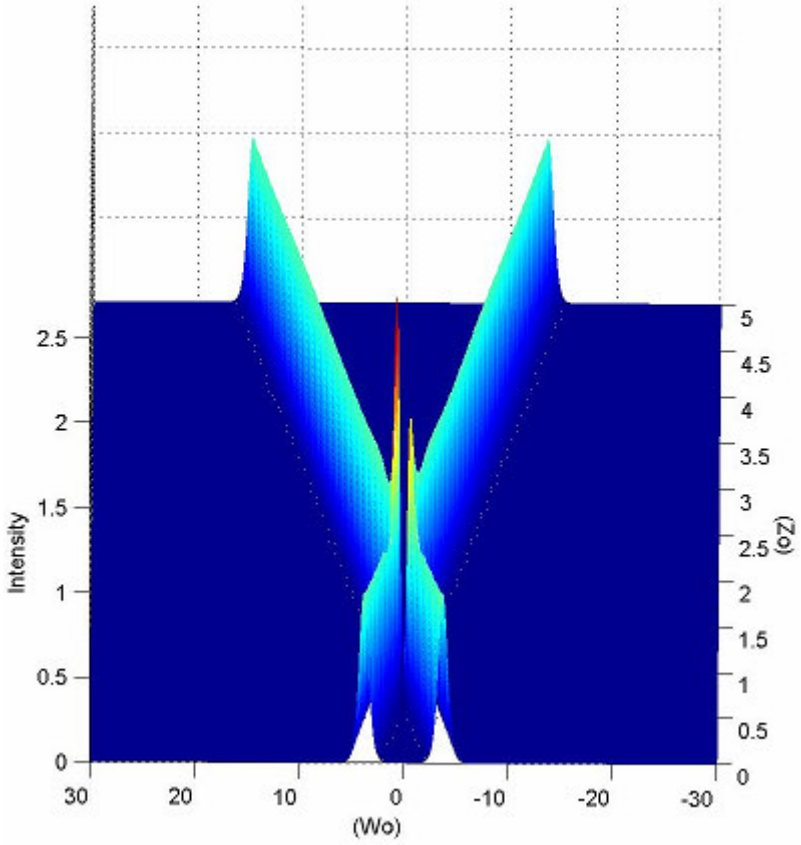
Optical Solitons

Sri Rama Prasanna Pavani
pavani@colorado.edu

Agenda

- Soliton theory in 1 slide
- Numerical simulation
  - Nonlinear split step beam propagation method
- Spatial solitions
- Soliton interactions
  - Collision
  - Attraction
  - Repulsion
- Soliton propagation through thin prism
- Soliton propagation through boundaries
  - Linear/nonlinear
  - Higher/lower refractive index
- Conclusion



Soliton theory in 1 slide

Impossible!

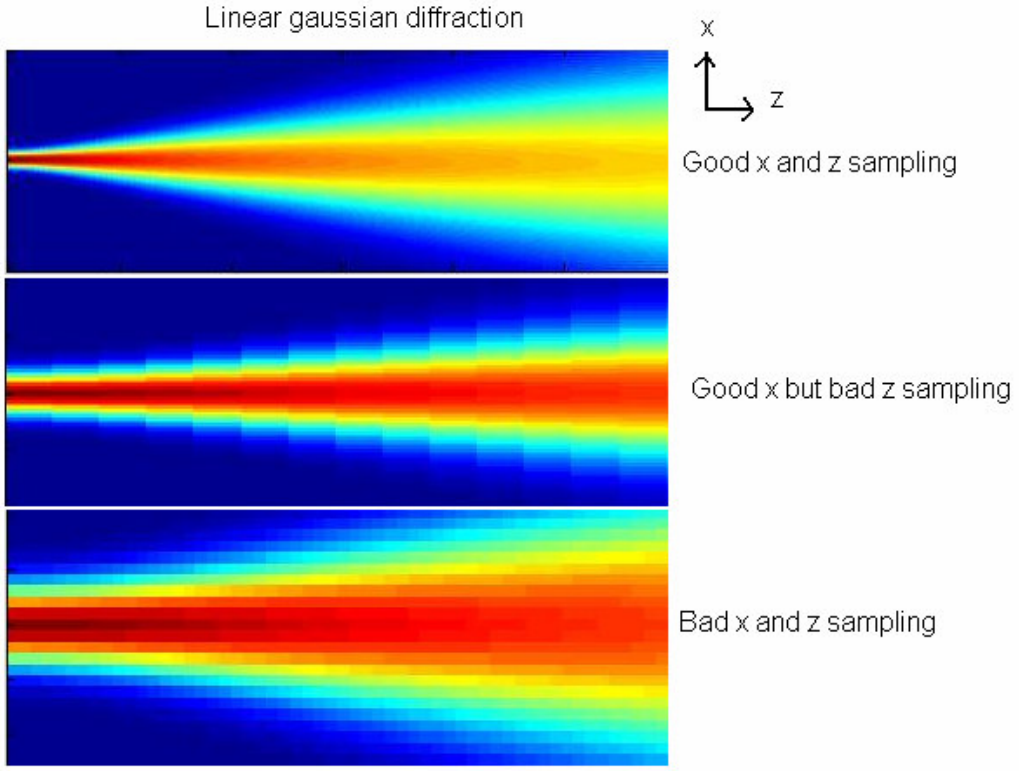
- Prof. Steve Blair wrote a 508 page thesis on it!
- Assume: We understood Prof. Kelvin's soliton lectures totally!

