Abstract Submitted
for the DFD10 Meeting of
The American Physical Society

Interaction of two magnetic particles in a rotating magnetic field
TAE GON KANG, Korea Aerospace University, MARTIEN HULSEN, JAAP DEN TOONDER, PATRICK ANDERSON, HAN MEIJER, Eindhoven University of Technology — A three-dimensional direct simulation method was employed to solve flows with paramagnetic particles suspended in a non-magnetic fluid. The numerical scheme enables us to take into account both hydrodynamic and magnetic interactions between particles in a fully coupled manner, regardless of the shape of particles. As for the magnetic forces working on particles, the results obtained from our scheme are compared with those from the dipole-dipole interaction model. We confirm the critical angle separating the nature of magnetic interaction with the angle obtained by the point-dipole approximation. Dynamics of interacting two particles in a rotating field is investigated, demonstrating the capability of the method to tackle general problems. Chain dynamics is highly influenced by the Mason number, the ratio of viscous force to magnetic force. Below a critical Mason number, the chain of two particles rotates as a rigid body following the field, but with a phase lag. Above the critical Mason number, however, the chain rotates in overall sense but with an oscillatory motion on top of the rotation. It is also found that the magnetic susceptibility of particles is a factor with an influence on the chain dynamics. At one representative value of the susceptibility, we compared our numerical results with experimentally observed data.

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Date submitted: 07 Aug 2010 Electronic form version 1.4