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Fachbereich Physik, Universität Stuttgart
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Duality, Helicity, Chirality – and how it's all intertwined

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Abstract

Chirality is a ubiquitous theme in science and gained particular attention in photonics. There, it is encountered in two flavours. On the one hand, objects can be chiral. It implies that the object cannot be superimposed onto its mirror object by any rotation or translation. On the other hand, the response from such objects is probed with light that is sometimes said to be chiral while we actually refer to its helicity. Now, helicity is the generator of the duality transformation, which establishes the link between the three terms mentioned in the title. Dual objects preserve the helicity of light and possess the same electric and magnetic response. Therefore, it is by no surprise that in the slipstream of research on metamaterials, dual objects and their applications gained attention.
This talk gives an overview on some aspects in this research field, emphasising the connection between the terms mentioned in the title. It starts with chiral photonic materials and asks the question how to quantify and measure the chirality of an object (as an answer we introduce the 'electromagnetic chirality'). It discusses maximal electromagnetic chiral objects (that necessarily have to be dual) and formulate requirements an object has to met to improve our ability to sense chiral molecules in its entire surrounding (the object should actually not be chiral but dual). Finally, directional dependent coupling effects from, what is sometimes called, 'chiral' emitters are critically assessed (this actually has nothing to do with 'chirality' but only with angular momentum).
The purpose of the talk is to give an overview of where the notion of duality, helicity, and chirality appeared in the recent past in photonics and how these research efforts are intertwined.