Numerical Simulation

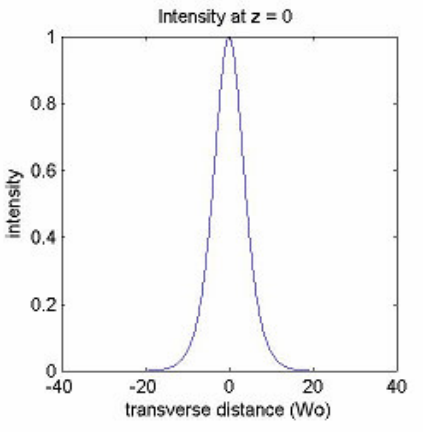
- Split step beam propagation
- Linear Diffraction
- Nonlinear self-focusing

$$\phi^{NL}(x, \Delta z) \approx k_f n_2 \left|A(x, \Delta z/2)\right|^2 \Delta z$$

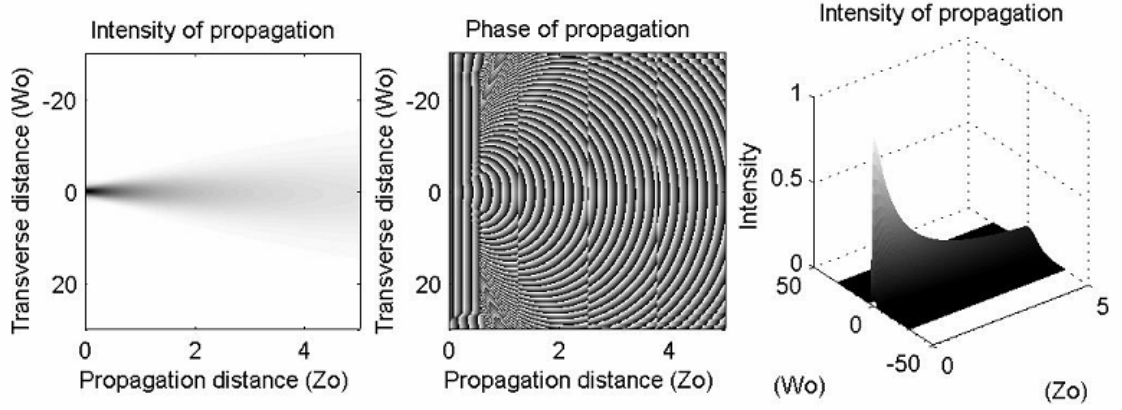
- Sampling
  - Must obey Nyquist x
  - dz must be very small



