Comments

Comments on "Plane Wave Excitation of an Infinite Dielectric Rod"

Mario Le Blanc and Gilles Y. Delisle

I. Introduction

In the above letter,[1] Keam provides analytical expressions for the fields inside and outside a lossy, circular cylindrical dielectric rod illuminated by a normally incident plane wave. The author is to be commended for noting the usefulness of analytical methods in studying such problems. However, it appears that a number of important references have been left out and, more seriously, that the computational results are in error. It is the purpose of this letter to correct these deficiencies.

II. Literature

The problem of scattering of a plane wave by an homogeneous, circular dielectric cylinder (in the general case of oblique incidence) was solved by Wait in 1955 [1], [2], but he gave no numerical results. The normal incidence case (for a multilayered, concentric structure) was treated by Bussey and Richmond [3],[2] who provided some values of scattering coefficients. Examples of analytical computations of internal fields are given in Figs. 3 and 4 of [4], both for TM and TE polarizations. The latter reference contains an extensive bibliography. The case of an eccentric multilayer has also been studied analytically [5]. An extension of the work of Wait to more than one layer has recently been published [6]. It should also be pointed out that the analytical solution of the problem discussed by Keam has been given in at least two textbook exercises [7], [8].

In his discussion of the evaluation of Bessel functions, Keam fails to acknowledge that du Toit [9] advocates the use of the recurrence method [10] rather than the FFT method. We have implemented the algorithms of [10] and used them to reproduce the results of [3] and [4], as well as to generate the numerical data of [6].

III. Results

Examination of Fig. 2 of the letter shows a distribution of the E-field magnitude that is symmetrical with respect to the y-axis. This suggests that the illuminated and shadowed halves of the object dissipate equal amounts of power, which is not expected. We have attempted to reproduce that result, using the wave number values $k = 41.9169\ m^{-1}$ and $k^d = (187.517 - j4.68499)\ m^{-1}$. The infinite series were truncated at $n = \pm 10$ (no significant differences were seen when truncating at $n = \pm 4$). Table I shows the values of the Bessel function J at a typical radius. The computed field distribution (both internal and external) is shown in Fig. 1. The difference with respect to Keam's result is obvious.

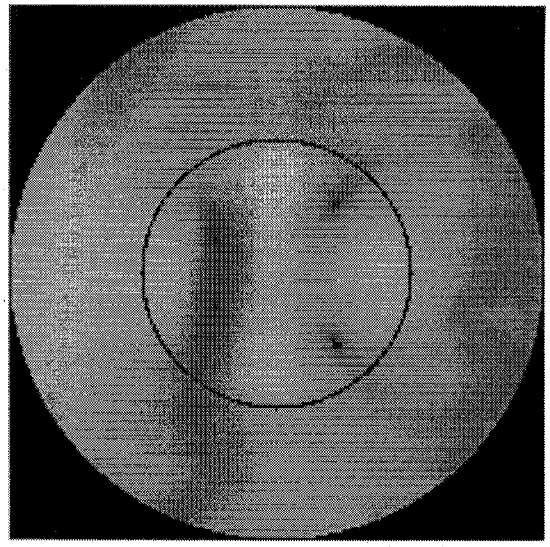

Fig. 1. Normalized electric field distribution inside and outside (incident + scattered) a dielectric rod for the case $f = 2$ GHz, $c = 20$ mm, and $\epsilon_r = 20 - j1$. The incidence is from the left. The range of internal field levels is from −38.3 to +5.5 dB (E_0). Overall radius is 40 mm.

TABLE I
Computed Values of $J_m(k^d r)$ for $r = 10\ mm$ ($k^d r$ = 1.87517 j0.0468499)

n	$J_n(k^d r)$
0	$0.29623978 + j0.027256247$
1	$0.58207727 + j0.000652906$
2	$0.32418167 - j0.011059051$
3	$0.10960524 - j0.006962174$
4	$0.02686074 - j0.002447319$
5	$0.00517940 - j0.000610954$
6	$0.00082436 - j0.000119113$
7	$0.00011178 - j0.000019106$
8	$0.00001321 - j0.000002607$
9	$0.00000138 - j0.000000310$
10	$0.00000013 - j0.000000033$

Similarly, the result for the smaller rod is shown in Fig. 2. The same total area is covered once again. Although the internal field is much more uniform than in the other case, it is still not axially symmetric.

IV. Conclusion

The purpose of this letter is only to correct erroneous results which could lead to incorrect interpretation of a study that was otherwise interestingly presented.

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[1] R. B. Keam, *IEEE Microwave and Guided Wave Lett.*, vol. 4, no. 10, pp. 326–328, 1994.

[2] There seems to be a minor error in the theoretical part of [3]: a factor equal to $(\pi r_m)/(2\mu_m)$ is missing from the right-hand side of (4). This is probably only an omission in typesetting as the results appear to account for the factor.

