
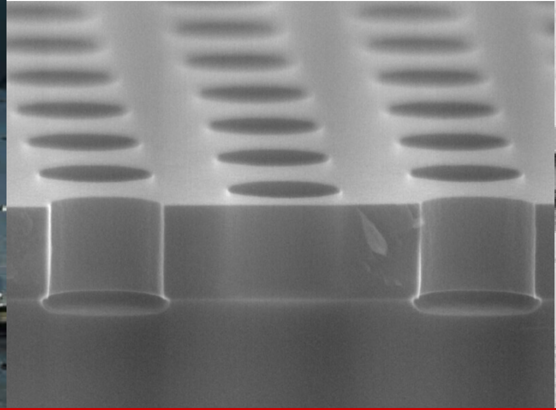
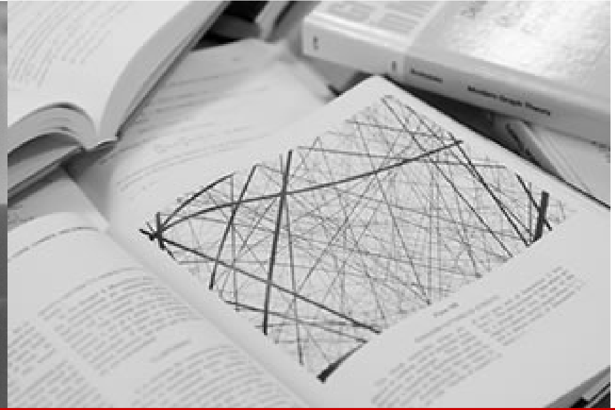

CLEO-PR & OECC/PS 2013 WI1-4 @ Room C-2 (Kyoto International Conference Center)

Analysis and Experimental Measurement of the *Q* Factor of Hexagonal Microcavities Fabricated with Crystal Growth

Hiroshi Kudo[1], Ryo Suzuki[1], Atsushi Yokoo[2,3],

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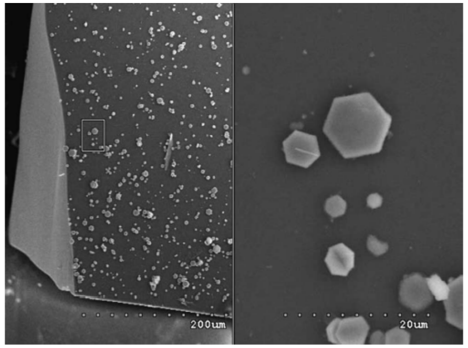
*takasumi@elec.keio.ac.jp

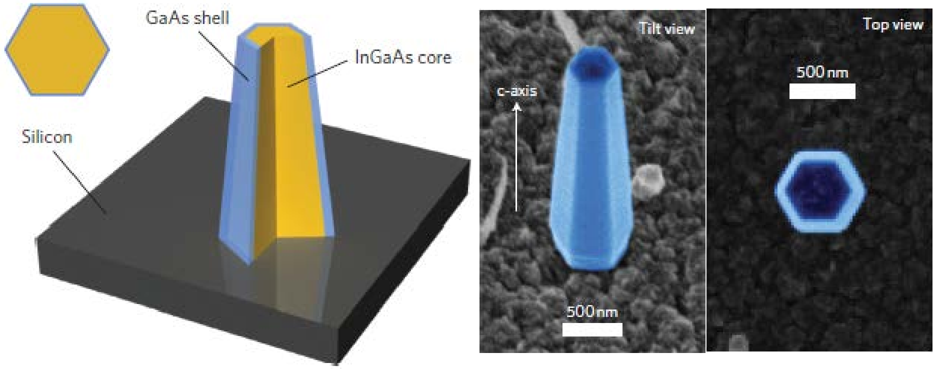
Progress of Polygonal microcavities

ZnO



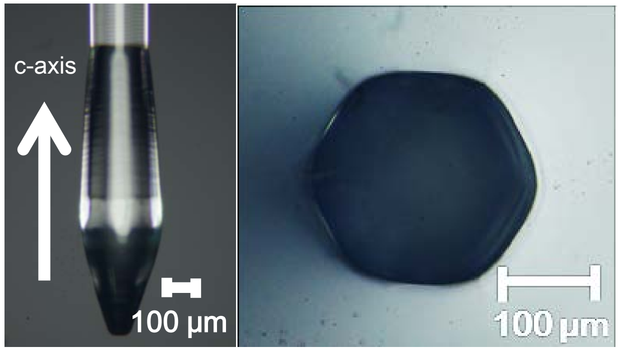
S. S. Kim *et al.*, J. Appl. Phys. **106,** 094310 (2009).

InGaAs/ GaAs



R. Chen *et al.*, Nature Photonics **5,** 170 (2011).

Al_2O_3



H. Kudo *et al.*, Appl. Phys. Lett. **102,** 211105 (2013).

Merit

- ✓ Sizeable light source on the substrate
- ✓ Robust system using coupling coefficient

CLEO-PR & OECC/PS 2013 **TuPM-12,** T. Kato *et al.,* "Analysis of Various Whispering Gallery Modes in an Octagonal Silica Toroidal Microcavity."

Laser-heated pedestal growth (LHPG)

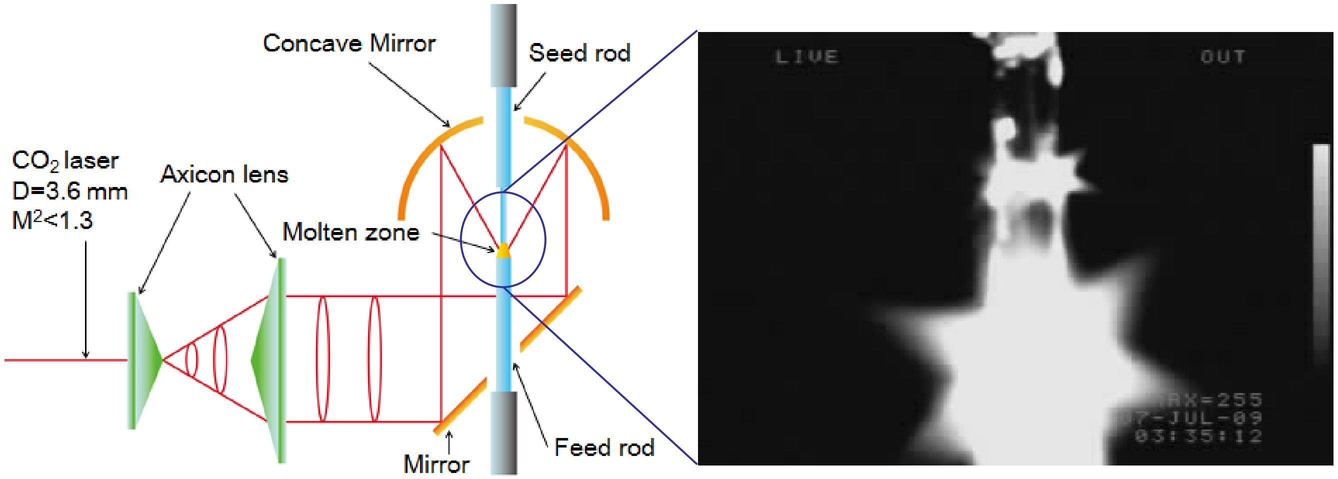
Original LHPG:

