**Modeling of Magnetic Shape Memory Alloys and Symmetry**  
  
Magnetic shape memory alloys (MSMAs), also referred to as ferromagnetic shape memory alloys (FSMAs), have more recently emerged as an interesting extension of the class of active materials. In addition to the strains originating from temperature- or stress-activated conventional shape memory behavior, large strains can be produced in these alloys under the application of magnetic fields. The macroscopically observable field-induced strains in MSMA are caused either by the microstructural reorientation of martensitic variants or by phase transformation from the austenitic phase to martensitic phase.

A free energy based constitutive formulation is considered for MSMAs. Internal state variables are introduced whose evolution describes the transition from the reference state to the deformed and transformed one. We impose material symmetry restrictions on the Gibbs free energy and on the evolution equations of the internal state variables. Discrete symmetry is considered for single crystals. The constitutive magnetization response for MSMA is highly nonlinear with the magnetic field. A boundary value problem where Maxwell’s equations of the magnetostatic problem are coupled with the nonlinear constitutive behavior is solved using finite element analysis. The numerical simulation reveals localization zones of the field variables, which appear due to loss of ellipticity of the magnetostatic problem. Local symmetries through Lie group analysis and the conservation laws associated with the field equations and the constitutive relations for such a material system will be discussed at the end.