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A Comment on “Phonon Band Gaps” by R.M. Hornreich et al.

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In the interesting work [1] certain mechanical models are considered, showing the existence of periodic structures where acoustical phonon band gaps can be obtained. Several possible physical applications of such a situation as regards the acoustical spectrum are noted in [1] and in the references there mentioned. There is one more application, whose physics, in the opinion of the author of the present comment, can be most interesting, and which, at least, has to be seen in the perspective of such an investigation, defining specific directions for the modeling.

The well known complexity of the lattice structure of high-temperature superconductors (e.g. [2]) suggests specific acoustic features of the superconductive materials, and if band gaps for low-energy acoustic phonons can be obtained in these materials, then this can be relevant to the explanation of the phenomena of high $T_c$ superconductivity.

Assume that for the energies outside the gap the acoustic phonon density distribution [3] is, basically, as that in thermodynamic equilibrium. If an electron which participates in the electrical current can, for physical reasons, emit only phonons of the energies which belong to the gap, i.e. phonons which the lattice cannot accept, then the electron cannot emit phonons and there is no conversion of the electrical energy into heat, i.e. there is no electrical resistance for the part of the electrical current associated with the movement of the electron. Such electrons must provide ideal “short-circuiting” of the whole sample, causing the superconductivity. The higher the borders of the phonon band gap, the higher should be $T_c$.

As regards the mechanical models one notes that they themselves can be quite readily modeled by means of electrical lumped-elements circuits. Such an electrical modeling is even more promising here because of the very well developed theory of electrical circuits (such as e.g. filters, delay lines, etc.) which usually are much more structurally complicated than mechanical laboratory-model systems. The latter is certainly important in view of the presumably difficult modeling of the mechanical oscillatory features of the complicated-structure high-$T_c$ superconductive materials.

Having here just a proposition the author wishes the reader to find this, nevertheless, as a contribution (after [1], but now just in the motivating plane) to the memory of Professor R.M. Hornreich.

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