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EIGENOSCILLATIONS LATTICES OF DIFFERENT DIELECTRIC MICRORESONATORS

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ВЛАСНІ КОЛИВАННЯ РІЗНИХ ДІЕЛЕКТРИЧНИХ РЕЗОНАТОРІВ

Досліджуються особливості розподілу амплітуд та частот власних коливань в системах зв'язаних між собою, відмінних за розмірами та діелектричної проникністю діелектричних мікрорезонаторів. Запропоновані нові структури мікрорезонаторів та види їх зв'язаних коливань. Вперше встановлено наявність квазі незалежних коливань між підсистемами різних резонаторів.

Dielectric microresonator gratings can be used in a variety of passive infrared and visible wavelength communication devices. [1 - 4, 7]. At that various microresonators can significantly improve parameters of the devices. In this report, we study the natural oscillations of the gratings constructed on different types of microresonators with basic modes.

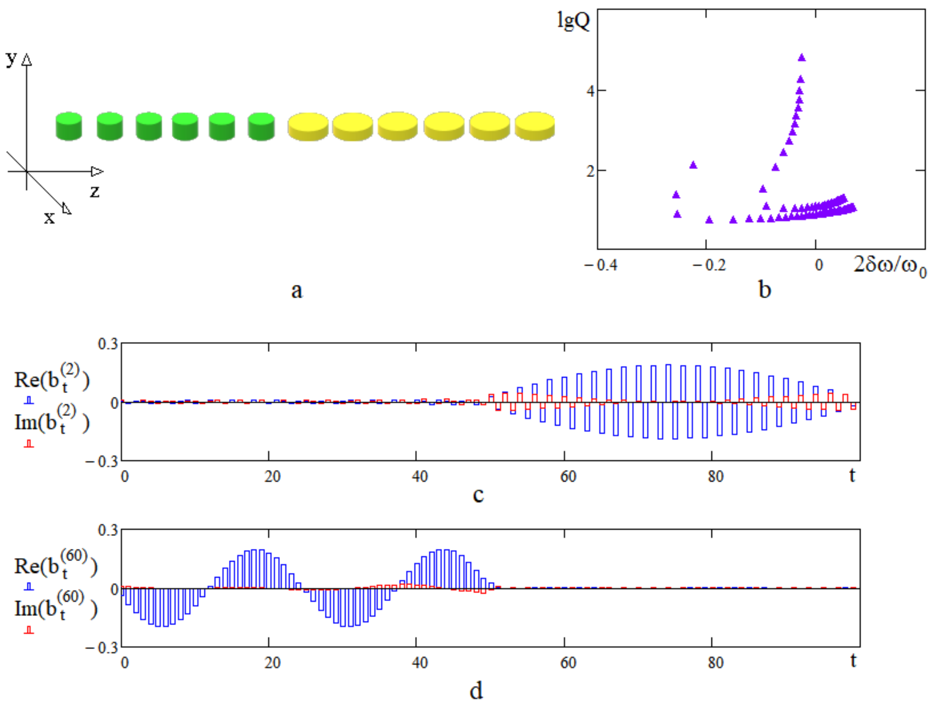

Fig. 1. One-dimensional lattice of different cylindrical microresonators with azimuthally symmetric magnetic modes H_{101} (a). Q-factors as functions of resonance frequencies (b) of the lattice (a) of 100 microresonators: ($\varepsilon_{1r} = 25$; $\varepsilon_{2r} = 16$; $\Delta_1 = 0,8$; $\Delta_2 = 0,3$). The real part of some amplitudes of the partial microresonators, localized in the sublettices regions.

Using the relations obtained earlier for the coupling coefficients [5, 6], we constructed the electrodynamic models [7] of the lattices, for example, shown in Fig. 1 - 4, a.

