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Spin-orbit interaction and topological states in spin 3/2 cold atomic gas

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The feasibility of manipulating a Fermi gas of cold atoms with spin $s > 1/2$ in a specially designed optical potential enables studying a new kind of topological insulators, described by a two band model where cold fermionic atoms with spin $s=3/2$ occupy a two dimensional optical lattice where spin orbit coupling is relevant. The pertinent time-reversal invariant Hamiltonian is an 8×8 matrix in $[\text{spin}] \times [\text{particle-hole}]$ spaces, whose spectrum and topological properties are remarkably distinct from those encountered for spin $1/2$ fermions. Specifically, on each edge of the 2D sample there are *two pairs of oppositely propagating helical states*. The two states in each pair move along the same direction, but they are protected against scattering with each other: they have different quantum numbers and different dispersion: (E_1 proportional to k and E_2 proportional to k^3). Strikingly, the corresponding bulk topological numbers are $Z_1=2$ and $Z_2=0$. Thus, the ubiquitous bulk-edge correspondence is broken here because the group velocity (and hence the conductivity) associated with the second edge state vanishes at $k=0$.

Biography

Yshai Avishai (PhD at Weizmann institute), is a professor of theoretical condensed matter Physics at Ben Gurion University, Beer Sheva Israel. He is a fellow of the American Physical Society, and during 2008-2014 he served as a Divisional Associate Editor for Physical Review Letters. In 2014 he was an Outstanding Referee for APS journals. Professor Avishai served as head of the Physics Department at Ben Gurion University, as head of the Ilse-Katz Center for Nanotechnology, as member of the Judging Committees for Israel prize in Physics and the Emet prize for exact Sciences. He is the author of 235 papers in high level journals including Physical Review Letters and Nature, and an author of three books in Physics. Professor Avishai occasionally serves as Faculty Member at NYU-Shanghai University, and he is an affiliated professor (2017) of the Yukawa Institute of Theoretical Physics at Kyoto Japan. He visited and worked in numerous institutes around the world, including Argonne National Laboratories, Lyon, Saclay, Orsay, Heidelberg, Tokyo, Kyoto, Hokkaido and others. Professor Avishai holds also a second degree in Economics and speaks numerous languages including French and Japanese. He is also an amateur Piano player.

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