# Optomechanical Crystals[1]

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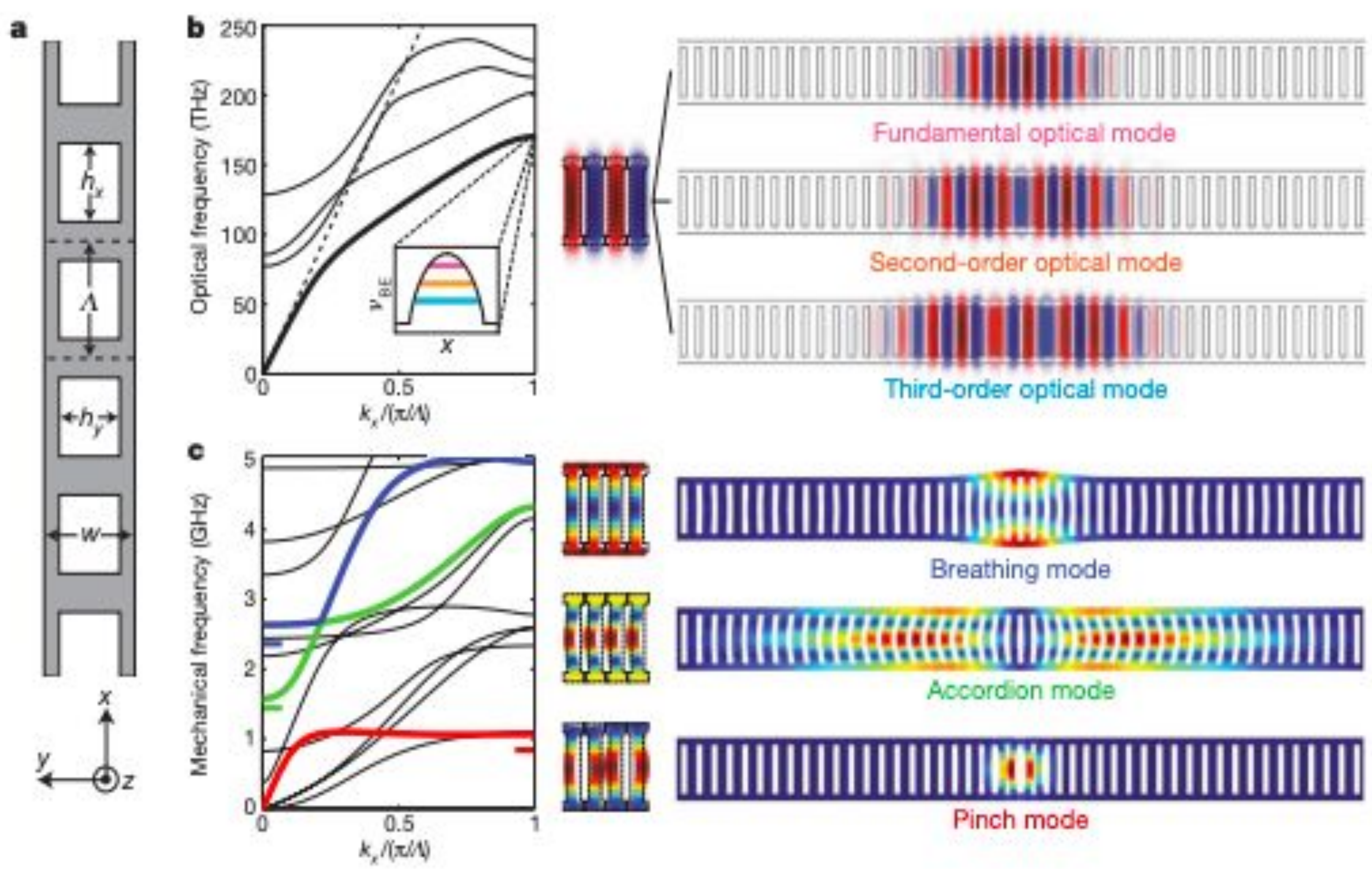
## Introduction

- Optomechanical crystals confine both optical properties of **light** and mechanical properties of **vibrations**.
- Photons and phonons are coupled in periodic nanostructures on a silicon chip.

