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Synthetic gauge fields in synthetic dimensions[1] GEDIMINAS JUZELIUNAS, JULIUS RUSECKAS, Vilnius University, Lithuania, IAN SPIELMAN, Joint Quantum Institute, NIST, USA, ALESSIO CELI, PIETRO MASSIGNAN, MACIEJ LEWENSTEIN, Institute of Photonic Sciences, Barcelona, Spain — Recently a general strategy has been put forward to extend the dimension of optical lattices by employing atomic internal degrees of freedom acting as an extra dimension [1]. Here we demonstrate that by employing atoms in a standard 1D optical lattice and including an "extra dimension" obtained by laser-assisted transitions between the atomic sub-levels in the ground state manifold, one can effectively engineer an extended 2D lattice with a non-trivial magnetic flux. The flux is generated by a combination of the ordinary tunneling in the real space and the laser-assisted tunneling in the extra dimension, the latter being characterized by the complex amplitudes. A distinctive feature of the proposed scheme is a formation of the sharp boundaries in the extra dimension, a feature which is difficult to implement in the real-space tunneling between the atoms in optical lattices. The boundaries of the extra dimension can be closed down using additional laser-assisted transitions. This leads to the realization of the fractional (Hofstadter butterfly-type) spectrum in a remarkably simple manner.

[1] O. Boada, A. Celi, J. I. Latorre, and M. Lewenstein, Phys. Rev. Lett. 108, 133001 (2012).

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