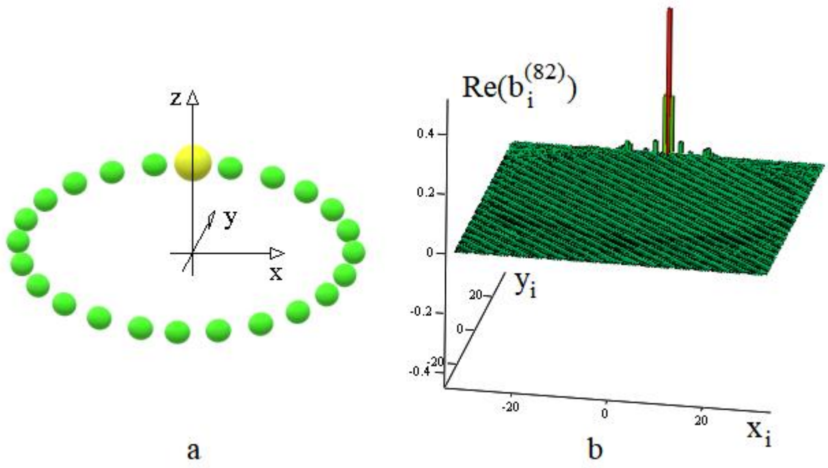

Fig. 2. Ring structure of 100 different spherical microresonators with magnetic modes H_{101} (a). ($\varepsilon_{1r} = 25; \varepsilon_{2r} = 16$). The real part of amplitudes of the partial microresonators, localized in the region of second microresonator (b).

It`s proposed that all microresonators are exited on azimuthally symmetric magnetic modes H_{101}. The relative dielectric permittivity of the resonators are $\varepsilon_{1r} = 25; \varepsilon_{2r} = 16$. The relative sizes of cylindrical microresonators are equal $\Delta_1 = L_1 / 2r_1 = 0{,}8$; $\Delta_2 = L_2 / 2r_2 = 0{,}3$, where L_s - is the height, r_s - is the radius of the

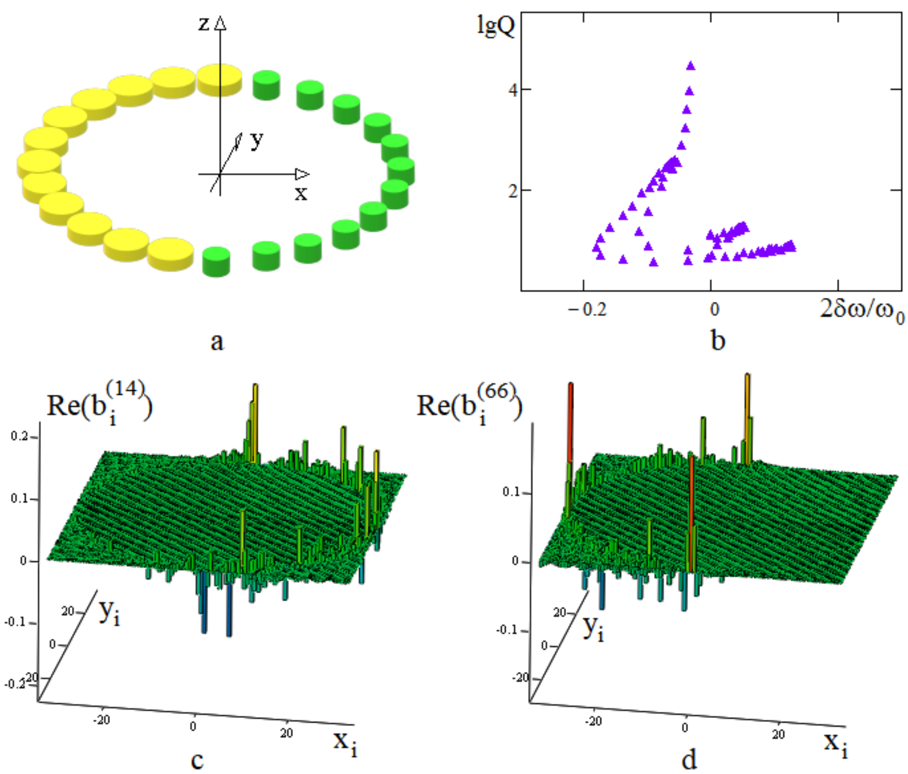

Fig. 3. Ring structure of 100 different cylindrical microresonators (a). Q-factors as functions of resonance frequencies of 100 microresonators (b). Some amplitudes of the partial microresonators, localized in the sublettices regions (c, d).

microresonator ($s = 1, 2$).

