Quodons in Mica 2013

Meeting in honour of Prof. Mike Russell.

A crowdion in mica. Between K^{40} recoil and transmission sputtering

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Abstract

Tracks in mica muscovite which apparently are caused by some kind of lattice excitation [1] may have been produced by the recoil of K^{40}. The isotope K^{40} can decay emitting an electron or a positron with the corresponding neutrino, the recoil energy of K^{40} is of about 40 eV. The experiment by Russell and Eilbeck [2] proved the transmission of localized energy along lattice lines in the K^+ layer. The impact of an α particle on one side of a mica specimen led to the ejection of an unidentified atoms from the other side. Typical surface binding energies for silicates are between 3 and 5 eV.

We construct a 1D model for mica, taking into account that the K^+ is a repulsive one, finding supersonic kinks [3] with a large range of energies and velocities, both with next-neighbour interaction and with many neighbours. The distances between ions are extremely small, but with the introduction of the ZBL repulsive short range potential, similar kinks are found again but with reasonable ion distances∼[4].

However, when a substrate potential obtained from empirical potentials is introduced there is an enormous change in kink properties. Below some characteristic energy E_c and velocity V_c the kinks are dispersed in phonons. Above that energy, kinks loose energy into phonons until they achieve E_c and V_c, thereafter propagating without radiation.

This lattice kink also called crowdion has a self-selected energy E_c 30 eV, which is exactly between the recoil energy of K^{40} and the surface binding energy of atoms in silicates.

Crowdion have been found with molecular dynamics in different materials as Ni [5] showing exceptional robustness and self-focusing properties.

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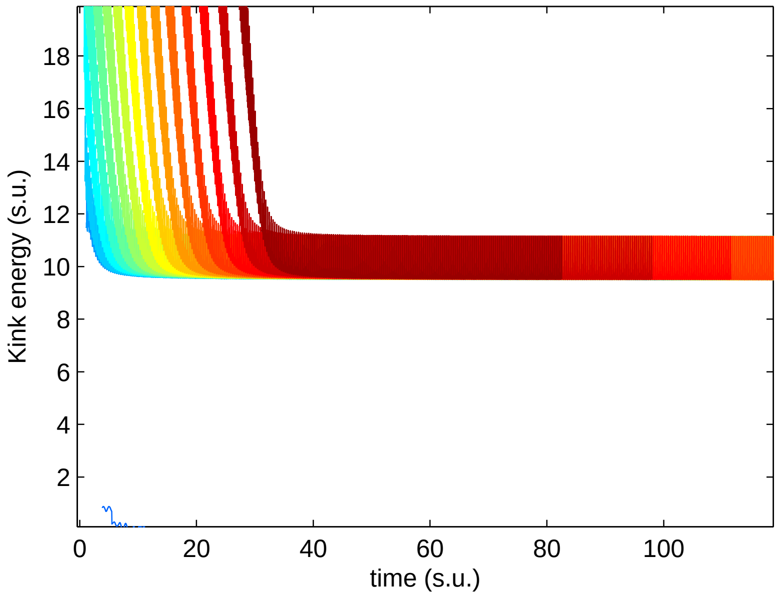

Figure 1: Large energies bring about the emission of phonons until a non-radiating lattice kink or crowdion is formed. The scaled units are equivalent to 2.8 eV.

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