Rotating optical microcavities with broken chiral symmetry

Raktim Sarma
Yale University, raktimsarma@gmail.com

Li Ge
The Graduate Center, CUNY

Jan Wiersig
Universitat Magdeburg

Hui Cao
Yale University

Rotating optical microcavities with broken chiral symmetry

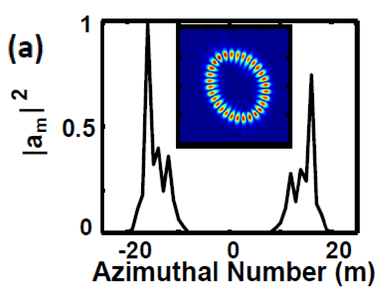
Raktim Sarma[1,*], Li Ge [2], Jan Wiersig[3], Hui Cao[1]

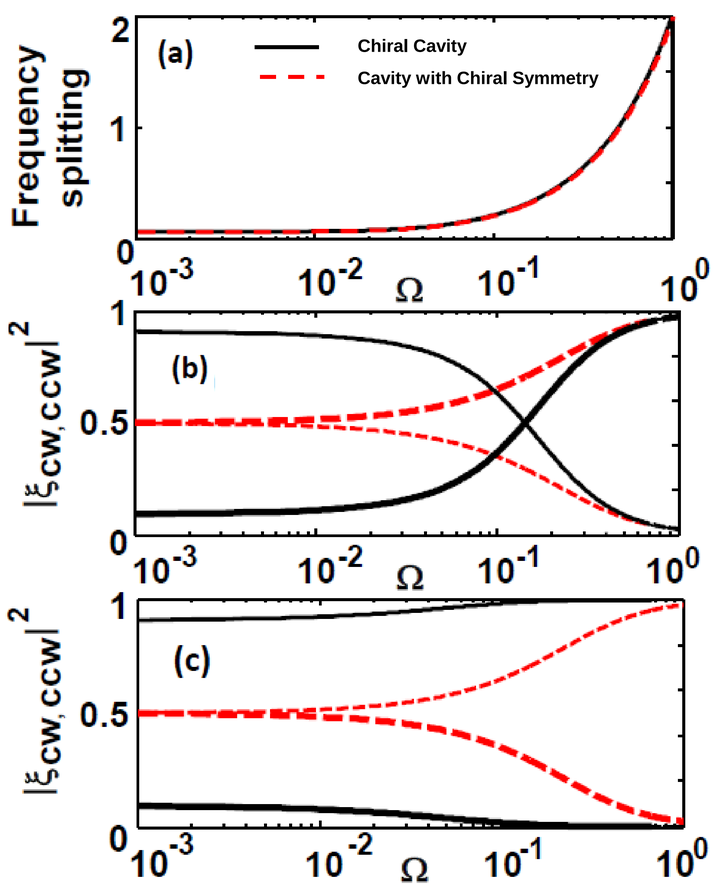
1. Yale University, New Haven, CT 06511 2. The Graduate Center, CUNY, New York, NY 10016, USA 3. Institut fur Theoretische Physik, Universitat Magdeburg, 4120, Germany

We demonstrate in open microcavities with broken chiral symmetry, quasi-degenerate pairs of co-propagating modes in a non-rotating cavity evolve to counter-propagating modes with rotation. The emission patterns change dramatically by rotation, due to distinct output directions of CW and CCW waves. By tuning the degree of spatial chirality, we maximize the sensitivity of microcavity emission to rotation. The rotation-induced change of emission is orders of magnitude larger than the Sagnac effect, pointing to a promising direction for ultrasmall optical gyroscopes.

