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Thermal-Controlled Scanning of a Bright Soliton in a Photonic Molecule

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Over the last few years, dissipative Kerr solitons (DKS) in microresonators have boosted the development of chip-scale frequency comb sources (microcombs) in a variety of applications, from coherent communications to ultrafast distance ranging [1]. However, the intrinsic large free spectral range (FSR) of microcombs (within the gigahertz regime) is still a drawback for applications such as molecular spectroscopy, in which the comb line spacing dictates the spectral sampling resolution. Overcoming spectral sparsity by scanning the comb modes across a full FSR is challenging for a DKS microcomb, since the soliton operation must be kept while the pump laser is continuously swept. So far, it has been accomplished for a single microresonator by combining a feedback control loop with the thermal tuning of the cavity resonances by means of a microheater [2]. Recently, the use of two linearly coupled cavities (a photonic molecule) has shown to be a promising alternative to generate soliton microcombs with high conversion efficiency and uniform power distribution [3]. In this contribution, we address the challenge of scanning the soliton comb modes of a photonic molecule by thermal tuning. Specifically, we implement a scheme to scan a bright soliton over 60 GHz by tuning simultaneously the pump laser and the resonances of two coupled cavities.

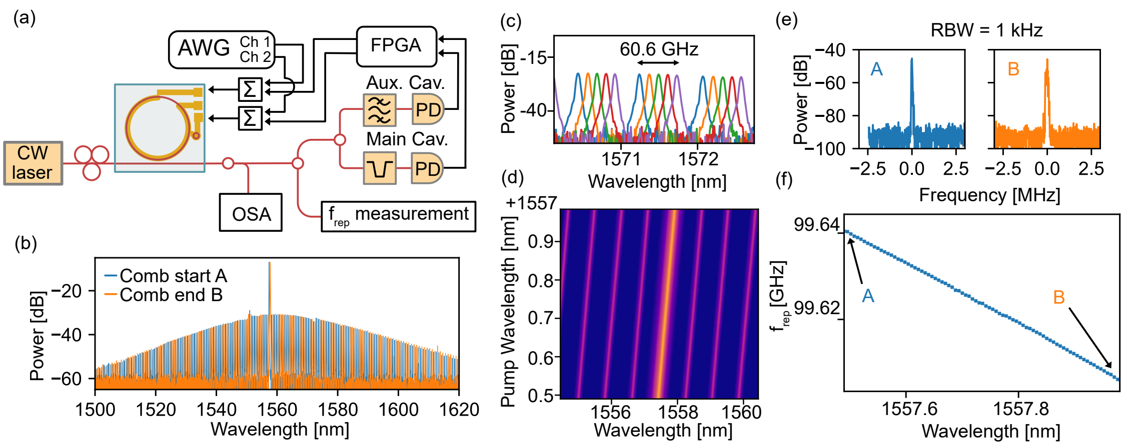

Fig. 1 Controlled scanning of a microcomb. (a) Experimental setup for the generation and control of the soliton. (b) Optical spectrum at the start and end of the tuning (c, d) The bright soliton is tuned over 60.6 GHz maintaining a constant power while scanning the pump laser over 0.49 nm. (e, f) The measured repetition rate of the soliton keeps a comparable signal-to-noise ratio and exhibits a linear change behavior over the scanning.

The experimental setup is shown in Fig 1. (a). Fig. 1 (b) shows the first and last optical spectrum of the soliton, the power efficiency corresponds to 12 percent. By simultaneously scanning the pump laser and both resonances of the cavities the soliton state is maintained. This is shown in Fig. 1 (c, d) where the optical spectrum power appears to be constant over the 60 GHz pump frequency shift. The tuning is performed using an arbitrary waveform generator (AWG) as a power supply and adding its voltage with a correction signal generated by an FPGA board. We use the soliton power as a set point to keep a fixed detuning between the pump and the main cavity resonance [4]. An additional band-pass filter is used to generate an error signal to force the auxiliary cavity to follow the pump frequency change. The repetition of the frequency comb was measured by electro-optic down-conversion. The photo-detected beat notes at the start and end of the tuning (Fig. 1 (e)) show that the comb remains coherent and stable over the scanning. We observed a linear change in the repetition rate as a function of the wavelength that can be attributed to the third-order dispersion of the cavity (Fig. 1 (f)).

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