✓Fabrication of uniform crystal rods possible
✓Fabrication of rods w/ diameter < 100 μm possible
✓Fabrication of rods w/ smooth surface possible

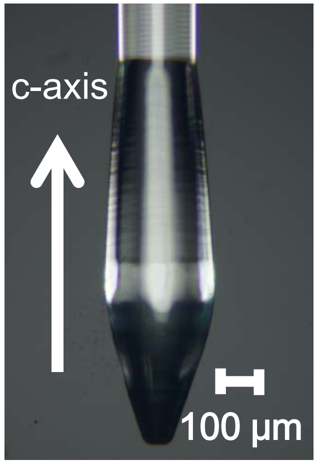
Modified LHPG:

✓Form bulge by changing growth rate (it allows WGM excitation)

Experimental setup



Fabricated cavity

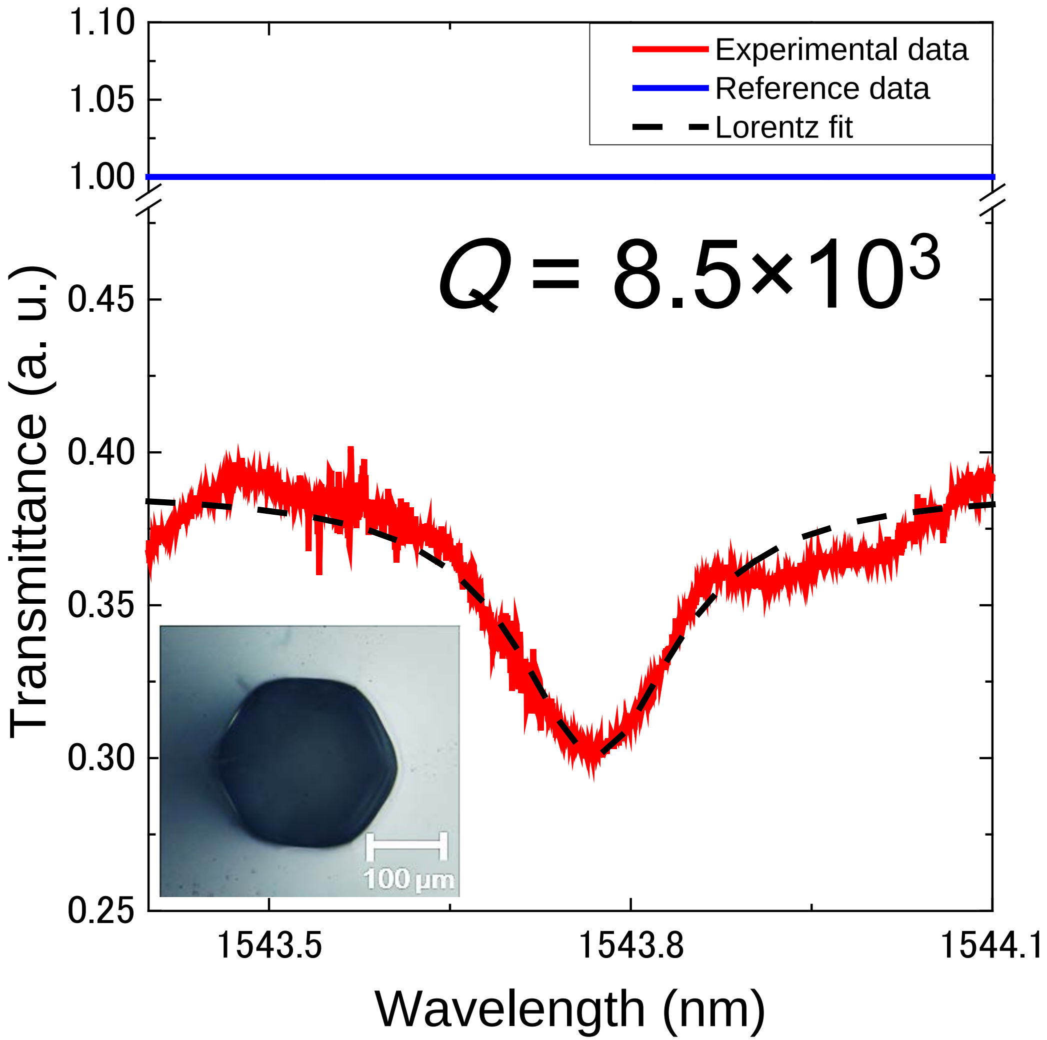


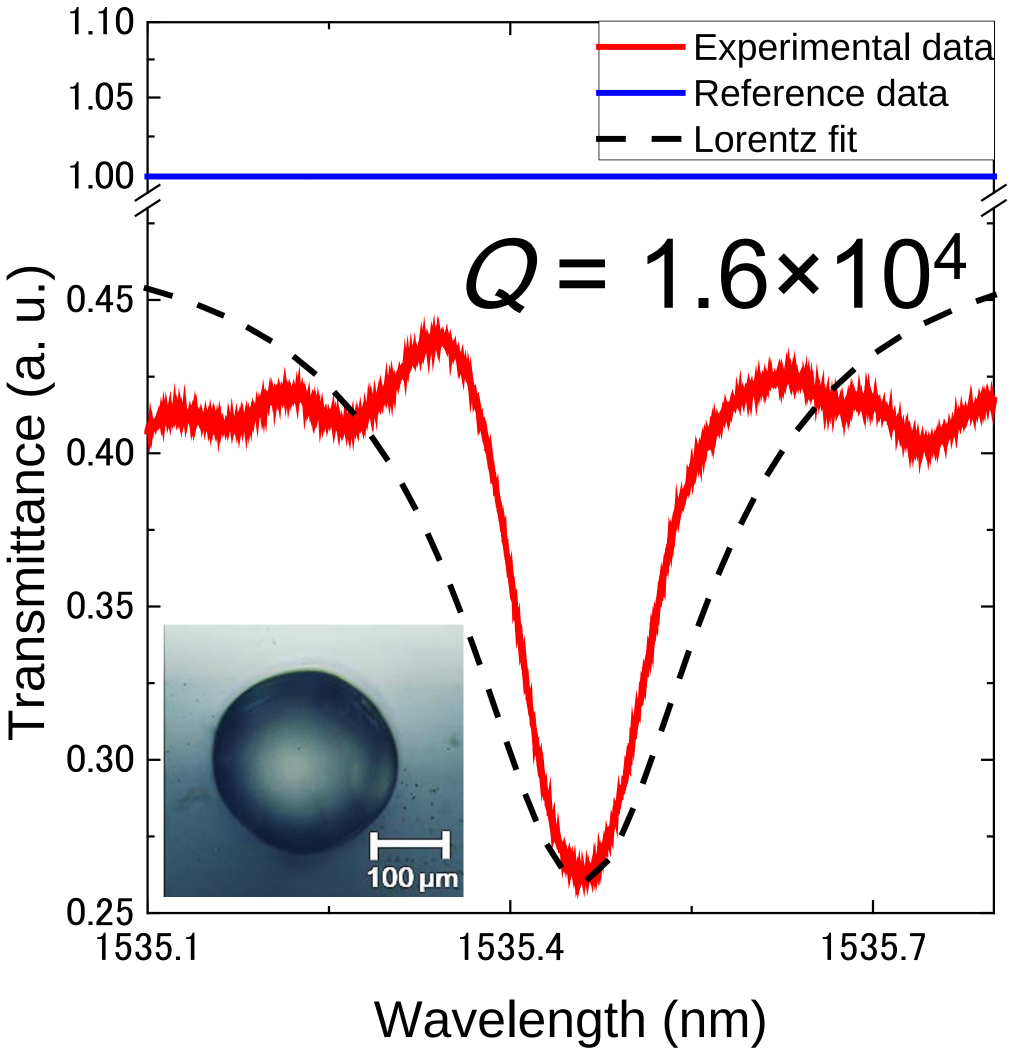
$$D_{grown} = D_{feed} \times \sqrt{v_{feed}/vse_{ed}}$$

✓ WGM cavity fabricated

Optical measurement

H. Kudo *et al.*, Appl. Phys. Lett. **102,** 211105 (2013).

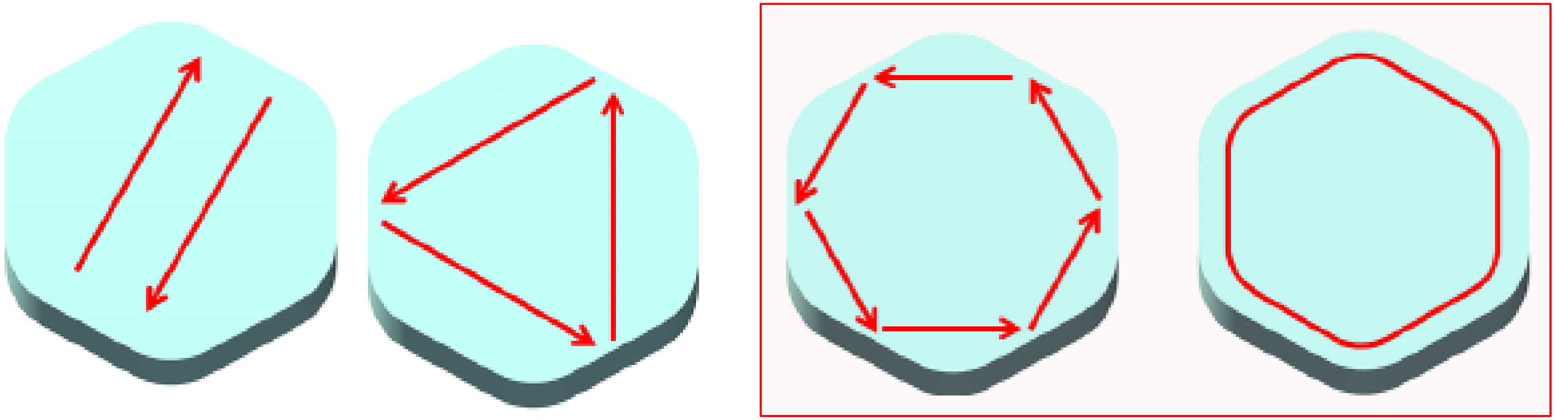


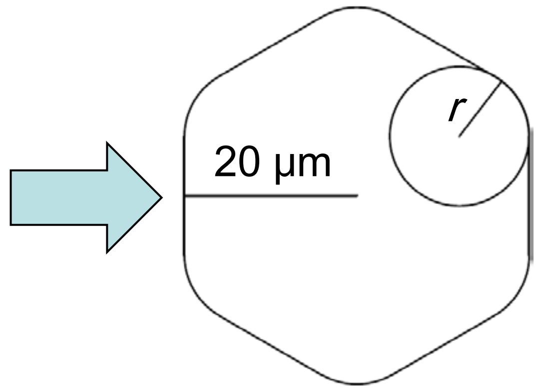


✓ The Q is dependent on the cross-sectional shape.

Q factor vs. corner radius

What kind shape is the best to obtain high Q ?

