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Engineering synthetic lattices with driven optical lattices[1]

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The concept of synthetic dimensions or synthetic lattices - where a set of internal or external states of a particle can be resonantly coupled together to form the sites of an effective tight-binding model - has enabled the recent development of new capabilities in the engineering of novel Hamiltonians in atomic, molecular, and optical systems. We describe how a set of linear momentum states of atomic matter waves can be resonantly coupled together by Bragg laser fields to form large, tunable synthetic lattices. Such simultaneous driving by multiple Bragg laser fields can alternatively be described as a temporal variation of the phase and amplitude of a periodic lattice potential. We describe how this method of lattice driving can allow for the spectroscopic engineering of effective tight-binding models with tunable disorder and topology, and how native atomic interactions in this system can give rise to correlated synthetic lattice dynamics. Finally, we discuss future prospects and generalizations of these techniques.

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