

FUNDING PROGRAM FOR NEXT GENERATION WORLD-LEADING RESEARCHERS

Project Title: Ultralow-power information processing device based on spin-wave spin current

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1. Background of research

Current electronics technology uses a flow of electron charge, a charge current, for information transmission and computation. However, a charge current causes the Joule heating, which gives rise to serious energy loss. This has been a critical problem in recent years and thus a new concept of electronics based on novel physical principle should be established for future energy-saving electronic devices.

2. Research objectives

The objective of this research project is to realize a ultralow-power information processing device based on a spin current, a flow of electron spins in a solid. Electrons have charge and spins. Although a charge current, a flow of electron charge, flows only in metals and semiconductors, a flow of spins, a spin current, can flow even in an insulator not only in metals and semiconductors. This project will develop physics of ultimate low-loss devices based on a spin current in an insulator by exploring the ways of controlling the spin current.

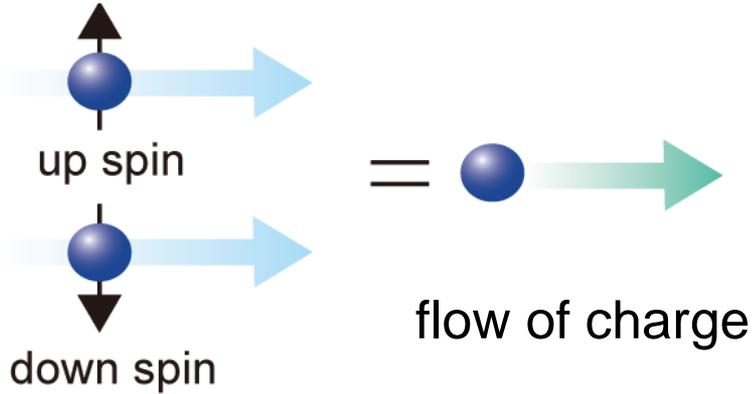
3. Research characteristics (incl. originality and creativity)

This project leads the field of spintronics by developing functionalities of spin currents in an insulator. Utilization of a spin current in an insulator promises low-energy electronic devices which cannot be realized in metals or semiconductors.

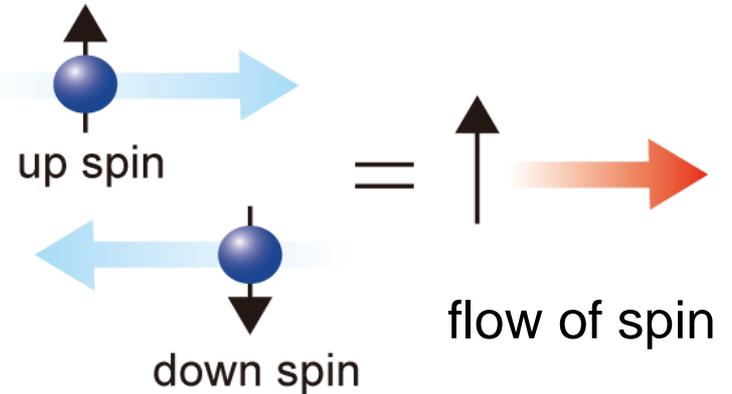
4. Anticipated effects and future applications of research

Ultralow-power information processing in an insulator solves the problem of energy loss due to the Joule heating that the electronics technology faces today. This enables environmentally-friendly electronics devices and will contribute the realization of energy-saving technologies.

