

Abstract Submitted  
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**Thermodynamics of Ferrotoroidic Materials** AVADH SAXENA, Los Alamos National Lab., TERESA CASTAN, ANTONI PLANES, University of Barcelona — The three primary ferroics, namely ferromagnets, ferroelectrics and ferroelastics exhibit corresponding large (or even giant) magnetocaloric, electrocaloric and elastocaloric effects when a phase transition is induced by the application of an appropriate external field ( $E$ ,  $H$  and stress). Recently the suite of primary ferroics has been extended to include ferrotoroidic materials in which there is an ordering of toroidic moments in the form of magnetic vortex-like structures, examples being  $\text{LiCo}(\text{PO}_4)_3$  and  $\text{Ba}_2\text{CoGe}_2\text{O}_7$ . We formulate the thermodynamics of ferrotoroidic materials. Within a Landau free energy framework we calculate the toroidocaloric effect by quantifying isothermal entropy change (or adiabatic temperature change) in the presence of an applied toroidic field ( $G = E \times H$ ) when usual magnetization and polarization may also be present simultaneously.

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