

# Nonlinear Properties of Magnetic Materials



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## Research Topics

- Measurement of linear and nonlinear susceptibilities, and magnetization curve
- Data analysis and parameter identification based on hysteresis models
- Monte Carlo simulation of magnetic lattice system

## Research Seeds

### ● Hysteresis Measurement by Lock-in Amplifier

Figure 1 shows a schematic of the measurement system. The system includes a Lock-in amplifier (LIA), a function generator (FG), a bipolar power supply (BPS), and a personal computer. To supply an AC current to the primary coil, the BPS is driven by the FG. The BPS also provides a reference signal to LIA by shunt resistance. By connecting the signal output from the secondary coil to the LIA, we measure the in-phase component  $V'_{n-1}$  and the out-of phase component  $V''_{n-1}$  of the fundamental and harmonics of the output voltage  $V$ . Both  $V'_{n-1}$  and  $V''_{n-1}$  are measured sequentially using a harmonic detection function of the LIA. Then a BH loop can be reconstructed from  $V'_{n-1}$  and  $V''_{n-1}$  by inverse Fourier transform. Figure 2 shows minor asymmetric BH loops measured at various field amplitudes. Because the LIA can extract a signal with a known carrier wave from an extremely noisy environment, this system is suitable for measuring BH loops of micro-magnets.

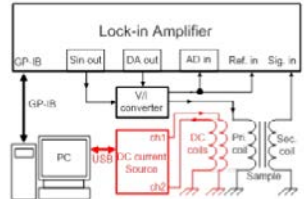


Fig. 1. Schematic of measurement.

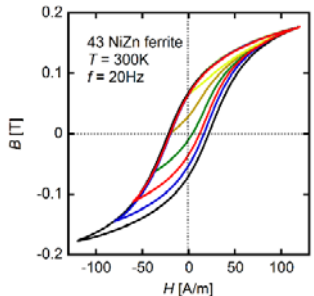


Fig. 2. Asymmetric BH loops.

### ● Research on Halbach-type Spin System

We have studied the feasibility and specific properties of a new type spin system, which is analogous to the Halbach array of ferromagnets, using Monte Carlo simulation.

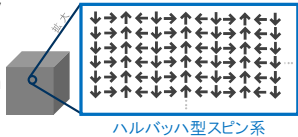


Fig. 3. Halbach-type spin.

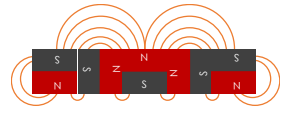


Fig. 4. Halbach array.

## Related Technology

- Numerical Analysis
- Instrumentation and Measurement
- Research on Phase Transition and Critical Phenomena