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Dynamic Tuning of Optical Nanocavity

- Manipulating trapped light -

NTT

Motivation

If you turn the tuning peg after you have plucked a guitar string, the pitch will change because you have changed the tension of the string before the vibration disappears. The vibration mode always follows the resonant mode of the string. This is obvious in sound, but what would happen if we apply this phenomenon to optics? It could open the possibility of a novel way of manipulating light, i.e., adiabatically changing the wavelength of light by using nanocavities.

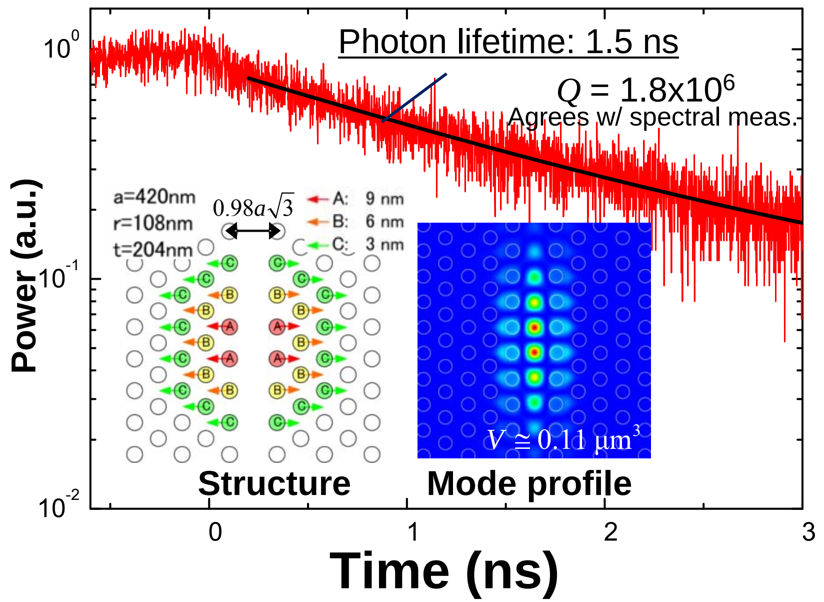
Originality

It has been believed that optical nonlinearities are required in order to change the wavelength of light. However, adiabatic wavelength shifting, a phenomenon based on classical physics, will change the wavelength of the light. Adiabatic wavelength shifting has not been considered in optics because of the difficulty in fabricating an optical cavity that can trap light for a long time in a small area. An optical cavity that can't trap light for a sufficient time is analogous to a guitar of which tuning peg can't be turned before the string vibration stops. By using a photonic crystal nanocavity that can trap light for a long time, we successfully demonstrated adiabatic wavelength shifting of the light.

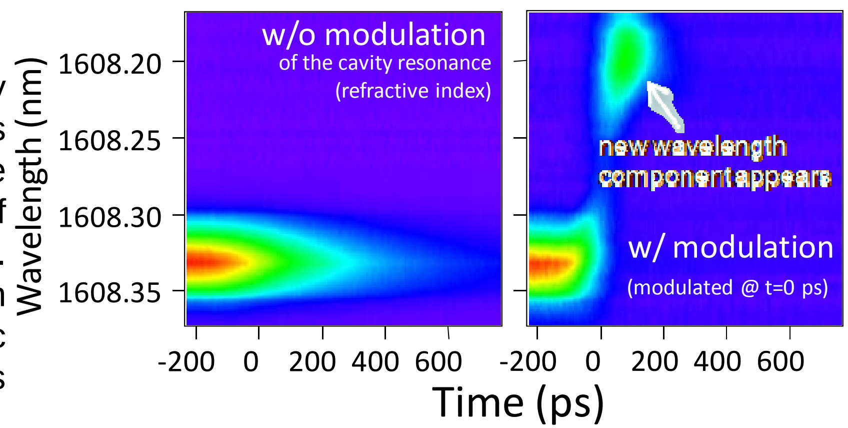
Impact

Wavelength shifting by the adiabatic process is different from that achieved by optical nonlinearities that usually requires high photon density. It allows wavelength conversion of single photon. It also enables us to change the extraction efficiency of light from the cavity, which will lead to the development of photonic memory that can hold and release light without loosing its coherence. We believe this will contribute to the development of quantum information processing. In addition, the underling physics involved in adiabatic wavelength shifting is closely related to opto-mechanics, which is another interesting research area.

Photonic crystal nanocavity with long photon lifetime



Adiabatic wavelength shifting experiment



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