Quantum phase diagram of the half filled Hubbard model with bond-charge interaction

ARIEL DOBRY, Instituto de Física Rosario (Argentina), ARMANDO ALIGIA, Centro Atómico Bariloche and Instituto Balseiro (Argentina) — Using field theoretical bosonization, we determine the quantum phase diagram of the one-dimensional Hubbard model with bond-charge interaction $X$ in addition to the usual Coulomb repulsion $U$ at half-filling, for small values of the interactions. We show that it is essential to take into account formally irrelevant terms of order $X$. They generate relevant terms proportional to $X^2$ in the flow of the renormalization group (RG). The model shows three phases separated by a charge transition at $U = U_c$ and a spin transition at $U = U_s > U_c$. For $U < U_c$ singlet superconducting correlations dominate, while for $U > U_s$, the system is in the spin-density wave phase as in the usual Hubbard model. For intermediate values $U_c < U < U_s$, the system is in a spontaneously dimerized bond-ordered wave phase, which is absent in the ordinary Hubbard model with $X = 0$. We provide an analytical expression for $U_s(X)$. The results, with only one adjustable parameter, are in excellent agreement with numerical ones for $X < t/2$ where $t$ is the hopping.