Collision of Light in Ultra-High-Q Microresonators

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Background - Ultra-High-Q microresonators are devices that can store light in small mode volumes for a long time. These devices have extremely sharp optical resonances that can be used for precision sensing and for exploring interactions between photons. Recently we have discovered that these resonators enable the observation of nonlinear interaction between counterpropagating light [1]. This interaction leads to a spontaneous symmetry breaking between clockwise and counterclockwise modes of light which we plan to exploit for exceptionally sensitive quantum sensors and devices. The projects focus on quantum engineering for navigation, sensing, and for precision molecular spectroscopy.

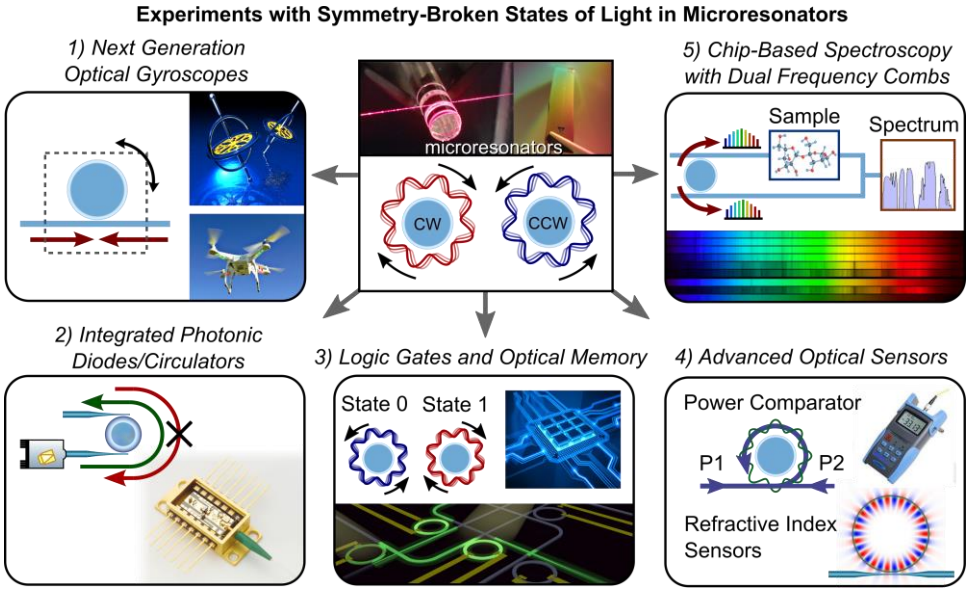

FIG. 1: Illustration of future applications for symmetry-broken states of light in microresonators.

PhD project - During the PhD project you will investigate applications of symmetry-broken states of light in microresonators. This is achieved by sending counterpropagating lasers into high-Q microresonators and studying the resulting optical interactions. The projects include:

- Development of nonlinear enhanced optical gyroscopes
- Near-field sensors with sensitivity at the quantum limit
- Dual frequency comb generation in microresonators for precision spectroscopy [2]
- Development of optical power comparators with quantum-limited sensitivity

MSc project - The MSc project will include building a setup for the experiments in the PhD project and starting a first research project from the list above. This includes CO_2 laser machining of ultra-high-Q microresonators and fabrication of optical fibers for coupling of light into the resonators. The MSc will include a 1 month placement with Dr Michael Vanner in the group of Prof Ian Walmsley at the University of Oxford to learn about enhanced nonlinear quantum optics using microresonators.

Location - The research project will be based at the National Physical Laboratory (NPL), Teddington. NPL is located south east of London, 40 minutes by train from London Waterloo.

For questions and to discuss more specific research directions please contact:
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[1] L. Del Bino, J. M. Silver, S. L. Stebbings, and P. Del'Haye, "Symmetry breaking of counter-propagating light in a nonlinear resonator," *arXiv preprint arXiv:1607.01194*, 2016.

[2] P. Del'Haye, A. Schliesser, O. Arcizet, T. Wilken, R. Holzwarth, and T. J. Kippenberg, "Optical frequency comb generation from a monolithic microresonator," *Nature*, vol. 450, no. 7173, pp. 1214–1217, 2007.