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FAST PHYSICAL OPTICS SOFTWARE

LightTrans' talks at SPIE Optical Systems Design 2018

## The concept of bidirectional operators and its application to the modelling of microstructures

Computational Optics

Thursday 17 May 2018 • 08:10 – 10:00 • paper 10694-15

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The well-established ray-tracing concept of Bidirectional Scattering Distribution Function (BSDF), used traditionally to model the scattering of rays at micro-structured surfaces, serves as the inspiration for what we have called “bidirectional”, or B, operators: a physical-optics generalization that refers not only to the modelling of surface scattering, but of any component in an optical system; the effect of said component on a general electromagnetic field is contained in the corresponding B operator; the S matrix concept in grating theory may be understood as a special case thereof. Any method to solve Maxwell's equations in the component can generally be formulated in the form of a B operator. A non-sequential connection of the different B operators solving Maxwell's equations in different regions of an optical system enables physical optics in the entire system. The use of specialized operator models provides a fast solution in various situations. Besides the introduction of the general concept of bidirectional operator, we consider in more detail a set of special B operators based on local assumptions. By their sequential or non-sequential connection, we obtain what we refer to as a split-step class of solvers. The different methods are demonstrated at different examples, including a non-paraxial diffractive beam splitter, micro- and diffractive lenses, and the modelling of scattering.