Comments and Replies

Comments on "Focusing Characteristics of Curvilinear Half-Open Fresnel Zone Plate Lenses: Plane Wave Illumination"

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We have read the paper by Hristo D. Hristov, L. P. Kamburov, J. R. Urumov, and Rodolfo Feick [1] and were surprised by some of their conclusions and results.

In [1, p. 1912], the authors wrote "*In [7] and [8] various plane and curved phase-corrected lens designs for millimeter waves were examined theoretically and experimentally by considering them particular cases of quasioptical diffraction elements (QDE). Analytical and numerical algorithms for the Kirchhoff diffraction integral solution involved in the curvilinear FZP lens theory were also proposed.*" This is known and we understand the authors are aware of references [7] and [8].

The main conclusion of the authors (see [1, p. 1918]) is "*In conclusion, the belief that the curvilinear FZP have superior (or inferior) electromagnetic characteristics, compared to those of the plane FZP lens is not true in general. Their focusing behavior can vary significantly depending on the lens joint positioning and dimensions.*"

But in [7], it was shown that for the curvilinear FZP with arbitrary shape the focusing (along the optical axis) and frequency properties (i.e., dependences of a focal distances versus frequency) may be written in invariant forms. For example, [7, p. 82]

$$\Delta_z^{\pm} \approx \Delta_{FZP}^{\pm} \pm \langle x \rangle$$

where $\Delta_{FZP}^{\pm}$ is "resolution" along the optical axis of a flat FZP (sign $\pm$ demonstrate the nonsymmetrical field intensity distribution near the focus along the optical axis), $\Delta^{\pm}$—the resolution power along the optical axis of arbitrary curvilinear FZP, $\langle x \rangle$—the relative average "height" of the curvilinear FZP. So the resolving power of curvilinear FZP along the optical axis may be as better as lower to comparison on a flat FZP. The same conclusion was described in [7] for the frequency properties.

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These results mentioned above were confirmed by both numerical simulations and experimental verifications [2], [7]. And these results were first published in [2], which was referenced in Hristov's book, *Fresnel Zones in Wireless Links, Zone Plate Lenses and Antennas* (Boston, MA: Artech House, 2000) on p. 308, reference [85].

So in the mentioned above works, based on numerical and experimental results in millimeter waveband, we have shown that the focusing (along the optical axis) and frequency properties of curvilinear FZP lens of arbitrary shape depends on the direction of incident wavefront and diameter-to-height ratio (i.e., focusing behavior depending on the lens positioning and dimensions). That is the curvilinear FZP lenses can be superior or inferior in their focusing (resolving) properties compared to the flat FZP lens [2], [7], and [8].

In addition, in [1, p. 1915], the authors described their numerical calculations for the FZP with the parameters "*All lenses share the same transverse circular aperture of diameter* $D \sim 144.4$ mm *and have totally 21 Fresnel zones. The distance F from the focal point to the aperture plane is* 67.5mm." For these parameters the relative diameter is $D/F \sim 144.4/67.5 = 2.14$. It is well-known (see, for example, [3]–[5] and [8, pp. 132–133]) that for such D/F ratio the physical effect of focus displacement (focal shift) to the aperture plane along the optical axis takes place. But from the results described in the paper such physical effect do not shown and do not describe by the authors. Some details according effect of a focal shift for FZP with low number of Fresnel zones may be found in [8, ch. 3]. It seems the numerical simplified algorithm offered by the authors is not correct in this case.

By the way, the conical FZP was introduced and investigated both theoretically and experimentally in millimeter waveband in [7].

References

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