Title: High-frequency limit of the inverse scattering problem: asymptotic convergence from inverse Helmholtz to inverse Liouville.

Abstract: Solving the inverse scattering problem at high-frequency in a stable fashion has been notoriously hard. Processing data at high-frequency using PDE-constrained optimization approach promises a better reconstruction of the unknown medium. Unfortunately, at high-frequency, the objective function becomes wildly nonlinear, thus deteriorating the quality of the reconstruction, leading to spurious non-physical local minima. Many approaches have tried to attenuate the lack of convexity by leveraging the multiscale nature of wave propagation or by regularizing the objective function.

In this talk, we will present a new formulation of the inverse scattering problem that, unlike its classical counterpart, coincides with the Inverse Liouville problem, known to be stable, in the high-frequency limit. This suggests that impinging tightly concentrated monochromatic beams can asymptotically provide stable reconstruction of the medium.

We will introduce the new formulation and how it is connected to the Liouville problem using the Wigner and Housimi transforms. We will provide the rationale for such construction and provide several examples of more stable reconstruction when the new formulation is paired with PDE-constrained optimization pipelines.

Joint work with Shi Chen, Zhiyan Ding, and Qin Li.