Formation of vortex superlattice and Bloch domains in a rapidly-quenched and fast-rotating antiferromagnetic spinor Bose-Einstein condensate

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By solving the stochastic projected Gross-Pitaevskii equation, we investigate the dynamics of an $F = 1$ spinor Bose-Einstein condensate of ^{23}Na during the rotating evaporative cooling. We find that, during the quench, the condensates described by the order parameter $\boldsymbol{\Psi} = (\Psi_1, \Psi_0, \Psi_{-1})$ grow up but in the meantime, quantized vortices nucleate in all three components of the spinor BEC. When the rotating cloud reaches equilibrium at very low temperatures, vortices of each component would closely bind up in pairs and then arrange themselves into some particular spatial structures rather than the conventional triangular Abrikosov lattice. Considering each tightly bound vortex pair as a single entity, and connecting the center-of-mass locations of these pairs, we then find that the vortex pairs in each Ψ_i form a square lattice as a response to the external rotation, when $|\Psi_1|^2 = |\Psi_0|^2 = |\Psi_{-1}|^2$. Furthermore, by stacking up lattices for all spin components, we observe that all three kinds of vortices are paired up to form three interwoven square lattices. Consequently, the overall structure can be regarded as a square superlattice, namely, a lattice with basis, which is made up of six vortices, two for each component. Additionally, the corresponding local spin textures of the spinor BEC are studied. Our numerical calculations indicate that the spin textures, whose projection on the plane perpendicular to the rotating axis forms domains of staggered magnetic moments, can always be decomposed of spin spirals of the Bloch type of domain walls along two orthogonal directions on the rotating plane.