Majority logic gate for 3D magnetic computing

For decades now, microelectronic circuits have been exclusively built from transistors. An alternative way is to use nano-scaled magnets for the realization of digital circuits. This technology, known as nanomagnetic logic (NML), may offer significant improvements in terms of power consumption and integration densities. Further advantages of NML are: non-volatility, radiation hardness, and operation at room temperature. Recent research focuses on the three-dimensional (3D) integration of nanomagnets. Here we show, for the first time, a 3D programmable magnetic logic gate. Its computing operation is based on physically field-interacting nanometer-scaled magnets arranged in a 3D manner. The magnets possess a bistable magnetization state representing the Boolean logic states $0$ and $1$. Magneto-optical and magnetic force microscopy measurements prove the correct operation of the gate over many computing cycles. Furthermore, micromagnetic simulations confirm the correct functionality of the gate even for a size in the nanometer-domain. The presented device demonstrates the potential of NML for three-dimensional digital computing, enabling the highest integration densities.