Determination of topological invariants in optical lattices

Tomasz Szołdra[1], *Krzysztof Sacha*[1], *Arkadiusz Kosior*[1]

[1] *Instytut Fizyki imienia Mariana Smoluchowskiego, Uniwersytet Jagielloński, ulica Profesora Stanisława Łojasiewicza 11, PL-30-348 Kraków, Poland*

Ultracold atoms in optical lattices form a clean quantum simulator platform to examine topological phenomena and test exotic topological materials. In this talk we propose an experimental scheme to measure Chern number of two-dimensional multiband topological insulators with bosonic atoms. We show how to extract the topological invariants out of a sequence of time-of-flight images applying a phase retrieval algorithm, used commonly e.g. in diffraction microscopy, to Bose-Einstein Condensate matter waves. By simple numerical simulations of experiments with ultracold atoms, we illustrate advantages of using bosonic atoms as well as efficiency of the method with two prominent examples of topologically non-trivial models: the Harper-Hofstadter model with an arbitrary commensurate magnetic field and the Haldane model on a brick-wall lattice. Robustness of the method against experimental imperfections (imaging system resolution, noisy data and excitations in the ultracold system) is analyzed. We find out that the proposed method is feasible for use in a real experiment.