

12.00 CTu14

Nonlinear polarisation effects in fibre Bragg gratings: experiment and theory

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Recently we demonstrated the operation of an all-fibre nonlinear AND gate based on polarisation coupled gap solitons [1]. In this system when a single pulse was incident upon the grating it was reflected irrespective of its polarisation. However when two pulses with orthogonal polarisations were incident upon the grating a coupled gap soliton was formed which was able to propagate through the grating [2].

In addition to the AND gate we also looked at the polarisation dynamics of a single linearly polarised pulse propagating in a fibre Bragg grating. Briefly we used high nanosecond pulses obtained from a sequence of cascaded fibre amplifiers (as in Ref[1]). These pulses were launched into a 8cm apodised fibre Bragg grating and at the output light from the two orthogonal polarisations were directed onto a fibre coupled photodiode and a sampling oscilloscope with a time resolution of ~ 50ps. These results are shown in Fig. 1(a) for both the input (solid line) and cross polarisations (dashed line). In these figures the initial peak is due to the intrinsic chirp on the leading edge of the pulse which is broader than the grating and is present in all traces regardless of the intensity. The other peaks are due to the formation of gap solitons inside the grating. What is clearly apparent from Fig. 1(a) is that the solitons have preferentially coupled to the orthogonal polarisation compared to the chirped peak.

To understand these results we have modeled the system using a set of nonlinear coupled mode equations which were solved numerically to model the experiment. These results are shown in Fig. 1(b) in which the parameters match as closely as possible the actual experimental parameters. Note that as in the experimental results the soliton components are preferentially rotated compared to the non soliton components.

In conclusion we have successfully modeled the effect of nonlinear polarisation rotation in fibre Bragg gratings. In the future we expect the model to be used to optimise the operation of nonlinear logic gates based on polarisation coupled gap solitons.

[1] D. Taverner et al. Opt. Lett. 23(4) pp259-261 (1998)  
 [2] C. M. de Sterke and J. E. Sipe, in Progress in Optics, edited by E. Wolf (North Holland, Amsterdam, 1994), Vol. XXXIII, Chap. III Gap Solitons, pp. 203-296.

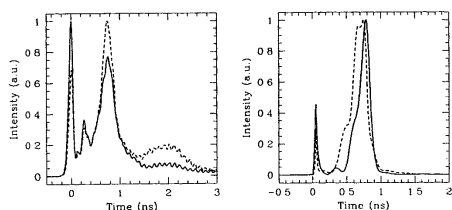


FIG. 1. Output for both the input (solid line) and orthogonal polarisations (dashed line). The graph on the left is the experimental curve while the one on the right is the theoretical curve. All curves have been scaled so that the maximum intensity is unity.

12.15 CTu15

Faraday Mirror Stabilization Scheme for Nonlinear Polarization Rotation in Optical Fibers: Model and Applications

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The potential of nonlinear polarization rotation (NPR) in waveguides is huge as it can be exploited for a large variety of ultrafast devices like optical switches, logic gates, intensity discriminators, nonlinear filters, or pulse shapers. However, an inherent problem to all this applications is the stability of the output polarization state. Fluctuations of the linear birefringence caused by temperature changes, drafts in the fiber environment, and vibrations generally disturb a proper functioning.

We propose an elegant method to remove these detrimental fluctuations in a passive way by employing a Faraday mirror (FM) and a double pass of the fiber where NPR takes place. The proposed stabilization scheme has the additional advantage that the double pass allows for a reduction of the fiber length times pump intensity value by almost a factor of two.

A model is developed that allows for an intuitive understanding of the action of the linear and nonlinear birefringence during the go- and return-path. Besides giving good insight in the underlying physical processes, it directly shows that the effect of NPR adds whereas the detrimental effects of the (fluctuating) linear fiber birefringence are removed. This allows to quantitatively measure NPR in an optical fiber, where it is otherwise completely covered by the linear polarization changes (Fig.1).

The successful implementation of our stabilization scheme is then demonstrated both for a self-switch and for a wavelength converter. The converter stability is monitored over several hours and is found to be excellent both for the use of a standard or a PM fiber as the NPR medium (Fig.2). Without our stabilization, the bias of the wavelength converter quickly changes - especially for the PM fiber - in an erratic way.

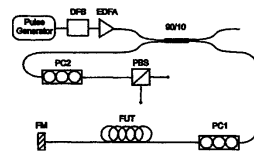


Figure 1: Experimental setup for the measurements of the NPR.

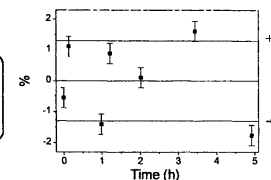


Figure 2: Relative fluctuations of the switch port signal power as a function of time.