Self-dual Josephson junction arrays: quantum dissipation and the quantum Hall effect

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Quantum dissipation and the quantum Hall effect are studied in a self-dual Josephson junction planar array (JJA) in the presence of commensurate offset charges and magnetic field frustration. The quantum phase model of JJA is mapped at low energy into a $U(1) \times U(1)$ mixed Chern-Simons Landau-Ginzburg theory consisting of disorder fields associated with electric and magnetic charges. The dual theory viewpoint offers a new insight into the study of the superconducting and insulating phases in JJA systems. I explore the interplay between the emergence of condensates in this model and intrinsic quantum dissipation effects. I evaluate the electromagnetic response functions of the system and I find, among other things, that in the presence of commensurate electric and magnetic frustrations, bound objects made up of electric and magnetic topological excitations are formed, and their condensation leads to the Hall effect. This effect is robust in the presence of quantum dissipation which originates from the production of internally generated gapless bosonic excitations. The ensuing longitudinal and transverse resistivities are found to be finite and universal, and satisfy a relation analogous to that found in the QHE of two-dimensional electron systems.