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Stability analysis for Inverse Random Source Problems

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The problem under investigation is to determine the strength of a random acoustic source from correlations of measurements distant from the source region. Specifically, we acquire measurements of the time-harmonic acoustic waves on a surface surrounding the source region and then average their correlation to approximate the covariance operator of the solution process on the measurement surface. A natural extension of the existing uniqueness results [1,4] are stability estimates. We were able to show in general settings that this problem is severely ill-posed. Particularly, we show two bounds the upper bound usually referred to as stability estimate and the lower bound called instability estimate. The stability estimate is shown by verifying a variational source condition [3] for the problem which in turn also provides convergence rates for a variety of spectral regularisation methods. Instability is based on a general entropy argument presented for operators of the type X -> L(H,H') with X some metric space and H some separable Hilbert space [2]. The talk will be finished with some numerical experiments that support our theoretical results.

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[2] M. Di Cristo and L. Rondi. Examples of exponential instability for inverse inclusion and scattering problems. In: Inverse Problems, 19 (2003), p. 685.

[3] T. Hohage and F. Weidling. Characterizations of variational source conditions, converse results, and maxisets of spectral regularization methods. In: SIAM Journal on Numerical Analysis, 55.2 (2017), pp. 698-630.

[4] T. Hohage, H.-G. Raumer, and C. Spehr. Uniqueness of an inverse source problem in experimental aeroacoustics. In: Inverse Problems 36(7) (2020)

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