On Sinc Methods and Photonic Crystal Fibers

Walaa Saad 1, Frank Gunzer 1, 3, Gerd Baumann 1, 2

1 German University in Cairo, Egypt - 2University of Ulm, Germany - 3University of Kiel, Germany

HC Photonic Crystal Fibers

Light transmission in HCPFs is governed by Helmholtz’s eigenvalue problem of electromagnetism. The Helmholtz’s eigenvalue problem is given by

$$-\nabla^2 u(x, y) + \lambda u(x, y) = 0$$

(1)

where $u(x, y)$ is the electric field, and $\lambda$ is the eigenvalue. The eigenvalue problem is solved numerically using the Sinc method.

Sinc Methods

Non-equidistant Sequence of Sinc points is generated using a conformal map over a finite interval $[a, b]$ that redistributes the infinite number of equidistant points on the real line to a finite interval. Large dense occur near end-points.

$$C_m(u, h) = \sum_{j=-N}^{N} \sum_{k=-N}^{N} u(\xi_k) S_{j}(h, \phi(\xi_k))$$

(6)

where $\phi(x) = \text{Ln}(x)$ and $S_j(h, \phi(y))$ are Sinc functions.

For positive $\alpha$, $N \in \mathbb{N}$. Collocating the Helmholtz partial differential equation with nonlinear potential function $V(x, y)$, which proposes a novel numerical model for the HC-PCF in different crystal lattices.

$$\lambda_\text{theoretical} - \lambda_\text{approx}$$

(5)

In error bounds measurements, stabilization and convergence curves are studied for the SC implementation.

Conclusion

SC approach achieves the FEM results with a comparable accuracy using fewer number of Sinc points. In addition, SC rapid exponential convergence regardless the discretization quantity, makes it an attractive alternative to traditional multi-grid computational methods. Moreover, Dynamic interactivity to the core technique has the advantage that error decay is estimated.

References

New Sinc Methods of Numerical Analysis. 
Hand of Sinc Numerical Methods. 
Fundamental of Photonics. 