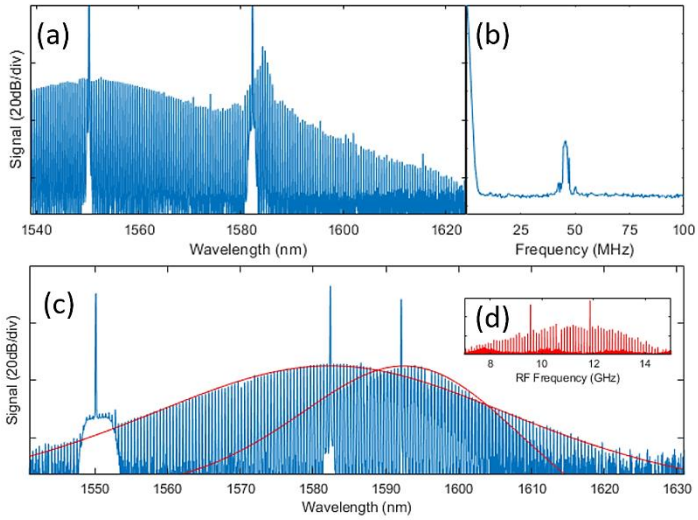
Soliton linear-wave scattering and soliton multiplexing via bichromatic driving of a Kerr microresonator

Pierce C. Qureshi,[1,2] Vincent Ng,[1,2] Farhan Azeem,[1,3] Luke S. Trainor,[1,3]
Harald G. L. Schwefel,[1,3] Stephane Coen[1,2], Miro Erkintalo[1,2] and Stuart G. Murdoch[1,2]

[1]*The Dodd-Walls Centre for Photonic and Quantum Technologies.*
[2]*Department of Physics, University of Auckland, Auckland, New Zealand.*
[3]*Department of Physics, University of Otago, Dunedin, New Zealand.*

Microresonator frequency combs (microcombs) are an attractive new source of miniature, low-power coherent combs. The applications of microcombs have been demonstrated across telecommunications, spectroscopy, and remote sensing [1]. In Kerr microresonators, coherent frequency combs rely on the excitation of ultra-short localized structures known as temporal cavity solitons. In this work, we show the injection of a second laser, in addition to the pump laser, can facilitate useful spectral expansion of the original soliton comb [2]. We demonstrate theoretically and experimentally that by varying the phase detuning of the second laser, flexible control of the output comb's spectral envelope is possible. Moreover, by tuning the second laser into a different spatial mode than that of the pump laser, the simultaneous excitation of two soliton combs is possible (soliton multiplexing). The beat notes of these dual combs reside in the RF domain, where information regarding adjacent pairs of optical comb lines can be quickly and precisely collected over a wide range of optical frequencies. We believe such soliton dual combs could find useful applications in spectroscopic and ranging measurements.



Experimental realization of soliton linear-waves and multiplexed solitons. (a) Spectral extension of the soliton comb. (b) RF beat note measuring the relative detuning between the pump and second lasers from resonance via scattering between the soliton and linear wave. (c) Two cavity soliton spectra. (d) RF beat comb with 112 MHz comb line spacing.

[1] A. Pasquazi, et al. *Phys. Reports* 729 (2018): 1-81.

[2] P.C. Qureshi, et al. *Communications Physics* 5.1 (2022): 1-8.