Self-sustained oscillations in coupled nanomechanical resonators

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We investigate theoretically the dynamics of a coupled nanomechanical oscillator consisting of moveable metallic grains integrated between two contacts (see Fig. 1). This double pendula structures in the nanoscale –also coined electron shuttles [1]– can be operated in radio frequencies (RF), possess a set of resonance frequencies, and reveal Coulomb blockade, even at room temperature [2]. Mechanically assisted charge transfer becomes possible as the mechanical motion of the shuttles is excited. This motion changes the capacitance of the islands, affecting the current through the system, which can in turn further excite the response in certain regions of the parameter space spanned by frequeny and intensity of the excitation. We explore these regions of parametric instabilities using a weak RF excitation and find self-sustained, greatly amplified oscillations in the response, suggesting a practical scheme for the realization of a vast nuber of future aplications in the nanoscale. In the absence of a DC bias, parametric instabilities induce spontaneous symmetry breaking with a subsequent observable direct current [3, 4]. The direction of the current is defined by the phase shift between parametrically excited mechanical oscillations and the RF signal [5].

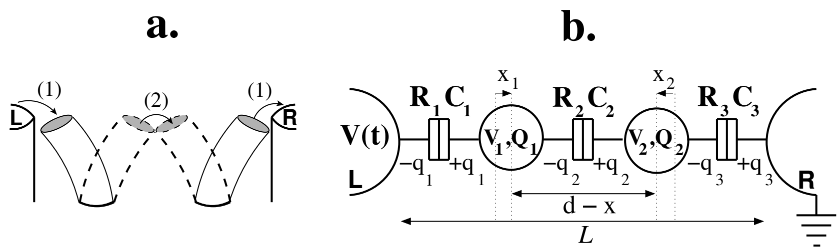

Figure 1: *a. The flexural mode which originates an efficient DC current has the center of mass at rest. b. Circuit representation: two metallic islands are capacitively coupled to each other and to both electrodes, L and R, which are connected to an external voltage source, $V(t)$. The islands are separated by a distance d in equilibrium, and their relative displacement is given by $x(t) = x_1 - x_2$. Their mutual capacitances C_i and the resistances R_i depend on this quantity, affecting the electrostatics of the device.*

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