2021 Conference on Lasers and Electro-Optics Europe & European Quantum Electronics Conference (CLEO/Europe-EQEC) | 978-1-6654-1876-8/21/$31.00 ©2021 IEEE | DOI: 10.1109/CLEO/Europe-EQEC52157.2021.9541887

# Generation of Dispersive Waves via Intermodal Cross-phase Modulation

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Supercontinua are of high interest due to their broad bandwidth and high brightness enabling a broad range of applications, e.g., optical coherence tomography or frequency metrology. During soliton-driven supercontinuum generation (SCG), a higher-order soliton (HOS) forms, generating a sufficiently broad spectrum prior to the HOS' fission to radiate phase-matched dispersive waves (DWs) [1].

Here, we present the observation of a novel effect, namely intermodal dispersive wave generation (iDWG): two pulses are launched into two different transverse modes, of which only one (strong) mode has sufficient energy to radiate a DW during SCG. However, we found that the pulse in the other (weak) mode radiates a DW as well, if its spectrum is sufficiently broadened via intermodal cross-phase modulation (iXPM).

The iDWG was studied in a 1.2 µm wide and 0.9 µm high $Si_3N_4$ waveguide, offering reliable SCG [3] and, related to waveguide birefringence, two distinguishable (TE- and TM-polarized) fundamental transverse modes. Using the experimental setup, shown in Fig. 1(a), the power launched into each mode as well as the relative delay between the pulses was controlled. The output of each mode was selected with a polarizer and measured with an optical spectrum analyzer (OSA).

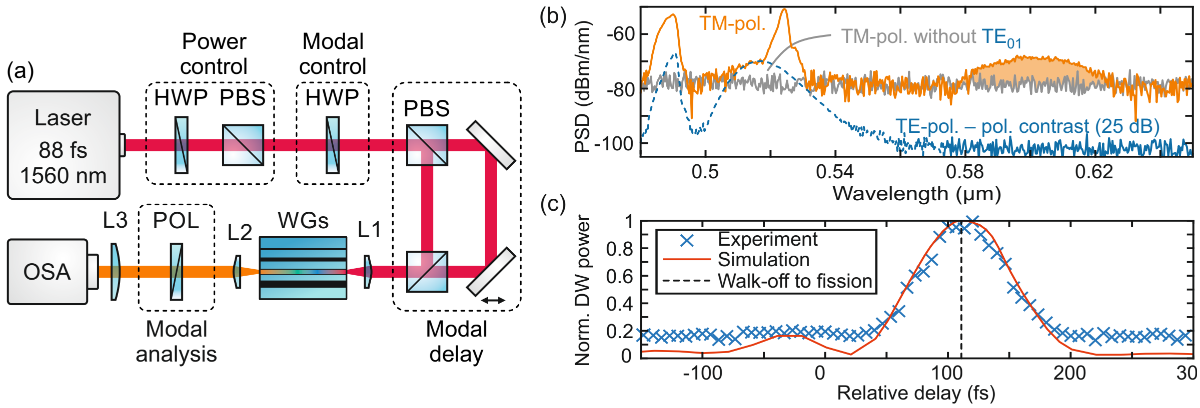


Fig. 1. (a) Schematic of the experimental setup. (b) Measured output spectra of the TE- (strong, blue) and TM-polarized (weak, orange) modes. (c) Measured and simulated power of the DW in the weak mode as a function of the delay between the pulses exciting the strong and weak modes.

Launching a pulse with 350 pJ pulse energy into the strong $TE_{01}$ mode (blue curve in Fig. 1(b)) generated a DW at 520 nm wavelength in addition to third harmonics in higher-order modes (at 490 nm and 525 nm). Launching an additional pulse with 40 pJ pulse energy into the weak $TM_{01}$ mode (orange curve), an intermodal DW appeared at 600 nm wavelength due to the interaction with the strong mode; this DW did not appear when the weak mode was excited solely (gray curve). Furthermore, the power of the intermodal DW as a function of the relative delay between the pulses (Fig. 1(c)) showed a maximum when the pulses were delayed such that the modal walk-off up to the fission of the HOS was compensated. Corresponding simulations, employing a nonlinear Schrödinger equation, confirmed the measurements and showed the inevitable role of iXPM for the iDWG.

We demonstrated the new mechanism of intermodal dispersive wave generation, using two orthogonally polarized modes in a $Si_3N_4$ waveguide. This process may be used to enhance the bandwidth of supercontinua or to enable the generation of frequencies at hardly accessible wavelengths.

## References

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