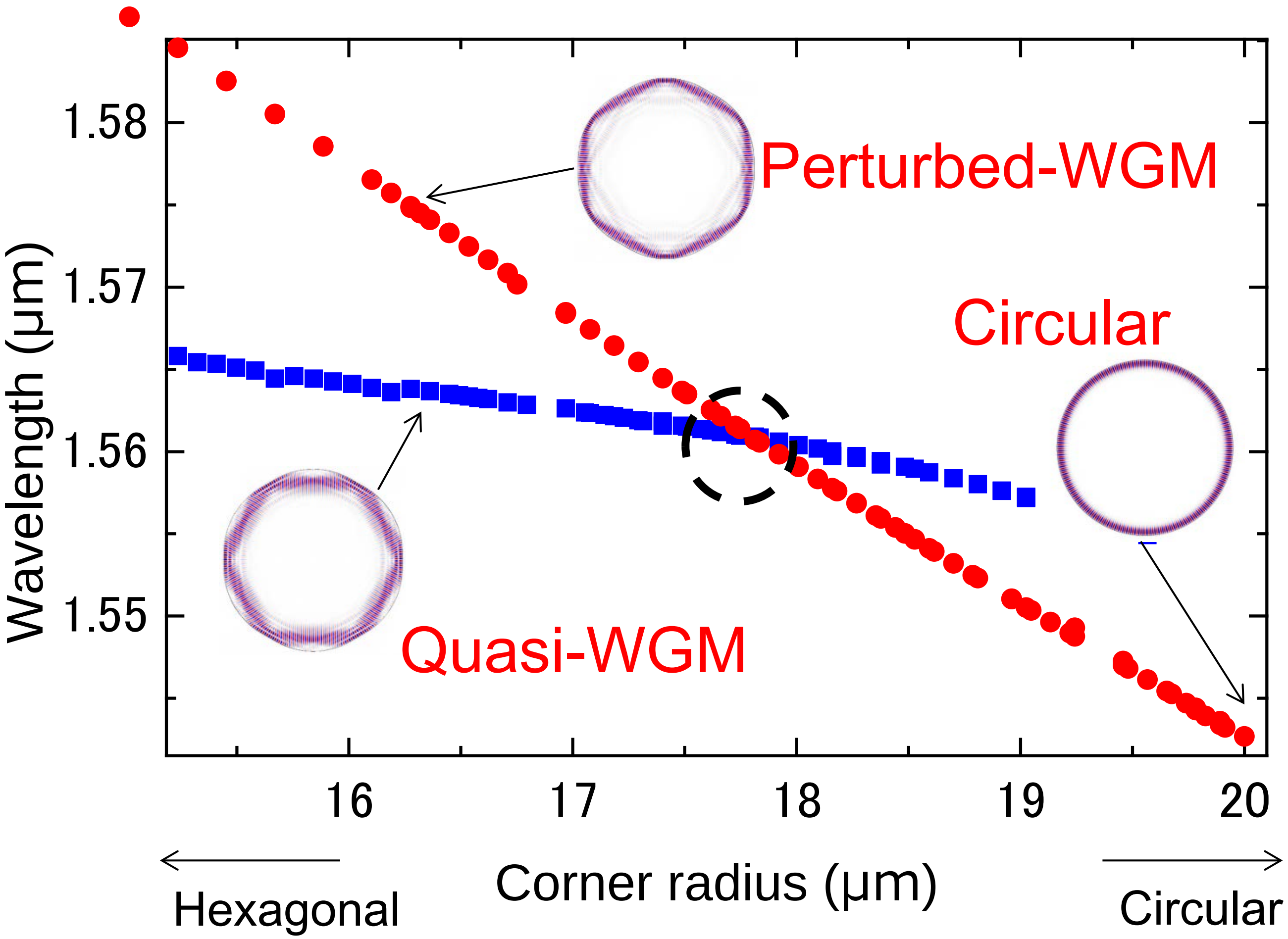


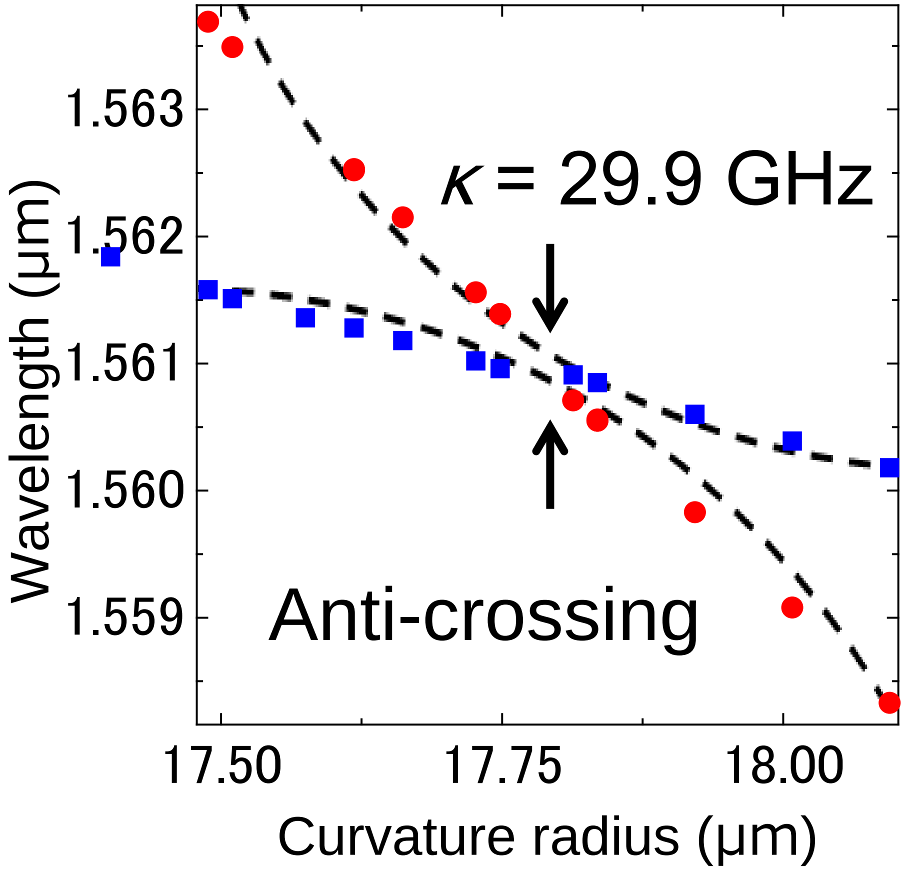


Quasi mode **Perturbed mode**

FDTD model

Mode mixing between different modes in hexagonal cavities

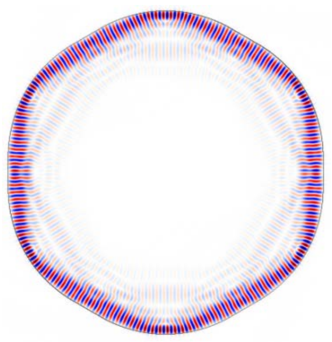




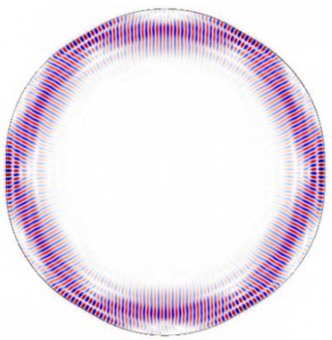
✓ Strong coupling occurs between perturbed & quasi modes

