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Power-efficient Dissipative Kerr solitons

Dissipative Kerr solitons (DKSs) circulating microresonators have gathered immense attention in the past few years as a way of realizing robust microcombs. They have been demonstrated in multiple applications, ranging from optical communications to calibration of astrophysical spectrometers [1]. Most of these demonstrations have relied on tuning a CW laser into a resonance of a single-mode cavity featuring anomalous dispersion. However, a soliton generated in such cavities cannot support high conversion efficiency due to the fact that the CW laser has to be red detuned from the pumped resonance [2]. Here, we find that this limitation can be overcome by applying a red-shift to the CW-pumped resonance (see figure 1). This allows the CW pump to be coupled more efficiently into the cavity while appearing red-detuned to other frequency components of soliton. Theoretically, a DKS with >99% conversion efficiency can be enabled in such a system. A red-shifted resonance is realized in practice by introducing coupling to a small auxiliary cavity (see figure 1b). Figure 1c shows the resulting integrated dispersion of the main cavity, revealing anomalous dispersion with a red-shifted resonance. Pumping such a shifted resonance, we realize a microcomb with >50% conversion efficiency, corresponding to a single DKS circulating the main cavity (see figure 1d). A deep study and further discussion on the performance and dynamics of these DKSs are provided in our recent manuscript [3]. Our findings constitute a significant step forward toward integrated microcomb systems and provide further insights into DKS dynamics.

References

[1] Kippenberg, T. J., Gaeta, A. L., Lipson, M. & Gorodetsky, M. L., *Science (80-.).* **361**, eaan8083 (2018)
[2] Xue, X., Wang, P.-H., Xuan, Y., Qi, M. & Weiner, A. M., *Laser Photon. Rev.* **11**, 1600276 (2017).
[3] Helgason, Ó. B. *et al. arXiv* 2202.09410 (2022).

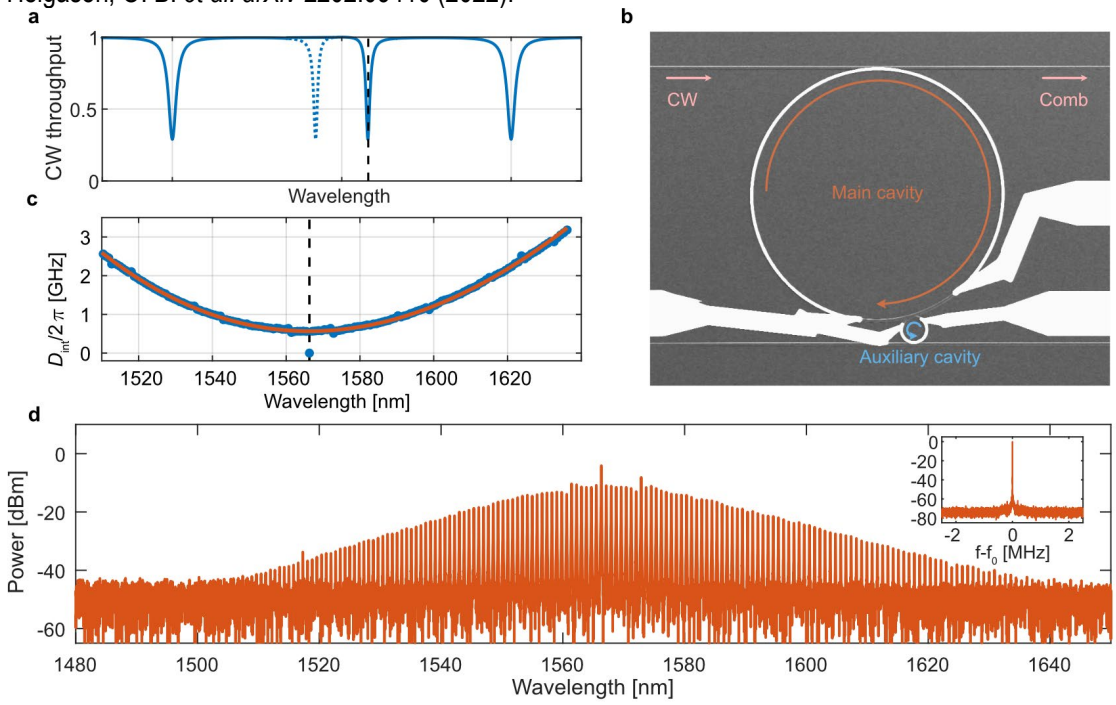

Figure 1: **a**, shifting the pumped resonance to allow efficient coupling of the pump (black dashed line) into the cavity. A second resonance (blue dashed) will appear if this is implemented via linear coupling to an auxiliary cavity. **b**, a microscope image of fabricated linearly coupled microrings. **c**, the blue (red) curve shows a measurement (parabola fit) of the integrated dispersion profile of the main cavity. **d**, The power distribution of the high-efficiency DKS. The inset shows a narrow repetition-rate beat note indicating a coherent comb state.