Coherent Imaging With Polarized Probes: When To Go For Vectorial?

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ABSTRACT

Although most of the coherent imaging methods use polarized beams, the formalism that is used to describe the probe-matter interaction and to solve the phase retrieval problem is usually scalar [1]. Such simplification is usually justified by the fact that polarization remains unaffected by the specimen. There exists however some cases where probe-matter interactions give rise to polarization changes. In the optical regime, well-known situations include microscopic anisotropy, which induces birefringence, and chirality, which is responsible for so-called optical activity. In the x-ray regime, polarization changes can be observed when photons are scattered in magnetic materials [2–5], depending on the spin orientations, or by specifically oriented bonds [6]. Polarization modifications carry therefore valuable information about material properties.

Recently, we have addressed the issue of probe polarization in the framework of the ptychography reconstruction problem [7]. A vectorial propagation formalism was used to derive a phase retrieval algorithm aiming at reconstructing the full polarization-related properties of an object, from measurements taken under an appropriate set of prepared and analyzed polarization states.

Here, we will discuss the application of this formalism, depending on the measurement conditions and investigated properties. Comprehensive criteria are provided, assessing whether the vectorial formalism is needed or not. Our discussion, which covers basic examples in the optical regime, will be extended to recent works aiming at revealing magnetic domains by means of x-ray coherent imaging [3–5].

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REFERENCES