Vortex molecules in thin films of layered superconductors

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Both the equilibrium and transport properties of the vortex matter are essentially affected by the intervortex interaction potential. In isotropic bulk superconductors this potential is well known to be repulsive and screened at distances larger than the London penetration depth λ. As a result, in perfect crystals quantized Abrikosov vortices form a triangular lattice. In thin films of anisotropic superconductors this standard interaction potential behavior appears to be strongly modified because of the interplay between the long-ranged repulsion predicted in the pioneering work by J. Pearl and the attraction caused by the tilt of the vortex lines with respect to the anisotropy axes. This interplay results in a new type of vortex arrangement formed by finite-size vortex chains, i.e., vortex molecules. Tilted vortices with such unusual interaction potential form clusters with the size depending on the field tilting angle and film thickness or/and can arrange into multiquanta flux lattice. The magnetic flux through the unit cells of the corresponding flux line lattices equals to an integer number N of flux quanta. Thus, the increase in the field tilting (or varying temperature) should be accompanied by the series of the phase transitions between the vortex lattices with different N. The similar scenario should be realized in strongly anisotropic BSCCO high T_c superconductors where in tilted field a crossing lattice of Abrikosov vortices and Josephson vortices appears.