Analysis of glide-symmetric metasurface waveguides using Floquet-mode representation

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Periodic metasurfaces can be used to prevent the propagation of EM waves along the structure, or to tailor their propagation in terms of velocity and direction. Two basic approaches in development of fully-metallic structures are based on the use of periodically distributed pins or holes of appropriate diameter and length. Glide symmetry refers to the periodic structures with a higher-order symmetry, which can be described by a set of basic geometrical operations (Hessel, Chen, Li, Oliner, *Proc. IEEE*, Feb. 1973). When considering parallel-plate waveguides with metasurface walls, glide symmetry is obtained through translation and mirroring operations. The main advantage of the aperture-type, glide-symmetric metasurfaces is their low cost of fabrication comparing to other solutions, such as the bed of nails (Quevedo-Teruel, Ebrahimpouri, Kehn, *IEEE Antennas Wireless Propag. Lett.*, Dec. 2016; Quevedo-Teruel et al., *11th European Conference on Antennas and Propagation (EuCAP)*, Paris, 2017). Till now, the glide-symmetric technology has been employed in realization of two-dimensional lenses and gap-waveguide technology.

We have developed a fast and accurate code for analysis and design of glide-symmetric metasurface waveguides based on the Floquet-mode representation of the EM field. The structures of interest are parallel-plate waveguides, the walls of which are aperture-type metasurfaces. The advantage of the proposed structure is its simplicity of production – periodic apertures are obtained simply by drilling holes in the metallic plates. Using EM terminology, one-dimensional periodic structures are realized via corrugations and two-dimensional periodic structures are realized via rectangular or circular short-circuited lateral waveguides. The EM field in the parallel-plate waveguide region is expanded in terms of the Floquet-modes, and the tangential components are matched to the tangential components of EM field inside the lateral waveguides (expanded in terms of the waveguide modes). In this way, a characteristic equation for the metasurface waveguide mode propagation constant is derived. The developed analysis method is verified by comparing the calculated propagation constant with the results obtained using a commercial electromagnetic solver.