Spin thermoelectric microscopy of magnetic skyrmions

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The magnetic skyrmion is a nanoscale topological object characterized by the winding of the magnetic moments, appearing in magnetic materials with broken inversion symmetry [1]. Because of its low current threshold for driving, the skyrmions have been intensely studied toward novel memory and storage devices, where the skyrmions act a career of information [2-4]. Their emergence and dynamics have been studied by using a variety of real-space microscopy methods, such as electron-beam, X-ray, and visible light spectroscopies and magnetic-force and scanning tunneling microscopies. In this work, we demonstrate a new method for imaging magnetic skyrmions; we show that the skyrmions can be visualized via thermoelectric signals of spin-caloritronic phenomena in combination with focused heating.

In the experiment, we applied a local temperature gradient to a metallic multilayer system and mapped the magnitude as well as the direction of the thermoelectric currents reflecting the local magnetic moment of the system via the spin-caloritronic effects [5-7], leading to the thermoelectric imaging of in-plane magnetic texture of the Néel skyrmions. This non-destructive method also enables the observation of skyrmion dynamics under driving current pulses, thus being a complementary and useful method for future development of skyrmion devices.

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