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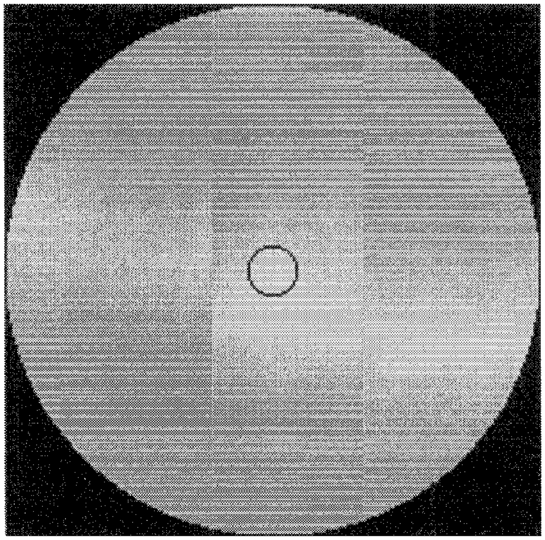

Fig. 2. Normalized electric field distribution inside and outside (incident + scattered) a dielectric rod for the case $f = 2$ GHz, $c = 3.5$ mm, and $\epsilon_r = 20 - j1$. The incidence is from the left. The range of internal field levels is from +2.7 to +4.2 dB (E_0). Overall radius is 40 mm.

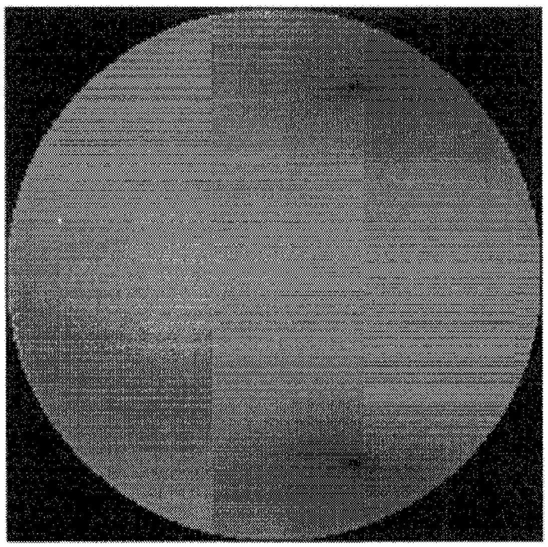

Fig. 3. Normalized electric field distribution inside a dielectric rod for the case $f = 2.8$ GHz, $c = 8$ mm, and $\epsilon_r = 42.6$ j13.1. The incidence is from the left.

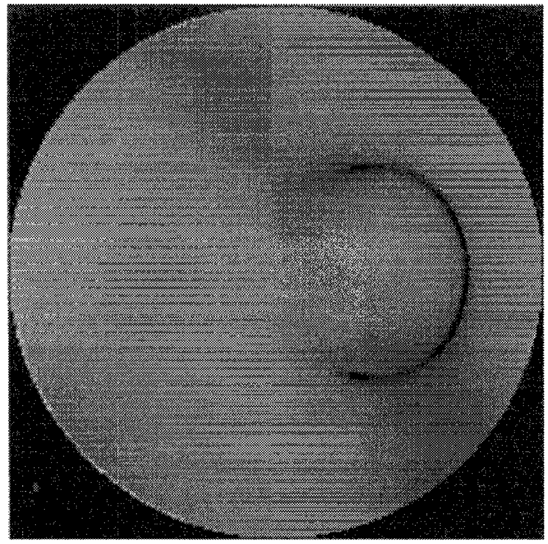

Fig. 4. Normalized electric field distribution inside a dielectric rod for the case $f = 2.8$ GHz, $c = 16$ mm, and $\epsilon_r = 42.6 - j13.1$. The incidence is from the left.

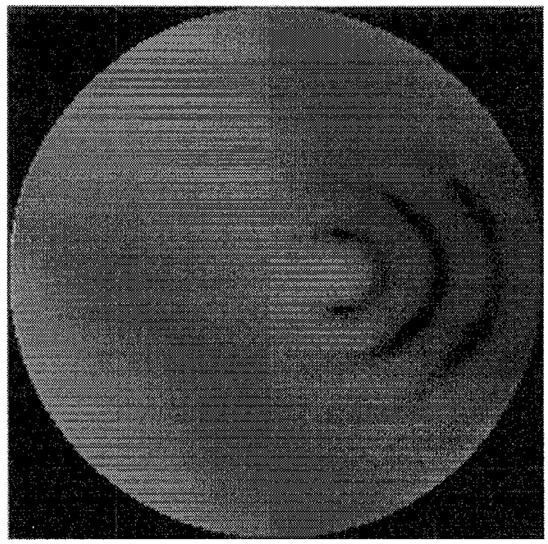

Fig. 5. Normalized electric field distribution inside a dielectric rod for the case $f = 2.8$ GHz, $c = 40$ mm, and $\epsilon_r = 42.6 - j13.1$. The incidence is from the left.

APPENDIX

In order to further emphasize our point, Figs. 3–5 give results that were obtained using our approach and which are immediately comparable with those published by Ayappa *et al.* [4] in their Fig. 4.

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[3] H. E. Bussey and J. H. Richmond, "Scattering by a lossy dielectric circular cylindrical multilayer, numerical values," *IEEE Trans. Antennas Propagat.*, vol. AP-23, no. 5, pp. 723–725, 1975.

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