Critical Behavior of Ferroelectric SrTi\textsuperscript{18}O\textsubscript{3}

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SrTi\textsuperscript{16}O\textsubscript{3} (STO16) is considered to be a classical displacive soft mode system where the ferroelectric phase is suppressed by zero point fluctuations leading to quantum paraelectricity [1,2]. Observed ferroelectricity in SrTi\textsuperscript{18}O\textsubscript{3} (STO18) [3] is a consequence of a larger mass of \textsuperscript{18}O which reduces quantum fluctuations and allows the condensation of the polar soft mode [4].

Because of unusual values of critical exponents determined recently [5] in STO18 we have measured the spontaneous polarization and dielectric constant in the vicinity of \(T_c\) in order to clarify the nature of this transition. The STO18 single crystal sample with 94.7\% \textsuperscript{18}O was employed and measurements were performed along the crystallographic c axis.

In Fig. 1, we compare the experimentally determined temperature dependence of the square of the spontaneous polarization with the Salje theoretical curve [6] for \(\Delta \ll 1\). \(P_0^2 = 11.35\) (\(\mu\)C/cm\(^2\))^2 and \(T_c = 28.40\) K are the extrapolated value of the square of the spontaneous polarization at the zero temperature and the transition temperature, respectively. As the saturation at low temperatures was not observed, which means that the quantum effects in STO18 are negligible, parameters have values \(\Delta \ll 1\) and \(\eta = 0\), which consequently means that \(\beta = 0.5\). The ratio between the saturation temperature \(T_s\) and \(T_c\) was chosen to be \(T_s/T_c = 0.3\).

When approaching \(T_c\), the Salje formula transforms to the classical Curie-Weiss law, i.e. it gives \(1/\varepsilon \propto (T - T_c)\), which means that \(\gamma = 1\). The value of \(\gamma\) is close to 1 in the temperature range approximately 3 K < \(T - T_c\) < 7 K (see the inset to Fig. 2).

The determined values of critical exponents \(\beta\) and \(\gamma\) have classical mean field values, which means that we are dealing with the classical paraelectric to ferroelectric transition of the soft mode type in agreement with recent optical studies [4,7]. We can conclude that the Lyddane-Sachs-Teller relationship is obeyed in this system.

References