PHONON MULTIPLEXING THROUGH 1D CHAINS

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Phonon propagation trough atomic structures have became an important study issue. The most important applications rise on the thermal field, since phonons can carry thermal and acoustic energy. The technological advantage makes possible to engineer thermal an acoustic paths as desire.

A linear numerical method was developed in order to analyze the scattering and filtering of phonons in 1D atomic structures. Only transverse propagation modes were taken into account. Bonding forces between atoms were assumed linear; also these forces were restricted to be first nearest neighbor interaction.

A simple phonon multiplexer proposed by Dobrzynski [2] was analyzed. It consists of two mono-atomic chains of atoms and a coupling structure between them which is made out of two atoms connected together. Dobrzynski´s results [2] were verified making possible to use the developed model in further analyzes. Earlier analysis of the structure did not establish a way of changing the wave length in which the phonon transfer occurs. Taking advantage on the friendly numerical methods, it was possible to establish simple rules that able us to actually select a wavelength of transmission and tune the structure by changing its constitutive parameters such as atoms masses and bonding forces. Multiplexer efficiency was also studied setting the limits of well performance of the filter. Finally frequency analysis led to obtain the energy gaps between the propagating modes. The developed method allows studying much more complex structures than the one presented here. In summary we find how the parameters of the structure allows us design phonon filters.

References:

[1] J. S. Jensen, “Phononic band gaps and vibrations in one- and two-dimensional mass-springs structures”, Journal of sound and Vibration 266 (2003) 1053-1078.

[2] L. Dobrzynski, et Alt., “A simple phonon multiplexer”, Europhys. Lett., 65 (6), pp. 791-794 (2004).

[3] Dobrzynski L., Djafari-Rouhani B., Akjouj A., Vasseur J. and Zemmouri J., Europhys. Lett., 46 (1999) 467.

Figures:

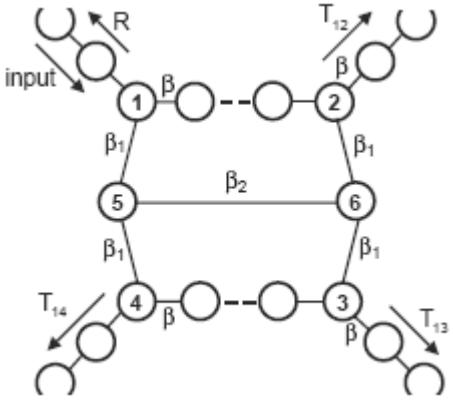
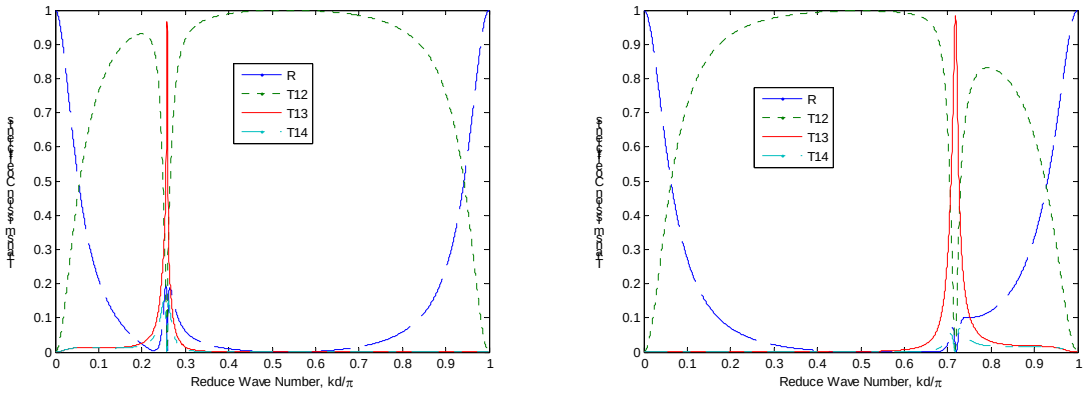


Fig.1. Phonon Multiplexer proponed by Dobrzynski [2].



(a) (b)

Fig. 2. Transmission coefficients tuned at different wavelengths.