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

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Abstract:

An elegant, passive stabilization method for ultrafast devices employing nonlinear polarization rotation (NPR) is demonstrated both theoretically and experimentally. It allows for a quantitative measurement of NPR in an optical fiber where it is otherwise completely covered by linear fluctuations, and when applied to a wavelength converter excellent stability over hours is obtained.

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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 Farady 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.

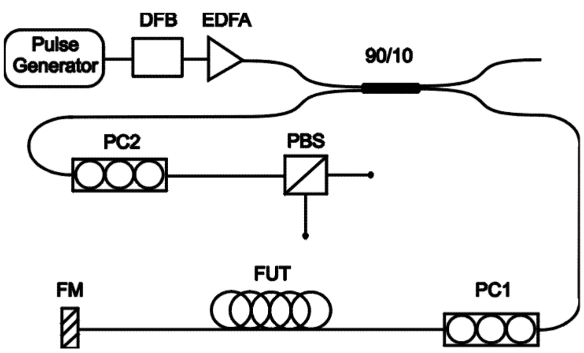

Figure 1: Experimental setup for the measurements of the NPR.

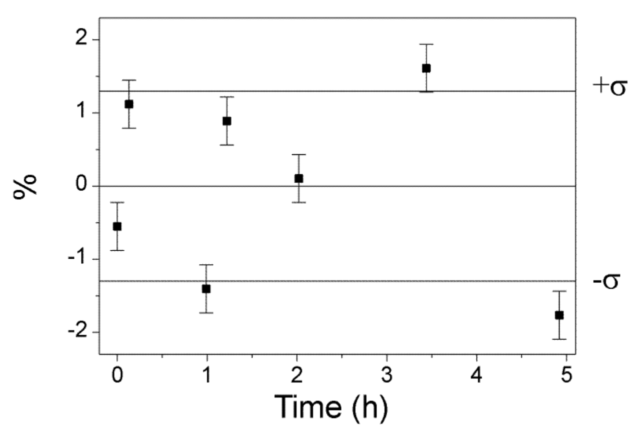

Figure 2: Relative fluctuations of the switch port signal power as a function of time.