Spectral and transport properties of strongly correlated disordered systems

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It is shown that strong electron-electron interactions in disordered systems lead to the enhancement of intrinsic disorder. The one-band Hubbard model with random on-site energies is studied in the infinite U limit. Electron correlations are treated in the mean-field slave boson technique. To average over disorder, both intrinsic (diagonal) and interaction induced (off-diagonal), we use a version of the coherent potential approximation. We illustrate the approach by calculating density of states, ac electrical conductivity, and effective carrier concentration. The obtained results are discussed in the context of recent experimental data on disordered strongly correlated materials. [S0163-1829(99)05243-1]

I. INTRODUCTION

The interplay of disorder and interactions is an important issue, which has recently been studied very actively theoretically[1] and experimentally.[2,3] On the theoretical part early work[1] has started with weak interactions treated perturbatively and found that the relevant couplings scale to large values. Thus, one virtually always ends up in the strong coupling limit. So it seems natural to start from the strongly correlated models suitably generalized to describe disorder.

This point of view has recently been used by a number of workers.[4–8] Zimanyi and Abrahams[4] have found that disorder in the t-J model suppresses superconductivity and leads to formation of localized magnetic moments. Kotliar and coworkers[6] have used dynamical mean-field theory to treat strong interactions, and found *inter alia* that even moderate disorder in the Anderson model leads to broad distribution of Kondo temperatures and thus induces strong ''effective'' disorder in the system. Another example of dramatic effect of normal impurities has been demonstrated in Ref. 7, where it has been shown that in correlated systems the Korringa ratio K_r is strongly enhanced by impurities beyond its standard value 1.0 (Korringa ratio is defined as $K_r = 1/T_1 TK^2$, where K is the Knight shift, T temperature, and $1/T_1$ nuclear relaxation rate). It turns out that the proper interpretation of experiments on correlated systems requires the effect of impurities to be taken into account.

The examples of strongly correlated disordered systems comprise such materials as (a) various heavy fermion alloys, e.g.: $Cu_{5-x}Pd_x$, $Sc_{1-x}V_xPd_3$, $La_{1-x}Ce_xCu_{2.2}Si_2$, in which non-Fermi-liquid features have been observed;[9] (b) transition metal perovskite oxides of the ABO_3 type and their alloys as, e.g., $Ca_{1-x}Sr_xVO_3$;[10] (c) heavily doped semiconductors as Si:P and Si:B[2]; (d) copper oxides and other high temperature superconductors.[11] These materials possess complicated phase diagrams and very intriguing normal and superconducting state properties. Doping of some of them with Zn (Ref. 12) or other[11] impurities has revealed unusual influence of impurity scattering on their superconducting and normal state properties (thermodynamics, transport etc.). In the superconducting phase, due to anisotropic character of the order parameters, the impurities provide pair breaking mechanism[13] and strongly reduce the critical temperature

T_c.[11] It is important to underline that even without extra impurities these materials are quite strongly disordered as the doping of insulating parent compounds is necessary in order to change them into metals and superconductors. The number of arguments point out that at the same time they are strongly correlated systems.[14]

All this makes the study of disordered versions of models describing correlated fermions very important and timely subject. In this paper, we shall start with the strongly interacting electrons described by the random version of the Hubbard model and show that correlations lead to additional disorder in the system. The disorder is introduced *via* random site energies ε_i [cf. Eq. (1) below]. To illustrate the approach, we shall calculate the density of states and ac conductivity for disordered correlated system and compare them with those calculated for clean correlated and/or disordered noninteracting models. Even though we are not aiming at explanation of particular experiments we shall discuss the obtained results in connection with available experimental data.

The organization of the rest of the paper is the following. In Sec. II, we shall present the model and approach, while Sec. III contains the numerical examples. The discussion of the approach and obtained results concludes the paper.