Rotation Converts Co-propagating modes to Counter Propagating Modes

Chiral Cavity $= R[1 + \epsilon_1 \cos(\theta) + \epsilon_2 \cos(2\theta + \delta)]$

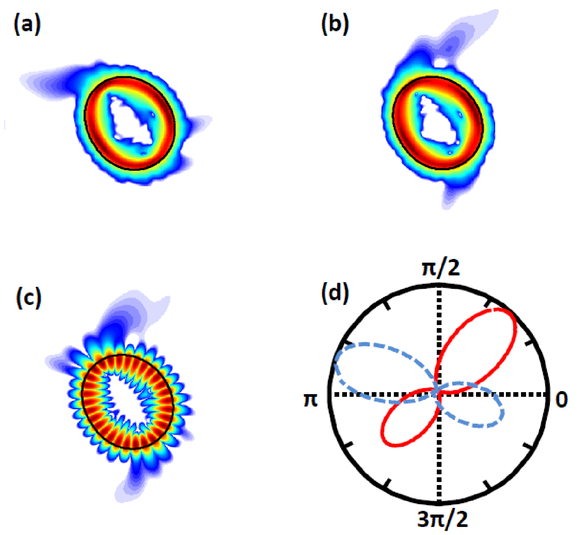




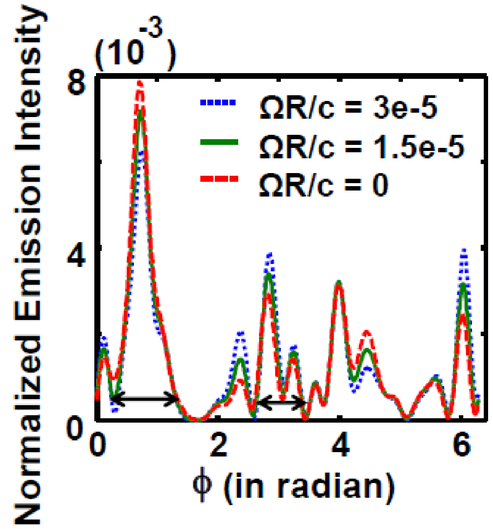
Bessel decomposition of modes with (kR ~ 6.2) shows dominant CW component. Farfield directionality is CW dominanted.

Sagnac effect is similar for chiral and non-chiral cavities. In chiral cavities, rotation changes co-propagating modes to counter-propagating.

Change in Farfield Intensity due to Rotation

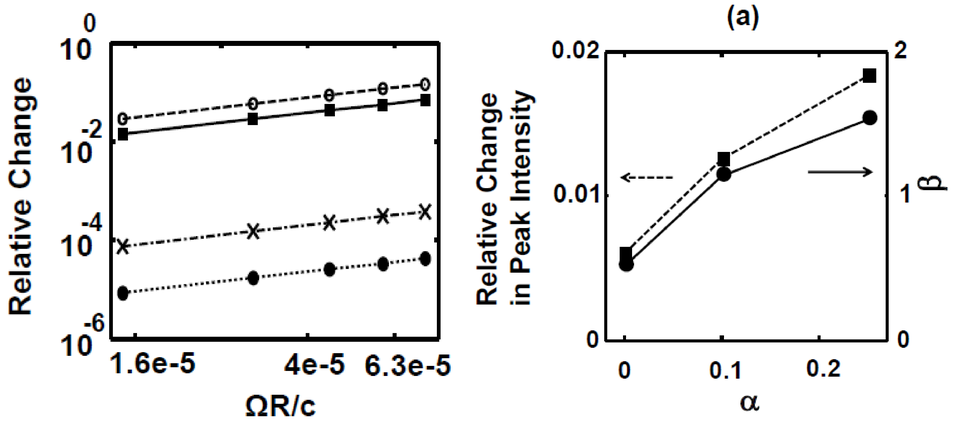


Rotation changes output directionality



The farfield intensity pattern changes due to rotation

Tuning Farfield Sensitivity By Tuning Spatial Chirality



The farfield intensity is two orders of magnitude more sensitive than Sagnac effect. The sensitivity can be tuned by tuning spatial chirality which changes the CW and CCW output directions.

The frequency shifts or Sagnac effect due to rotation are similar for a chiral and non-chiral cavity. The maximal chirality leads to largest difference in CW and CCW output directions, making the emission pattern most sensitive to rotation. This process of tuning chirality to enhance farfield sensitivity to rotation does not lead to Q spoiling of the modes of the cavity.

References : [1] J. Wiersig et al., Phys. Rev. A, **84**, 023845 (2011) [2] R.Sarma et al., arxiv:1404.5362