Double-Split-Ring-Resonators: Towards an Efficient Isotropic Magnetic Resonant Particle for Metamaterial Design

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Split Ring Resonators (SRRs) were first proposed for the design of negative magnetic permeability media (NMPM) in view of its resonant behavior, small electrical size and high induced magnetic moment. Later, these particles were applied to the fabrication of anisotropic left-handed media (LHM). It is well known that this particle is essentially a (bi)-anisotropic particle. Although it is possible to design an isotropic array of SRRs, the design of a fully isotropic individual magnetic particle with the aforementioned properties is of interest, since it would make possible to build-up modular isotropic NMPM (and LHM) of arbitrary size, by simply adding these particles in a proper way. As an example, stochastic non-periodic isotropic NMPM could be easily fabricated by using these particles. Also, multi-band and/or defect-loaded NMPM could be easily designed. In addition, the aforementioned particles could be easily re-cycled and re-used in multiple experimental arrangements.

Some theoretical and experimental attempts have been made for designing such isotropic particles. However, only two-dimensional isotropic particles have been reported to the date. In this paper, the problem of designing an isotropic magnetic particle is revisited. A new particle is proposed for this purpose: the double-split-ring-resonator (DSRR). This particle (see Figure 1) shows two perpendicular symmetry planes, which allows for the design of an isotropic system of three mutually orthogonal DSRRs (see Figure 2). The frequency of resonance of the DSRR is twice the frequency of resonance of the SRR with the same dimensions. This disadvantageous fact can be compensated by increasing the broadside-coupling in each DSRR (this coupling has been made unrealistically small in Figures 1 and 2 in order to a better understanding of these figures). Following [6], a model for the proposed particle has been developed, and experiments have been carried out which confirm the reported analysis.

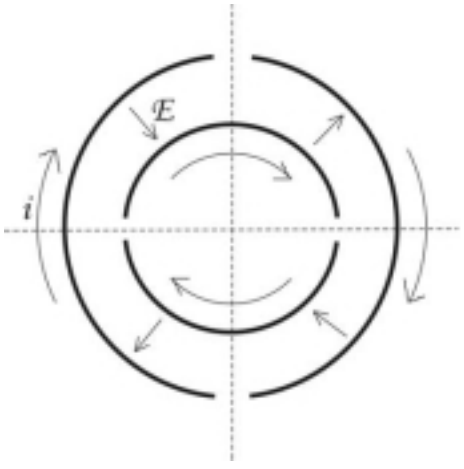

Figure 1.

Figure 2.