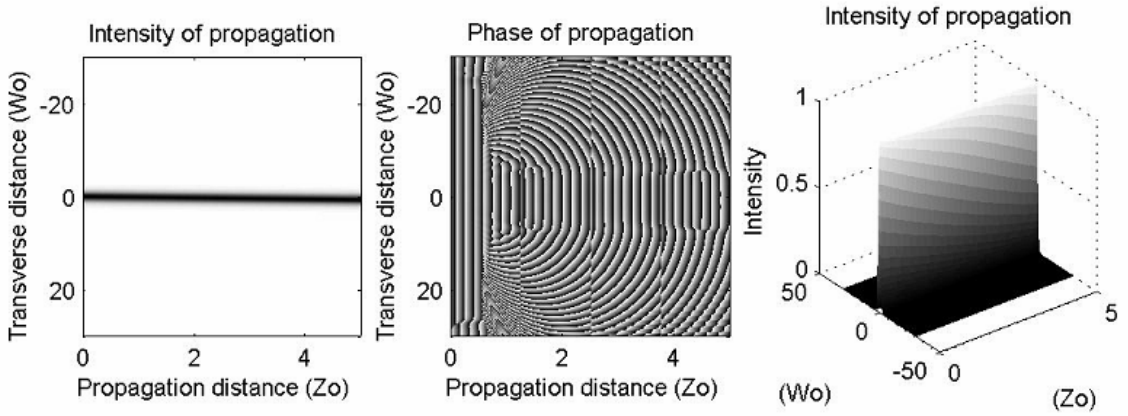
Spatial solitons



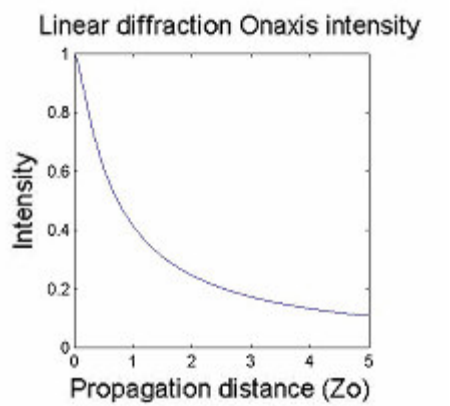
linear

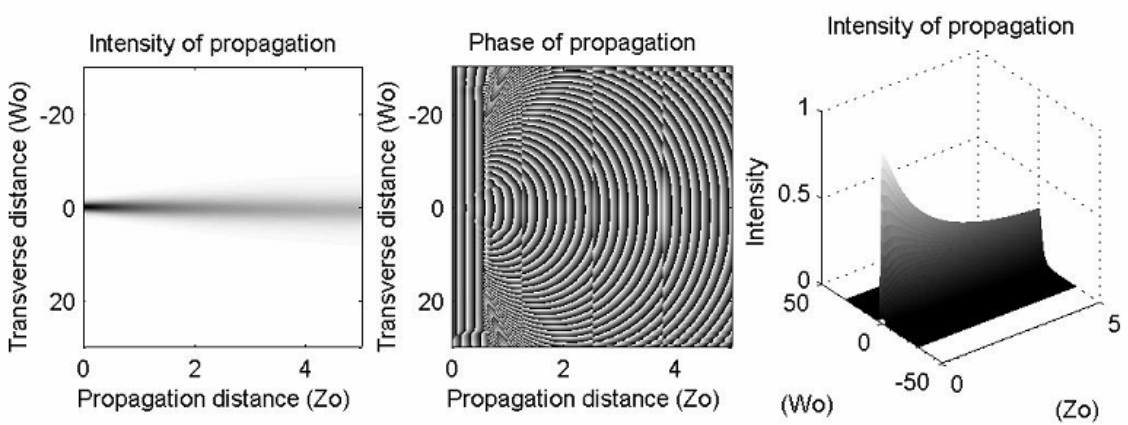


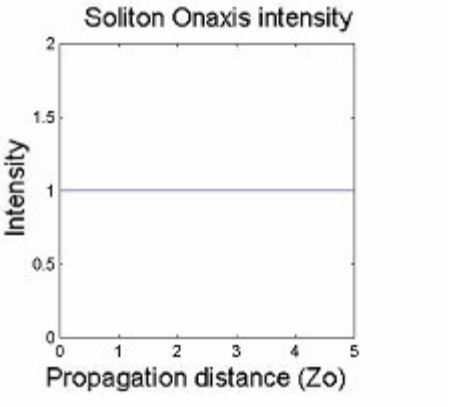
nonlinear

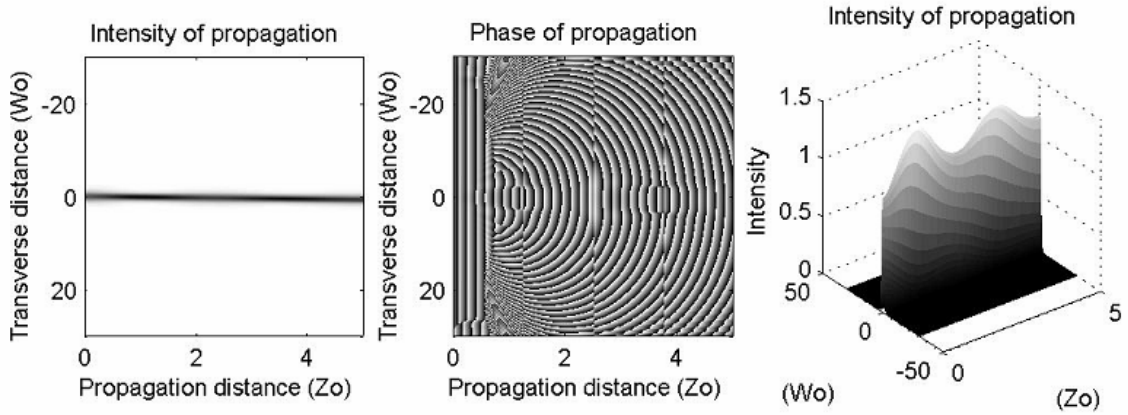


Spatial solitons

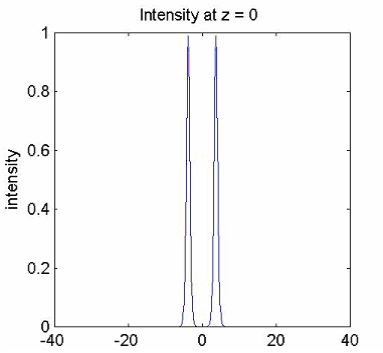






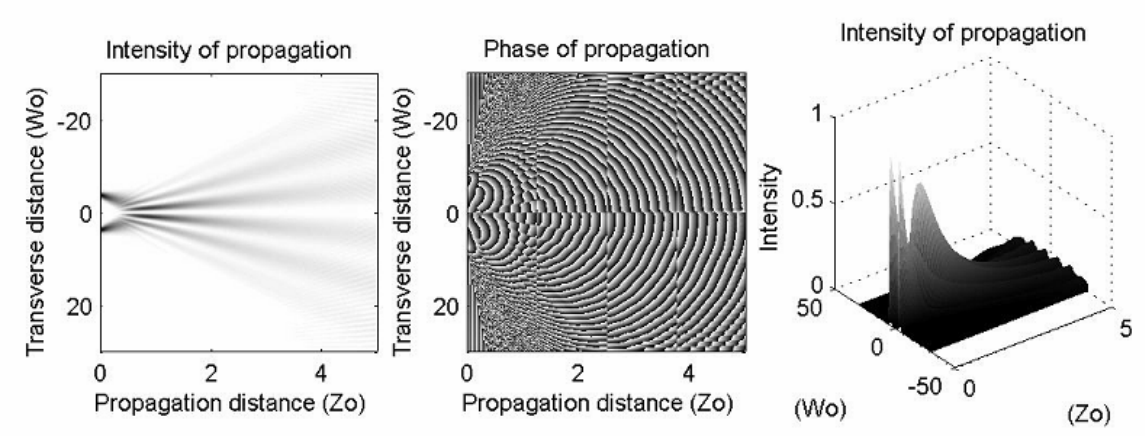


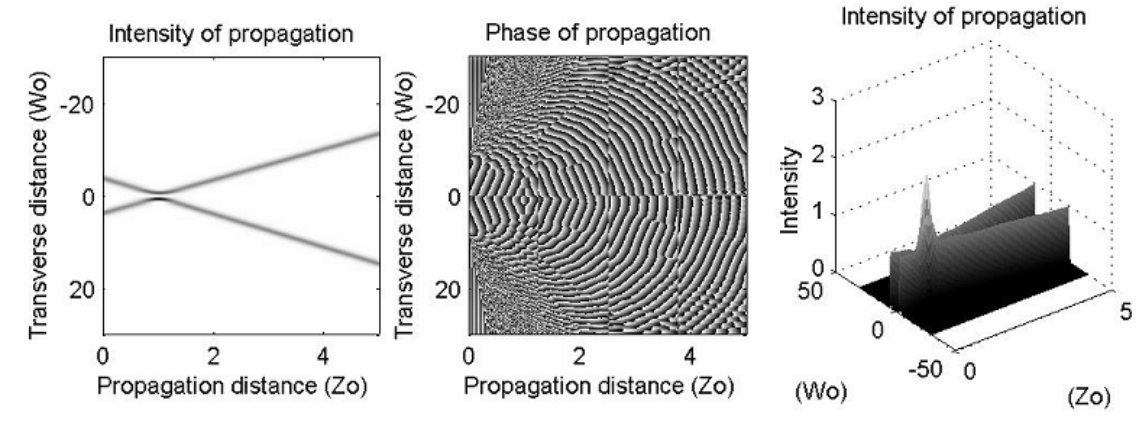
