Effective Metamaterial Representation by Parameter-fitting of Dispersion Models

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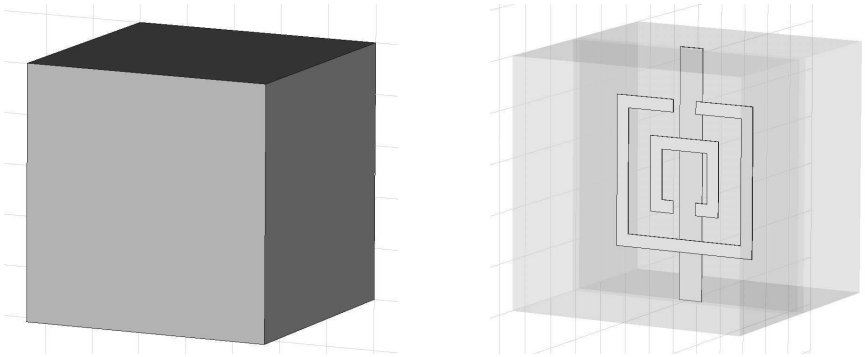
In this paper, a straightforward approach to the extraction of effective electric permittivity and effective magnetic permeability for double negative (DNG) metamaterial structures from 3D field simulation data is presented. Effective parameters are obtained by fitting transmission and reflection of a homogeneous material (Fig. 1(a)) parameterized by frequency dependent Drude model (ϵ_{eff}) and Lorentz model (μ_{eff}) with the transmission and reflection of the simulated metamaterial cell (Fig. 1(b)).

Main difference between the proposed method and the known approaches based on invertion of reflection/transmission results, is that with the presented method one does not need to solve direct equations relating μ_{eff} and ϵ_{eff} with the simulated/measured scattering parameters. In this way one avoids numerical problems connected with the computation of these equations.

Proposed approach is applied to the extraction of effective material parameters for DNG meta- material cells. Optimization results for $\mid s11 \mid$ parameter and extracted effective permittivity obtained with CST Microwave Studio are given in the Fig. 2.



(a) (b)

Figure 1: (a) Effective representation of the SRR/wire structure; (b) SRR/wire reference structure.

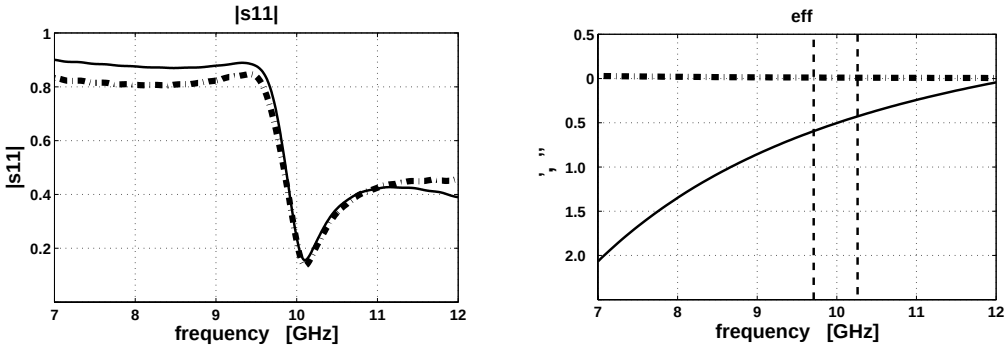


Figure 2: (LHS) Magnitude of the scattering parameter s11 for SRR/wire reference structure from Fig. 1(b) (solid line) and for the optimized effective structure from Fig. 1(a) (dash-dot line); (RHS) Effective electric permittivity $\epsilon_{eff} = \epsilon' - j\epsilon''$ extracted for the optimized structure in Fig. fig:1(a): ϵ' solid line, ϵ'' dash-dot line.