It was found that eigenoscillations are possible in one and two-dimensional structures, whose amplitudes are noticeably different for microresonators of various types (Fig. 1, 3, c-d; fig. 2, b; fig.4, c-e).

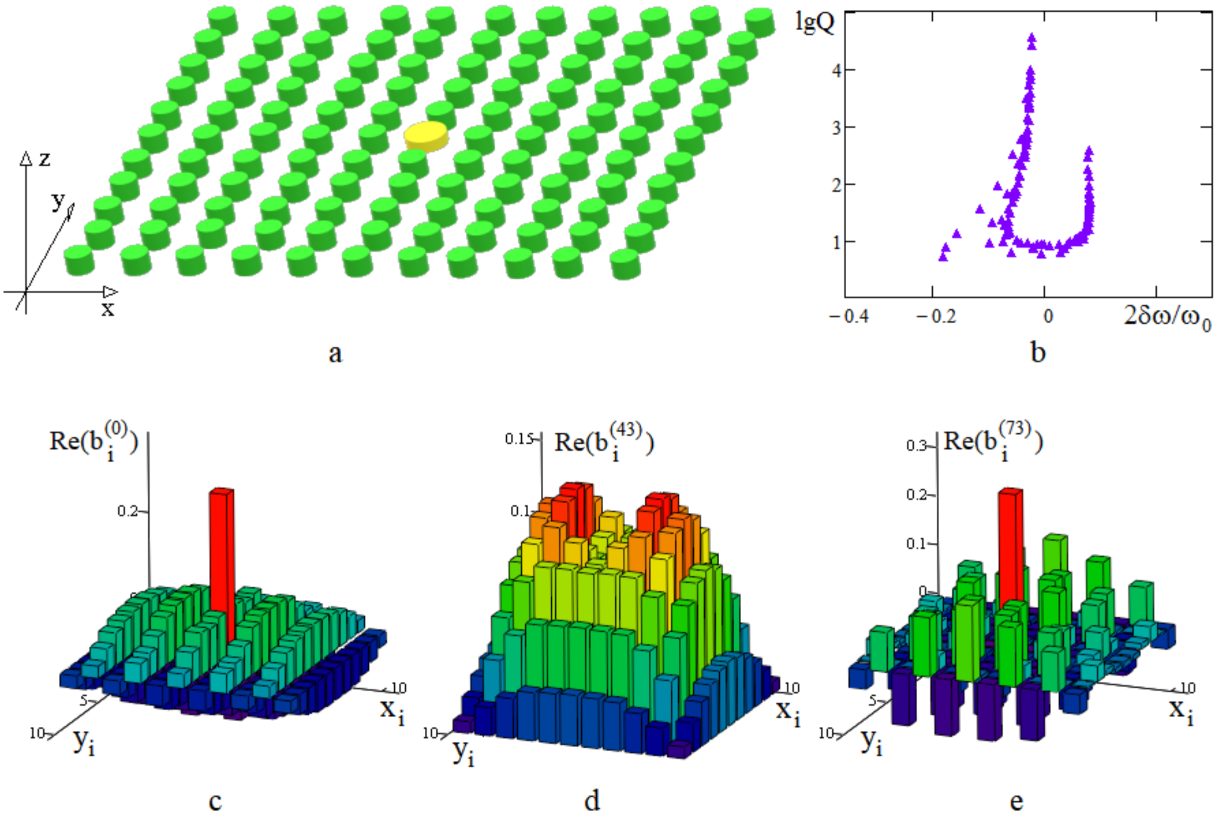

Fig. 4. The square lattice of 121 microresonators (a). Q-factors as functions of resonance frequencies of the microresonators (b). Some amplitudes of the partial microresonators (c, d, e). $b_s^{(t)}$ - is the complex amplitude of the field of the s-th microresonator; (x_i, y_i) - is the coordinate of the i-th microresonator center.

