Mode filtering for extinction measurements on strongly scattering systems

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Understanding and quantifying the extinction of electromagnetic radiation, upon propagation through strongly scattering systems, is pivotal in a variety of fields, from measurements in aquatic and atmospheric environments to characterization of biological tissues [1,2]. Optical extinction measurements can be challenging to perform on systems where the transmitted light contains a strong scattering contribution. In one of the seminal papers in the field, Deepak et al. had concisely formulated the challenges one is faced with when conceiving an experimental setup for optical extinction measurements on strongly scattering systems: "in making extinction measurements, one may optimally design the experimental apparatus so that the effects due to forward scattered radiation (and stray light) are minimized, but still in order to get the true extinction measurement, one must calculate and, if significant, correct for the forward scattering contribution"' [3]. In the course of the following decades, numerous approaches have been proposed to overcome these challenges, and still nowadays measuring the extinction of light in strongly scattering systems is a relevant research topic. Arguably, one of the main reasons why tackling this issue remains difficult is that the use of the term "forward scattering" in this context can lead to ambiguity.

We explain in this talk that "forward scattering" is to be understood as part of the field scattered by the probed system that is coupled into the original mode of the illuminating laser beam. We thereby revisit the fundamentals of optical extinction to formulate, in terms of field modes, both the optical theorem and the attenuation of the power carried along the mode of the illumination beam. We present a novel and simple experimental method, whereby the power propagated in the probing beam's mode can be distinguished from the power propagated in other scattered modes by means of mode-filtering on the intensity level, without having to recourse to sophisticated calculations. We conclude with a short discussion regarding applicability limits of extinction measurements on strongly scattering systems.

References

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Preferred mode of presentation: Oral/Poster