Josephson superconductivity in 2D Luttinger Liquid

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The exact self-dual theory of coupled Luttinger chains identifies particle-particle and particle-hole interchain channels generated under renormalization. The same physics may be viewed as a Coulomb gas of charge-monopole composites whose Aharonov-Bohm statistical phase kills the second-order linear response and promotes composite pairing.
Starting from that exact two-chain input, we construct both a two-chain cluster mean-field embedding for a two-dimensional array and a spinful many-chain superconducting extension. The cluster construction keeps one adjacent pair of chains exact, embeds it into self-consistent particle-particle and particle-hole source fields, and yields a self-dual double-sine-Gordon problem whose pinned relative mode coarse-grains to an anisotropic compact 2 + 1D sine-Gordon theory. The spinful continuation identifies the superconducting field as a singlet charge-2e pair on each chain and the microscopic tunneling-pair observable as a Josephson-like bond amplitude between neighboring chains.