Elliptic power generation and storage are indispensable for our lives. Although nuclear power plants generate a huge amount of energy, the most part is displaced away by the heat flow. To enhance its efficiency, the thermoelectric material is one of plausible candidates. We study such functional materials emerging from the electronic internal degrees of freedom. Since the spin Seebeck effect is induced by the spin-orbit interaction (SOI), we study the SOI of Fe in Au by high metal by a magnetic quantum Monte Carlo (QMC) simulation of a realistic multiorbital Anderson impurity model. We show that the SOI is strongly renormalized by the quantum spin fluctuation. We can explain why the giant SHE in Au is sensitive to impurities in recent experiments, while it is not visible in the anomalous Hall effect. In addition, we show that the SHE is strongly suppressed by the Coulomb correlation effect. Based on this picture, we can explain the discrepancy in the calculated orbital angular moment for Fe in Au by an onset of a spin gap.

In addition, we theoretically show a novel route to obtain giant room temperature SHE using a topological superconductor. The effect is robust to impurities due to the non-trivial topology of the electronic band structure. Our results provide a potential pathway to realize a topological superconductor with a giant SHE at room temperature.

Enhanced pair correlations near oxygen dopant in cuprate superconductor

Recent experiments on Bi-based cuprate superconductors have revealed an unexpected enhancement of the pairing correlations near the interstitial oxygen dopant. In this study, we propose a possible mechanism - based on local screening effects - by which the oxygen dopants modify the electronic parameters within the CuO$_2$ planes and strongly increase the superconducting coupling $\lambda$. This enhancement is due to the observation of the spin Seebeck effect that is universally present in a global spin current, and predict that the substrate condition affects the observed signal.

In addition, we formulate a linear response theory of the spin Seebeck effect [4]. Our approach focuses on the collective magnetic excitation of spins, i.e., magnons. We show that the magnonic spectrum provides a new qualitative and quantitative understanding of the spin Seebeck effect observed in the magnetic insulator.

References