



物理工学科セミナー

日時： 8月6日（木） 16:00 – 17:00

場所： 葛飾キャンパス研究棟8F第1セミナー室

Speaker : Prof. Jacek Herbrych

Affiliation : Institute of Theoretical Physics,
Wrocław University of Science and Technology (Poland)

Title : **Electronic correlations driving chirality-induced spin selectivity**

Abstract :

Chirality-induced spin selectivity (CISS) describes the emergence of spin-polarized electron transport through chiral molecules, even in the absence of ferromagnetic order. Since many organic molecules are composed mainly of light elements, their intrinsic spin-orbit coupling is usually too weak to explain the large spin polarizations observed experimentally, especially at elevated temperatures. We propose that strong electron-electron interactions offer a natural mechanism for this effect.

We study low-dimensional helical molecular models in which competing hopping processes, together with interaction-driven double-exchange and superexchange mechanisms, generate non-collinear helical spin correlations. These correlations produce partially spin-polarized single-particle bands, corresponding to p-wave magnetism: a coupling between momentum and spin that is driven primarily by magnetic exchange rather than by spin-orbit coupling. Using density-matrix renormalization group, cluster perturbation theory, and Monte Carlo simulations, we show that even very weak spin-orbit coupling can select the orientation and handedness of these correlation-induced spin structures.

Importantly, long-range magnetic order is not required. Short-range non-collinear spin correlations are sufficient to yield strong spin selectivity, and the resulting polarization can persist at temperatures well above the bare spin-orbit scale. Our results therefore suggest that CISS in organic helical molecules can arise from the interplay of molecular chirality, Coulomb interactions, and correlation-driven spin textures. This mechanism provides a many-body explanation for robust spin-selective transport and offers a direct connection to experiments on chiral molecules, biomolecules, and molecule-substrate interfaces.

The talk will be based on recent preprint arXiv: cond-mat/2605.30240