II. THEORY

To be specific let us consider a single-band Hubbard model with random site energies given by the Hamiltonian

$$H = \sum_{ij\sigma} t_{ij} c_{i\sigma}^+ c_{j\sigma} + \sum_{i\sigma} (\varepsilon_i - \mu) c_{i\sigma}^+ c_{i\sigma} + U \sum_i c_{i\uparrow}^+ c_{i\uparrow} c_{i\downarrow}^+ c_{i\downarrow}.$$

(1)

Here, $c_{i\sigma}^+$ ($c_{i\sigma}$) is the creation (annihilation) operator of a spin σ electron at site i, t_{ij} denote (periodic) hopping integrals, μ is the chemical potential and ε_i are random site energies. They take on values $\varepsilon_A(\varepsilon_B)$ depending on whether site i is occupied by an atom of A or B type. U is the on-site electron-electron repulsion. For arbitrary value of on-site interaction U a site can be empty, singly or doubly occupied

and to trace its state one requires four operators and two constraints.[15,16] The theory becomes much simpler in the $U \to \infty$ limit, valid for narrow band materials and for description of low energy properties. In this limit the slave boson approach[17] to correlated system makes use of a single boson operator. One replaces the electron operators $c_{i\sigma}^+$ by the product of fermion $f_{i\sigma}^+$ and boson b_i operators, and introduces the constraint $Q_i = b_i^+ b_i + \Sigma_\sigma f_{i\sigma}^+ f_{i\sigma} = 1$, which says that in this large U limit each site can be empty or at most singly occupied. The easiest way to incorporate the constraint is to use Lagrange multiplier λ_i at each site i and write the Hamiltonian

$$H_{Sb} = \sum_{ij\sigma} t_{ij} f_{i\sigma}^+ b_i b_j^+ f_{i\sigma} + \sum_{i\sigma} (\varepsilon_i - \mu) f_{i\sigma}^+ f_{i\sigma}$$
$$+ \sum_i \lambda_i \left(b_i^+ b_i - \sum_\sigma f_{i\sigma}^+ f_{i\sigma} - 1 \right). \quad (2)$$

In the mean-field approach to the above Hamiltonian in clean system[17] one replaces the boson operators by the classical variables $\langle b_i \rangle = \langle b_i^+ \rangle = r$ and assumes $\lambda_i = \lambda$. In the random system at hand, one expects dependence of boson amplitudes on site index, i.e., the correlation between these amplitudes and random site energies. The statistical averages $\langle b_i \rangle$ do, in disordered system, depend on the kind of atom at site i. Denoting these site-dependent boson amplitudes $\langle b_i^+ \rangle = \langle b_i \rangle = \xi_i$ we arrive at the mean-field Hamiltonian

$$H_{Sb}^{MF} = \sum_{ij\sigma} \xi_i t_{ij} \xi_j f_{i\sigma}^+ f_{i\sigma} + \sum_{i\sigma} (\varepsilon_i - \lambda_i - \mu) f_{i\sigma}^+ f_{i\sigma}$$
$$+ \sum_i \lambda_i (\xi_i^2 - 1), \quad (3)$$

which except diagonal disorder, given by the fluctuating parameters ε_i and, possibly, λ_i possesses also off-diagonal one, i.e., *random* hopping integrals $\tilde{t}_{ij} = \xi_i t_{ij} \xi_j$ which represent special form of band width fluctuations. Note that original hopping parameters t_{ij} are periodic, i.e., nonrandom quantities. It is site-dependent boson amplitudes $\xi_i (\xi_j)$ that make the parameters $\tilde{t}_{ij}$ random. Thus, one finds that interactions in the system induce additional disorder.

To proceed, we propose the following generalization of the Newns and Read[17] approach. Let us imagine a given configuration of atoms in a system (to be denoted by superscript $\{\nu\}$) and calculate the total electron energy appropriate to this configuration of atoms

$$E^{\{\nu\}} = \langle H_{Sb}^M \rangle^{\{\nu\}}, \quad (4)$$

where $\langle \cdots \rangle$ denotes the thermal average

$$\xi_i^2 = 1 - \sum_\sigma \langle f_{i\sigma}^+ f_{i\sigma} \rangle^{\{\nu\}} \quad (5a)$$

$$\lambda_i \xi_i^2 = -\frac{1}{2} \sum_{j\sigma} \xi_i t_{ij} \xi_j \langle f_{i\sigma}^+ f_{j\sigma} \rangle^{\{\nu\}}. \quad (5b)$$

Calculation of the correlation functions $\langle f_{i\sigma}^+ f_{j\sigma} \rangle^{\{\nu\}}$ entering last equations is in general extremely complicated task because they do depend on the positions of all atoms in the system. Surely, one expects the strongest dependence on the type of atoms located at the terminal sites (i,j). Then it is legitimate to replace each configuration-dependent quantity $A_{ij}^{\{\nu\}}$ by the conditionally averaged one: $\langle A_{ij} \rangle_{ij}$–the condition being that sites i,j are occupied by given types of atoms and the rest of the system is replaced by an effective medium to be calculated in the coherent potential approximation[18] (CPA).

