Broadband Planar Luneburg Lens Antenna Using Glide-symmetric Meandered Transmission Lines

Mahsa Ebrahimpouri[1], Oscar Quevedo-Teruel[1], and Anthony Grbic[2]

[1] School of Electrical Engineering, KTH Royal Institute of Technology, SE-100 44 Stockholm, Sweden.
[2] Department of Electrical Engineering and Computer Science, University of Michigan, Ann Arbor, Michigan 48109-2122, USA.

Lens antennas are popular at millimeter-wave frequencies where their dimensions become small enough for integration. A Luneburg lens is a symmetric graded-index lens which can be used as the basis of a beamsteering antenna. 2D Luneburg lens antennas have attracted research interest over the years because of their planar profile and ability to steer beam without requiring phase shifters. Patterned metallic structures that are low loss and cost effective can be used to realize the required graded-index profile of these lenses. These metasurface designs tune the refractive index of a surface or PPW by changing the geometry of each unit-cell or lattice constant along a plane. Various designs have been reported in literature (C. Pfeiffer and A. Grbic, IEEE Transactions on Antennas and Propagation, vol. 58, no. 9, pp. 3055-3059, Sept. 2010). The designs vary in terms of bandwidth, efficiency and cost depending on the patterned structure used.

Here, we propose an ultra-wideband lens profile which employs glide-symmetric, meandered micro-strip transmission lines. Glide-symmetric periodic structures were introduced by the authors (O. Quevedo-Teruel, M. Ebrahimpouri and M. Ng Mou Kehn, IEEE Antennas and Wireless Propagation Letters, vol. 15, pp. 484-487, Dec. 2016.). Adding glide symmetry to the patterned metallic structure provides less dispersive and higher values of refractive index. In this work, a glide-symmetric, meandered hexagonal lattice is used to realize the profile of a Luneburg lens. The proposed lattice operates over a large bandwidth (from 10 GHz to 60 GHz), and can be fabricated using a low-cost PCB process.

Radiation from the metasurface is achieved by appending a planar leaky wave structure to the luneburg lens, keeping the full structure low-profile and light-weight. The leaky wave structure is designed using a hexagonal lattice of circular slots radiating into a dielectric of permittivity equal to 3. The hexagonal lattice ensures isotropic radiation in all directions and the dense dielectric provides the required radiation angle. The full structure can scan the beam angle from -60° to 60° azimuthally with radiation angle of 45°.