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NUMERICAL INSTABILITIES DURING THE SIMULATION OF CHIRAL METAMATERIALS AND A MULTI–SCALE APPROACH

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Metamaterials are artificial materials with properties which are not found in nature. For electromagnetic metamaterials, these properties are produced by merging resonating metallic inclusions within a dielectric matrix. Different applications are possible, depending on the shape, size, orientation and arrangement of these inclusions. Typical examples could be a negative index of refraction material, a lens with perfect focus or polarisers that rotate the plane of polarisation (optical rotatory dispersion) or that change the polarisation itself (circular dichroism).

Our simulation is based on a Yee type algorithm, which has been generalised to unstructured meshes, using a primal Delaunay mesh and its orthogonal Voronoi dual. This enables the efficient and accurate modelling of curved and complex boundaries.

The numerical modelling of metamaterials is challenging for a number of reasons. All metamaterials are frequency dependent and the material parameters are typically described as Lorentz type. Furthermore, chiral metamaterials are characterised by electric permittivity, magnetic permeability and an additional parameter, which is referred to as the chirality. Our results demonstrate that this additional parameter may lead to numerical instabilities and we show the circumstances under which these instabilities arise [2]. We will also present initial results of a multi–scale approach which allows us to deduce the material parameters of a metamaterial from a single unit cell. Our simulations are compared to experimental results. [2].

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