American Mineralogist, Volume 84, pages 1632–1640, 1999

A new explanation for the unusual critical behavior of calcite and sodium nitrate, $NaNO_3$

M.J. HARRIS*

ISIS Facility, Rutherford Appleton Laboratory, Chilton, Didcot, Oxfordshire, OX11 0QX, U.K.

ABSTRACT

The phase-transition behavior of both calcite and the isostructural compound $NaNO_3$ have long been thought to be anomalous. In particular, the β critical exponent for the orientational order-disorder transitions takes on a value close to tricritical behavior (β = 0.25) in both materials, and in $NaNO_3$ two crossovers to regimes where β = 0.22 and then β = 0.41 have been reported as T_c is approached. The most significant puzzle was why both materials should appear to be tricritical under ambient conditions of both pressure and the conjugate field. The experimental work on these materials is reanalyzed in the light of recent progress in understanding two-dimensional magnetic ordering. It is shown that the experimental results are fully consistent with the two-dimensional XY model. Unlike the tricritical model, this gives a simple physical explanation for the disordering process and observed critical exponents. In particular, it supports other recent experimental findings from calcite and $NaNO_3$ that the orientational order-disorder occurs through continuous planar rotations of the carbonate and nitrate groups, rather than discrete jumps.