A path to new nanofluidic devices applying spintronics technology

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Researchers in the ERATO Saitoh Spin Quantum Rectification Project in the JST Strategic Basic Research Programs have elucidated the mechanism of the hydrodynamic power generation using spin currents in micrometer-scale channels, finding that power generation efficiency improves drastically as the size of the flow is made smaller.

In a microchannel, the flow takes on a state referred to as laminar flow, where a micro-vortex-like liquid motion is distributed widely and smoothly throughout the channel. This leads to properties that are more suitable to miniaturization, and an increase in power generation efficiency. Group leader Mamoru Matsuo, et al., predicted the basic theory of fluid power generation using spin currents in 2017, and in this present study, the researchers experimentally demonstrate the fluid power generation phenomenon in the laminar flow region. As a result of experiments, they confirm that in the laminar flow region, energy conversion efficiency was increased by approximately 100,000 times.

The characteristics of the spin fluid power generation phenomenon in laminar flows that they elucidate in this research are that an electromotive force proportional to flow velocity can be obtained, and that conversion efficiency increases as flow size decreases. Also, whereas hydroelectric power generation (also known as fluid power generation) and magnetohydrodynamic power generation require additional equipment such as turbines and coils, the phenomenon in the research requires almost no additional equipment, both inside and outside of the flow channel. Due to these characteristics, application to spintronics-based nanofluidic devices such as liquid metal flow cooling mechanisms in fast breeder reactors or semiconductor devices, as well as application to flowmeters that electrically measure micro-flows, can be hoped for.

More information: R. Takahashi et al, Giant spin hydrodynamic generation in laminar flow, *Nature Communications* (2020). DOI: 10.1038/s41467-020-16753-0

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