SIAM Seminar

Wednesday 24th of May at 11:00
Lipkenszaal - EEMCS

Untangling nonlinearity in inverse scattering with data-driven reduced order models

We consider an inverse problem for the acoustic wave equation, where an array of sensors probes an unknown medium with pulses and measures the scattered waves. The goal is to determine from these measurements the structure of the scattering medium, modeled by a spatially varying acoustic impedance function. Many inversion algorithms assume that the mapping from the unknown impedance to the scattered waves is approximately linear. The linearization, known as the Born approximation, is not accurate in strongly scattering media, where thewaves undergo multiple reflections before they reach the sensors in the array. Thus, the reconstructions of the impedance have numerous artifacts. In this talk we show that it is possible to remove the multiple scattering effects from the data registered at the array, using a reduced order model (ROM). The ROM is defined by an orthogonal projection of the wave propagator operator on the subspace spanned by the time snapshots of the solution of the wave equation. The snapshots are known only at the sensor locations, which is enough information to construct the ROM. The main result of the paper is a novel algorithm that uses the ROM to map the data to its Born approximation. We develop the algorithm from first principles and demonstrate its accuracy with numerical simulations.

Vladimir L. Druskin
Scientific Advisor at Schlumberger-Doll Research and SIAM Fellow
Throughout his career, Vladimir Druskin made fundamental contributions to inverse problems, scientific computing, and numerical analysis and their application to hydrocarbon exploration.

Organized by Rob Remis and Jörn Zimmerling

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