Similariton Compression in a Comb-like Dispersion Decreasing Fibre

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Abstract

Optical pulse compression using similariton propagation in an optical fibre with decreasing dispersion has been demonstrated for the first time. This compression scheme is a practical application of the sech-similariton solution to the generalized nonlinear Schrödinger equation (NLSE) with distributed coefficients recently found using the self-similarity technique. The sech-similariton solution exhibits a characteristic positive linear frequency chirp, which increases in slope as the pulse compresses. The solution does not develop any side pedestals or deformation in pulse shape as it propagates, making it a promising candidate for a new compression technique. Unlike the adiabatic compression technique, rapid compression can be achieved in a fibre with a specifically designed decreasing group velocity dispersion profile since the sech-similariton is an exact solution to the NLSE. A cost-effective and efficient method of realising decreasing dispersion in a fibre has been developed using a comb-like dispersion profiling technique and its feasibility has been experimentally demonstrated. An optimised experimental similariton compressor system has been built using two industry standard fibres which compressed an $11\,ps$ linearly chirped sech input pulse to $400\,fs$, yielding a compression factor of greater than 25.

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Abbreviations

ASE	Amplified Spontaneous Emission
CALM	Compressing nonlinear Amplifying Loop Mirror
CDDF	Comb-like Dispersion Decreasing Fibre
CW	Continuous Wave
DCF	Dispersion Compensating Fibre
DCM	Dispersion Compensation Module
DDF	Dispersion Decreasing Fibre
DSF	Dispersion Shifted Fibre
DS-HNLF	Dispersion Shifted Highly Nonlinear Fibre
EDFA	Erbium-Doped Fibre Amplifier
EDFL	Erbium-Doped Fibre Laser
ENLSE	Extended Nonlinear Schrödinger Equation
FBG	Fibre Bragg Grating
FROG	Frequency Resolved Optical Gating
FWHM	Full Width at Half Maximum
FWM	Four-Wave Mixing
GNLSE	Generalised Nonlinear Schrödinger Equation
GVD	Group Velocity Dispersion
HNLF	Highly NonLinear Fibre
HW	Half-Width
LEAF	Large Effective Area Fibre
MFD	Mode Field Diameter
NALM	Nonlinear Amplifying Loop Mirror

NL	NonLinear
NLSE	NonLinear Schrödinger Equation
NOLM	Nonlinear Optical Loop Mirror
NZ-DSF	Non Zero Dispersion Shifted Fibre
OSA	Optical Spectrum Analyser
OTDR	Optical Time Domain Reflectometer
PC	Polarisation Controller
PCF	Photonic Crystal Fibre
RMS	Root-Mean-Square
RS	Raman Scattering
SHG	Second Harmonic Generation
SMF	Single-Mode Fibre
SPM	Self Phase Modulation
SRS	Stimulated Raman Scattering
SS	Self-Steepening
SSFM	Split-Step Fourier Method
TOD	Third Order Dispersion
TBP	Time-Bandwidth Product
THG	Third Harmonic Generation
VOA	Variable Optical Attenuator
WDM	Wavelength Division Multiplexing
XPM	Cross-Phase Modulation