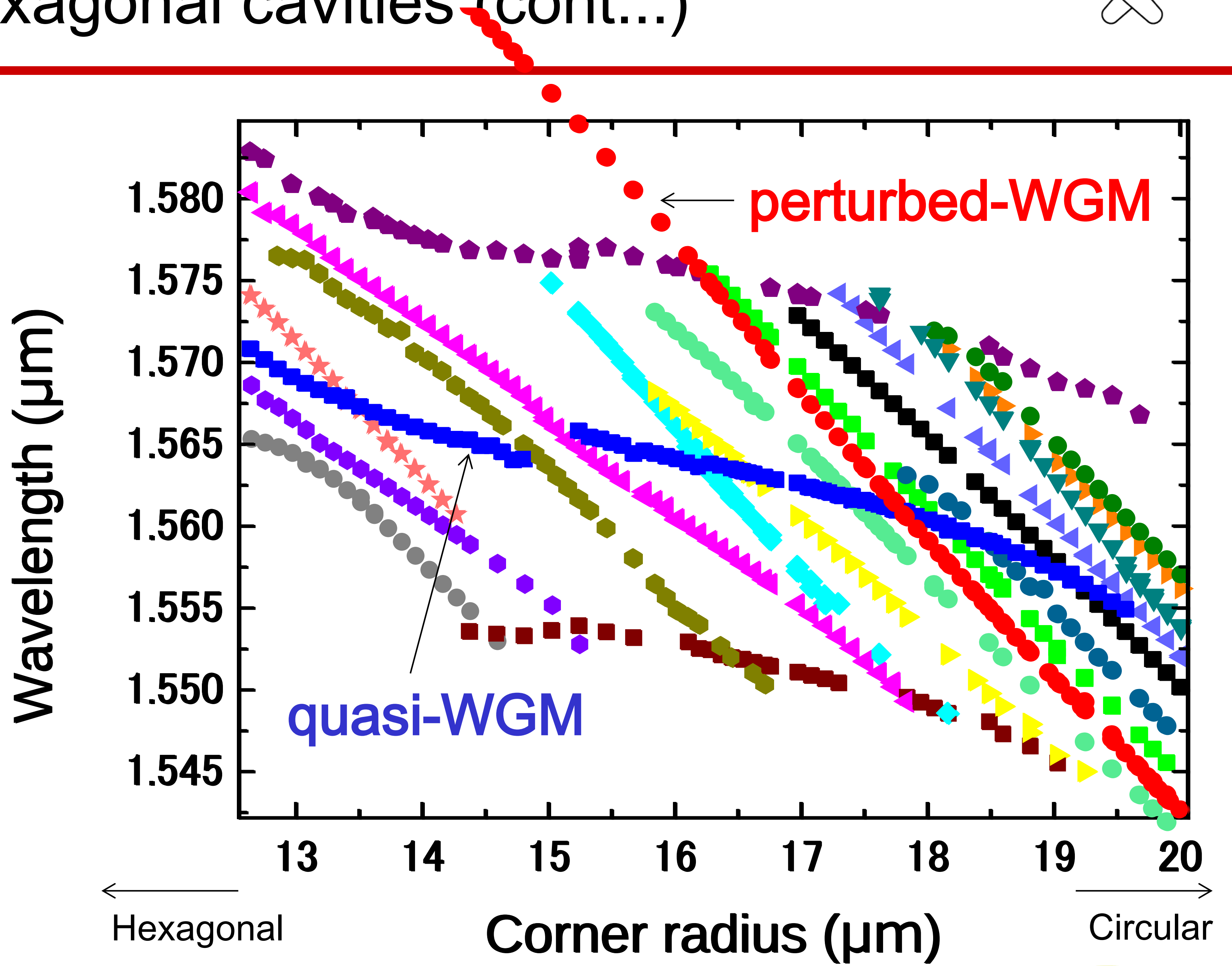
Modes in hexagonal cavities (cont...)

