Skyrmion Memory

Efficient Method to Write Skyrmion Bits in Magnetic Storages

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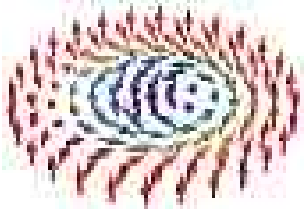
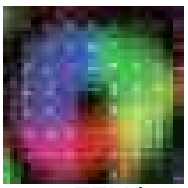
1. Introduction

- Topological spin vortices called ***skyrmions*** in chiral magnets have numerous advantageous properties for application to information carriers in next-generation magnetic memories.
- A new efficient method to create skyrmions on a thin-film specimen by applying an ***E***-field without Joule-heating energy losses.

2. Magnetic skyrmions with electric polarizations in chiral magnetic insulator

2.1 Magnetic Skyrmion



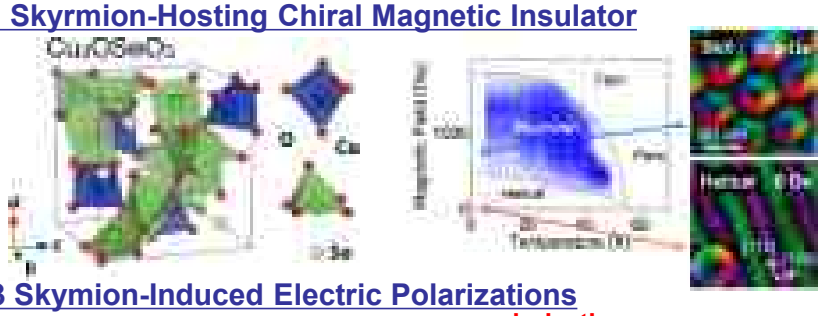


Lorentz TEM image

- **Nanometric small size (3-100 nm)**
  ⇒high information density
- **Topologically protected stability**
  ⇒robust against thermal agitations
- **Low fields to drive motions**
  ⇒low energy consumption
- **High transition temperature**
  ⇒high operational temperature

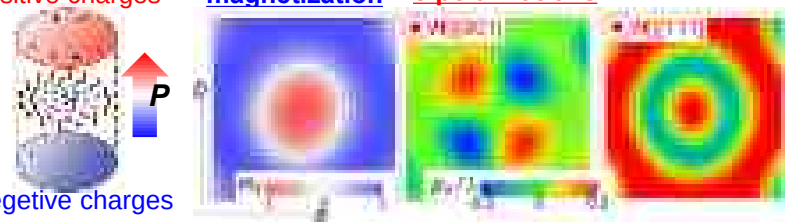
⇒ Promising for memory application

2.2 Skyrmion-Hosting Chiral Magnetic Insulator



2.3 Skymion-Induced Electric Polarizations

positive charges **magnetization** **e.polarizations**

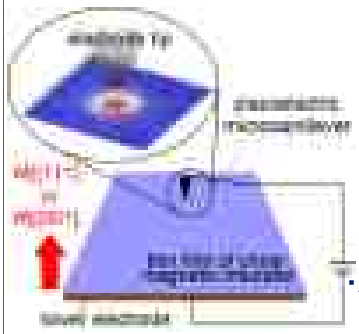


negetive charges

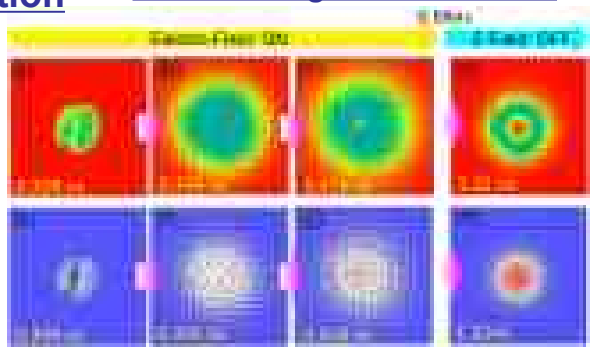
・Skyrmion induces electric polarizations, which renders the system magneto-electric and enables us to create and manipulate skyrmions with ***E***-fields.

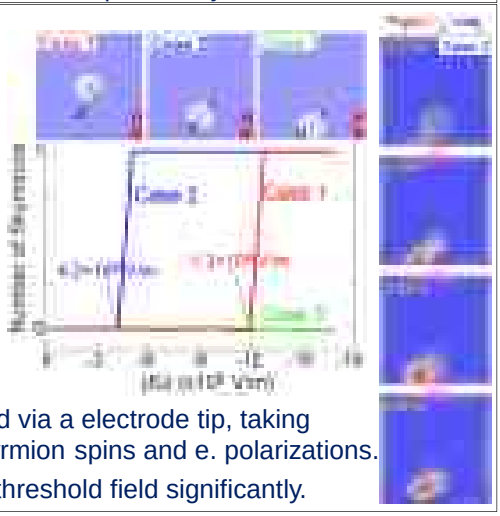
3. Proposal & Simulation

3.1 Proposed Setup



3.2 Micromagnetic Simulation





・A skyrmion bit is created by local application of an ***E***-field via a electrode tip, taking advantage of the magnetoelectric coupling between skyrmion spins and e. polarizations.

・Application of the ***E***-field at a sample edge reduces the threshold field significantly.

4. Application Examples

- **High-performance magnetic memory**
  - Ultra-high density,
  - Ultra-low energy consumption
  - Non-volatile, - Robust, -Random access
  - No mechanical elements

Skyrmion race-track memory

Skyrmion MRAM

5. Patent Licensing Available

Patent No.: WO2016/158230

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