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INTEGRATION OF THE MANAKOV-PMD EQUATION WITH PRECOMPUTED $\mathbf{M}(\boldsymbol{\omega})$ MATRICES FOR PMD SIMULATION

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Abstract: A novel direct integration technique of the Manakov-PMD equation for the simulation of polarisation mode dispersion (PMD) in optical communication systems is demonstrated and shown to be numerically as efficient as the commonly used coarse-step method. The main advantage of using a direct integration of the Manakov-PMD equation over the coarse-step method is a higher accuracy of the PMD model. The new algorithm uses precomputed $\mathbf{M}(\boldsymbol{\omega})$ matrices to increase the computational speed compared to a full integration without loss of accuracy. The simulation results for the probability distribution function (PDF) of the differential group delay (DGD) and the autocorrelation function (ACF) of the polarisation dispersion vector for varying numbers of precomputed $\mathbf{M}(\boldsymbol{\omega})$ matrices are compared to analytical models and results from the coarse-step method. It is shown that the coarse-step method achieves a significantly inferior reproduction of the statistical properties of PMD in optical fibres compared to a direct integration of the Manakov-PMD equation.

keywords: Photonics, Optical Transmission Systems, PMD.

1. Introduction

The coarse-step method [1,2] is numerically more efficient than the direct integration of the Manakov-PMD equation [3] as recent demonstrated in [4] and it has been used for the simulation of PMD for many years despite its well known problems [4]. A direct integration of the Manakov-PMD equation delivers superior accuracy, but was an order of magnitude slower and thus not feasible until now. However, the part of the integration of the Manakov-PMD equation dealing with the rapid motion of the PMD vector on the Poincaré sphere [4] is independent of the actual signal transmitted and can be precomputed. This makes the method numerically as efficient as the coarse-step method.

We will first review the integration scheme of the Manakov-PMD equation [4] and then describe the improved algorithm using precomputed $\mathbf{M}(\boldsymbol{\omega})$ matrices. Simula-