Dispersive Shock Waves in Bose-Einstein Condensates and Nonlinear Photonic Crystals

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Thunder, the crack of a whip, and the boom heard from a jet plane surpassing the speed of sound are familiar occurrences in human experience and all result from the generation of "classical" shock waves. This talk will focus on a very different type of shock wave that propagates through dispersive media such as the superfluidic Bose-Einstein condensate (BEC) and defocusing, nonlinear photonic crystals. These shock waves cannot be heard but have been observed in recent experiments and represent a relatively new and exciting area of physical and applied mathematical research. The mathematical theory of dispersive shock waves (DSWs) will be presented along with the analysis of recent experiments. Numerical simulations in one, two, and three dimensions will be used to demonstrate the existence of DSWs in BECs and to verify the mathematical theory presented. Dispersive shock wave interactions in BECs and in the propagation of light through a nonlinear photonic crystal will also be discussed.

Bio:

Dr. Mark Hoefer obtained his Masters degree in applied mathematics from Harvard University in 2000 and his Ph.D. in applied mathematics from the University of Colorado, Boulder in 2006 working with Professor Mark Ablowitz. The university granted him the Creative Work Award for his doctoral thesis. His research interests involve applications of mathematics such as asymptotics, numerical analysis, scientific computing, and mathematical modeling to physical problems ranging from nonlinear dynamics in Bose-Einstein condensates to magnetodynamics of nano-structures. He is currently a National Research Council postdoctoral fellow in the magnetics group at the National Institute of Standards and Technology.