Anharmonic effects of constant measuring field in determination of susceptibility near phase transitions

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The low-frequency susceptibility diverges at the point of continuous phase transition. The inverse of the susceptibility then follows a *v* – shaped line. The slopes of this line below and above the phase transition: C_- and C_+ respectively, are called Curie constants. Whenever the phase transition obeys the mean field theory, the Curie constants do not depend on temperature and their ratio should amount to $C_-/C_+=2$. However, the ratio of Curie constants shows an astonishing variety of values even in the cases of phase transitions otherwise perfectly complying with the mean field predictions [1]. Thus, the reason for this discrepancy does not seem to reside in a non–classical critical behavior. In the present note the consequences of the constant measuring field *E* routinely applied in dielectric, magnetic and acoustic experiments are studied. Far enough from the phase transition the experimentally determined susceptibility $\chi_E = \dfrac{P(E)-P_s}{E}$ (where *P(E)* and P_s are the polarisations in the presence and without the field respectively) gives a correct approximation to the susceptibility $\chi = \left.\dfrac{\partial P}{\partial E}\right|_{E=0}$. The difference is, however, no longer negligible in the vicinity of phase transition, where anharmonic terms of free energy dominate. Fig. 1 exhibits the predicted behavior of the inverse static susceptibility in the simplest Landau theory with the free energy $F(T,P) = \frac{a}{2}(T-T_c)P^2 + \frac{B}{4}P^4 - EP$ for some values of the measuring field *E*. The Cole–Cole representation of the AC susceptibility expected for the same free energy at $T=T_c-2$ is represented in Fig. 2. The inset shows the plot of the free energy at $T=T_c-2$.

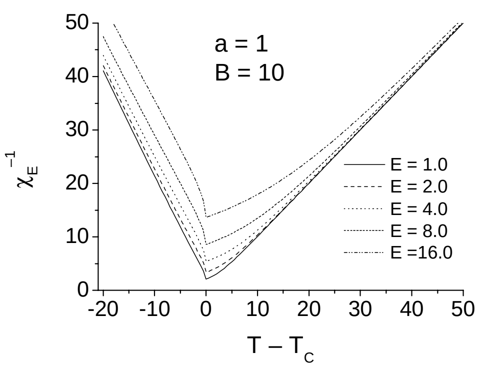

Fig. 1 Static susceptibility at various measuring fields E.

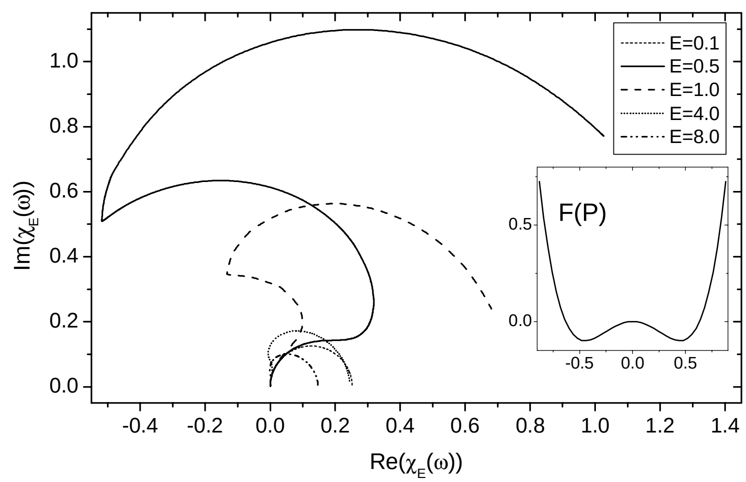

Fig. 2 Cole-Cole representation of AC susceptibility at T = T_C – 2. Free energy in inset.

[1] P. Carpentier, J. Lefebvre, R. Jakubas, W. Zając and P.Zieliński, Phase Transitions **67**, 571 (1999)