Resonant photonic oscillators and regenerative frequency dividers

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Mode-locked Kerr frequency combs generated in nonlinear microresonators pumped with coherent monochromatic light [1] have attracted significant attention because of their practical importance associated with their applications in optical and microwave frequency generation, signal synthesis, clocks and others. Dichromatic resonant continuous wave pumping of a nonlinear optical resonator can result in generation of broad microcombs at low power levels [2] as well as other comb structures different from the usual Kerr combs [3-5]. These frequency combs can be fully stabilized by means of pump harmonics and the repetition rate of the microcombs can be significantly smaller than the frequency difference between the pump frequencies. These combs can be considered as realizations of large order discrete time crystals [3] and can be used as regenerative photonic frequency dividers.

Dichromatically pumped nonlinear cavities can generate frequency combs just because of the thresholdless frequency mixing process. The optical nonlinearity can be utilized to lock repetition rates of two frequency combs having nonoverlapping spectra or generated at orthogonal polarizations [6] in the same cavity. A Kerr comb can be injection-locked to a low power reference light coupled to the nonlinear cavity [7]. A higher power pump also leads to generation of frequency combs resulting from the time symmetry breaking in the cavity [3-5]. Stability of these unique comb states depends on the optimization of the dispersion of the nonlinear cavity.

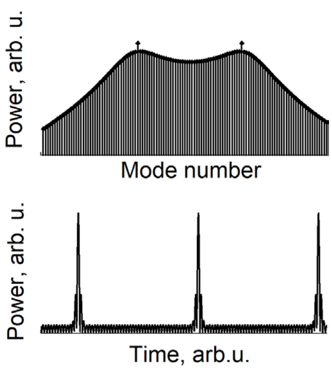

Fig.1. An example of a Kerr frequency comb and corresponding pulses generated in a nonlinear microcavity coherently pumped with dichromatic coherent light.

The dichromatically pumped frequency comb fully locked to the pump light is a periodic in frequency structure in which two harmonics coincide with the pump frequencies. In the case the dichromatically pumped frequency comb becomes an ideal regenerative radio-frequency (RF) divider realized by pure optical means. Demodulation of the frequency comb on a fast photodiode results in generation of an RF beat note characterized with better spectral purity than the original pumping light can provide. In this presentation we will discuss properties and applications of the optical frequency combs generated in cavities by means of dichromatic light.

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