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Strongly interacting fermions in 1D LI YANG, Department of Physics and Astronomy, Rice University, Houston, Texas 77251, USA, LIMING GUAN, Institute for Advanced Study, Tsinghua University, Beijing 100084, People's Republic of China, HAN PU, Department of Physics and Astronomy, Rice University, Houston, Texas 77251, USA, DEPARTMENT OF PHYSICS AND ASTRONOMY, RICE UNIVERSITY, HOUSTON, TEXAS 77251, USA TEAM, INSTITUTE FOR ADVANCED STUDY, TSINGHUA UNIVERSITY, BEIJING 100084, PEOPLE'S REPUBLIC OF CHINA TEAM — Under second order degenerate perturbation theory, we show that the physics of N fermions with arbitrary spin in one dimension in Tonks-Girardeau (TG) and super-Tonks-Girardeau(sTG) regions can be described by super-exchange interaction. An effective spin chain Hamiltonian (none-translational-symmetric Sutherland model) can be obtained from this procedure. For spin-1/2 particles, this model is the none-translational-symmetric Heisenberg model, where a transition between Heisenberg anti-ferromagnetic (AFM) and ferromagnetic (FM) states is expected to occur when the interaction strength is tuned from TG to sTG limit. We show that the FM and AFM states can be distinguished in two different methods: the first is based on their distinct response to a spin-dependent magnetic gradient, and the second is based on their distinct momentum distribution. We examine the validity of the spin-chain model by comparison with results obtained from unbiased techniques such as exact diagonalization and TEBD.

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