Design of the Artificial Energy-Efficient Spintronic Neurons

Bakgrund

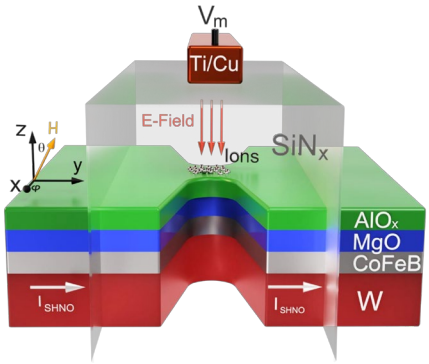
Neuromorphic oscillatory networks, including human brains, provide great performance in cognitive tasks, e.g. speech and image recognition or complex data analysis. Since modern semiconductor technology lacks the key elements of such networks – artificial "neurons", scientists are looking for other fundamental principles for their implementation.

Spintronics, which operates with magnetic moment of electron, is armed by tiny oscillators (~100nm in size), known as spin-Hall nano-oscillators (SHNOs), which are perfect candidates to become artificial neurons.

Recently, researchers at GU discover a new energy-efficient tuning mechanism of SHNOs, in which the key parameters of oscillators can be strongly tuned, with negligible energy consumption, using a voltage-induced electric field, which opens a way to the new functionality of the spintronics "neuromorphic networks".

Problembeskrivning

The aim of the project is to design novel building blocks of spintronics neuromorphic networks, by employing electrical and micro-magnetic simulations of SHNOs, followed by the numerical analysis of the excited magneto-dynamics. The first part of the project will study novel magneto-dynamics phenomena in the oscillator itself by varying the layout and physical properties of both the magnetic layer and the voltage gate. The second part will investigate voltage-controlled coupling between SHNOs to bring "synaptic" functionality.



Arbetssätt

Electrical simulations will be conducted in COMSOL Multiphysics software. Micro-magnetic simulations will be done in Mumax3 - GPU-accelerated PDE solver and will rely on a unique setup that exists at GU – Ragnarok cluster. The data analysis will be conducted employing Python language and/or Wolfram Mathematica.

Gruppstorlek och Målgrupp

3-6 students. Students from F, E or GU-physics may apply. The optimal set is 2 groups working in parallel.

Handledare

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