Mathematics Colloquium

Reduction-based strategies for optimal control of dispersive waves

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Building 180, Room 112

Abstract

This talk will be aimed at students and colleagues alike who are interested in learning how to use and apply optimal control theory in their research. Put simply, optimal control problems are a search over a space of functions with differential equation constraints. I will motivate one of its modern applications involving Bose-Einstein Condensates (BEC), an interesting and well-studied type of quantum fluid, and its use in experimental/technological settings. Optimal control theory has proven to be a reliable framework to prepare technologically desirable BEC states while avoiding undesirable excitations that distort the coherence of the fluid. BECs are modeled by a type of partial differential equation (PDE) called the Gross-Pitaevskii equation (GPE). Optimal control problems constrained by this PDE results in a large computational optimization problem. To overcome this challenge, we use a mixture of classical PDE reduction techniques via eigenfunction expansions, and a hybrid optimization strategy involving genetic algorithms and gradient descent methods. This strategy allows us to greatly reduce excitations both in the reduced model and the full GPE model without ever having to solve the full PDE-constrained optimization problem. We demonstrate our strategy numerically in one spatial dimension and motivate its extension to multiple spatial dimensions as a direction for future research. No background in optimal control theory or the above-mentioned optimization/PDE techniques will be assumed and they will be discussed at an appropriate level of depth in regards to their application in the overall methodology.

About the speaker: Jimmie Adriazola obtained his Ph.D. from the New Jersey Institute of Technology under advisor Roy Goodman. He is currently a Postdoctoral Scholar at the University of California at Santa Barbara. His research interests are in nonlinear wave equations, wave propagation in random media, and numerical optimization.