

## **Cardiomagnetism: Modeling the nonlinear magneto-elastic interactions**

Luis Dorfmann, Tufts University

The seminar focuses on recent theoretical work concerning the nonlinear coupling of mechanical and magnetic effects in so-called magneto-sensitive materials. We first give an overview of magnetic fields in the human body, in particular of the magnetic heart activity. The talk summarizes the equations of magnetostatics and the magnetic forces and couples acting on the material. The main objective is to combine the nonlinear theory of elasticity with the magnetostatic theory in order to provide a general framework of nonlinear magnetoelastic interactions. The linear theory of magnetoelasticity neglects the magneto-mechanical coupling in the sense there is no change in the mechanical properties due to the magnetic field and no change in the magnetic properties due to mechanical deformations. The mechanical balance equations are modified to incorporate the magnetic contributions and are used to catalogue a variety of forms of the general constitutive law for a nonlinear magnetoelastic material, first in Eulerian form. Lagrangian versions of the magnetic field and the magnetic induction field vectors are then introduced, leading to particularly simple forms of the constitutive laws. Material symmetry is discussed in general form, and explicit representations for the constitutive equations of a nonlinear isotropic magnetoelastic material are obtained. We apply the theory to a number of representative boundary-value problems.