perturbed-WGM



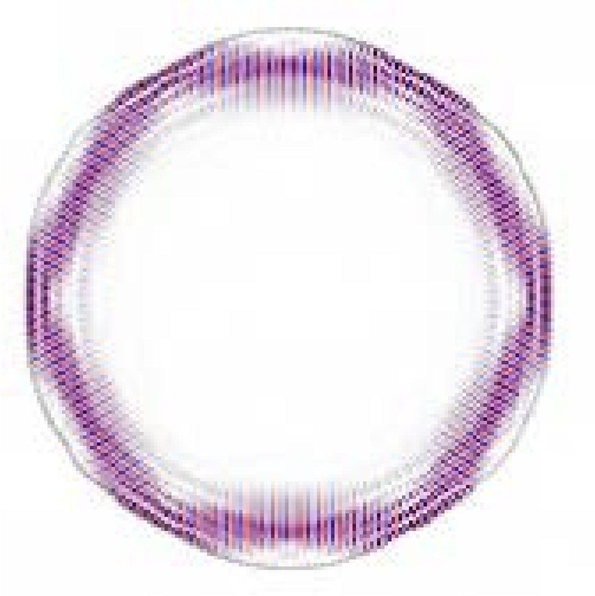
quasi-WGM

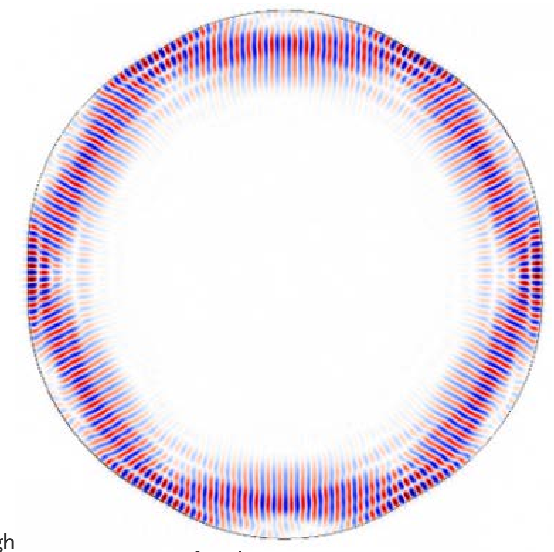


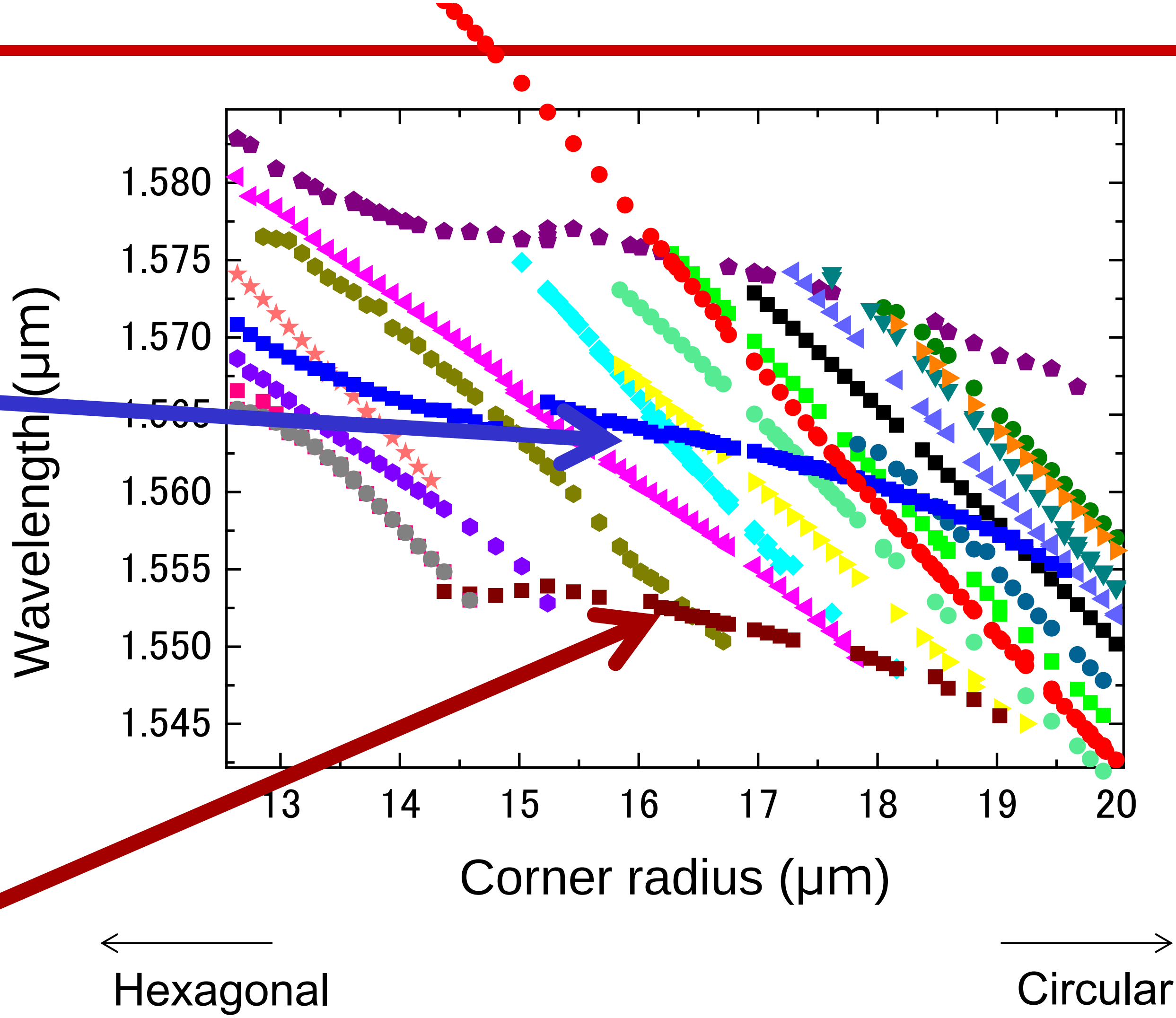


✓ A number of perturbed modes couple w/ quasi mode.

