

2025-2026 Ulam Colloquium



Speaker: Liliana Borcea, Columbia University

Opening remarks by Kevin Knudson, Interim Associate Dean, CLAS, UF

Monday, April 20, 2026, 4:05-4:55 PM, Fine Arts B 105; Refreshments at 3:30 PM in Lit 339

Data driven reduced order modeling for waveform inversion

Abstract: Waveform inversion seeks to estimate an inaccessible heterogeneous medium by using sensors to probe the medium with signals and measure the generated waves. It is an inverse problem for a hyperbolic system of equations, with the sensor excitation modeled as a forcing term and the heterogeneous medium described by unknown, variable coefficients. The traditional formulation of the inverse problem, called full waveform inversion (FWI), estimates the unknown coefficients via nonlinear least squares data fitting. For typical band limited and high frequency data, the data fitting objective function has spurious local minima near and far from the true coefficients. This is why FWI implemented with gradient based optimization can fail, even for good initial guesses. We propose a different approach to waveform inversion: First, use the data to “learn” a good algebraic model, called a reduced order model (ROM), of how the waves propagate in the unknown medium. Second, use the ROM to obtain a good approximation of the wave field inside the medium. Third, use this approximation to solve the inverse problem. I will give a derivation of such a ROM for a general first order hyperbolic system satisfied by all linear waves in lossless media (sound, electromagnetic or elastic). I will describe the properties of the ROM and will use it to solve the inverse problem for sound waves.

About the speaker: Liliana Borcea is the George P. Livanos Professor of Applied Physics and Applied Mathematics at Columbia University. She received her undergraduate degree from the University of Bucharest in Romania and her PhD from Stanford University. Following a postdoctoral fellowship at Caltech, she joined the faculty at Rice University in 1996, where she was later named the Noah Harding Professor. She subsequently joined the University of Michigan, where she served as the Peter Field Collegiate Professor of Mathematics before moving to Columbia University in 2024. Professor Borcea’s research is in applied mathematics, with major contributions to wave propagation in random media, wave-based imaging, inverse problems for partial differential equations, and data-driven reduced order modeling. In recognition of her distinguished work, she was a Simons Fellow in Mathematics in 2015, the AWM-SIAM Sonia Kovalevsky Lecturer in 2017, and a plenary speaker at the 2022 SIAM Imaging Science Conference. She was elected a SIAM Fellow in 2018 and to the American Academy of Arts and Sciences in 2023, and she also held a Rothschild Distinguished Visiting Fellowship at the Isaac Newton Institute of Mathematical Sciences, Cambridge University, in 2023.

About the colloquium: Stanislaw Ulam (1909-1984) was a Graduate Research Professor at the University of Florida from 1974-1984, and was one of the 20th Century’s leading mathematicians. In 1998-99, under the leadership of Chair Krishnaswami Alladi, the Department of Mathematics initiated the annual Ulam Colloquium Lecture Series in Applied Mathematics at the University of Florida.