LABORATORY MEASUREMENTS OF FULL-MUELLER-MATRIX SINGLE-PARTICLE SCATTERING

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We have developed a setup for precise multi-angular measurements of light scattered by mm- to µm-sized samples. Our scatterometer can conduct a combination of polarization-controlled measurements, from which we can construct the full angular Mueller matrix of the scatterer.

The system comprises a tunable multimode argon-krypton laser, with 12 wavelengths ranging from 465 to 676 nm, linear polarizers, wave retarders, a reference photomultiplier tube (PMT) monitoring beam intensity, and several PMT's mounted radially towards the sample at an adjustable radius. The current 150 mm radius allows measuring all azimuthal angles except for ±4° around the backward scattering direction. The measurement angle is controlled by a motor-driven rotational stage with an accuracy of 15'.

The optical path includes, in this order, the laser, optical fiber, collimator, linear polarizer, wave retarder, the sample, wave retarder, linear polarizer, and the PMT detector. The novel Hamamatsu PMT's are quite small, only about 15 mm wide, so multiple PTM's easily fit the rotational stage. This enables us to measure at several scattering angles simultaneously. Furthermore, by rotating the stage, the whole angular profile in one scattering plane can be recorded.

The first verification measurements have been carried out with a sphere mounted on a cone-shaped base. Next, the static base will be removed and replaced with an ultrasonic levitator. A high-speed camera, time-linked with the data acquisition, can be used to monitor the sample position in the beam. The verification target is a spherical particle with a diameter of 5 mm (Edmund Optics). The sphere material is N-BK7 glass with refractive index of m=1.517. With the laser wavelength of 514 nm, the size parameter of the sphere is 30,560. The incident beam had a vertical polarization state.

The verification results can be simulated using Mie theory. The shape of the scattering phase function agrees for the model and the measurements, and, e.g., the low intensity range between 100° and 150° due to total internal reflections is nicely reproduced.

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