Energy and charge transport in a silicate layer

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Abstract—It has been observed in fossil tracks and experiments in layered silicates the transport of charge through the cation layers. In this paper we present a realistic model in which a breather can trap a hole. This hole will be tight-bound to an ion and it can travel from ion to ion when they become close enough during the breather motion. The properties of such combination of breather and hole are analyzed and also, their suitability to explain the experimental data

1. Introduction

From the sixties it has been know than the silicate mica muscovite has the capability for recording the tracks of swift particles of positive charge, as positrons, protons and antimuons. The presence of most of the tracks without the characteristic kinkiness of Coulomb scattering by atomic nuclei but along the lattice close packed lines of the K^+ cation interlayer demonstrated that nonlinear excitations, called *quodons*, were able to travel long distances, which was also proved experimentally [1]. These works have reviewed recently in Ref. [2].

In 2015 it was observed that only positive particles were recorded and that the thickness of quodon tracks was very similar to the end of positron tracks, and it was postulated that quodons have electric charge, mainly positive [2]and triggered by the recoil of K ions after beta emission. Depending of the recoil momentum and energy the resultant linear excitation could be a breather, a kink or a travelling charge state [3]. Charge transport by nonlinear excitations was demonstrated experimentally [4, 5]. A model was constructed with realistic potentials and kinks [6], nanopterons [7] and pterobreathers [8] were found.

2. A model for charge transport

Previous models were augmented to form a tight-binding model for hole and electron transport coupled to a lattice excitation. Most parameters are known except the charge hoping integral J_0 but its approximate value can be deduced from the moving breather theory described in [8] imposing the condition that the both the dispersion relation for the lattice and for the charge have to be nearly tangent to parallel resonant lines separated at specified intervals.

Different degrees of linearization are studied to find out the properties of moving breathers coupled to a charge. The full model is analyzed numerically and the results compared of the approximations.

The different excitations are described and their correspondence with the known properties of *quodons* are analyzed.

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