CPA is the best mean-field approximation to treat disorder. It is the self-consistent theory of the frequency-dependent self energy associated with impurities. Recent studies of the disordered t-J model[19] have shown that the frequency dependence of the impurity self energy together with self consistency are the necessary ingredients of any quantitative theory, and especially important in narrow band systems and/or in the presence of Van Hove singularity.[19] CPA respects this requirement.

The multiplicative type of off-diagonal disorder in the Hamiltonian (3) makes the application of the single site CPA an easy task.[20] One defines an operator $\hat{\xi} = \Sigma_{i\sigma} \xi_i f_{i\sigma}^+ f_{i\sigma}$ and transforms Hamiltonian $\tilde{H} = \hat{\xi}^{-1} H^{\{\nu\}} \hat{\xi}^{-1}$ as well as the Green's function $\tilde{G}(z) = \hat{\xi} G \hat{\xi} = (z\hat{\xi}^{-2} - \tilde{H})^{-1}$. It is a matter of simple calculation to check that the transformed Hamiltonian $\tilde{H}$ contains only diagonal disorder. The properties of the system, however, are still defined in terms of original Green's function G or its averaged over impurities counterpart $\langle G \rangle_{imp}$. The procedure is standard[20] and one gets the set of equations for the average medium $\Sigma(z)$ to be solved self consistently

$$\left\langle \frac{\Sigma(z) - (z - \varepsilon_i + \mu - \lambda_i)/\xi_i^2}{1 - [\Sigma(z) - (z - \varepsilon_i + \mu - \lambda_i)/\xi_i^2] F[\Sigma(z)]} \right\rangle_{imp} = 0 \quad (6)$$

$$F(z) = \frac{1}{N} \sum_{\vec{k}} \frac{1}{z - \varepsilon(\vec{k})}. \quad (7)$$

Here, $\varepsilon(\vec{k})$ is the Fourier transform of the bare hopping t_{ij}; $\varepsilon_{\vec{k}} = 1/N \Sigma_{ij} t_{ij} e^{-i\vec{k}(\vec{R}_i - \vec{R}_j)}$. Once the coherent potential $\Sigma(z)$ is found then the density of states $D(\varepsilon)$ is calculated from

$$D(\varepsilon) = -\frac{1}{\pi} \mathrm{Im} \left\langle \frac{\xi_i^{-2} F[\Sigma(\varepsilon^+)]}{1 - [\Sigma(\varepsilon^+) - (\varepsilon^+ - \varepsilon_i + \mu - \lambda_i)/\xi_i^2] F[\Sigma(\varepsilon^+)]} \right\rangle_{imp} \quad (8)$$

with the usual limiting process implied by $\varepsilon^+ = \varepsilon + i0$.

The symbol $\langle \cdots \rangle_{\mathrm{imp}}$ in Eqs. (6) and (8) denotes the averaging over disorder. We specifically assume the distribution of local parameters, which is a proper one for the description of $A_x B_{1-x}$ alloys and define

$$\langle O_i \rangle_{\mathrm{imp}} = x O_A + (1-x) O_B \tag{9}$$

for arbitrary single-site random quantity O_i.

