Cavity-enhanced broadband light generation

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Broadband (multiline frequency) light combs present a wealth of applications, ranging from meteorology, sensing and measurements to those potentially in the domain of attosecond science. We report here on detailed investigations of, what we believe is, a novel Raman self-synchronous process that is accompanied by extreme enhancement of the bandwidth of the generated light frequencies.

Over the last decade, there have been several reports of cavity contexts where efficient broadband multiline generation is possible. These contexts include spherical micro-cavities [1], monolithic microresonators [2] and so-called 'bottle micro-resonators' [3], in which the cavity quality to mode volume ratio (Q / V) plays a dominant role in the characteristics of the device and its constituent whispering gallery modes. Typically, maximum quality and low volume lead to the optimal condition of high Q / V.

To illustrate distinctiveness from these well-known contexts, we highlight where bandwidth generation has local optimisation in either: low-Q resonators (with very moderate reflectivities), or; larger volume cavities (e.g. with longer cavity lengths). For example, such cavity-enhanced bandwidth regimes may result in 100's of generated frequencies; maximum bandwidths of only up to 30 to 50 frequencies arise in the corresponding non-cavity contexts.

We will summarise results from an exhaustive exploration of this new effect (in terms of cavity parameters) and compare these results with semi-analytical models that we have developed to lend insight into the origins of this bandwidth enhancement and its correspondence with self-synchronisation.

References

[1] Spillane S M, Kippenberg T J and Vahala K J, *Nature* **415**, 621 (2002).
[2] Del'Haye P et al, *Nature* **450**, 1214 (2007).
[3] Pollinger M et al, *Phys. Rev. Lett.* **103**, 053901 (2009).