Simulations of Kerr based non linear optical components with the Complex Jacobi iteration

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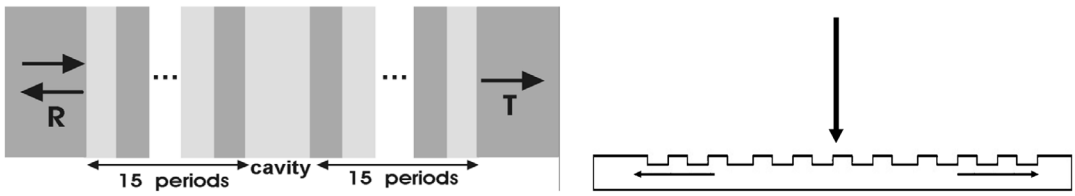
We present several non-linear structures simulated with the non-linear complex Jacobi iteration. This method numerically integrates the fields of the Helmholtz equation for points located on a grid. Because the fields are calculated on each grid point this results in a very flexible method. This iterative method refines each iteration step the calculated fields until a desired error has been achieved.

The first structure under discussion is a one dimensional study of a cavity surrounded by two Bragg gratings, fig. 1(a). These two Bragg gratings create a photonic band gap. The introduced cavity creates a resonance wavelength in the middle of this band gap. All light with this resonance wavelength will be transmitted by this structure. Introducing a non-linear material in the cavity will shift the resonance peak to higher wavelengths. A comparison with non-linear eigenmode expansion confirms the accuracy of our simulation tool. We have also shown that the numerical dispersion introduced by a discrete mesh can be controlled if the discretization step $\Delta x < \frac{\lambda}{20}$.



(a) Cavity encapsulated by 2 Bragg gratings (b) Vertical grating coupler

Fig. 1. Non linear wavelength scale structures

We will also present preliminary simulation results from a 2 dimensional vertical coupler. Light coupled vertically in the coupler is symmetrically injected in a left and right waveguide. Injection efficiency in one waveguide reaches a maximum for a certain wavelength. Adding non-linearity in the grating material will hopefully result in a shift of this maximum.

Parts of this work has been performed in the context of the Belgian IAP Photon network.

[1] G. Ronald Hadley, 'Solving the 3D Helmholtz Equation By Complex Jacobi Iteration', *Optical Waveguide Theory and Numerical Modelling 2004,* **OWTNM'04**, p.15, 2004.

[2] Peter Vandersteegen, Peter Bienstman and Roel Bates, 'Using the Complex Jacobi method to simulate Kerr non-linear photonic components', *Optical and Quantum Electronics (to be published)*

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Cover photos by *Hanna Skrobek*:
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Printed by *National Institute of Telecommunications,*
Transmission and Fiber Optics Department

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IEEE Catalog Number: 06EX1326
ISBN: 1-4244-0235-2
Library of Congress: 2006921097