To close the system of equations, we need to relate the chemical potential μ to the carrier concentration n and calculate parameters $n_A(n_B)$ and $\lambda_A(\lambda_B)$ which denote carrier densities at sites occupied by atom $A(B)$ and the corresponding values of Lagrange multipliers. The carrier densities are easily obtained from

$$n_{A,B} = \int d\omega f(\omega) \left(-\frac{1}{\pi} \right) \mathrm{Im} \left\{ \frac{\xi_{A,B}^{-2} F[\Sigma]}{1 - [\Sigma(\varepsilon^+) - (\varepsilon^+ - \varepsilon_{A,B} + \mu - \lambda_{A,B})/\xi_{A,B}^2] \cdot F[\Sigma]} \right\} . \tag{10}$$

Note that the relation (5a), which we shall interpret in CPA in terms of local conditionally averaged quantities as

$$\xi_{A,B}^2 = 1 - n_{A,B} \tag{11}$$

together with Eq. (10) provide the self-consistency conditions for the determination of $n_{A,B}$ and the effective bandwidth parameters, $t_{ij} \xi_i \xi_j$.

Unfortunately there is no simple interpretation of Eq. (5b), which would allow us the calculation of λ_A and λ_B separately. In principle λ_i should be calculated at each site, by evaluating the rhs of Eq. (5b), which is very difficult task. The simplest approach is to remind that λ_i is the Lagrange multiplier introduced, in the slave boson technique, in order to take into account the constraint stating that the number of particles (fermions plus bosons) at a site i cannot exceed 1. As our approach is a mean field one it is thus natural to expect that also in impure system λ_i can be assumed site independent as in Ref. 15. Mean-field theory of slave bosons neglects the fluctuations of λ_i. The same approximation has been used previously in the study of random version of $t - J$ model.[4] Therefore, we have assumed $\lambda_A = \lambda_B = \lambda$. It can be further combined with the chemical potential μ into the effective one $\bar{\mu} = \mu - \lambda$, easily calculated from

$$n = \int d\varepsilon f(\varepsilon) D(\varepsilon), \tag{12}$$

n being the total concentration of carriers in the system. In Eqs. (10) and (12) $f(\varepsilon)$ denotes the Fermi distribution function $f(\varepsilon) = (e^{\varepsilon/k_B T} + 1)^{-1}$. This finishes the formal analysis. The knowledge of the Green's function can be used to calculate the combined effect of disorder and correlations on electronic properties of system.

One way to get experimentally the information on the electronic structure of materials and the dynamics of carriers is to study their optical spectra. This is of special importance as they can be measured both in normal and superconducting state. Here we shall, however, be interested in normal state only. The Kubo-Greenwood formula can be used to calculate frequency dependent conductivity $\sigma(\omega)$. It can be expressed via the function

$$\phi(z) = \frac{1}{N} \sum_{\vec{k}} \frac{v_x^2(\vec{k})}{z - \varepsilon(\vec{k})} \tag{13}$$

of the complex argument z as[20]

$$\sigma(\omega) = \frac{e^2}{2\pi} \mathrm{Re} \int d\eta \frac{(f(\eta) - f(\eta + \omega))}{\omega}$$
$$\times \left\{ \frac{\phi[\Sigma(\eta^- + \omega)] - \phi[\Sigma(\eta^-)]}{\Sigma(\eta^- + \omega) - \Sigma(\eta^-)} \right.$$
$$\left. - \frac{\phi[\Sigma(\eta^+ + \omega)] - \phi[\Sigma(\eta^-)]}{\Sigma(\eta^- + \omega) - \Sigma(\eta^-)} \right\}, \tag{14}$$

where $\eta^{\pm} = \eta \pm i0$ and $v_x(k) = 1/\hbar \ \partial \varepsilon(\vec{k})/\partial k_x$ is the carrier velocity.

It is common practice to present the data for the real part of ac conductivity in the Drude-like form

$$\sigma(\omega) = \frac{\sigma(0)}{1 + \omega^2 \tau^2(\omega)}, \tag{15}$$

with the frequency-dependent relaxation time $\tau(\omega)$, and $\sigma(0)$ denoting the dc conductivity of the system.

In the experimental study of optical properties of correlated systems the important role is played by the effective carrier density $n_{\mathrm{eff}}(\omega_0)$. It is the number of carriers contributing to the $\sigma(\omega)$ up to the frequency ω_0. We denote it by $n_{\mathrm{eff}}(\omega_0)$ and define as[21]

$$n_{\mathrm{eff}}(\omega_0) = \frac{m_e}{8\pi e^2} \int_0^{\omega_0} \sigma(\omega) d\omega. \tag{16}$$

As it follows from the last equation $n_{\mathrm{eff}}(\omega_0)$ is a convenient measure of the spectral weight contained in the low-frequency part of $\sigma(\omega)$.

