Abstract for an Invited Paper
for the MAR10 Meeting of
The American Physical Society

Dynamics of particle suspensions subjected to biaxial and triaxial magnetic fields: vortex mixing and isothermal magnetic advection[1]

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We have developed several new magnetic methods for stimulating functional fluid flows. These methods depend on adding magnetic particles to the fluids and subjecting them to spatially uniform, time-dependent magnetic fields. The key aspect is the nature of the particles and the way in which the direction and magnitude of the magnetic field changes with time. The first of these new methods, which we call *vortex field mixing*, gives rise to vigorous fluid mixing that occurs uniformly throughout the sample volume, eliminating the stagnation regions that plague standard methods. This method is ideally suited for microfluidic devices, but can used for mixing at any scale. The second method involves the stimulation of organized fluid flow fields that can efficiently transfer heat and mass along any desired direction. This *isothermal magnetic advection* has the functionality of natural convection, but because the effect does not depend on gravity or the existence of a thermal gradient, it can be used to stimulate flow where natural convection fails. It is possible to cool under or beside a hot object, in the microgravity environments of space, and without any concern over the magnitude of the thermal gradient.

[1]Sandia is operated by Sandia Corporation, a Lockheed Martin Company, for the U.S. Dept. of Energy (DOE) under Contract No. DE-AC04-94AL85000. This work was supported by the Division of Materials Sciences and Engineering, Office of Basic Energy Sciences.