Soliton interaction: Collision



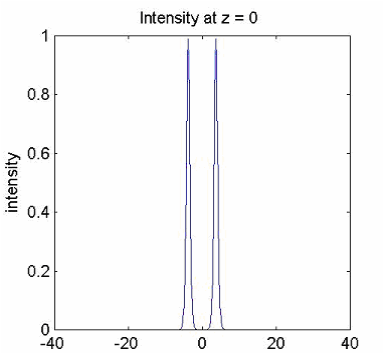
linear

nonlinear



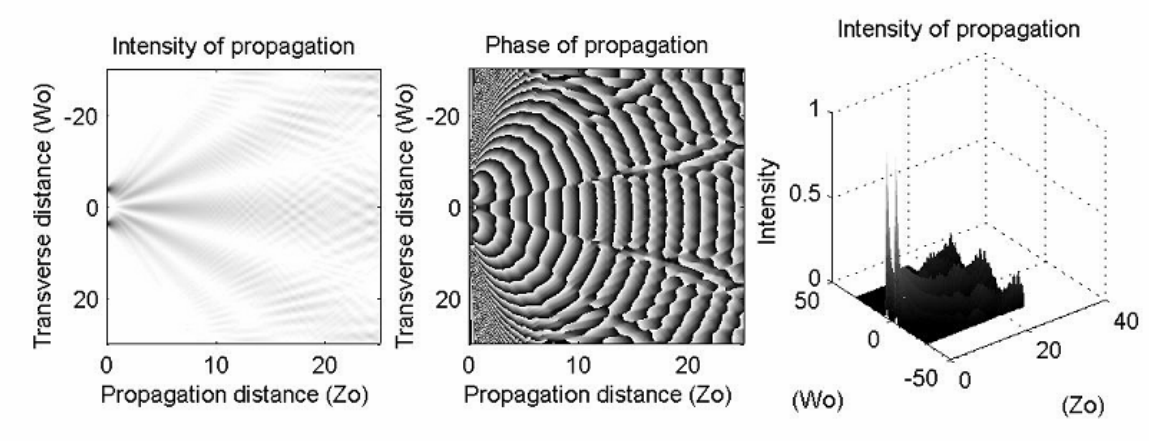


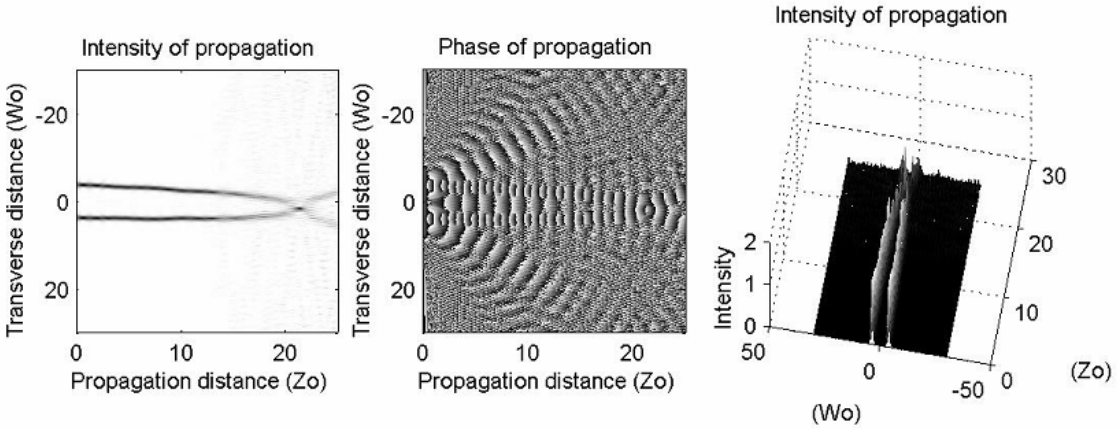
Soliton interaction: Attraction



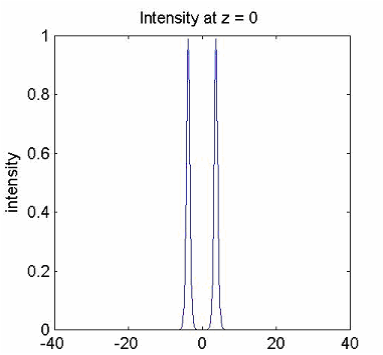
linear

nonlinear



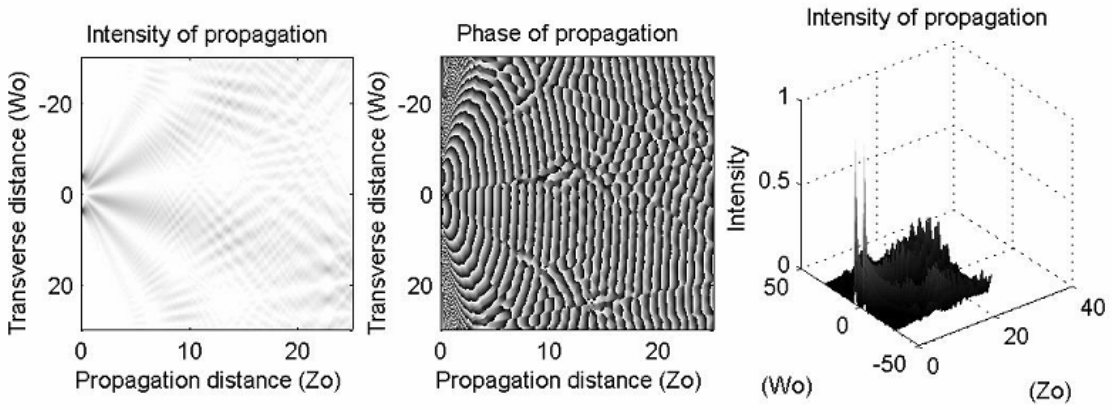


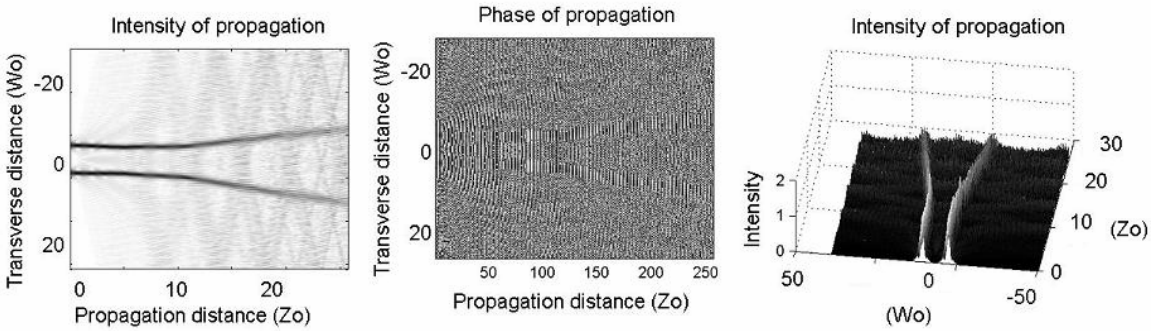
Soliton interaction: Repulsion



