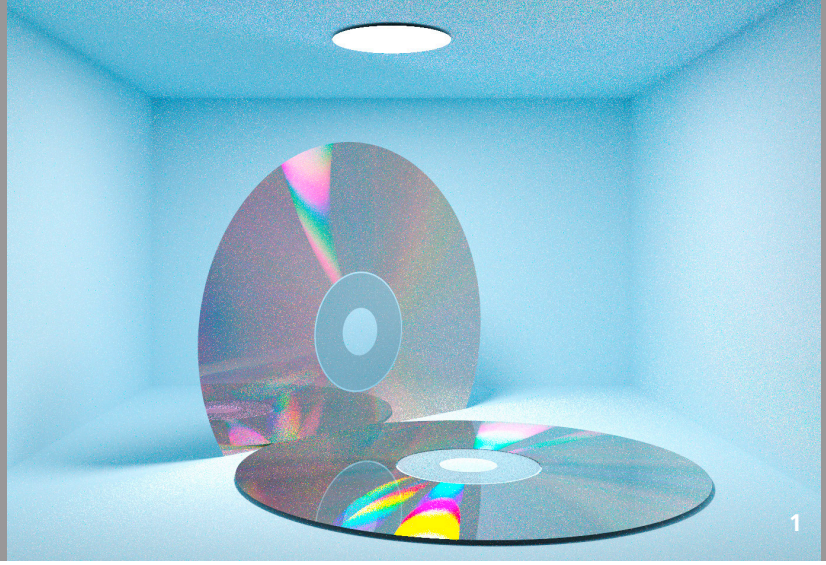

Subject to alterations in specifications and other technical information. 06/2022.

ALGORITHM DEVELOPMENT FOR THE RIGOROUS SIMULATION OF WAVE OPTICAL ELEMENTS

Task

As components become smaller and smaller, and more precise manufacturing processes are developed, optical elements in production engineering and other applications are also becoming more and more compact. If their structure sizes are in the order of magnitude of the wavelength used, wave-optical effects occur. Since these effects enable a functionality that cannot be achieved with conventional optics, they open up novel possibilities for beam shaping. For example, in so-called meta-optics, these effects can be used to create a very short focal length or an unexpected beam deflection at perpendicular beam incidence. However, since the physical principles for these optical systems are more complex than for conventional optics, innovative methods are necessary to design corresponding optical elements, also for near-application, macroscopic situations.

Method

For the simulation of wave-optical elements, the Chair for Technology of Optical Systems (TOS) at RWTH Aachen University has developed algorithms that rigorously solve the underlying physical equations on a microscopic level and simultaneously couple these with macroscopic computational methods. The latter are, for example, methods for analyzing overall optical systems or for rendering complex scenarios. In the future, these methods will be coupled with optimization algorithms so that the systems can not only be analyzed, but also designed.

Results

With the methods developed, the institute could simulate illumination scenarios even for complex configurations. The method was validated by comparison with experimentally taken photographs.

Applications

The methods developed here have multiple applications in areas such as beam shaping for laser material processing, in AR applications such as near-eye displays, or for the generation of structural color.

This work is being partly funded by the German Research Foundation (DFG) under the Excellence Strategy of the German Federal and State Governments – EXC-2023 Internet of Production – under grant number 390621612.

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1 Result of a wave-optical simulation of an illumination scene with two CDs.