Talk:

The Fokker-Planck equation and its application to error rates in spin torque MRAM

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Abstract:

Spin torque MRAM is a promising new memory technology which promises very fast average switching times. However, there are large fluctuations in the switching time, which it is important to understand in order to make a reliable MRAM. The statistical study of this switching requires the application of the Fokker-Planck equation to calculate the evolution of the probability distribution of the magnetization direction. We will describe the FP equation, and since it is normally applied to conservative systems, we discuss its generalization to non-conservative spin torque. We have done numerical and exact analytic calculations of non-switching probabilities, as well as stochastic simulations. The results are quite consistent. They lead to an analytic form for the non-switching probability which is useful for fitting experimental data and for guiding the search for modifications in materials and structures that may have improved switching reliability.

Fokker-Planck theory has been extended to include non-conservative current-induced spin torque

The equation can be numerically solved in the uniaxial (perpendicular magnetization) case.

There is an exact solution which is accurate for currents >~ 1.5 Icrit, and gives an analytic form for the long-time tails of PNS.

For the in-plane case, numerical solutions with approximate boundary conditions are accurate for large currents

Also for the in-plane case, there is an analytic solution which is accurate for currents >~ 1.5 Icrit and gives an analytic form for the long time tails.

In a usefull device, we want to switch the magnetization by applying a current pulse of a few microseconds' duration.

Write Error Rate

= probability of not switching must be SMALL (~ 10^{-9} ?)

Need to calculate evolution of probability distribution.