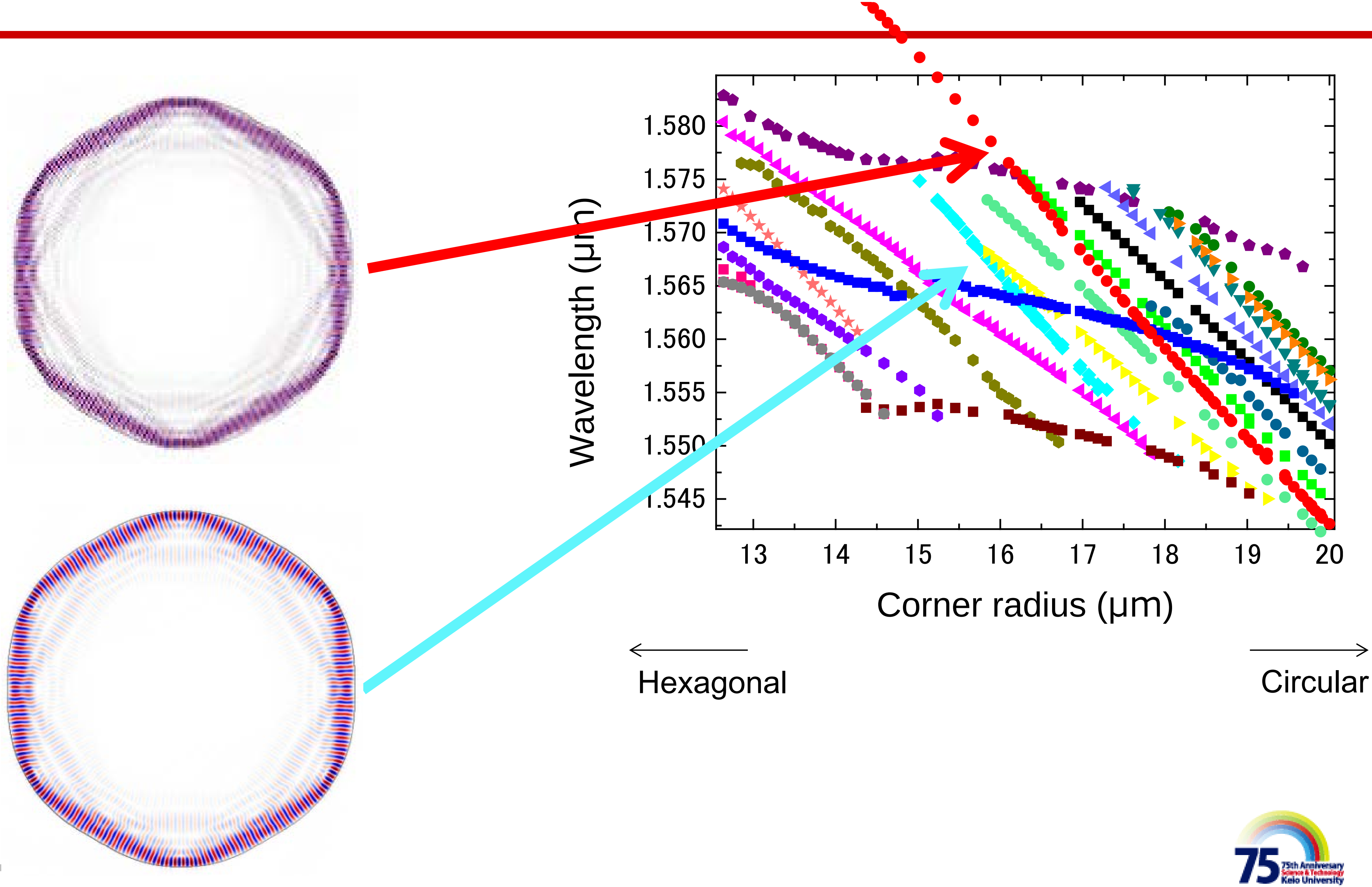
In Detailed: Quasi-mode



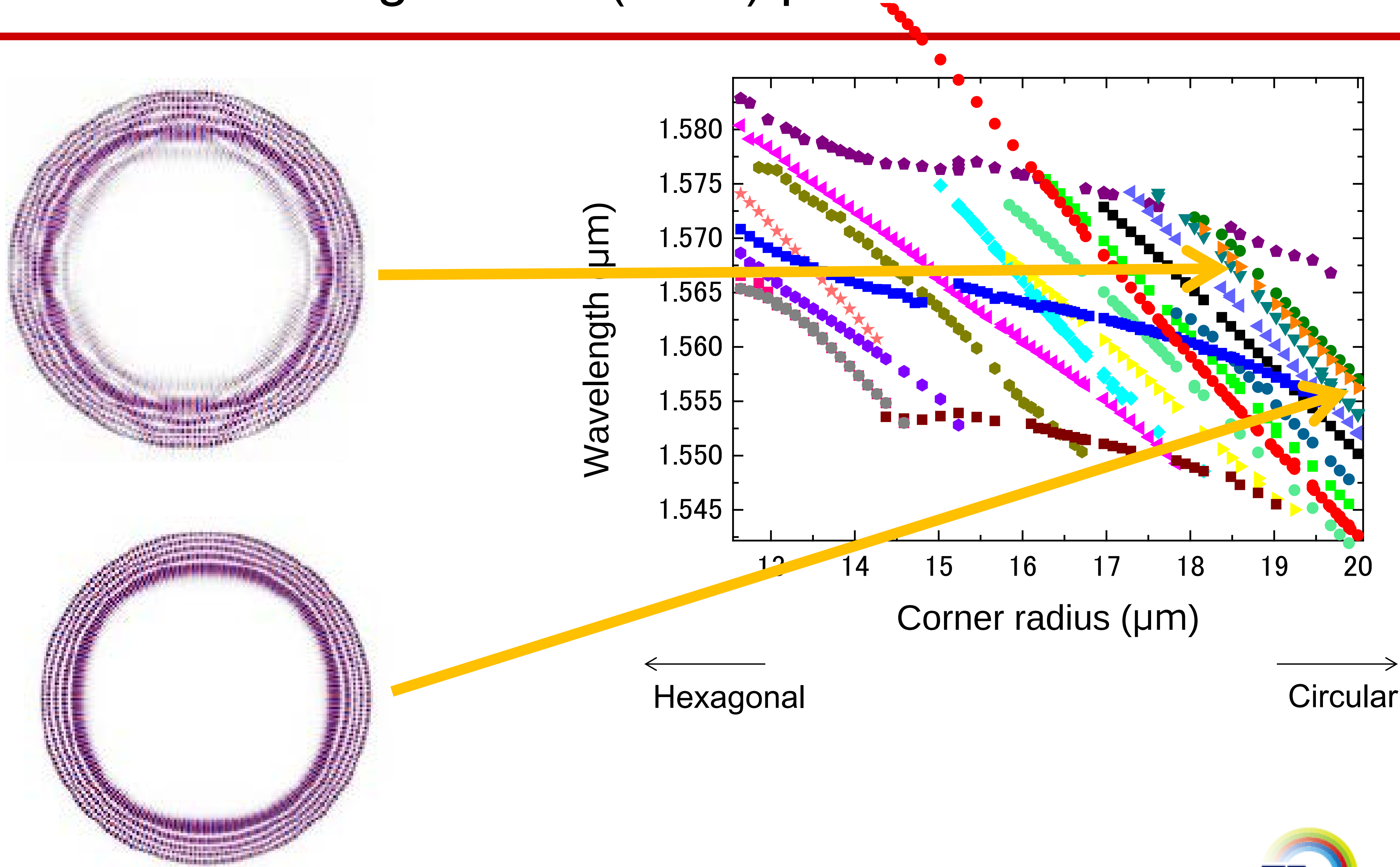




In Detailed: Perturbed mode

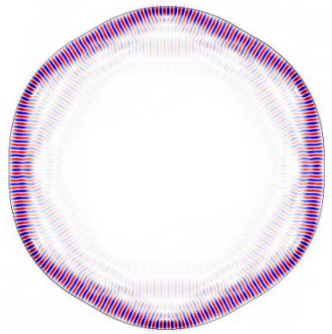


In Detailed: High-order (multi) perturbed mode

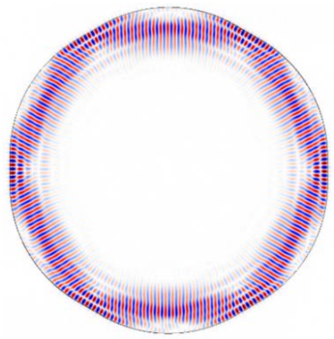


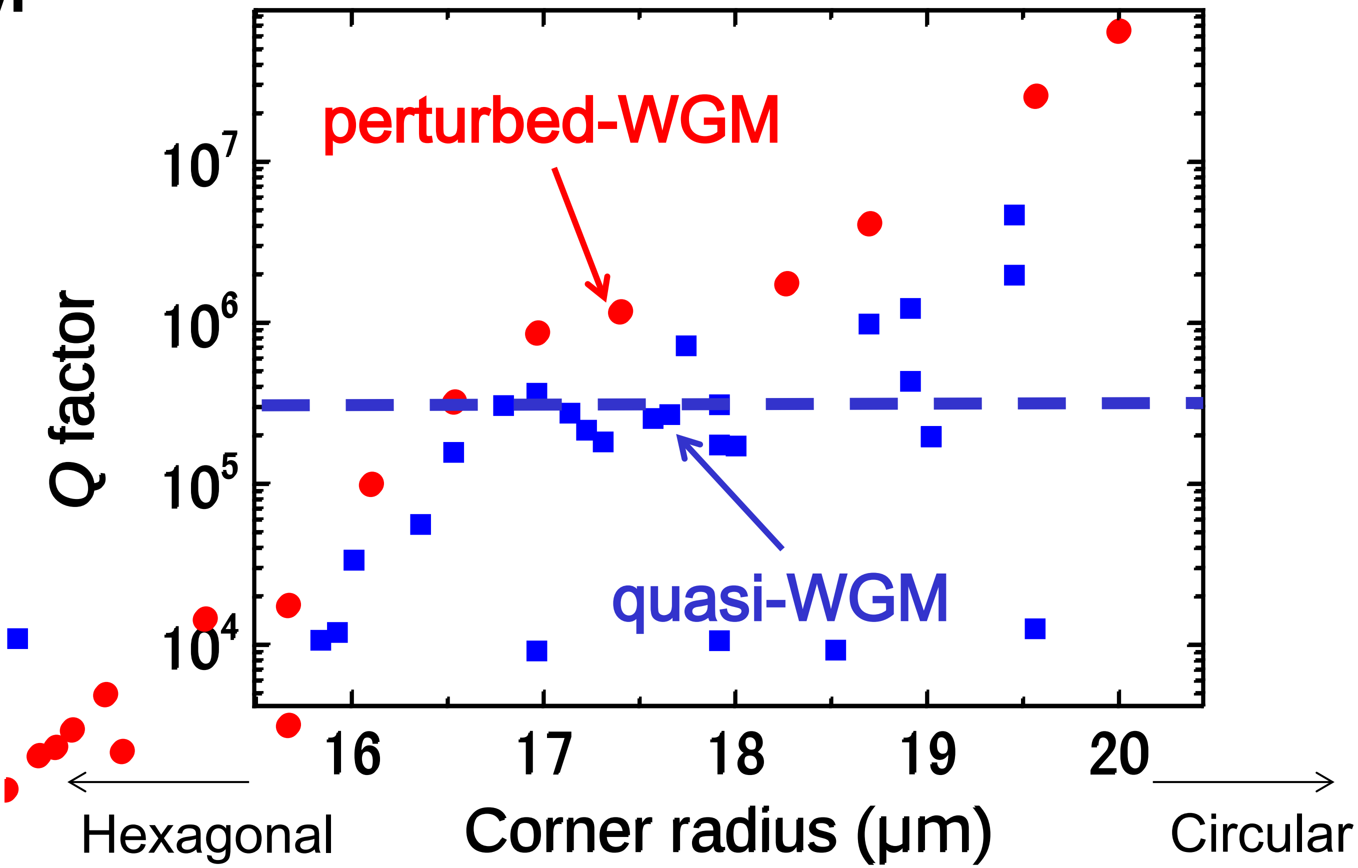
Q factors for different WGM modes

perturbed-WGM



quasi-WGM