III. NUMERICAL EXAMPLES

For the purpose of numerical illustration of our general ideas we have used the three-dimensional system density of states possessing van Hove singularity in the middle of the band. It corresponds to bcc tight-binding spectrum for nearest-neighbor hopping integral $t_{ij}^0 = -t$

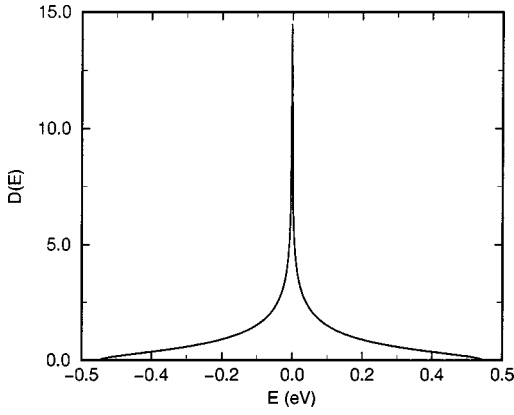$$\varepsilon_{\vec{k}} = -8t \cos(k_x a) \cos(k_y a) \cos(k_z a).$$

FIG. 1. Host system density of states used in the calculations.

Using $t=0.0625$ eV leads to the noninteracting system bandwidth $W=1$ eV. In the following all energies and frequencies are expressed in eV. The density of states of the clean noninteracting system is shown in Fig. 1.

The changes of the spectrum due to correlations in disordered system are illustrated in Fig. 2 where we show the averaged $D(E)$ and conditionally averaged densities of states $D_A(E)$ and $D_B(E)$ for an $A_x B_{1-x}$ alloy ($x=0.6$, $\varepsilon_A=0.0$, $\varepsilon_B=0.4$ eV) without [Fig. 2(a)] and with [Fig. 2(b)] electron correlations. The carrier concentration $n=0.4$. We observe
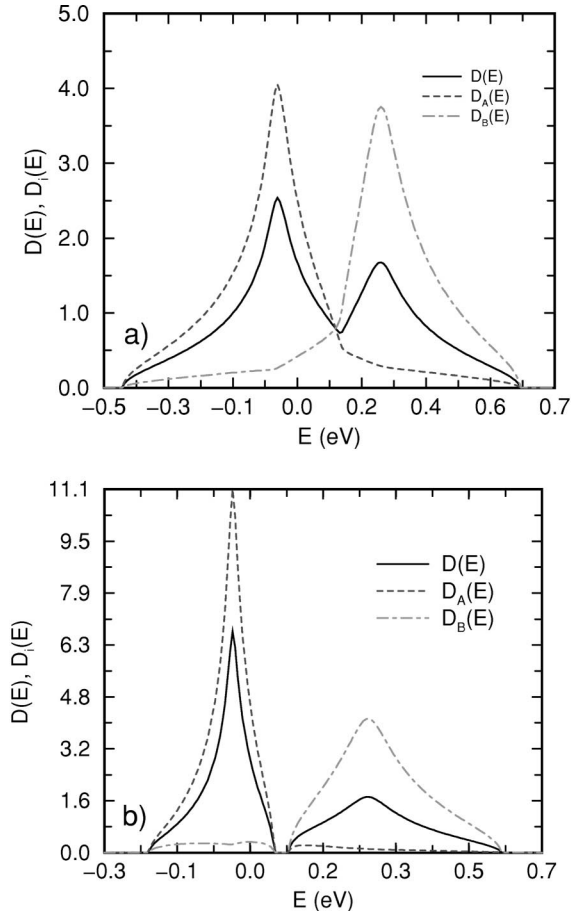

FIG. 2. Total and local densities of states of the noninteracting ($U=0$) (a) and correlated ($U=\infty$) (b) $A_{0.6}B_{0.4}$ system. The Fermi energy is placed at $E=0$.

the opening of the real gap in the spectrum and the appreciable increase of the density of states at the fermi level (taken as $E=0$ in the figure).