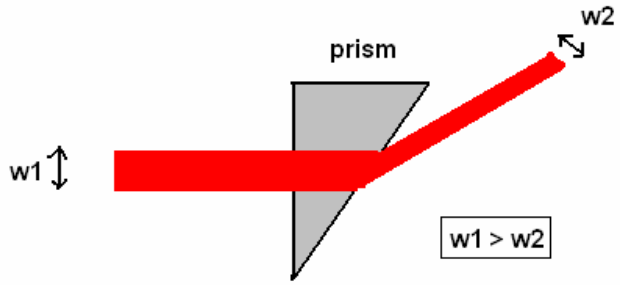
linear

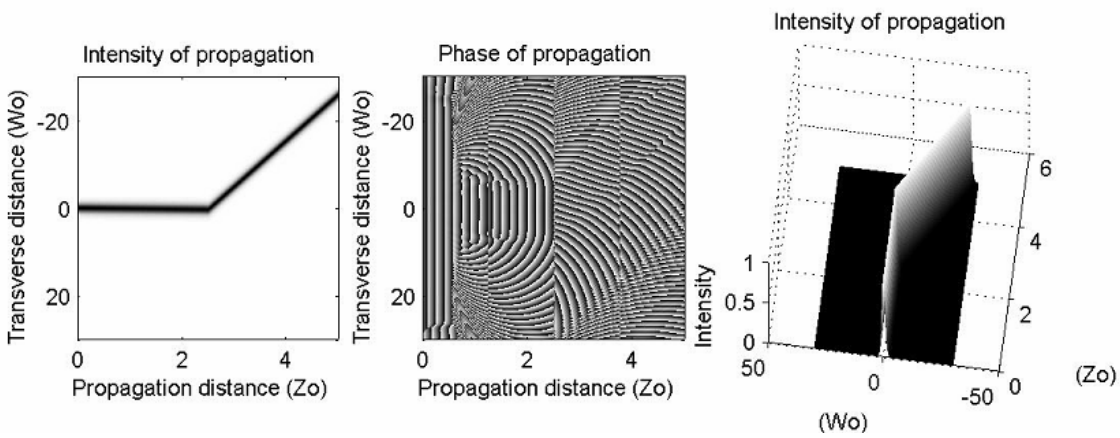
nonlinear

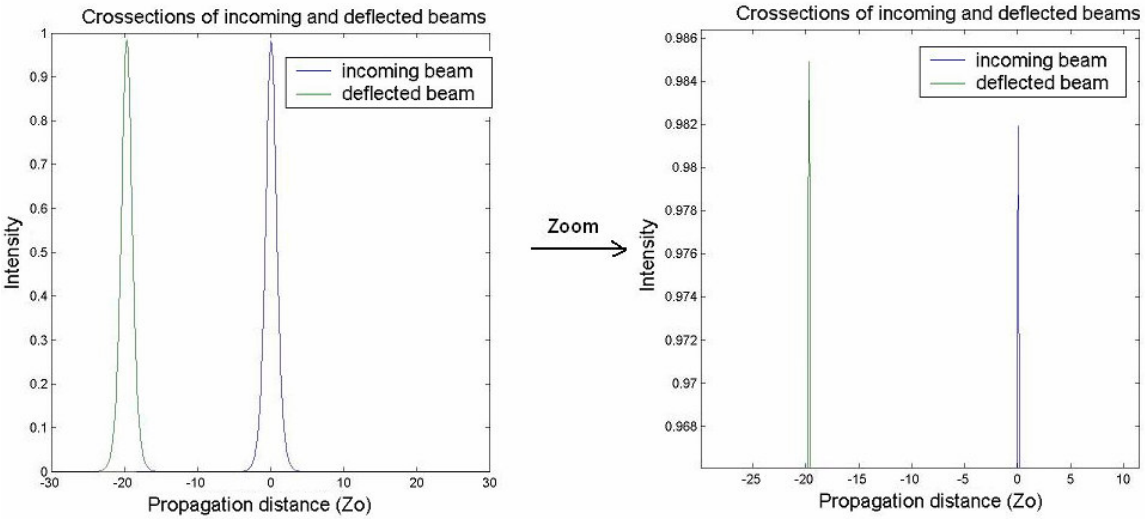




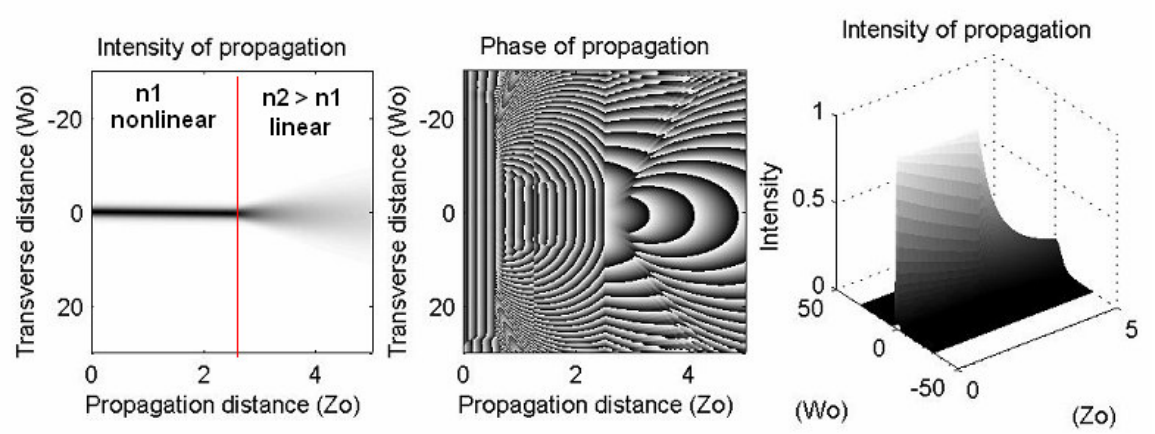
Soliton through a thin prism

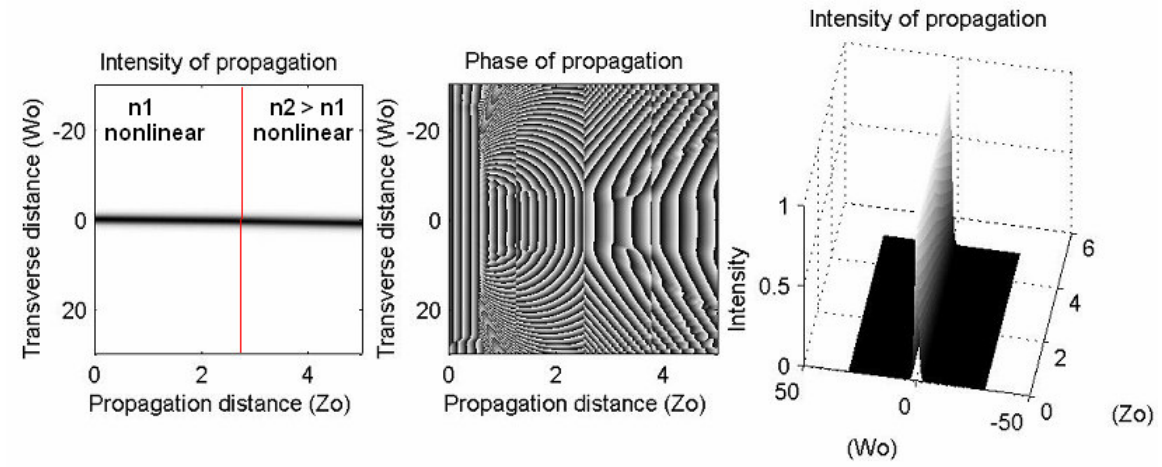




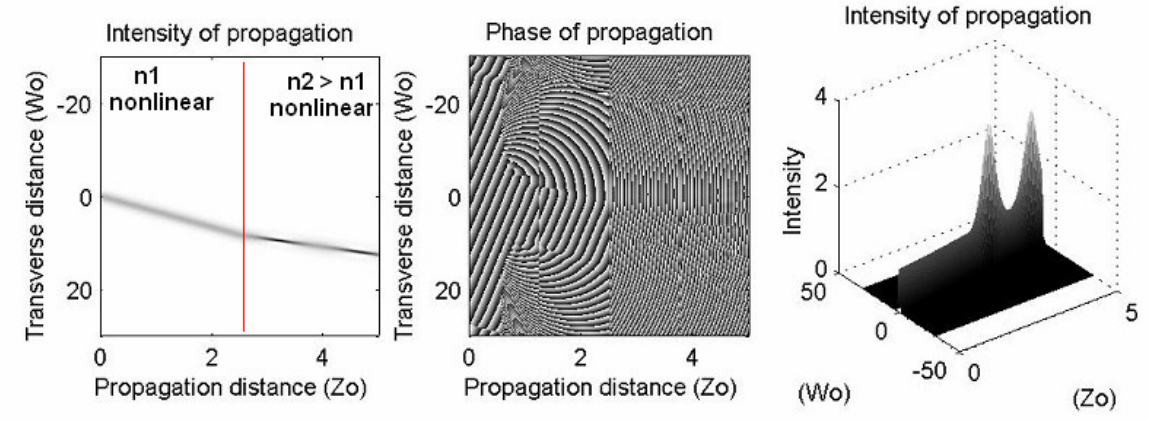


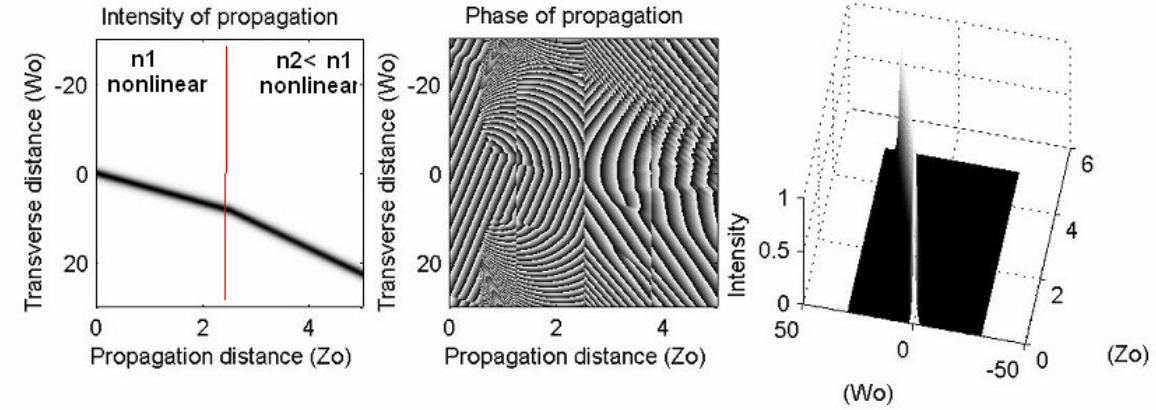
Soliton through boundaries

