relatively modest dimensions, operating on transitions from a resonant to a metastable level. They are therefore expected to find many scientific and practical applications.

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MOTT TRANSITION IN QUASI-ONE-DIMENSIONAL DISORDERED SYSTEMS

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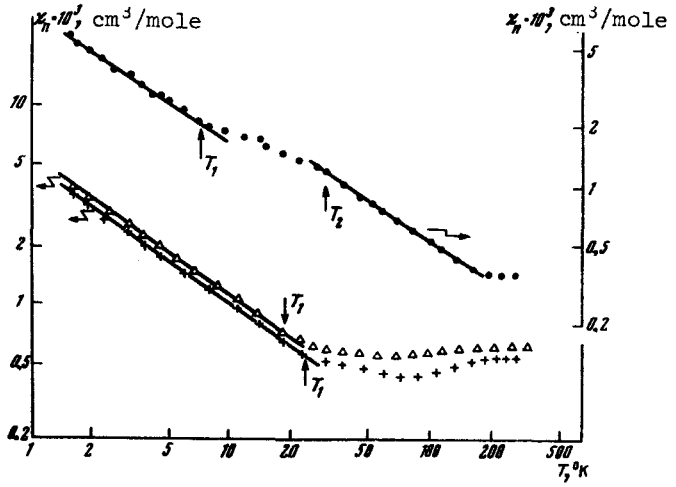
The initial conduction band in high-conductivity complexes of tetracyanoquinodimethane (TCNQ) is partly filled, but the temperature dependence of their conductivity has a nonmetallic character (a review of their properties is given in [1]). It was shown in [2] that below ~15°K the electrons in these complexes are in a state of a one-dimensional disordered Mott dielectric (DMD). Owing to the presence of the Mott gap in the spectrum of the electronic excitations, the low-lying states of the system in this temperature region are well described by a Heisenberg Hamiltonian, and the disorder of the lattice leads to random variations of the exchange parameter and to a fractional-power dependence of the susceptibility χ on the temperature T and of the magnetic moment on the field H at $kT \ll g\mu_B H$. The disorder of the lattice is apparently a property inherent in all high-conductivity TCNQ complexes and is connected with the random character of the packing of the asymmetrical cations [3, 4], which leads to the occurrence of a random potential along the conducting chains of the TCNQ molecules. This leads to a random distribution of the electron density on the TCNQ molecules and causes by the same token random variations of the exchange integral.

The DMD state can apparently not exist at temperatures much higher than the Mott gap [5]. The latter can be estimated from data [1, 6] on the temperature dependence of the conductivity σ. At 10 - 15°K the slope of the plots of $\ln \sigma$ against 1/T does not exceed 80°K in high-conductivity TCNQ complexes, so that it can be assumed that these complexes should be, at any rate above this temperature, in a state that can be called the state of a one-dimensional disordered metal (ODM). The nonmetallic character of the $\sigma(T)$ dependence may be connected in this case with the spatial electron localization caused by the disorder of the lattice [1, 6, 7].

A general property of the energy spectrum of the one-dimensional disordered systems is apparently the existence of a singularity in the density of states at the center of the energy band. Such a singularity arises for example in a number of exactly calculated models [8, 9]. For narrow impurity bands, a proof of its existence was given in [10]. It was noted in [2] that in the "metallic" state n the behavior of a complex with a half-filled band, in the presence of such a singularity, should differ qualitatively from the behavior of a complex with a quarter-filled band, for in the former case the Fermi level lies exactly in the center of the band. Strictly speaking, the absence of such a difference at low temperatures was one of the arguments in favor of the DMD state of high-conductivity TCNQ complexes.



Temperature dependence of the magnetic susceptibility of several high-conductivity TCNQ complexes I (+), II (Δ), and III (o). T_1 and T_2 are the temperatures of the start and end of the Mott transition. The right-hand ordinate scale pertains to complex III, and the left-hand one to complexes I and II.

