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Exchange Coupling in a One-Dimensional Wigner Crystal[1] ALEXIOS KLIRONOMOS, REVAZ RAMAZASHVILI, KONSTANTIN MATVEEV, Materials Science Division, Argonne National Laboratory — We consider a long quantum wire at low electron densities. In this strong interaction regime, a Wigner crystal ground state can form, in which the electrons comprise an antiferromagnetically ordered Heisenberg spin chain. The coupling constant J is exponentially small as it originates from tunneling of two neighboring electrons through the potential barrier that separates them. Because of the long range nature of the Coulomb interactions, tunneling is in fact a many body process. We calculate the exchange constant J taking into account all electrons in the chain, for both an idealized one-dimensional quantum wire and a more realistic device of finite width. We show that in current experiments, J can be smaller than the temperature, which should have an effect on the electron transport in the wire.

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