In the clean systems the main effect of strong correlations is the band narrowing. Thus, the resulting density of states has the same shape as host one shown in Fig. 1, but spread out over narrower energy range. The narrowing factor is simply given by $(1-n)$. In disordered case the situation is more complex and the various components of the band are changed in different manner. The band narrowing observed for that part of the spectrum which is of mainly A character is different from that found for B component and depends on the carrier concentration. This behavior is easy to understand–band-narrowing factors ξ_i are proportional via (11) to $1-n_i$, were n_i is the local carrier concentration. This in turn is related to the total carrier concentration n via $n = x n_A + (1-x) n_B$. It, thus, follows that the more occupied subband is narrowed more strongly.

The two peak structure of DOS we observe in Fig. 2 is related to the disorder scattering and not correlations. By assuming $U=\infty$ we have pushed the upper Hubbard subband to infinity and are dealing with lower one modified by the disorder. Strong interplay between disorder and interactions is responsible for the detailed structure of the total $D(E)$ and local $D_{A(B)}(E)$ densities of states. In the present treatment of correlations via mean field slave boson theory the carrier density n serves as only parameter, which controls the correlations, and also the off-diagonal disorder. Depending on the parameters the factors n_A, n_B can take quite different values and this induces strong off-diagonal disorder. Generally for large n the bands are very narrow. The genuine parameters that control the disorder in the noninteracting systems are x–the alloy concentration and $\delta=(\varepsilon_B-\varepsilon_A)$–the scattering strength. Even if both these parameters are small the induced disorder can be very large.

The changes in the spectrum have, in turn, an important influence on the transport properties and in particular on the ac conductivity $\sigma(\omega)$ [cf. Eq. (14)] and relaxation time $\tau(\omega)$. Figure 3(a) shows the comparison of the ac conductivity of noninteracting electrons (solid curve) with that for strongly interacting carriers (dashed curve) for the same parameters as previously. The following comment concerning these data is in order. Due to the $U=\infty$ limit the upper Hubbard subband does not contribute to $\sigma(\omega)$ of correlated system and the sum rule for the conductivity

$$\int_0^\infty \text{Re } \sigma(\omega)d\omega = \frac{\pi n e^2}{2m} \qquad (17)$$

does not have its usual meaning and gives only the effective kinetic energy. The integral in the above sum rule, when evaluated for correlated system, says how strongly the carriers are correlated. This explains why one observes lower values of $\sigma(\omega)$ in correlated alloy as compared to noninteracting one. It is the redistribution of the spectral weight, which is important.

Comparing the two curves one notes the appearance of the appreciable spectrum for frequencies around 0.2–0.3 eV. This, so called, ''midinfrared'' band arises from the disorder in the system. It is seen to be much more pronounced in the correlated case. Similarly the frequency-dependent relaxation times do change with correlation. Their changes are

FIG. 5. The normalized effective carrier density calculated from Eq. (16) vs carrier concentration n.
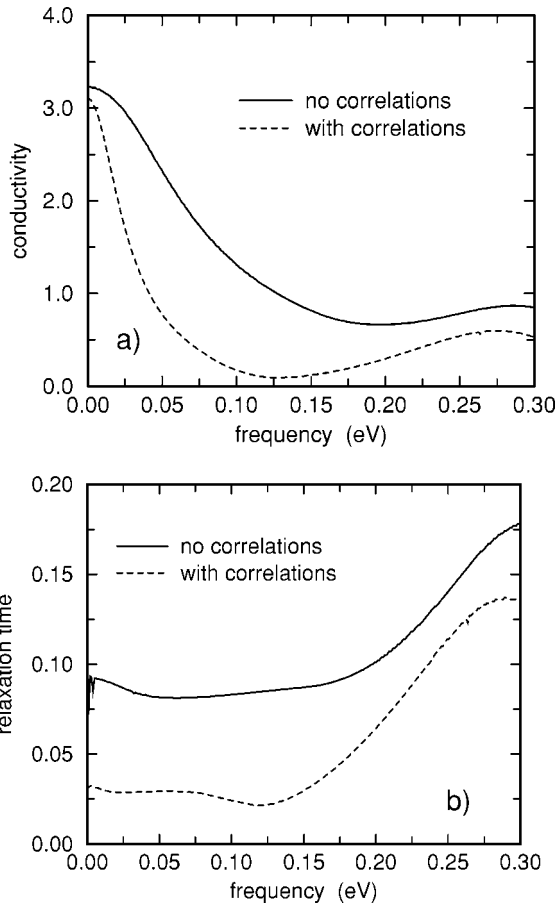
FIG. 3. (a) Comparison of the frequency-dependent conductivity calculated for $A_{0.6}B_{0.4}$ non-interacting (solid curve) and correlated (dashed curve) systems. (b) Relaxation times of the same system.

