Regular-Orbit-Engineered Chaotic Photon Transport in Mixed Phase Space

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Yun-Feng Xiao

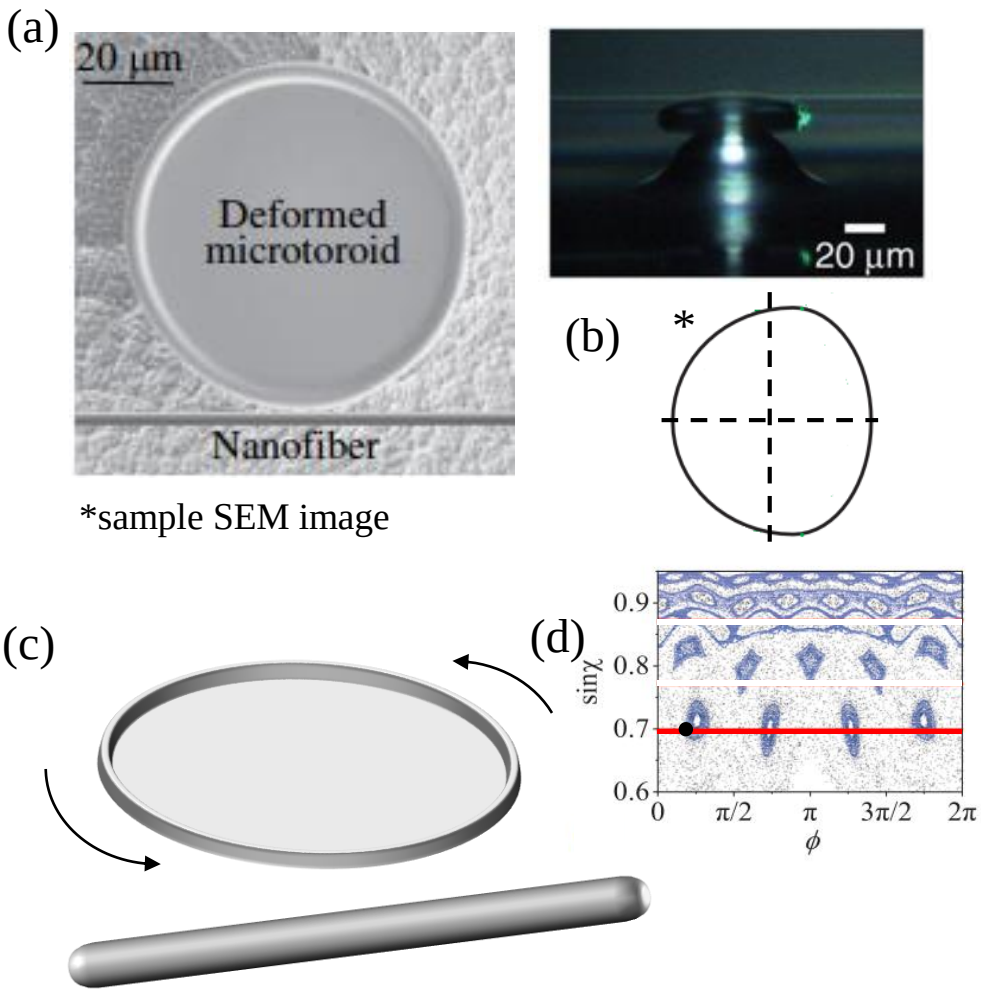
- **Biography**

- **2007:** PhD, University of Science and Technology of China
- **2007~2009:** Postdoctor, Washington University in St. Louis
- **2012:** Awarded Excellent Young Scientist by China
- **2014~:** Associate Professor with tenure

