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Helicoidal Modes in a Triangular Coaxial Line with DNG Metamaterial Deflectors

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Coaxial lines whose inner conductor has a cross-section with sharp edges, such as a rectangular coaxial cable, may be susceptible to dielectric breakdown because of the singularities of some field components at those edges. For a coaxial line of rectangular cross-section, this difficulty has been eliminated by the insertion of DNG metamaterial deflector prisms at the corners of the cross-section [1][2], leading to the discovery of helicoidal plane-wave modes propagating along the line. In the present work, that technique is extended to coaxial lines of triangular cross-section.

The cross-section of the surface of the inner metallic (PEC) conductor and the cross-section of the inner surface of the outer metallic conductor are triangles of identical shape, separated by a linear, lossless and isotropic dielectric layer of uniform thickness, characterized by a real positive wavenumber $k = 2\pi/\lambda$ and a real positive intrinsic impedance Z. Three lossless anti-isorefractive DNG metamaterial prisms characterized by a real negative wavenumber $-k$ and a real positive intrinsic impedance Z are located at the three corners of the cross-sectional area. The cross-section of each prism is a right-angle triangle with the hypotenuse in the plane containing a sharp edge of the inner conductor and the corresponding concave edge of the outer conductor; this plane bisects the angle of the wedges. It is shown that plane-wave modes may propagate in a helicoidal fashion along the line at an angle ϑ with the direction of the line, provided that $\sin \vartheta = n \lambda/p$, where n is an integer and p is the perimeter of the triangular cross-section of the inner conductor. The number n of possible helicoidal modes can be reduced by replacing portions of the dielectric layer with DNG prisms of rectangular cross-section, in which case the perimeter p is replaced by an "effective perimeter" equal to p minus twice the portion of p that is occupied by DNG metamaterial. Both number and direction of propagation of the helicoidal modes are independent of the shape of the triangular cross-section and of the thickness of the dielectric layer.

1. P. L. E. Uslenghi, "Helicoidal *p lane*-wave modes in a rectangular coaxial cable containing DNG deflectors", *Proc. Electromagnetic Theory Symposium*, Bologna, Italy, June 2025.

2. P. L. E. Uslenghi, "Further studies of helicoidal modes in a rectangular coaxial line with DNG deflectors", *IEEE AP-S/URSI Symposium*, Ottawa, Ontario, Canada, July 2025.