Squeezing Alters Frequency Tuning of WGM Optical Resonator

Tuning rates for modes of different indices can be made to differ.

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Mechanical squeezing has been found to alter the frequency tuning of a whispering-gallery-mode (WGM) optical resonator that has an elliptical shape and is made of lithium niobate. It may be possible to exploit this effect to design reconfigurable optical filters for optical communications and for scientific experiments involving quantum electrodynamics.

Some background information is prerequisite to a meaningful description of the squeezing-induced alteration of frequency tuning: The spectrum of a WGM resonator is represented by a comblike plot of intensity versus frequency. Each peak of the comblike plot corresponds to an electromagnetic mode represented by an integer mode number, and the modes are grouped into sets represented by integer mode indices. Because lithium niobate is an electro-optically active material, the WGM resonator can be tuned (that is, the resonance frequencies can be shifted) by applying a suitable bias potential. The frequency shift of each mode is quantified by a tuning rate defined as the ratio between the frequency shift and the applied potential. In the absence of squeezing, all modes exhibit the same tuning rate. This concludes the background information.

It has been demonstrated experimentally that when the resonator is squeezed along part of either of its two principal axes, tuning rates differ among the groups of modes represented by different indices (see figure). The differences in tuning rates could be utilized to configure the resonance spectrum to obtain a desired effect; for example, through a combination of squeezing and electrical biasing, two resonances represented by different mode indices could be set at a frequency...
specified frequency difference — something that could not be done through electrical biasing alone.

This work was done by Makan Mohageg and Lute Maleki of Caltech for NASA’s Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1).

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