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Measuring Chern Numbers with Cold Atoms: From 2D to 4D Quantum Hall Physics

In this talk, I will describe how Bloch bands with non-trivial topology can be engineered and probed in cold-atom systems. I will first briefly describe a scheme by which the topological Chern number has been extracted from a Bose gas trapped in a 2D modulated optical lattice [1]. I will then explain how this scheme can be extended to access 4D quantum Hall physics using the concept of synthetic dimensions [2]. In particular, I will present a proposal for measuring the second Chern number, an emblematic topological invariant associated with 4D Bloch bands [3].

[1] Measuring the Chern number of Hofstadter bands with ultracold bosonic atoms, M. Aidelsburger, M. Lohse, C. Schweizer, M. Atala, J. T. Barreiro, S. Nascimbène, N. R. Cooper, I. Bloch, N. Goldman, Nature Physics 11, 162–166 (2015)

[2] Synthetic gauge fields in synthetic dimensions, A. Celi, P. Massignan, J. Ruseckas, N. Goldman,
I. B. Spielman, G. Juzeliunas, and M. Lewenstein, Phys. Rev. Lett. 112, 043001 (2014)

[3] Four_Dimensional Quantum Hall Effect with Ultracold Atoms, H. M. Price, O. Zilberberg, T. Ozawa, I. Carusotto, N. Goldman, arXiv:1505.04387