## Motivation

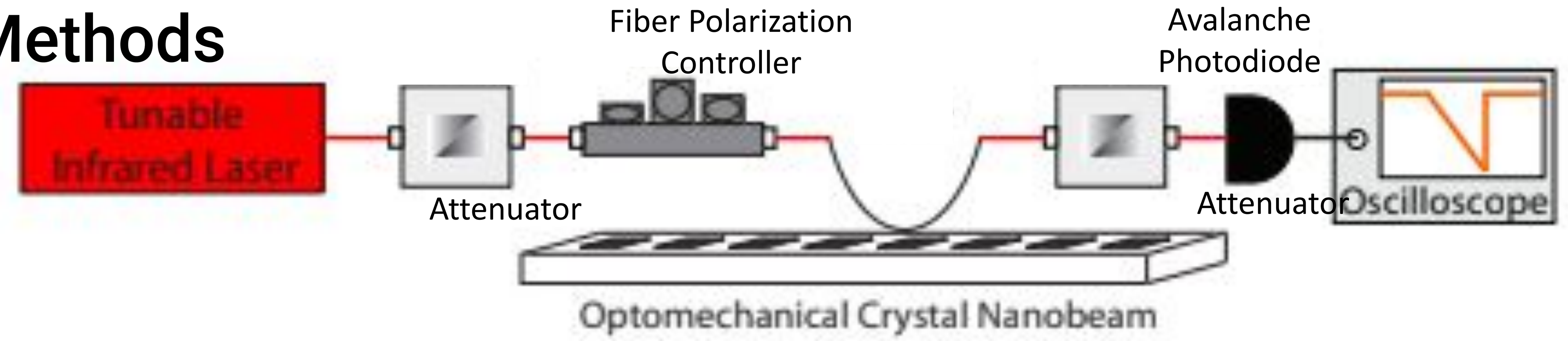
- Coupling optical and mechanical modes helps with microwave signal processing, creating zeptogram mass sensors, and microwave to optical transduction

## Design




- A **Quasi-harmonic potential** created by changing the hole shape confines optical and mechanical vibrations
- Differing **localized** (colored areas) **vibrations** have low to high frequencies with pinch, accordion, and breathing modes respectively

