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Maximizing the electromagnetic chirality of thin metallic nanowires at optical frequencies

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Electromagnetic waves impinging on three-dimensional helical metallic metamaterials have been shown to exhibit chiral effects of large magnitude both theoretically and in experimental realizations. Chirality here describes different responses of scatterers, materials, or metamaterials to left and right circularly polarized electromagnetic waves. These differences can be quantified in terms of novel chirality measures, which attain their minimal value zero for achiral scatterers, materials, or metamaterials that interact similarly with left and right circularly polarized waves. Scatterers, materials, or metamaterials with positive em-chirality measure show weaker interactions with either left or right circularly polarized waves, and maximally em-chiral scattering objects or media do not interact with fields of either positive or negative helicity at all.

In this talk we discuss the optimal design of thin metallic free-form nanowires that possess measures of electromagnetic chirality as large as fundamentally possible. We focus on optical frequencies and develop a gradient based optimization scheme to determine the optimal shape of highly chiral silver and gold nanowires. We discuss a series of numerical examples showing that the electromagnetic chirality measures of our optimized nanowires exceed those of traditional metallic helices. Therefore, these should be well suited as building blocks of novel metamaterials with an increased chiral response.

This is joint work with Ivan Fernandez-Corbaton, Marvin Knoöller, and Carsten Rockstuhl (KIT).