Monday, October 1  
3:00 pm  
1008B Digital Media Center  
Louisiana State University  

Dynamic monopoles in ferromagnetic nanoparticles

The competition between different magnetic forces at the nano-scale gives rise to unexpected phenomena. When the size of ferromagnetic nanoparticles becomes comparable to the fundamental magnetic length scales, topological constraints play a crucial role in the magnetization process, and a reversal cannot be completed by the well-known curling instability without violating topological constraints [1]. Irreversibility is closely associated with a change in the topology of the magnetic texture in ferromagnetic particles. Specifically, full magnetization reversal can only be achieved by the pair-creation of topological point defects, otherwise known as hedgehogs or Bloch points. These defects move rapidly through the solid and generate emergent electric fields with solenoidal character, in analogy to the magnetic field generated by a moving electric charge (shown in the figure to the right, taken from [1]). The solenoidal character of the emergent fields highlights the monopole nature of the defects. Importantly, these defects move with unprecedented speeds in excess of 1000 m/s, faster than any other known magnetic object, and the emergent fields have a magnitude on the order of megavolts per meter, comparable to the dielectric breakdown in vacuum. These results emphasize the importance of topological arguments in magnetic systems and support possible applications with dynamic emergent fields.