Vortex cutting and recombination processes in a mesoscopic superconductor

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The non-linear dynamics of vortex loops, generated by the inhomogeneous stray field of a magnetic dipole on top of a current-carrying mesoscopic superconductor, is studied within the time-dependent Ginzburg-Landau theory. We show that vortex loops with profound 3D features undergo vortex cutting and recombination processes, yielding periodic voltage vs. time characteristic signals from where these novel vortex phases can be read. We also claim that standard vortex detection techniques are applicable here to observe cutting and recombination, as in these processes, vortices arise in surfaces where they were not found prior to the application of the external current.