shown in Fig. 3(b).

The same ''midinfrared'' contribution, calculated for different alloy and two values of carrier concentration is seen in Fig. 4. Its appearance can be traced back to the enhanced disorder in the system. The effect is seen to be much stronger for larger electron concentration, when the correlation effects become more important. The interference of disorder and interactions is responsible for the strong band-filling dependence of the calculated functions. On a doubly logarithmic
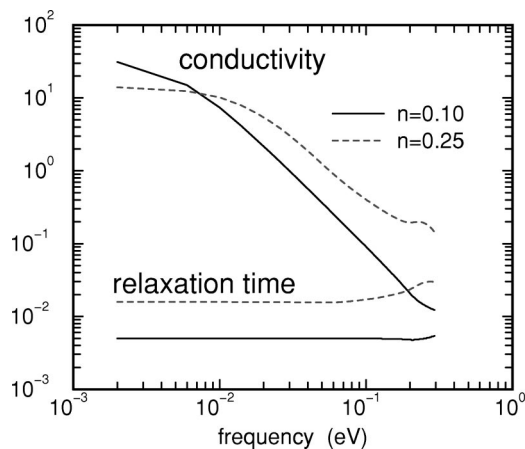

FIG. 4. Conductivities and relaxation times for $A_{0.7}B_{0.3}$ system and for two values of the carrier concentration $n=0.1$ (solid curves) and $n=0.25$ (dashed curves).
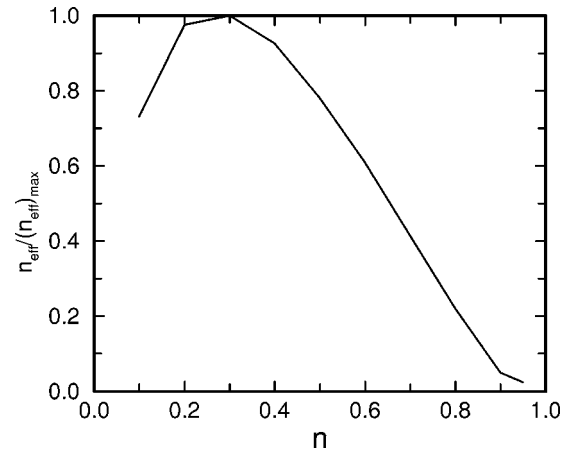
plot we show here the conductivity $\sigma(\omega)$ and relaxation time $\tau(\omega)$ vs frequency ω for an $A_{0.7}B_{0.3}$ alloy with $\varepsilon_A-\varepsilon_B = 0.3$ eV and for two different band fillings $n=0.1$ and 0.25. The conductivity shows Drude behavior with practically constant relaxation time τ for $n=0.1$ and strongly non-Drude behavior (particularly so at elevated frequencies) for $n =0.25$. In consequence the relaxation times display quite different frequency dependence with τ calculated for $n =0.25$ being frequency dependent above 0.1 eV. The strong doping dependence of $\sigma(\omega)$ has recently been observed in experimental results[21] for the normal state of high-temperature superconductors. It is important to note that such behavior could not be obtained, within the one band model without correlations or disorder.