- **RESEARCH INTERESTS**

- Whispering-gallery microcavity optics

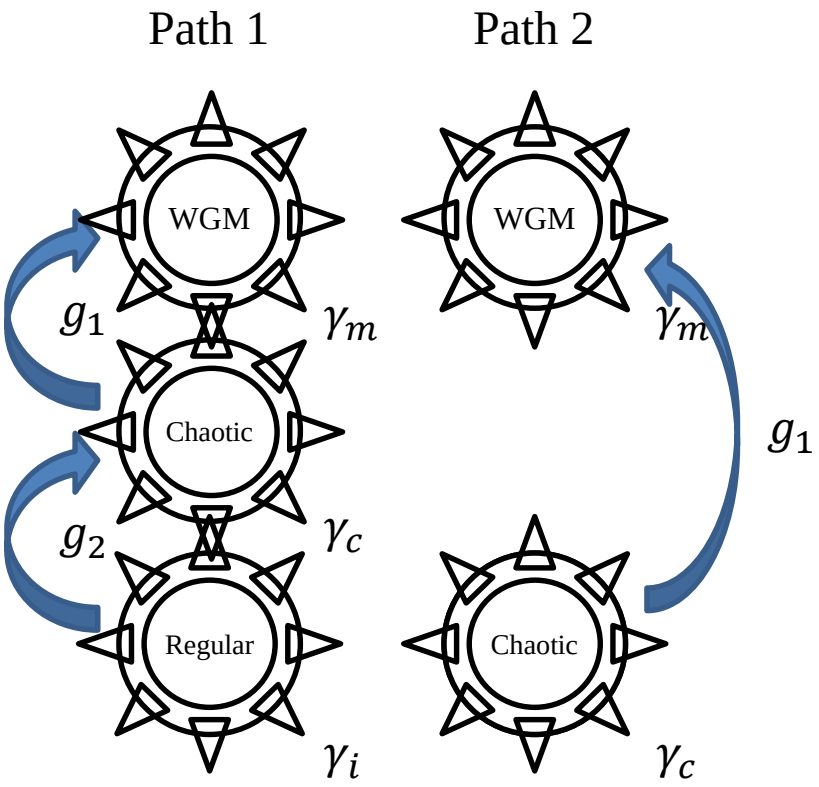
Techniques

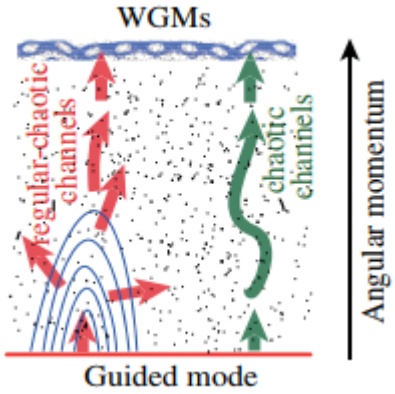


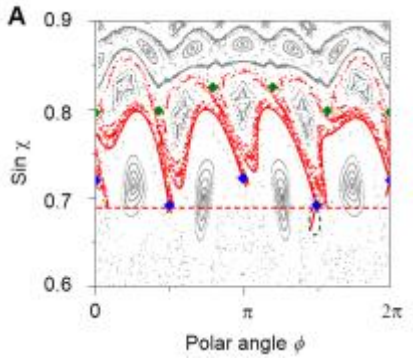
*sample SEM image

- Fabrication [Figure (a)]
  - Toroid: Photolithography and consecutive fabrication procedures of semiconductor laser(made from SO_2)
  - Fiber: commercial single-mode optical fiber(pulling with stepper motor and heating→automated)
- Cavity geometry [Figure (b)]:
- $R(\phi) =$
  $\begin{cases} R_0 + R_0 \sum_{i=2,3} a_i \cos^i \phi & \text{for } \cos\phi \geq 0 \\ R_0 + R_0 \sum_{i=2,3} b_i \cos^i \phi & \text{for } \cos\phi < 0 \end{cases}$
- For a general deformed microcavity, the position-momentum phase space is mixed with both chaotic and regular regions. The excitation position in phase space can be precisely controlled by varying the effective mode index $n_{eff}(\rightarrow \sin\chi_0)$ and angular position ϕ_0 .[Figure (c) and (d)]

