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Implementing quantum gates through scattering between a static and a flying qubit GUILLERMO CORDOURIER-MARURI, Cinvestav, Department of Applied Physics, Cordemex 97310, Merida, Mexico, FRANCESCO CICCARELLO, Universit'a degli Studi di Palermo, CNISM, I-90128 Palermo, Italy, YASSER OMAR, Universidade Tecnica de Lisboa, P-1200-781 Lisbon, Portugal, MICHELANGELO Z, Universit'a degli Studi di Palermo, Palermo, Italy, ROMEO DE COSS, Cinvestav, Department of Applied Physics, Cordemex 97310, Mérida, Mexico, SOUGATO BOSE, UCL, Department of Physics and Astronomy, London WC1E 6BT, UK — We investigate whether a two-qubit quantum gate can be implemented in a scattering process involving a flying and a static qubit. We focus on a paradigmatic setup made out of a mobile particle and a quantum impurity, whose respective spin degrees of freedom couple to each other during a one-dimensional scattering process. A condition for the occurrence of quantum gates is derived in terms of spin-dependent transmission coefficients. This can be fulfilled through the insertion of an additional narrow potential barrier. Under resonance conditions this procedure enables a gate only for Heisenberg interactions and fails for an XY interaction. We show the existence of parameter regimes for which gates able to establish a maximum amount of entanglement can be implemented. The gates are found to be robust to variations of the optimal parameters.

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