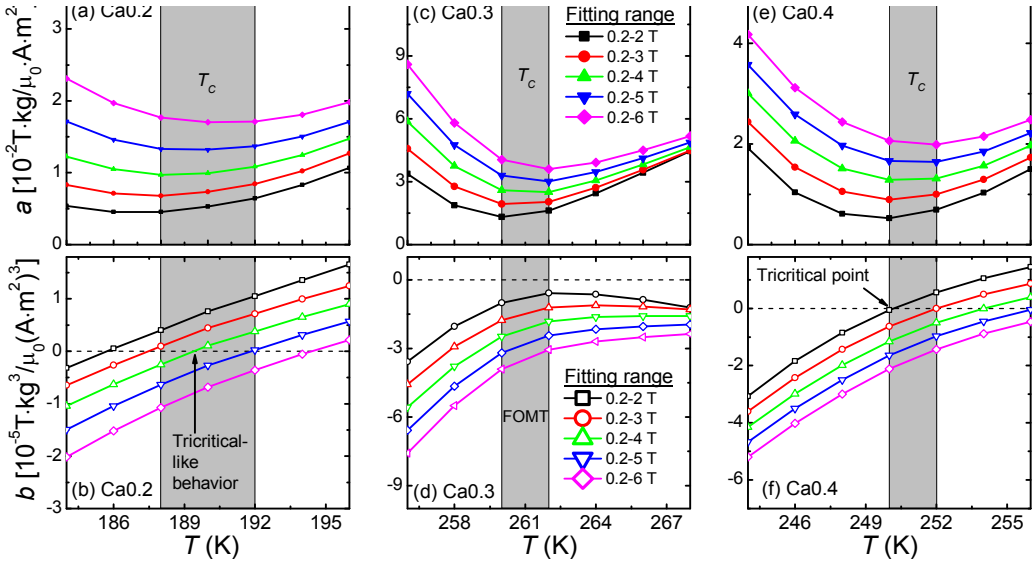

Fig. 1. a and b parameters in the Landau-Lifshitz equation of state obtained by fitting in different field ranges as a function of temperature in $La_{1-x}Ca_xMnO_3$.
The shadowed areas represent the temperature zone of T_C shifting with the applied field.