Comment on "Localized versus Itinerant Electrons at the Metal-Insulator Transition in Si:P"

The specific heat of uncompensated Si:P for concentrations N in the vicinity of the metal-insulator transition at N_c has recently been measured very carefully.[1] In reporting these data the authors state: "An interesting and hitherto unexplained feature is the fact that for uncompensated Si:P the exponent ν of the electrical conductivity $\sigma \sim (N-N_c)^{\nu}$ is $\frac{1}{2}$, while for virtually all other materials, including compensated semiconductors, it is close to 1, in agreement with scaling predictions." This statement is incomplete. An explanation of $\nu = \frac{1}{2}$ in uncompensated Si:P and $\nu = 1$ in partially compensated samples was given by me some time ago in terms of the quantum-mechanical separability of N for $N > N_c$ into localized and itinerant components in the uncompensated case.[2] The reasons why this separation fails and classical scaling becomes valid in the compensated case were also given.[3] Recently I have noted[4] that these arguments closely parallel the arguments given for domain formation in the d-dimensional random-field Ising model by Imry and Ma.[5] The validity of these arguments is generally conceded in the classical case. In view of the complexity of even the classical problem it may be that my parallel argument for the quantum-mechanical problem is the best that one can do. (Special cases of my argument have been discussed by Dorokhov[6] and Kaveh.[7]) In any case the reader should know that a configurational approach fundamentally different from classical scaling and much more successful in explaining the data does exist.

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