# Polarokinks and polarobreathers in a model for silicate layers

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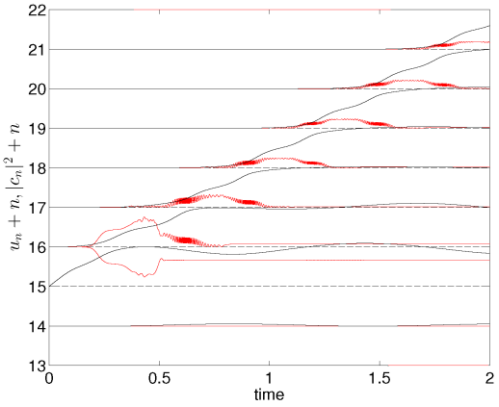
It has been observed in fossil tracks and experiments in mica muscovite and other layered silicates that the transport of charge through the cation layers sandwiched between the silicate tetrahedra-octahedra-tetrahedra layers [1].

Lattice kinks or crowdions imply the movement of the cation in the K+ layer and therefore the transport of charge at supersonic speed. Single crowdions and double crowdions with no radiation have been found in [2,3]. The energy of single crowdions is large, about 26 eV and could be a good candidate for primary tracks in muscovite. There are however fainter tracks, called secondary tracks, scattered from the primary tracks that should have much smaller energies of the order of tenths of eV. Moving exact breathers with such energies have also been found in [4]. However, they do not transport charge.

If a K+ ion loses an electron, for example by beta- decay of the nuclei, or other causes, it can be described as the creation of a trapped positive hole. Within an insulator, the probability of the hole to be transferred to another ion is very low but a relatively large vibration enhances enormously the probability of transmission [5]. In this way a travelling anharmonic vibration can trap a hole and move along the lattice.




This charged vibration can be a polarokink, that is a kink or crowdion trapping an extra hole as seen in the figure.

A kink is called a crowdion because it is basically a moving interstitial, which in an ionic crystal implies a moving charge. Therefore, a polarokink transports two units of charge. It should be noted that an electric current, as measured in hyperconductivity experiments, needs this extra charge because electrons have to move through the metal contacts and wires. The anharmonic vibration can also be a breather trapping a hole, that is a polarobreather.

We study the conditions of the transfer integrals for travelling anharmonic vibrations and their properties, analyzing which are more consistent with the experimental results.

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Bibliography:

[1] FM Russell, JFR Archilla, Ballistic charge transport by mobile nonlinear excitations
Phys. Status Solidi RRL 16, 2100420 (2022)

[2] JFR Archilla, Yu A Kosevich, N Jiménez, V Sánchez-Morcillo and LM García-Raffi. Ultra-discrete kinks with supersonic speed in a layered crystal with realistic potentials. PRE E 91, 022912 (2015).

[3] JFR Archilla, Y Zolotaryuk, YA Kosevich and Y Doi. Nonlinear waves in a model for silicate layers. Chaos 28, 083119 (2018).

[4] JFR Archilla, Y Doi, M Kimura. Pterobreathers in a model for a layered crystal with realistic potentials: Exact moving breathers in a moving frame. PRE 100 (2019) 022206.

[5] VI Dubinko, PA Selyshchev and JFR Archilla. Reaction rate theory with account of the crystal anharmonicity. PRE E 83, 041124 (2011).