

Active-subspace analysis of speckle patterns

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Laser speckle measurements have been used to optically characterize samples such as rough surfaces [1] and ensembles of particles [2–4]. The approach relies on linking, theoretically or heuristically, certain statistical properties of the measured speckle pattern with the macroscopic properties of the sample. For example, the mean speckle intensity and the width of the speckle autocorrelation function (the characteristic ‘size’ of the speckle) may be related with the refractive index and concentration of particles in an aerosol.

In this talk we present an active-subspace analysis [5] of some statistical parameters of the speckle pattern for laser light transmitted through a water suspension of microparticles. Such analysis can yield directions in the space of macroscopic sample parameters along which the speckle measurements are the most or the least sensitive. This, in turn, can qualify the obtained estimates of sample parameters in the presence of uncertainty. Our analysis is non-asymptotic, and can therefore also account for suspensions of electrically large particles.

References

- [1] Lehmann, P., 1999: Surface-roughness measurement based on the intensity correlation function of scattered light under speckle-pattern illumination. *Appl. Opt.* **38**, 1144–1152.
- [2] Piederrière, Y., Boulvert, F., Cariou, J., Le Jeune, B., Guern, Y., and Le Brun, G., 2005: Backscattered speckle size as a function of polarization: influence of particle-size and -concentration. *Opt. Express* **13**, 5030–5039.
- [3] Buaprathoom, S., Pedley, S., Prins, A. D., and Sweeney, S. J., 2012: High concentration measurement of mixed particle suspensions using simple multi-angle light scattering system. *Proc. SPIE* **8439**, 843923.
- [4] P. Romanov, P., O’Neill, N. T., Royer, A., and McArthur, B. L. J., 1999: Simultaneous retrieval of aerosol refractive index and particle size distribution from ground-based measurements of direct and scattered solar radiation. *Appl. Opt.* **38**, 7305–7320.
- [5] Constantine, P. G., 2015: *Active Subspaces: Emerging Ideas for Dimension Reduction in Parameter Studies*. SIAM, Philadelphia.

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