

# UCCS Mathematics Colloquium

Thursday, April 15<sup>th</sup>  
12:30 pm – 1:30 pm  
(Refreshments at 12:15)  
UC Room 307

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## **Excited Bose-Einstein Condensates: Quadrupole Oscillations and Dark Solitons**

**Abstract:** Atomic Bose-Einstein condensates (BECs) constitute ideal systems for studying nonlinear macroscopic excitations in quantum systems. The statics and dynamics of BECs can be described by means of an effective mean-field model, known as the Gross-Pitaevskii equation, which is a variant of the well-known nonlinear Schrödinger equation. This description allows for an understanding of fundamental properties of BECs, including their collective excitations. These refer to the internal oscillatory modes of the system and confirm the superfluid nature of the condensate. Within the so-called Thomas-Fermi approximation, a first order system of differential equations that describes the parameters of the BEC wave function is derived. Using perturbation theory arguments, analytical expressions for the phase, density and width of the condensate are found. Finally, the dynamics of a dark soliton on top of a breathing BEC are also briefly discussed.