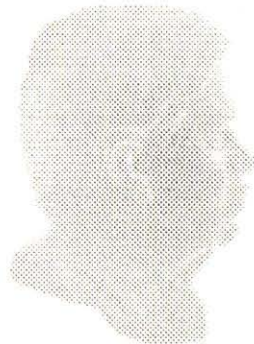
National Academy of Sciences of Ukraine
Bogolyubov Institute for Theoretical Physics
Young Scientists Council



III Young Scientists Conference

Modern Problems of Theoretical Physics

December 21-23, 2011
Kyiv, Ukraine

Program & Abstracts

Kyiv 2011

Structure of the Bloch point in spherical nanoparticle

O. V. Pylypovskyi[1], D. D. Sheka[1], Yu. B. Gaididei[2]

[1]*Taras Shevchenko National University of Kyiv, Faculty of Radiophysics,*
64 Volodymyrs'ka str., 01601, Kyiv, Ukraine
[2]*Bogolyubov Institute for Theoretical Physics, NAS of Ukraine,*
14-b Metrolohichna str., 03680, Kyiv, Ukraine
engraver@univ.net.ua

Bloch point is the simplest 3D topological singularity in micromagnetism [1]. Such a singularity naturally appears during the process of the vortex polarity switching i. e. the reversal of the vortex core magnetization (polarity) [2]. The ultrafast switching of the vortex polarity is a key point for usage them as elements of high-speed magnetic random access memory.

We consider different types of Bloch Points (BP_q^p) in a spherical sample of radius R, which are described by the singular distribution of normalized magnetization $\mathbf{m}(\mathbf{r}) = (\sin\Theta\cos\Phi, \sin\Theta\sin\Phi, \cos\Theta)$ of the form: $\Theta \quad p\vartheta - \alpha$, $\Phi \quad q\varphi - \gamma(r)$, where $\mathrm{r} = (r, \vartheta, \varphi)$ is a radius-vector, $p = \pm 1$, $=\alpha \quad 0, -\pi$, and $q = \pm 1$. Such BP_q^p singularities correspond to different observed structures during vortex polarity switching [2, 3]. The BP_q^p does not form a remanent state in a spherical particle; we stabilize it by external gradient field $\mathbf{H} = h\mathbf{r}$. We study the equilibrium distribution γr : analytically for small h and numerically for a wide range of fields; its value is mainly defined by competition between magnetostatic and external field. Without field γ = arcos(-p/4) for q=1 which provides smaller energy than previous estimations [4].We also study BP_q^p singularities in a spherical layer. The critical field, which stabilized the Bloch point decreases when the inner radius increases. All analytical results are confirmed by spin-lattice simulations [5].

This work was supported by the Grant of the President of Ukraine No. F35/538-2011.

[1] E.Feldtkeller,H.Thomas, Zeitschrift fur Physik B Cond. Matt., **4**, 8(1965).
[2] A. Thiaville et. al, Phys. Rev. B, **67**, 094410 (2003).
[3] X. J. Xing et al, Appl. Phys. Lett., **93**, 202507 (2008).
[4] W. Döring, J. Appl. Phys, **39**, 1006 (1968).
[5] Kyiv National Taras Shevchenko University high-performing computing cluster http://cluster.univ.Kyiv.ua