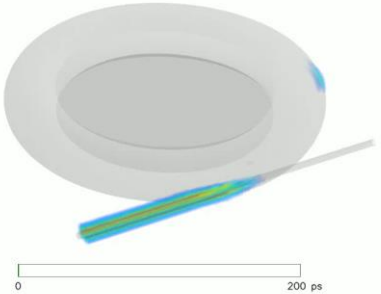
Coupling mechanisms







<Chaotic channels>



Couplings: $g_1 \approx g_2$

Decay rate: $\gamma_i \gg \gamma_c > \gamma_m$

Coupling mechanisms

3D FDTD simulation

Incident beam: 10 fs duration pulse

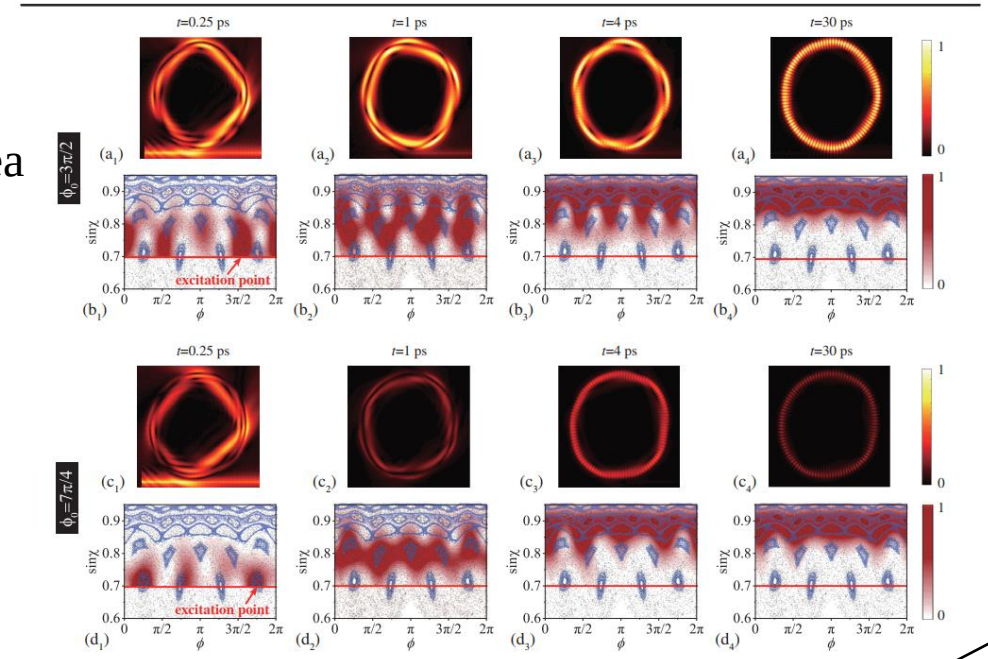
$=>\Delta\lambda = 10^2 \sim 10^3$ nm

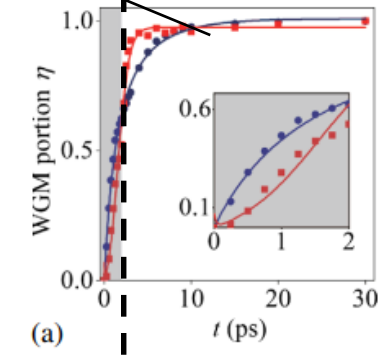
1 if perfectly overlapped with WGM

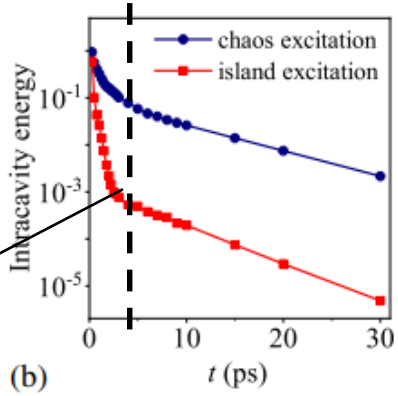
2 ps

Excitation
in a Chaotic sea

Excitation
in islands

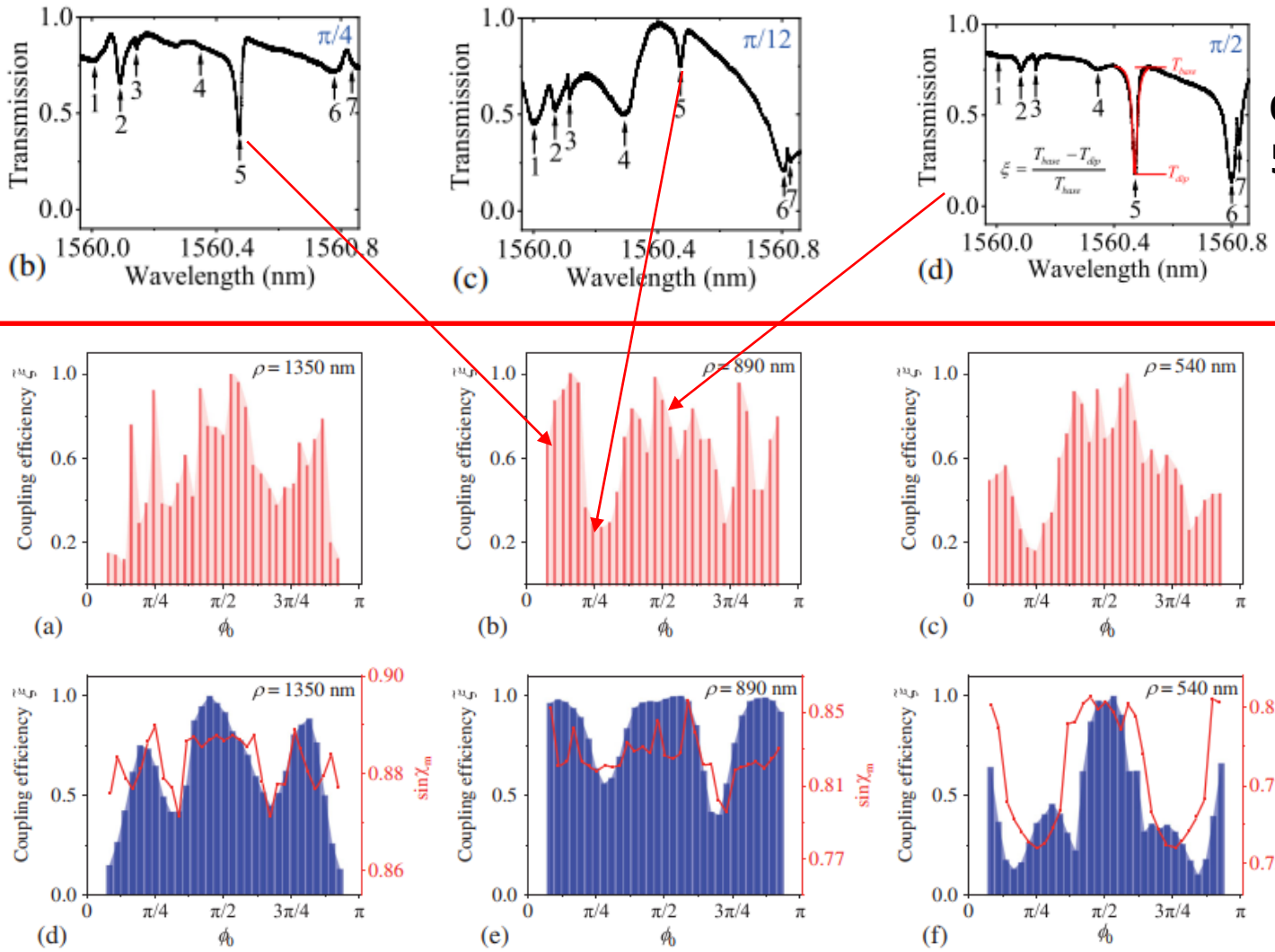






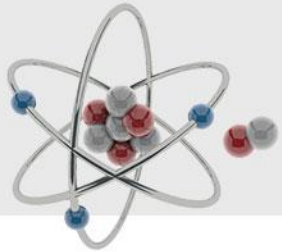
island mode → low Q → energy loss ↑→ low coupling efficiency

Coupling efficiency measurements



Q-factor:
5×10^6 fixed

Conclusion



- The chaotic photon transport can be engineered by the regular orbits in the mixed phase space of a high-Q asymmetric microcavity
- An effective nanofiber technique to probe phase space is developed by accurately controlling the excitation position of the light.
- The efficiencies of coupling to high-Q WGMs are found to be distinguishable depending on different photon transport paths.