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Artificial gauge fields and chiral edge states for ultracold fermions in synthetic dimensions

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I will report on very recent experiments performed at LENS with ultracold 173Yb Fermi gases in artificial gauge fields. We have engineered Raman transitions between different 173Yb nuclear spin states to synthesize an effective lattice dynamics in a finite-sized "extra dimension," which is encoded in the internal degree of freedom of the atoms [1]. By using this innovative approach, we have realized synthetic magnetic fields for effectively-charged fermions in ladder geometries with a variable number of legs. Direct imaging of the individual legs allowed us to demonstrate the emergence of chiral edge currents and to observe edge-cyclotron orbits propagating along the edges of the system [2], thus providing a direct evidence of a fundamental feature of quantum Hall physics in condensed-matter systems.

[1] A. Celi et al., Synthetic gauge fields in synthetic dimensions, Phys. Rev. Lett. 112, 043001 (2014).
[2] M. Mancini et al., Observation of chiral edge states with neutral fermions in a synthetic Hall ribbon, preprint arXiv:1502.02495 (2015).