Staggered magnetization and entanglement enhancement induced by magnetic impurities in $S = 1/2$ spin chains

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We study the effects of a magnetic impurity on the behavior of a $S = 1/2$, XX spin chain in transverse field, at zero and at finite temperature. We find that the impurity modifies the spin configuration on a spatially extended portion of the chain: At $T = 0$, both with and without an applied uniform magnetic field, an oscillating magnetization appears, which decays algebraically with the distance from the impurity. As a consequence, an entanglement redistribution is observed along the chain, with pairwise entanglement either enhanced or markedly decreased, depending on the position of the spin pair with respect to the impurity. As the external field and impurity contribute to the energy of the system via terms that commute with the total Hamiltonian, we can suggest that an adiabatic manipulation of the entanglement distribution can be performed by acting on the magnetic field and/or on the intensity of the impurity. The robustness of our results against temperature has been checked and we also propose possible experimental realizations and applications of our model not only in the field of magnetism, but also for atoms trapped in artificial lattices.