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Multiscale analysis of a Davydov model with an harmonic long range interaction of Kac-Baker type

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ABSTRACT

The classical equation of motion of a Davydov model in a coherent state approximation in analyzed using the multiple scales method. An exponentially decaying long range interaction (Kac-Baker model) was included. In the first order the dominant amplitude has to be a solution of the nonlinear Schrödinger equation (NLS). In the next order the second amplitude satisfies an inhomogeneous linearized NLS equation, the inhomogeneous term depending only on the dominant amplitude. In order to eliminate possible secular behaviour the dominant amplitude has to satisfy also the next equation in the NLS hierarchy (a modified complex KdV equation). When the second order derivative of the dispersion relation vanishes the scaling of the slow space variable has to be changed, and a generalized NLS equation with a third order derivative is found for the dominant amplitude. As the coefficient of the third derivative is small a perturbational approach is used to discuss the equation. A complete solution is given when the dominant amplitude is the one-soliton solution of the NLS equation.