A spectral method to characterize single spheres from light-scattering patterns

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We report a fast method to determine the size and refractive index of homogeneous spheres from the power spectrum of their light-scattering patterns (LSPs), measured with the scanning flow cytometer. Specifically, we use two spectral parameters: the location of the non-zero peak and zero-frequency amplitude, and numerically invert the map from the space of the particle characteristics (size and refractive index) to the space of spectral parameters. The latter parameters can be reliably resolved only for particle size parameters greater than 11, and the inversion is unique only in the limited range of the relative refractive index with the upper limit between 1.1 and 1.25 depending on the size parameter and particular definition of uniqueness. The method developed was tested on two experimental samples, milk fat globules and spherized red blood cells, and resulted in accuracy not worse than the reference method based on the least-square fit of the LSP with the Mie theory. Moreover, for particles with a significant deviation from the spherical shape the spectral method was much closer to the Mie-fit result than the estimated uncertainty of the latter. The spectral method also showed adequate results for synthetic LSPs of spheroids with aspect ratios up to 1.4. We additionally tested two other spectral parameters, the absolute and relative amplitudes of the non-zero spectral peak. They performed fine on ideal data but led to large systematic shifts in the presence of even minor shape distortions. Hence, they were largely inferior to the method based on the zero-frequency amplitude in all test cases. Finally, the general framework developed can be used to construct an inversion algorithm for any other experimental signals.

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