Dynamics of multicomponent Bose-Einstein condensates on two- and three-dimensional optical lattices

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Exact solutions to the mean field equations of motion are constructed for multicomponent Bose-Einstein condensates on square, rectangular and simple cubic optical lattices. For two condensates on a rectangular optical lattice, we find temporally-periodic solutions in which the optical lattice is divided into two sublattices, and the condensates oscillate back and forth between these sublattices. For a square optical lattice, a solution is found in which single condensate moves in a checkerboard vortex-antivortex array. We also obtain fascinating solutions for two condensates in which the square optical lattice is divided into a total of four sublattices, and the condensates move cyclically between these sublattices. Stationary solutions of high symmetry are constructed for two, three and four condensates on a simple cubic optical lattice. Finally, the stability of the solutions in two dimensions is probed thorough numerical integrations of the mean field equations of motion.