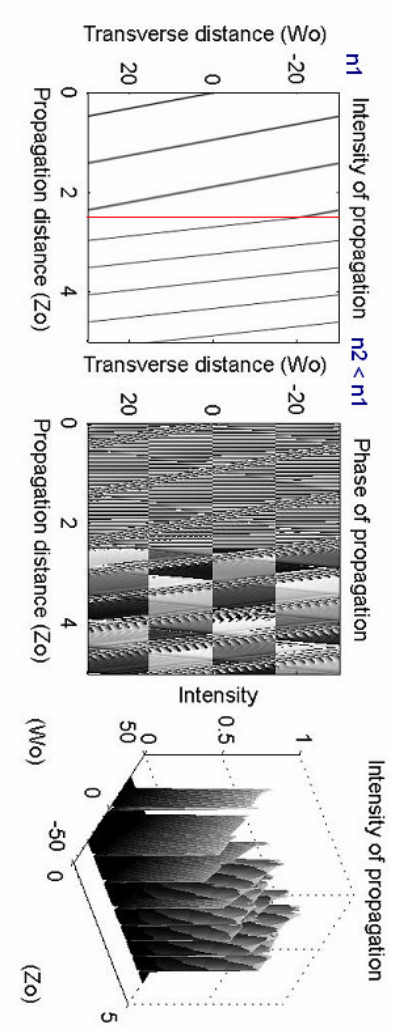




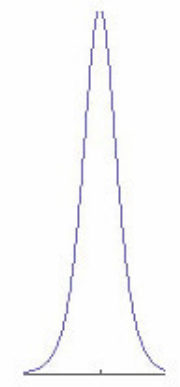
Soliton through boundaries







Conclusion



Project Report: http://eces.colorado.edu/~pavani/Optical_Solitons.pdf

- Numerically implementations
  - Spatial soliton
  - Soliton interactions (collision, attraction, repulsion)
  - Soliton through a prism
  - Soliton through linear/nonlinear high/low index boundaries

References

[1] Steve Blair, “Optical soliton based logic gates”, PhD Thesis, University of Colorado at Boulder, 1998. Download: http://www.ece.utah.edu/~blair/P/dissert.pdf

[2] Balakishore Yellampalle, “Optical soliton controlled inverters in quadratic mediaand inhomogeneous waveguides”, PhD Thesis, University of Colorado at Boulder, 2004

[3] Prof. Kelvin Wagner – Nonlinear/Crystal optics class notes – Fall 2006

[4] Prof. Kelvin Wagner – Fourier Optics and Holography class notes – Fall 2005

[5] J. P. Gordon, “Interaction forces among solitons in optical fibers”, optics letters, vol. 8, pp 596-598, November 1983

[6] Mollenauer, “Solitons in optical fibers”, Elsevier, 2006

Acknowledgements

http://moisl.colorado.edu

http://cdm-optics.com

- Thank You!