Analysis of Wave Propagation in Glide-Symmetric Metasurfaces Using Mode-Matching Technique

Fatemeh Ghasemifard * (1), Guido Valerio (2), and Oscar Quevedo-Teruel (1)
(1) Department of Electromagnetic Engineering, KTH Royal Institute of Technology, Stockholm, Sweden, fatemehg@kth.se, oscarqt@kth.se
(2) Sorbonne Universités, UPMC Univ Paris 06, Paris, France, guido.valerio@upmc.fr

Glide-symmetric structures are a special case of the structures with higher symmetry. The exceptional characteristics of these structures were discovered by Prof. Oliner (A. Hessel, M. H. Chen, R. C. M. Li, and A. A. Oliner, *Proceedings of the IEEE*, 61(2), 183-195, 1973).

Recently, the idea of glide-symmetry has been applied to 2D periodic structures, i.e. metasurfaces. Metasurfaces with glide-symmetric geometries have been proposed to produce non-dispersive (ultra-wideband) antennas (O. Quevedo-Teruel, M. Ebrahimpouri, and M. Ng Mou Kehn, *IEEE Antennas Wireless Propag. Lett.*, 15, 484-487, 2016). Therefore, glide-symmetric configurations have mitigated one of the main limitations of the conventional metasurfaces-based antennas which is a narrow band of operation. Moreover, low–cost glide-symmetric metasurfaces have been proposed to create Electromagnetic Band Gap (EBG) surfaces, which can be employed to produce low-cost gap-waveguide technology for high frequency (M. Ebrahimpouri, E. Rajo-Iglesias, Z. Sipus, and O. Quevedo-Teruel, *10th European Conference on Antennas and Propagation (EuCAP)*, 2016).

Due to the promising properties of glide-symmetric metasurfaces, computing their propagation characteristics in an efficient way is of great importance. A recent work for analyzing glide-symmetric metasurfaces was presented in (G. Valerio, Z. Sipus, A. Grbic, O. Quevedo-Teruel, 2016 *IEEE AP-S and URSI Joint Meeting*). In this work, the equivalent circuit model for two-dimensional glide-symmetric corrugated metasurfaces has been derived. Although the evaluation of this model is very fast and accurate, it has one limitation: the width of the corrugations should not be larger than the half of the spatial period.

Here, we propose a mode-matching technique to analyze two-dimensional glide-symmetric corrugated metasurfaces. The method is fast, accurate, and it does not have the limitation of the aforementioned circuit model. This method can be employed to calculate the dispersion diagram of corrugated structures with an excellent agreement with *CST Microwave Studio* results.

Furthermore, the mode-matching technique has been used to analyze three-dimensional glide-symmetric metasurfaces with cylindrical holes. In this case, the formulation needs the combination of Cartesian coordinates for the unit cell, and cylindrical coordinates for the holes. Although this issue increases the difficulty of the formulation, the method remains fast and accurate since it is quasi-analytic. Also in this case, *CST Microwave Studio* has been employed to validate our method. Comparison with the *CST Microwave Studio* results demonstrates the liability of the mode-matching results, and its significant improvement in terms of computational time.