We have calculated the effective carrier concentration, n_{eff} using Eq. (16) and $\omega_0=0.1$ eV. The n dependence (note that doping $=1-n$) of n_{eff} normalized to its maximal value $(n_{eff})_{max}$ is plotted in Fig. 5. To get these data we have assumed that carriers are introduced into the system by the B component of an alloy, i.e., we have assumed $n=1-x$. The scattering strength $\varepsilon_B-\varepsilon_A$ was taken to be very small 0.01 eV, in order not to get splitting of the Van Hove singularity. Assuming that optimally doped sample corresponds to the maximum in the density of states at the Fermi level the data shown in Fig. 5 can be interpreted in the following way. In the underdoped case there is strong increase of n_{eff} with doping, while in overdoped regime the decrease of n_{eff} is observed. The experimental data obtained in the normal state of various superconducting oxides show similar behavior:[21] the increase of n_{eff} with doping in underdoped regime and nearly constant value or small decrease in overdoped case. The experimental data, we are referring to, have been obtained on quasi-two-dimensional systems with different density of states. Also it has to be underlined that the single-band Hubbard model is certainly to simple to describe normal state optical spectra in high-temperature superconductors.

IV. DISCUSSION AND CONCLUSIONS

In this paper we have presented calculations illustrating the interplay of disorder and correlations in solids. Using the simple but by far not trivial model with diagonal disorder, we have shown the mechanism by which correlations in the system induce additional strong off-diagonal disorder. For the purpose of explicit calculations we have assumed very
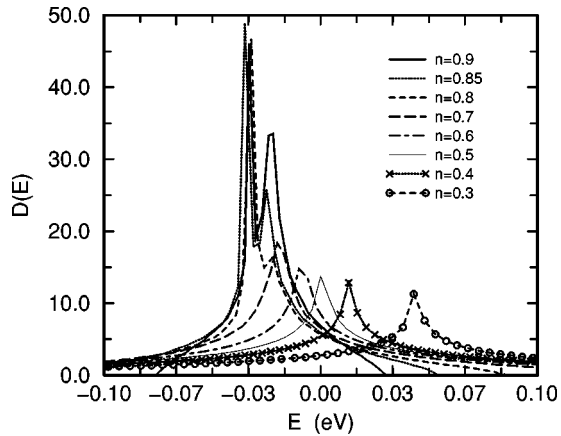
FIG. 6. The densities of states for a series of disordered correlated systems of the $A_x B_{1-x}$ type with carrier concentration $n = 1 - x$ and $\varepsilon_A - \varepsilon_B = 0.1$ eV.

strong correlations ($U = \infty$) and treated them by the slave boson technique using mean-field approximation. The same conclusion is obviously valid for finite U. Moreover, finite correlation U have to be taken into account in order to get quantitative description of particular materials. The disorder, both diagonal and, interaction induced, off-diagonal has been treated in the coherent potential approximation.

The effect is very strong and may be of relevance in the interpretation of measurements on transition-metal alloy oxides, heavy fermion systems, and high-temperature superconductors. To illustrate the statement we show in Fig. 6 the evolution of the density of states with doping. Here, the bare disorder strength is assumed to be small ($\varepsilon_B - \varepsilon_A = 0.1$ eV).

Such small disorder would lead to rigid band picture for noncorrelated electrons. It means that the density of states would be essentially that shown in Fig. 1 for all values of band-filling n. We see in Fig. 6 that in correlated system one gets huge changes of the spectrum with n. For large electron concentrations ($n = 0.9, 0.85, 0.8$) the band is very narrow (of order of 0.1 to 0.2 eV) and shows two peak structure. For lower concentrations the electron mass gets smaller (the bandwidth increases), and the peak in $D(E)$ moves with respect to Fermi energy E_F (located at $E = 0$). For the parameters studied it moves from below E_F to above it with decreasing n.

The pronounced contribution to $\sigma(\omega)$ at midinfrared frequencies routinely observed experimentally[22,23] can in this theory be attributed to the, enhanced by correlations, scattering of electrons off impurities. There exist in the literature other proposals to explain the ''midinfrared'' band. One of them, called two component scenario, assumes the existence of two types of carriers. Beside mobile carriers one considers bound carriers, which give temperature-independent contribution to $\sigma(\omega)$ in midinfrared band. Here, we propose that the midinfrared band can be caused by spectral weight transfer due to interplay of disorder and correlations.

This work has been limited to the study of normal state properties and $U = \infty$ limit. The same phenomenon of correlation induced disorder, however, does play an important role for finite U and also in the superconducting state. These problems are presently under investigation.

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