ELECTRON SELF-TRAPPING IN DISCRETE TWO-DIMENSIONAL LATTICES. II. ANALYTICAL STUDY

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In the previous paper [1], self-trapped (spontaneously localized) electron states in a discrete, anisotropic, two-dimensional electron-phonon lattice were investigated numerically. Here this problem is studied analytically for an isotropic lattice. It is shown that, in the adiabatic approximation, the continuum limit of the discrete equations leads to a two-dimensional nonlinear Schrödinger equation with an extra term. This extra term comes from the lattice discreteness and is shown to be essential to prevent a soliton from collapsing. This is achieved when the nonlinearity parameter takes values within some finite interval: $g_{c1} < g < g_{c2}$. It is shown, within the variational scheme, that the energy minimum is attained for the delocalized states provided $g < g_{c1}$, and for the strongly localized states (essentially on one lattice site) provided $g > g_{c2}$. The radius of the quasiparticle localization as a function of the electron-phonon coupling constant is evaluated. Some preliminary results on moving solitons are also presented.