Despite the fact that all isolated microresonators have the same frequency of the lower mode, they can form quasi-independent substructures in the lattices, the characteristic frequencies of which are grouped in different ways, which is noticeable on the Q-plane-relative detuning shown in fig. 1, 3, 4, b (here $\delta\omega = \omega - \omega_0$; ω - is the frequency of the coupled eigenoscillation of the microresonator system).

The indicated properties of natural oscillations of the lattices consisting of different type microresonators should be considered when designing various devices based on them. In particular, gratings with different microresonators can be used to more effectively concentrate the field in a given spatial region (fig.1, 3, 5, c, d; fig. 2, b; fig. 4, c-e). Where $b_s^{(t)}$ - is the complex amplitude of the field of the s-th microresonator in the lattice with t-th coupled oscillation [5]; (x_i, y_i) - is the coordinate of the i-th microresonator center.

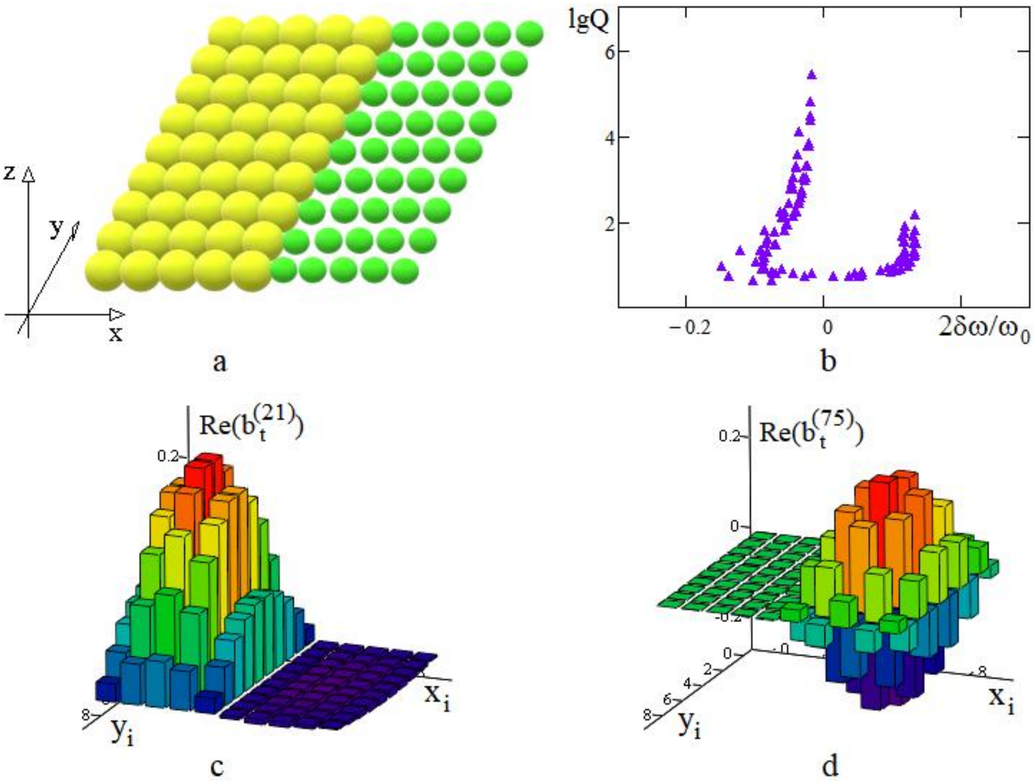

Fig. 5. The square lattice of 100 spherical microresonators (a). Q-factors as functions of resonance frequencies of the microresonators (b). Some amplitudes of the microresonators, localized in the region of different ones (c, d, e).

The conducted studies demonstrate new properties of lattices made on the basis of different microresonators. Possible distributions of the amplitudes of the field of coupled oscillations in such lattices should be taken into account when designing optical and quantum communication devices, as well as optical filters, antennas, sensors, etc.

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