Interaction Effects in Weakly Localized Regime of Two- and Three- Dimensional Disordered Systems

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Anderson localization (Anderson 1958) has been an important and difficult problem in solid state physics (Anderson 1978, Mott 1966, 1974, 1975, 1978). However there has been great development in the understanding of the phenomenon after the recent works by Abrahams et al. (1979) and Anderson et al. (1979). They elaborated scaling theories which had been discussed before (Thouless (1974), Licciardello and Thouless (1975), Wegner (1976)), and obtained remarkable results

for each dimension, d; (1) absence of the minimum metallic conductivity in d=3 and (2) absence of metallic ground state in d=2. This new scaling theory has not only concluded these unexpected findings but also developed a systematic way to treat localization microscopically through the definite identification of the expansion parameter by which effects of localization can be examined perturbatively from the metallic limit. The regime where such perturbative treatment is valid is now called the weakly localized regime (WLR). This is the regime where one can see the precursor to the complete localization and where various scattering mechanisms are seen to play distinct roles. Especially the importance of the mutual interactions has become clear. The validity of perturbation theory in this regime makes quantitative comparison possible between theory and experiment and the detailed knowledge of WLR obtained through the analysis will be essential to the better and complete understanding of the localization phenomenon.

In this paper interaction effects in WLR are reviewed for two- and three-dimensions. In order to maintain self-containedness results for non-interacting cases are also summarized.

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