INTRODUCTION

High spin single molecule magnets

• Applications:
  • Nanoscale magnetic memory
  • Quantum computing

• Features:
  • Distinct magnetization states
  • Store memory in “spin up” or “spin down” states

What is Quantum Tunneling of Magnetization (QTM)?

(a) Thermal relaxation
(b) Thermally assisted tunneling
(c) Quantum tunneling tunneling

• Configurations of particles described by quantum numbers.
• Zeeman energy level is degenerate at zero magnetic field.
• Applied magnetic field alters energy and breaks degeneration.

Zeeman graph shows the splitting of an energy level as a magnetic field is applied.

Classic physics: An electron’s different orientations are permanently separated and are assumed to remain in the same orientation.

Quantum physics: In a region, occurring around a zero magnetic field, electron may switch orientations and tunnel through the energy barrier into a different energy state. This transition is called quantum tunneling.

METHOD

Magnetization measurements under pulsed magnetic fields

Steps:
• Sample concentration preparation
• Cooling system (temperature variable cryostat with He system)
• Signal detection (standard induction method with pick-up coils)
• Pulsed field + steady field (to control the initial spin state) measurements

RESULTS

Quantum tunneling found:
• Rapid change in magnetization with zero magnetic field

CONCLUSIONS

In quantum tunneling-region, quantum tunneling occurs even though temperature is larger than ten times the tunneling gap
• Quantum tunneling produced by fast-sweeping fields may be possible at higher temperatures

ACKNOWLEDGEMENTS

Research conducted at the Institute for Materials Research, Tohoku University, Japan