DYNAMIC CORRELATION ANALYSIS OF THE SPECKLE PRODUCED BY PARTICLES DIFFUSING BEHIND A SCATTERING LAYER

Antoine Delon[1], Anirban Sarkar[1], Joerg Enderlein[2], Irène Wang[1]
[1]University Grenoble Alpes and CNRS, LIPHY, F 38000 Grenoble, France
[2]Third Institute of Physics, University of Goettingen, 37077 Goettingen, Germany
E-mail: antoine.delon@univ-grenoble-alpes.fr

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Fully scattering layers are called opaque, because the speckle they produce does not make it possible, by a simple visual inspection, to locate and determine the shape of any object situated behind such a diffuser. The object is then so-called "hidden". Here, using the "memory effect", we show that a correlation analysis can be applied to quantify the number and the diffusion constant of an ensemble of dynamic fluorescent beads diffusing on a 2D surface. As shown in Fig. 1, we use an epi-fluorescence microscope where both the illumination and detection light patterns are speckled, due to light scattering by a thin disordered layer.

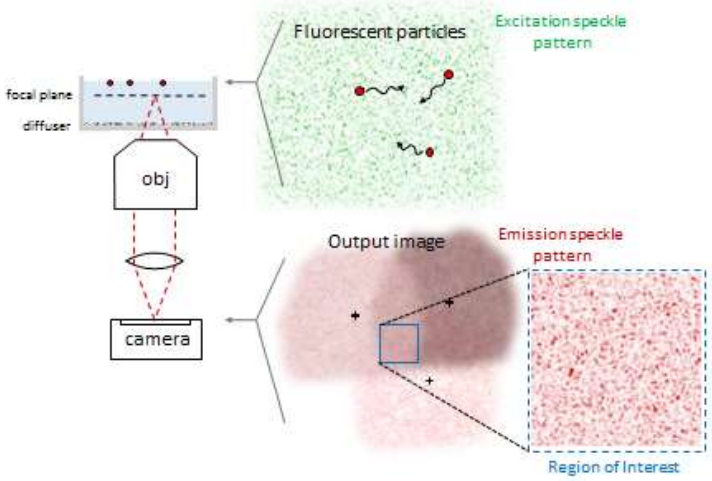

Figure 1: Schematics of the illumination and detection speckle patterns. Within the angular memory effect range, the moving beads emit identical patterns (in red, below). However, due to the random distribution of excitation intensity (in green, above), their overall time-varying intensities are uncorrelated. In practice, the emission patterns of all the beads overlap each other in the analyzed ROI.

The spatio-temporal cross-correlation of the detection speckle pattern is calculated as a function of lag time and spatial shift and is used to determine the diffusion constant and number of fluorescent particles in the sample without requiring any phase retrieval procedure. It is worth to note that the "memory effect" range is not required to extend beyond a distance of few speckle grains, thus making our method potentially useful for nearly arbitrary values of the thickness of the scattering layer.

A. Sarkar et al., "Quantitative analysis of hidden particles diffusing behind a scattering layer using speckle correlation", *Opt. Exp.* **28**, 32936-32954 (2020)