知の物理学研究センター

ipi seminar

Institute for Physics of Intelligence

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「Fluctuations in Mesoscopic Systems」

２０19年7月８日(月)　15時００分～16時００分

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Since 1980s mesoscopic systems have been serving as an ideal test stage to investigate quantum scattering problems, because the quantum transport through a single site can be probed by electric measurements in a tunable way. Usually, researchers mainly investigate the current (or the conductance) that is the average number of electrons that pass through the system for a finite time. On the other hand, the fluctuation of the current, namely the fluctuation of the number of electrons passing through it, conveys us very unique information.

As an interesting example I discuss the "spin shot noise". In 1918, Schottky showed that the electric flow in a vacuum tube fluctuates and the resulting current noise spectral density is proportional to the unit of charge and to the mean current. This is the shot noise, the direct result of the discreteness of the electron charge. As an electron possesses spin as well as charge, one may ask how the discreteness of electron spin affects the current fluctuation. Although such "spin shot noise" has been discussed theoretically in various contexts [1-6], it has never been proven experimentally.

Here we demonstrate the detection of shot noise induced by nonequilibrium spin accumulation in a lateral all-semiconductor spin valve device. This proves the relevance of the above concept of spin shot noise [7]. By using the Landauer-Büttiker formalism, we successfully extracted charge and spin currents and charge and spin noise and found that the spin degree of freedom is preserved in electron tunneling. Recently, we discuss the dynamics of the spin current in the high-frequency quantum regime [8]. Given the importance of shot noise in various fields, especially in device technology and mesoscopic physics, spin shot noise could serve as a unique probe to explore nonequilibrium electron transport.

In addition, in this seminar I would like to describe our ongoing research plan to detect "magnetic" fluctuations, which could reveal the relevance of the machine learning in mesoscopic systems.

References

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