北京大学物理学院凝聚态物理与材料物理所

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Magnetic wafer based magnonics

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：Magnonics, which involves unified information storage and processing using magnons—spin waves that are collective quasi-particle excitations of magnetic moments—offers a promising platform for next-generation, energy-saving information technology. Many magnonic structures have been proposed and studied in a range of designs, but a unified and scalable magnonic platform is still lacking.

Here, we propose the design of magnonic integrated circuits that can in principle perform a large number of magnonic operations. [1] We use domain walls and surface anisotropy stripes as two different spin wave waveguides. The magnonic integrated circuits that we design include a single square magnetic wafer, which is analogous to a silicon wafer. We experiment with yttrium iron garnet thin film magnetic wafers of several sizes (roughly a few thousand nanometers on a side). Since the magnetic texture of our circuits can be easily modified, our magnonic hardware architecture is reprogrammable, unlike most present-day information-processing architectures. Using this new architecture, we design the simplest magnonic component, a spin wave diode that admits only the unidirectional propagation of spin waves. We find that the bound spin wave states in a domain wall become chiral and are spatially separated depending on their propagation direction, which enables us to realize the diode effect for spin wave transport. Furthermore, we demonstrate that the function of the spin wave diode is easily altered from forward-transmitting to reverse-transmitting by simply moving domain walls via current-induced spin-transfer torque. Our magnonic architecture opens up new pathways for realizing a pure spin wave computer.

：Jiang Xiao received his B.S. in Physics from Peking University in 2001, and Ph.D. in Physics and M.S. in Applied Mathematics from Georgia Institute of Technology in 2006. After performing postdoctoral research in the Kavli Institute of NanoScience at Delft University of Technology in The Netherlands, he joined Fudan University in 2009 as associate professor, and has been professor since 2012. His research is on the theoretical condensed matter physics, and focuses on spintronics, including spin transport in magnetic nanostructures, magnetization dynamics, parametric pumping, spin wave excitation, magnonics etc.

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联系人：俞大鹏　教授　　邮箱：yudp@pku.edu.cn

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