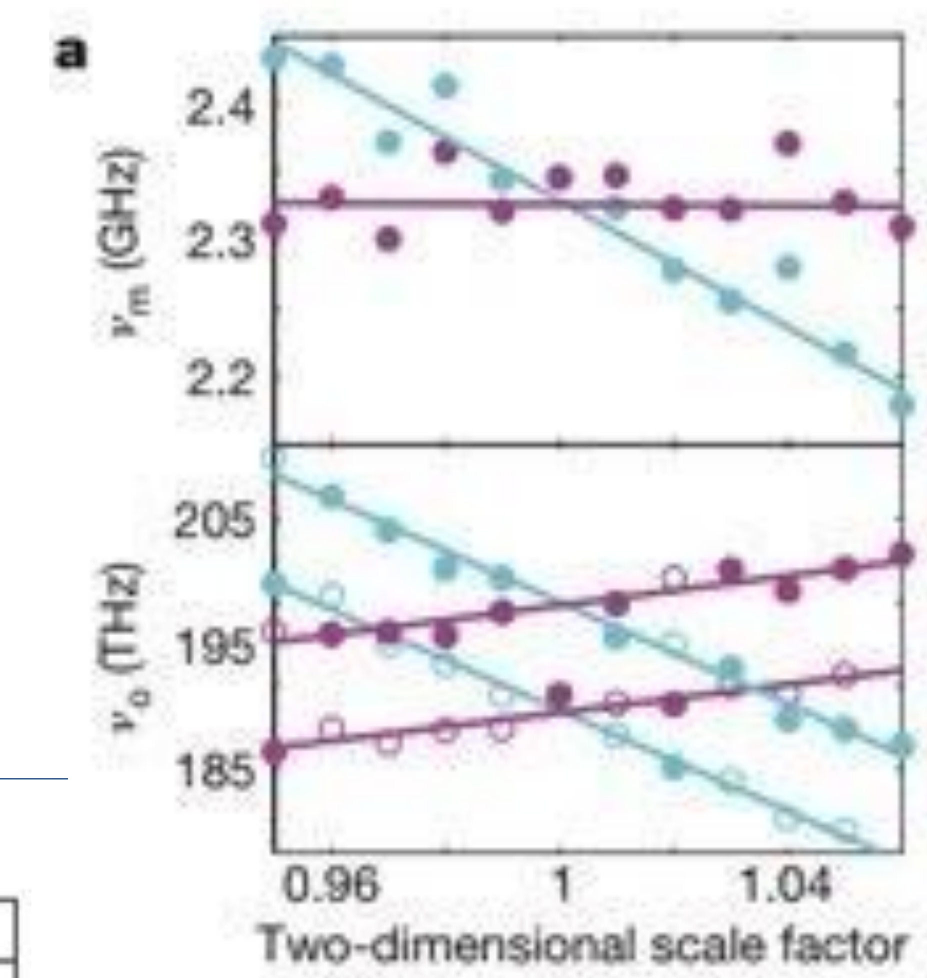
## Methods

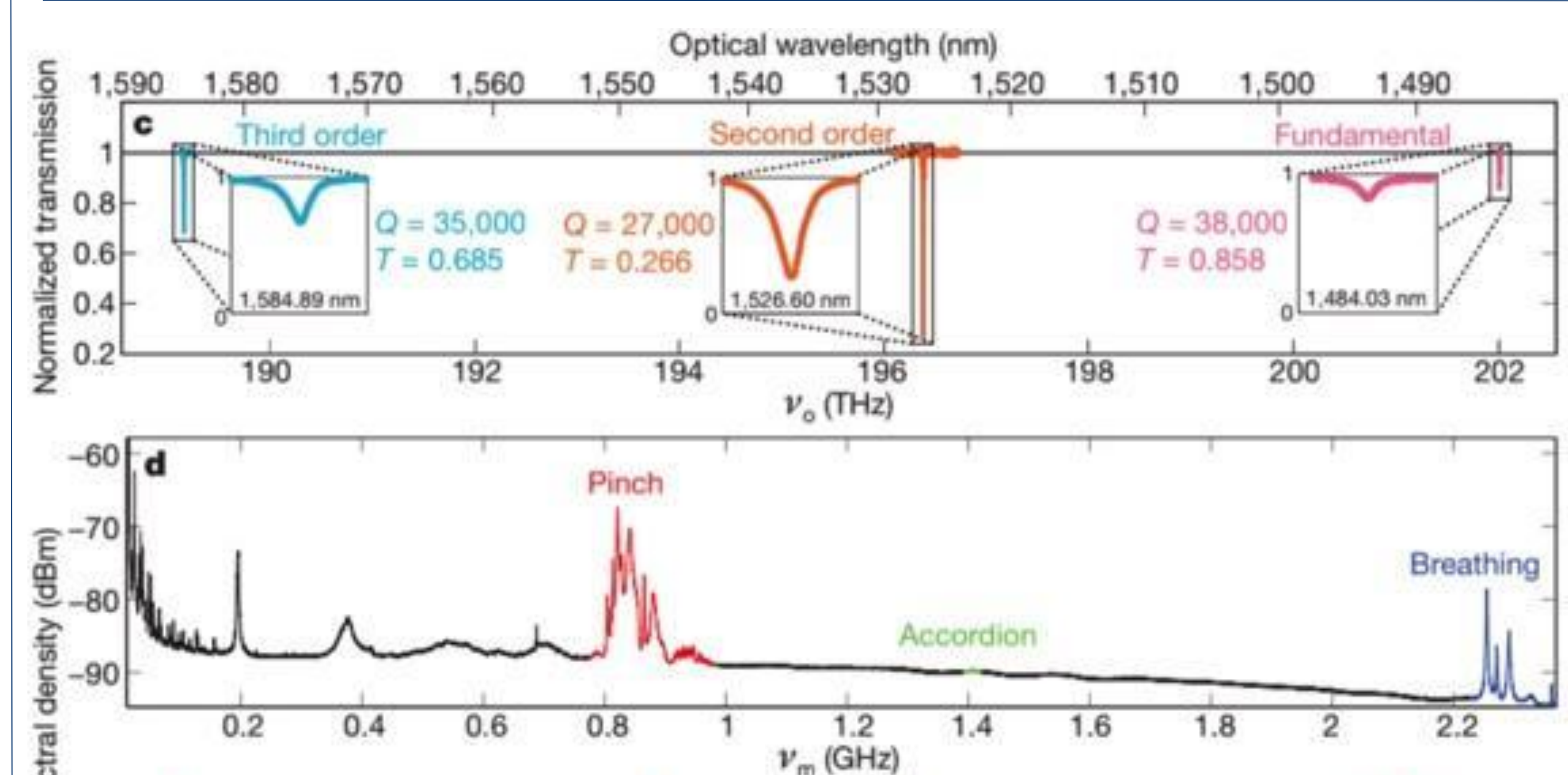



- **Attenuators** and **optical fibers** in the pathway help collect the optical cavity transmission spectrum
- **Tunable Infrared Laser**: Light Source
- **Optomechanical Crystal**: Device the light passes through
- **Avalanche photodiode**: Detector of light

## Results

- Measures **transmission signal** ($P_{out}/P_{in}$) using a laser (single wavelength) to the detector.
- When the laser hits **localized areas**, photons become excited and trapped in cavities and don't reach the detector, thus, **lowering strength** of transmissions. Whereas the laser will pass through if specific wavelengths aren't hit.
- If dips occur at expected frequencies/are high quality (narrow/sharp in structure), then it's applicable that the device is good with holes in the right place.




- The **Q-factor** is the figure of merit for how well a resonator stores energy: **[Q =$f_r/\Delta f = w_r/\Delta w$]**

- This enhanced light and mechanical interaction in small spaces can be potentially used for signal processing such as filters and mixers for microwave photonics in electronics and **detection** of tiny masses.

## Acknowledgements

[1] Eichenfield M., Chen J., Camacho R. M., Vahala K. J. & Painter O. (2009) Nature. *Optomechanical Crystals*, 78-82.

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