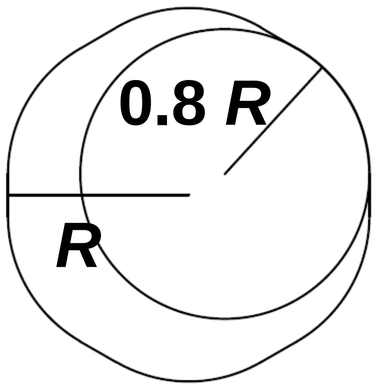




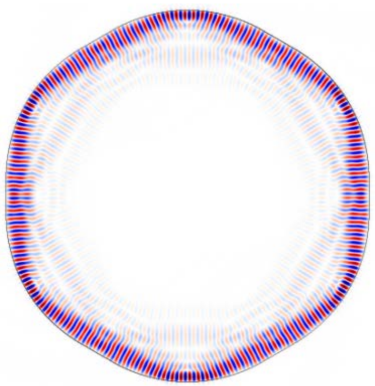
- ✓ Low Q = quasi–WGM (due to strong mode mixing)
- ✓ High Q = perturbed–WGM (but only w/ round corner)

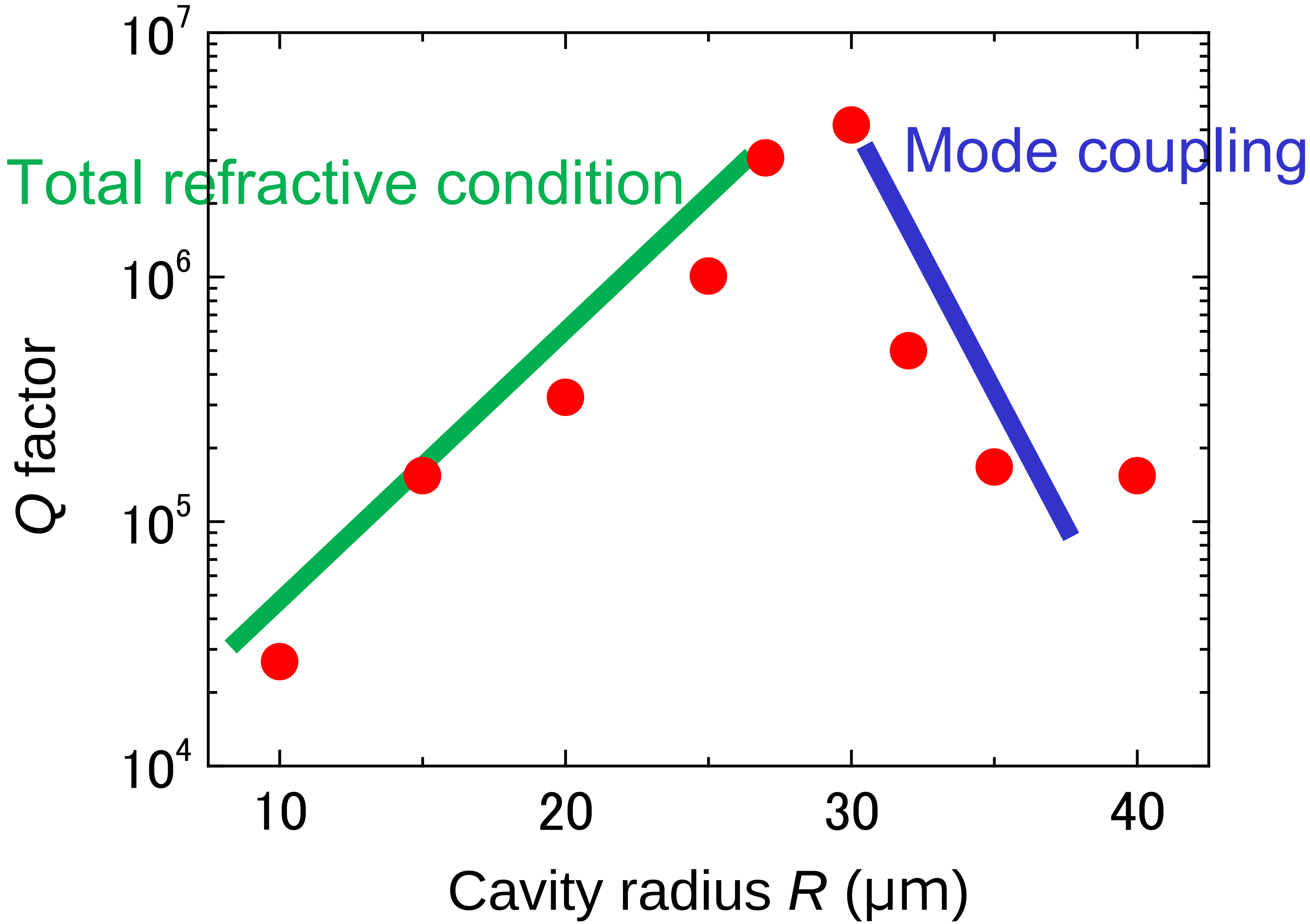
Optimal size of hexagonal cavity for high-Q.

Cavity parameter



Perturbed mode





✓ **In perturbed mode, the optimal radius is 30 μm.**

Summary

① Perturbed mode and Quasi mode is strongly coupled.

- ✓ Coupling coefficient κ = 29.9 GHz
- ✓ Large number of perturbed mode coupled with quasi-mode.

② Studied the effect of circle ＆ hexagonal shape for these *Q* factor.

- ✓ Both perturbed and quasi mode exhibit low *Q* when the cavity is hexagonal.
- ✓ There are a optimal radius when the cavity is polygonal.

Acknowledgements

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