The Hall Number, Optical Sum Rule and Carrier Density for the $t-t'-J$ Model

SRIRAM SHASTRY, UCSC, Santa Cruz, CA, JAN HAERTER, UCSC — Mott Hubbard systems, epitomizing strong correlations and a sensitivity to half filling, display striking departures from band theory for many measurables. E.g. consider two quantities; the Hall constant $R_H$ and the optical conductivity sum rule $\omega_P^2/8$. These are often inverted to give the carrier densities $n_H \equiv 1/q_e e R_H$ and $n_{Op} = m\pi q_e^2 \omega_P^2$. There is considerable difficulty in reconciling these with $x$, the “chemical” estimate of density in many High $T_c$ systems[1]. We have argued previously[2] that the Hall constant is a manybody object, that need not scale simply with $x$. In this work, we compute the variables $n_H$ and $n_{Op}$ for a $t-t'-J$ model by using exact diagonalization of small clusters and different dopings $x$. We compute the Kubo formulas exactly for small clusters, and also the high frequency Hall constant for even larger systems, and obtain a strong dependence of these variables on the ratio $t'/t$. We also comment on the departure from Luttinger’s theorem for the Fermi surface for these clusters, defining the same from the tower of excited states for a given wave vector for an added particle or hole. [1] W. Padilla et.al., Phys. Rev. B 72, 060511(2005). [2] B. S. Shastry, B. I. Shraiman and R. R. P. Singh, Phys. Rev. Lett.70, 2004(1993).