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Engineering exotic phases for topologically protected quantum computation: Emulating quantum dimer models[1] A.F. ALBUQUERQUE, H.G. KATZGRABER, M. TROYER, G. BLATTER, ITP ETHZ — Motivated by recent interest in engineering topologically ordered phases for achieving fault-tolerant quantum computation, we analyze an implementation of a quantum dimer model on the triangular lattice using an array of Josephson junctions [L. B. Ioffe *et al.*, *Nature* **415**, 503 (2002)]. Using the numerical Contractor Renormalization (CORE) technique, we are able to derive in an unbiased way an effective Hamiltonian describing the low-energy physics of the underlying Bose Hubbard model on the Josephson junction lattice. Our results show that resonances and interactions with three or more dimers have to be included in order to obtain an optimal set of junction capacitances and currents. We discuss the effects of these higher-order terms on the topological dimer liquid phase which is required for fault-tolerant quantum computation. Attempts to suppress higher-order dimer operators can only be attained if the junction's capacitances and currents are far beyond values obtainable with current technology. An alternative implementation based on cold-atoms loaded into optical lattices is also considered, but in this case the absence of sizable interactions is a major obstacle. Our results suggest that the emulation of topological phases in quantum devices can only be a viable approach if special attention is paid to the design and engineering limits.

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