Letters

Comments on "A Coordinate-Free Approach to Wave Reflection from a Uniaxially Anisotropic Medium"

FEDOR I. FEDOROV

I would like to point out that part of the contents of this paper[1] appear similar to sections 6, 17, 21, and 26 of [1], with some variation of notation. Section III of the above paper gives formulas which represent particular cases of general relations given in sections 19 and 23 of [1].

The coordinate-free (covariant) approach to the theory of electromagnetic waves was first proposed in 1952 and was later developed in several papers and three monographs in Russian, as indicated in the references.

Reply[2] *by Hollis C. Chen*[3]

I would like to thank Dr. Fedorov for bringing to our attention the existence of some Russian literature, previously unknown in the West.

After some search, it seems clear that these works were published in some obscure journals and by minor publishers not widely known even in the USSR. None of the references cited are available in United States and British libraries, but I have traced a copy of [1] to the U.S. Library of Congress.

Finally I might add that intial perusal of [1] indicates that the author does not appear to have treated the problem solved in my paper.

References

[1] F. I. Fedorov, *Optics of Anisotropic Media* Minsk: Izd. AN BSSR, 1958.

[2] F I. Fedorov, "Determination of the optical parameters of uniaxial crystals by reflected light," *Dokl. Akad. Nauk SSSR*, vol 84, pp. 1171–1174, 1952.

[3] F. I Fedorov, "Invariant methods in optics of anisotropic media," Doctoral thesis, Leningrad, 1954

[4] F I. Fedorov, "Reflection and refraction of light by transparent uniaxial crystals," *Uch. Zap. BGU*, no. 41, pp 219–229, 1958.

[5] F I. Fedorov and V V. Filippov, *Reflection and Refraction of Light by Transparent Crystals*. Minsk: Nauka i Technika, 1976.

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[1]H. C. Chen, *IEEE Trans. Microwave Theory Tech.*, vol. MTT-31, pp. 331–336, Apr 1983

[2]Manuscript received October 20, 1987

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Comments on "A Spectral-Domain Analysis of Periodically Nonuniform Microstrip Lines"

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Section 26 of Floquet's paper [3] has become known as Floquet's theorem. Its application to transmission line problems leads indeed to a fundamental system like eq. (2) in the paper[1] in question, but with several values of β allowed. (Other fundamental systems are also possible [3, ch. II] but are of little practical importance.) Usually the lowest possible value $\beta=\beta_0$ is chosen as the phase constant of the forward-traveling periodic wave and $\beta=-\beta_0$ as the phase constant of the backward-traveling periodic wave. The general solution is the sum of some forward- and some backward-traveling periodic waves. Periodic waves (also referred to as Floquet modes) are used here instead of the ordinary well-known waves which transport power independently of each other. The latter ("partial waves" in [4]) will be called physical waves throughout this comment. Both forward- and backward-traveling periodic waves consist of both forward- and backward-traveling space harmonics with the phase constant $\beta=\pm\beta_0+k2\pi/\text{p}$, where the plus sign is valid for a forward and the minus sign for a backward-traveling periodic wave. If such whole numbers k_1, k_2 exist that $\beta=+\beta_0+k_1 2\pi/\text{p}=-\beta_0+k_2 2\pi/\text{p}$, then the respective space harmonic is part of both the forward- and the backward-traveling periodic wave. Without knowing the characteristic impedances of forward- and backward-traveling periodic waves beforehand, it is very difficult to split the space harmonics into their components belonging to the forward- or backward-traveling periodic wave, respectively. For this purpose the authors use a physical plausibility check [2, p. 55] demanding the power transported by periodic waves not to vary along the line.

Collin stresses the importance of distinguishing between periodic and physical ("partial") waves [4, sec. 9.3]. Both forward- and backward-traveling periodic waves consist of both forward- and backward-traveling physical waves. Although referencing Collin's standard textbook [4], the authors are totally unaware of the foundations described there. In the first place they rather unclearly introduce the periodic waves used throughout their paper. ("In contrast to the case of the uniform microstrip line, in the case of the periodically nonuniform microstrip line the functions ... are still periodic functions of the coordinate z.") But in order to obtain unique solutions, they then use the physical plausibility check already mentioned above—although totally inappropriate for the periodic waves under consideration. (As a matter of fact they demand them to be physical waves at the same time!)

Their results represent some obscure mixture of a forward- and a backward-traveling periodic wave, instead of a pure forward-traveling periodic wave, as the reader is led to believe. Because both forward- and backward-traveling periodic waves have the same phase constant, this parameter has been calculated correctly and is presented in the paper in question, but characteristic impedances have not been included. As the voltages and currents shown in Figs. 11–14 in the paper include a backward-traveling periodic wave component, the characteristic impedance does not equal the ratio of voltage to current [4, sec. 9.3, eq. (25)], as the reader is led to believe.

The method is an application of Jansen's work [5] which has the great advantage of including the effects of loss and finite strip thickness. Because of the dependence on the z coordinate, a much more complicated series expansion has to be used. The authors apply a very special field theoretic description with special-case expansion functions that must be matched to each type of nonuniformity, such as zigzag or sine-shape contours.

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[1]F. J Glandorf and I. Wolff, *IEEE Trans. Microwave Theory Tech*, vol. MTT-35, pp 336–343, Mar. 1987.