Comment on 'The scale-transformation of electromagnetic theory and its applications', 'Distribution characteristic of scattering field for an ellipsoidal target irradiated by an electromagnetic wave from an arbitrary direction' and 'Electric fields inside and outside an anisotropic dielectric sphere'*

Zhao Shi-Hua(赵诗华)† and Li Ying-Jun(李英骏)

School of Science, China University of Mining & Technology (Beijing), Beijing 100083, *China*

(Received 3 December 2009; revised manuscript received 11 August 2010)

It is shown that the 'scale-transformation' method proposed by Li Ying-Le *et al.* is not applicable to the Maxwell theory.

Keywords: scale transformation, Maxwell theory, vacuum light speed

PACS: 02.60.Lj, 03.50.De, 41.20.–q, 41.20.Jb **DOI:** 10.1088/1674-1056/20/3/030205

In several recent papers,[1−3], Li Ying-Le *et al.* calculated a few electromagnetic problems using the so-called 'scale transformation' method. In Ref. [1], the detailed description of the 'scale transformation' was given. The results and calculations in Refs. [2] and [3] were directly based on the 'scale transformation' method developed in Ref. [1]. Note that Ref. [4], which was also cited by Refs. [2] and [3], was the improved version of Ref. [1].

We would like to point out that the 'scale transformation' method and its application for Maxwell theory in Refs. [1]–[3] are not appropriate. The reasons for them are as follows.

(a) In Ref. [1], the 'scale transformation' defined by Eq. (2a) and the relevant transformation matrices in Eqs. (2b) and (8b) are written:

$$x' = x/a,\ y' = y/b, z' = z/c, \tag{1}$$

$$\boldsymbol{T}(a,b,c) = \begin{bmatrix} a^{-1} & 0 & 0 \\ 0 & b^{-1} & 0 \\ 0 & 0 & c^{-1} \end{bmatrix},$$

$$\boldsymbol{M}^{-1} = \begin{bmatrix} bc & 0 & 0 \\ 0 & ac & 0 \\ 0 & 0 & ab \end{bmatrix}. \tag{2}$$

The transformation for the vacuum dielectric constant and the vacuum permeability are given by Eq. (16a) in Ref. [1]:

$$\varepsilon_0' = \varepsilon_0 \boldsymbol{M}^{-1} T \quad , \ \mu_0' = \mu_0 \boldsymbol{M}^{-1} T. \tag{3}$$

From Eqs. (1)–(3), it is easy to see that in the simple isotropic case, e.g. $a = b = c = 1/3$, applying the 'scale transformation' in Ref. [1], the light speed $v_{\rm c}'$ in the new space Σ' is

$$v_{\rm c}' = 3v_{\rm c}, \tag{4}$$

where $v_{\rm c}$ is the usual definition of vacuum light speed, $v_{\rm c} = 1/\sqrt{\varepsilon_0\mu_0}$. Since the positive parameters a, b and c are unrestrained, $v_{\rm c}'$ could be either far above or well below $v_{\rm c}$. Therefore, generally the new space Σ' is not the physics space in the common sense. If we neglect the physical meaning and treat the 'scale transformation' in Ref. [1] only as an intermediate mathematical step, then neither its success nor its convenience is justified by its application in Refs. [1]–[3] in solving the ellipsoidal problems as shown below.

(b) The electromagnetic field scattered by an ellipsoidal target was calculated in Refs. [1] and [2] based on the 'scale transformation'. The equivalent problem is to calculate the electromagnetic wave scattered by a sphere in anisotropic space. To our knowledge the analytical solution to this problem has not yet been found. However, the far field expressions in isotropic space were incorrectly taken for the analytical solution in anisotropic space, as shown by Eq. (26)

*Project supported by the Fundamental Research Funds for the Central Universities.

†Corresponding author. E-mail: z_sh_h@yahoo.com.cn

© 2011 Chinese Physical Society and IOP Publishing Ltd

in Ref. [1] and Eq. (5) in Ref. [2]. Hence the results were inevitably erroneous.

(c) Reference [3] claimed that the electrostatic field inside an anisotropic dielectric sphere was calculated via the 'scale transformation' method in Ref. [1]. However, the critical calculations for the boundary conditions of the ellipsoid problem after the 'scale transformation' could not be found in Ref. [3]. In fact, simply by assuming that the electrostatic field inside an anisotropic dielectric sphere is a constant vector, one could straightforwardly obtain the solution to the problem raised in Ref. [3]. That is to say, supposing $E_x = \alpha$, $E_y = \beta$, $E_z = \gamma$, it is easy to see that $u = \alpha x + \beta y + \gamma z + \sigma$ is a solution of Eq. (2) in Ref. [3], where α, β, γ and σ are constants. Together with the solution outside the sphere and the boundary conditions, these constants can be determined directly in the original isotropic space. On the other hand, the procedure to determine the coefficients of Eq. (4) in Ref. [3] by the boundary conditions for the ellipsoid was not given. Thus the availability of the 'scale transformation' in Ref. [1] is not found.

References

[1] Li Y L and Huang J Y 2005 *Chin. Phys.* **14** 646

[2] Li Y L, Huang J Y, Wang M J and Zhang J T 2008 *Chin. Phys.* B **17** 3394

[3] Li Y L and Wang M J 2009 *Chin. Phys.* B **18** 2420

[4] Li Y L and Huang J Y 2006 *Scale Transformation of Electromagnetic Theory and Its Application* (Xian: Xidian University Press)