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Presentation ”Energy levels in a 2D spin-dependant optical lattice”

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Abstract: “In this study the energy levels of a 87Rb atom in a 2D spin dependent optical lattice are examined. Four counter-propagating laser beams produce a periodic scalar potential. As shown by Le Kien et al. [1], polarizing the beams by 45° results in an additional, spin dependent vector potential, that can be expressed through a fictitious magnetic field B_fic. The spectrum of energy levels is analyzed as a function of the external magnetic field B_ext, in lattice cells of various n x m sizes, with either Dirichlet (DBC) or periodic (PBC) boundary conditions. It is found that avoided crossing between multiplets of eigenstates occurs only for cells larger than 1 by 1 with DBC. Szulim et al. [2] also observed level crossing in a 1 by 1 DBC cell of a honeycomb lattice and suggested hexagonal symmetry as the cause. Rectangular cells are studied by varying the angle between the laser beams and it is shown that even with the loss of rotational symmetry, avoided crossing does not occur with PBC or in a 1 by 1 cell with DBC. Furthermore, eigenstates are discovered in DBC cells, with energies lying outside the bands computed for a PBC cell. Analysis of the probability density of their wave functions reveals that they are hinge states. It is further demonstrated how the states localized near the Dirichlet walls tend to have higher energies than corresponding states localized in the center of the cell. [1] F. Le Kien et al., European Physical Journal D 67 92 (2013) [2] P. Szulim et al., New Journal of Physics 24, 033041 (2022)”

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