Charge current

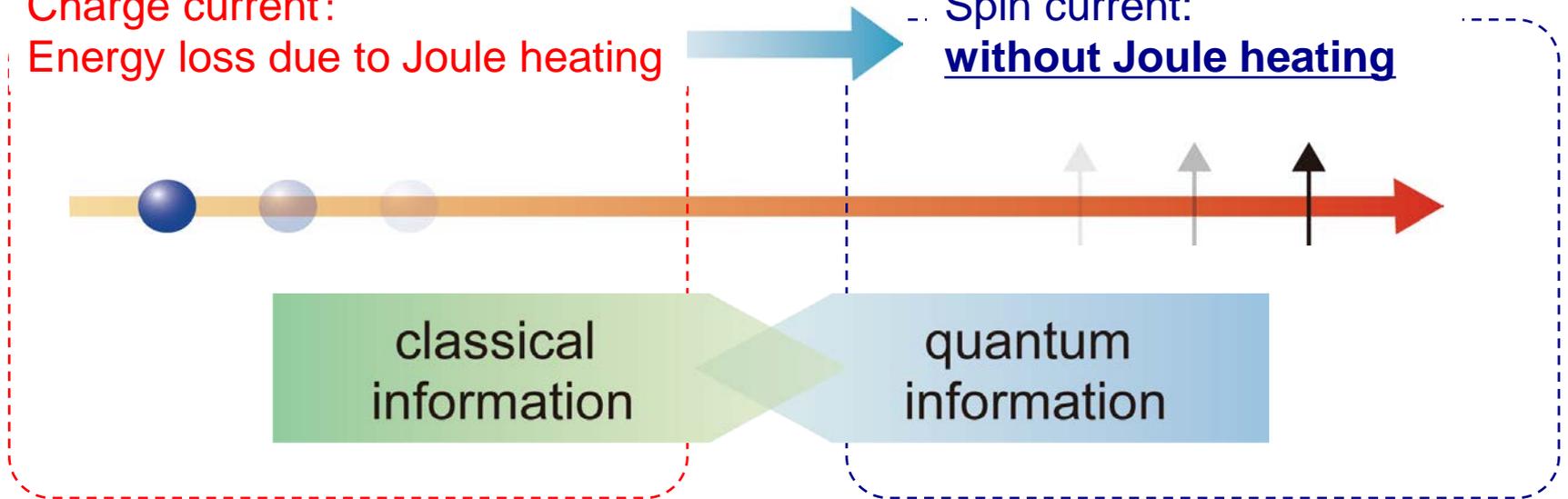


Spin current



Charge current:
Energy loss due to Joule heating

Spin current:
without Joule heating

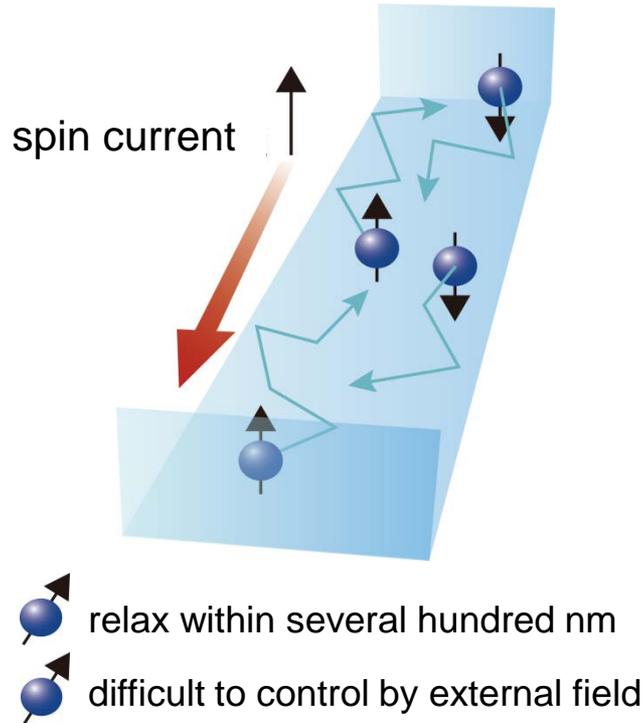


Ultralow-power information processing device

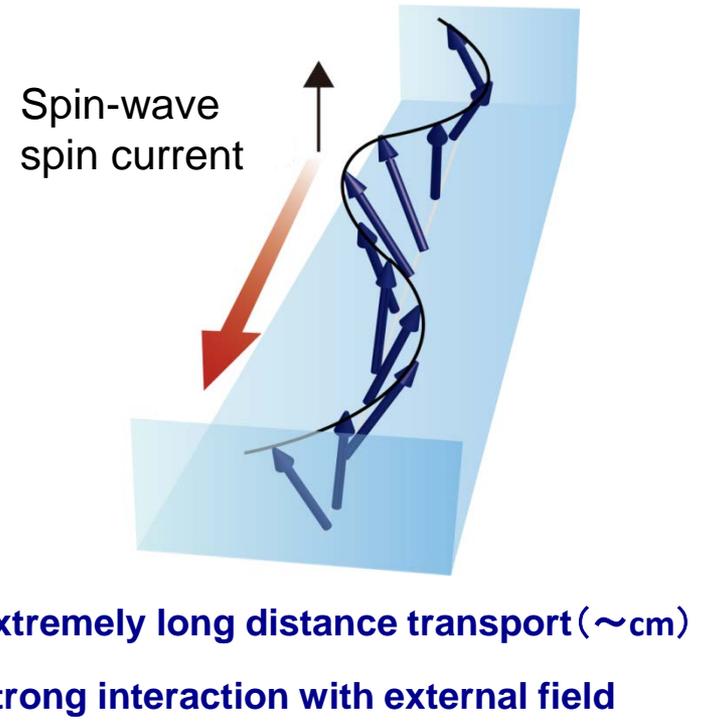
Spin currents flow even in an insulator

magnetic insulator : insulator for charge current, conductor for spin current

Conduction-electron spin current



Spin-wave spin current



OBJECTIVE: realization of ultralow-power information processing device based on spin-wave spin current