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LOCALIZATION AND INTERACTION IN ONE DIMENSION

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Abstract:

A new approach is given to the problem of an interacting impure one-dimensional electronic system. First the inelastic mean free path $l_{in}(T)$, which results from collisions with other electrons is calculated. The elastic mean free path $l_{el}(T)$ due to impurity scattering is obtained from the resistivity of an infinitesimal short sample. Following Thouless /1/ we argue that the impurity scattering is classical when $l_{in}(T) \ll l_{el}(T)$. From the temperature dependence of the mean free path's we conclude that for $2g_2-g_1 < -\frac{3}{5} 2\pi v_f$ and $g_1 > 0$ (excluding the Peierls transition) this condition is satisfied at sufficiently low temperature and as a result the resistance is proportional to the length of the sample. The value of the resistivity vanishes in the limit $T \to 0$ due to the complete screening of the impurity potential. In the other regime, $l_{in}(T) \gg l_{el}(T)$ and the impurity scattering must be treated quantum mechanically. The resistance diverges exponentially with a positive power (depending on the interaction) of the length. The results of the present approach agree with those obtained previously using a scaling theory /2/ and lead to a simpler interpretation. A more detailed account of this approach will appear elsewhere /3/.

References:

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