# Design and Comparison of Backward Helical and Spiral Antennas

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Primary feeds with rear-radiating patterns are significantly advantageous in small front-fed reflector antennas, as they can be mounted directly from the apex of the reflector through a single rod. As such, the need for supporting struts is eliminated, resulting in lesser blockage on the reflector aperture. The very first design of such interesting feeds was introduced for dipole feeds, in which a cylindrical cavity was utilized to direct the dipole radiation in a half-space region [A. Calvin, IRE Trans. Antennas Propag., 2, 113-119, 1954]. Other well-known rear-radiating feeds are dipole-disk with beam-forming ring [P. S. Kildal and S. Skyttemyr, IEEE Trans. Antennas Propag., 30, 529–534, 1982] and dipole-conical reflector [L. Shafai and P. Bhartia, US Patent, 4 982 198, 1991]. The aforementioned antennas were designed for linear polarization and possibility of utilizing cross-dipole feeds have also been reported for circularly polarized (CP) applications. These radiating elements are resonant structures and provide backward radiation patterns with a very narrow frequency bandwidth.

Helical and spiral antennas are excellent circularly-polarized candidates for broadband frequency applications. The backward radiation patterns of helical antennas have been investigated by many researchers. In particular, a monofilar helical antenna was studied over a finite ground plane [H. Nakano and et. al, IEEE Trans. Antennas Propag., 36, 1359-1364, 1988]. It was shown that the diameter of the ground plane size played a key role to determine the direction of the radiation. That is, the radiation is forward for a ground plane size larger than the helix diameter and it becomes backward when the ground plane size reduces to the order of helix diameter. However, to the best of our knowledge, spiral antennas with backward radiation patterns have not found much attention in the literature.

The focus of this paper is to investigate and compare designs of rear-radiating helical and spiral antennas as primary feeds in symmetric front-fed parabolic reflector antennas. First, backward helical antennas are addressed based on the ground plane size less than the helix diameter. Then, rear-radiating spiral antennas are investigated. It is shown that, as opposed to the helical antennas, shrinking the supporting ground-plane size does not result in a backward radiation for a spiral antenna. Instead, if the spiral diameter is selected such that it is smaller than its conventional active region, it is possible to direct the radiation to the lower-half space, resulting in a backward radiation. For such a reduced-sized spiral, the currents travel along the spiral arms, producing reflected waves at the arm ends, leading to backward radiation patterns. The sense of polarization of the corresponding CP waves is opposite to the winding direction of the spiral, due to the fact that the reflected waves are now the source of radiation. Different radiation properties such as CP gain, beamwidths, and cross polarization will be discussed and presented in the conference.