We present now results showing that at higher temperatures (above ∼30°K) such a difference is indeed observed. The figure shows, in logarithmic coordinates, the dependence of χ on T for the complexes (quinoline) $(TCNQ)_2$ (I), (acridine) $(TCNQ)_2$ (II), and (N-methylphenazine) (TCNQ) (III). At low temperatures we have for all complexes $\chi \sim T^{-\alpha}$ with $0 < \alpha < 1$, and this indicates, as shown in [2], that the DMD state has been realized. We note that such a law holds down to 0.1°K [2]. With increasing temperature, starting with a certain value T_1 which is different for each complex, the susceptibility ceases to obey this law. However, in the simple salt III, with a half-filled band, the dependence $\chi = AT^{-\alpha}$ is again observed at $T > T_2 \approx 30$°K, with $A = 1.1 \times 10^{-2}$ cm^3/mole and $\alpha = 0.63$ ($\alpha = 0.58$ in the low-temperature part), apparently evidencing that the ODM state has been realized and is a manifestation of a singularity in the density of states in the center of the band. At the same time, in the complicated salts I and II, one-quarter of whose initial band is filled, the susceptibility depends little on the temperature in the high-temperature region and can be interpreted as Pauli susceptibility. We note that the deviation of $\chi(T)$ in the complex III from the $T^{-\alpha}$ law in the region between T_1 and T_2 lies far beyond the limits of measurement accuracy, as can be seen from the small scatter of the points in the figure.

The susceptibility of all the known high-conductivity TCNQ complexes with one-quarter filled initial band has a behavior similar to that shown in the figure for complexes I and II. Unfortunately, complex III is the only known high-conductivity TCNQ complex with a half-filled initial band, but one can hope its behavior to be sufficiently representative.

The results thus indicate apparently that Mott transitions exist in high-conductivity TCNQ complexes and are probably the first experimentally established manifestation of a singularity in the density of states in the center of the band of one-dimensional disordered "metals."

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POSSIBLE EXPLANATION OF NON-POWER-LAW RADIO SPECTRA OF COSMIC RADIO SOURCES

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Braude et al. [1] have observed that the radio spectra of discrete cosmic radio emission sources do not follow the power law in the 30 - 300 MHz range and can be explained by assuming that the radio emission is synchrotron radiation of relativistic electrons whose energy spectrum is given by

$$N(E) = K(E/E_0)^{-\gamma}\exp[p(E/E_0)^{-2}]. \qquad (1)$$

This empirical formula was obtained from an analysis of almost 100 radio sources and the parameter ranges turned out to be $0.5 \leq p \leq 5.6$, $E_0 \simeq 10$ MeV, and $1.6 \leq \gamma \leq 3.2$ (on the average, $\gamma \simeq 2.5$). There was no theoretical interpretation of (1).

We shall show that a spectrum of the type (1) follows naturally from the assumption that the electrons are scattered and accelerated by moving magnetic inhomogeneities if their range $\Lambda(E)$ in a wide energy interval $E > E_0$ decreases with energy like $\Lambda(E) = \Lambda_0(E_0/E)$. Such a $\Lambda(E)$ dependence can be realized, for example [2], in acceleration by Alfven waves, if the exponent of the turbulence spectrum is close to $\nu = 3$. The scattering and acceleration of electrons by moving magnetic inhomogeneities having an energy-dependent range were considered by the authors earlier [3]. The equation for the energy distribution of the electrons, with allowance for the acceleration and energy loss, is

$$\frac{\partial}{\partial E}\left[D(E)E^2\frac{\partial}{\partial E}\left(\frac{N}{E^2}\right)\right] + \frac{\partial}{\partial E}\left[b(E)N\right] = 0 \qquad (2)$$

D(E) is the diffusion coefficient in energy space. In the model of moving magnetic inhomogeneities, it takes the form [3] $D(E) = \langle u^2\rangle E^2[3c\Lambda(E)]^{-1}$, where $\langle \Delta u^2\rangle$ is the mean-squared velocity fluctuation of the magnetic field carried by the turbulent plasma. The coefficient b(E), which describes the energy lost to synchrotron and Cerenkov radiation in a fully ionized plasma, is given by [4] $b(E) = A(H_\perp)E^2 + B(n)$, where

$$A(H_\perp)E^2 = 9.8\cdot 10^{-4}\left(\frac{EH_\perp}{mc^2}\right)\left(\frac{\text{eV}}{\text{sec}}\right); \quad B(n) = 7.62\cdot 10^{-9}n \times$$
$$\times\left[\ln\frac{E}{mc^2} - \ln n + 73.4\right]\left(\frac{\text{eV}}{\text{sec}}\right), \qquad (3)$$

$H_\perp$ is the magnetic-field component perpendicular to the electron velocity, and n is the concentration of the thermal electrons in the acceleration region. The logarithmic dependence on the energy in (3) can be neglected at $E \lesssim 100\ mc^2$. The solution of (2) then takes the form (1), with