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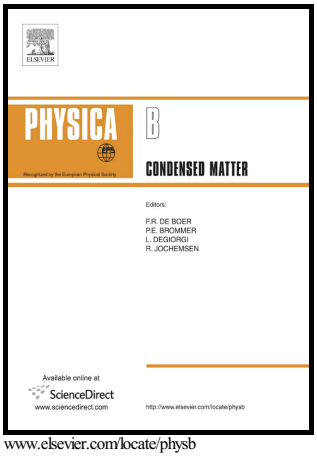

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Finite size effect on the magnetic excitations spectra, phonons and heat conduction of the quasi- one-dimensional spin chains system $SrCuO_2$

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Abstract

We report inelastic neutron scattering measurements of the phonons modes, in the one-dimensional half integer spin chains cuprate $SrCuO_2$. We study the longitudinal and the transverse modes propagating in the direction of the chains, along Q (0 0 L) and Q (2 0 L), respectively. On the other hand, we investigate the effect of substitution by impurities in the corresponding doped compounds, namely, $SrCu_{0.99}M_{0.01}O_2$ with M=Mg or Zn, and $La_{0.01}Sr_{0.99}CuO_2$. Our results evidence a systematic strong spinon-phonon interaction leading to an important decrease of the phonon scattered intensity as well as a decrease of the group velocity of the transverse acoustic modes upon substitution, and a shift of the transverse optical B_{3u} mode in the La-doped $SrCuO_2$, in terms of energy.

I. INTRODUCTION

Additionally to classical heat transport by electrons and phonons, magnetic heat transport by spin quasi-particles (spinons and magnons) has been evidenced in series of compounds [1–9]. Among them, Mott insulating spin chains/ladders cuprates are of particular interest, as they allow the investigation of lattice and spin dynamics contribution to the thermal conduction, free from any electronic contribution.

The anisotropic magnetic heat transport in these compounds occurs along the spin chains/ladders direction. It involves magnetic quasi-particles excitations, namely, magnon, for the case of the ladder compounds, for instance, $Sr_{14}Cu_{24}O_{41}$ [3]; and spinon, in the case of the simple and double chains compounds, Sr_2CuO_3 and $SrCuO_2$ [5,6,10]. Heat transport by spinon and phonons gives rise to a variety of scattering channels including spinon-phonon and two-phonon scattering that are highly relevant to the subsequent thermal properties. The intentional insertion of controlled amounts of dopants (defects) allows for further probing defect-quasi particle scattering paths.

Here, we focus our interest on the spin chains material $SrCuO_2$. The crystal structure of $SrCuO_2$ consists in alternating stacks of ribbons of zigzag Cu-O chains, along (H 0 0) and (0 K 0), separated by Sr atoms along (0 K 0). The compound crystallizes in the orthorhombic space group *Cmcm*, and all of the atoms occupy equivalent 4c Wyckoff sites. Within this structure, two types of oxygen atoms can be found. The first one is linked to Cu^{2+} within the chains, which we will note as O_{Cu}; the second one is linked to Sr^{2+}, and will be denoted O_{Sr}. A more extensive description of the structure can be found in [11,12].