Comment on "Electric Power Generation from Earth's Rotation Through its own Magnetic Field"

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(Received 14 December 2016; revised manuscript received 31 March 2019; accepted 10 January 2020; published 3 February 2020)

In a 2016 article [Phys. Rev. Applied **6**, 014017 (2016)], Chyba and Hand proposed a new scheme to generate electric power continuously at the expense of the Earth's kinetic energy of rotation, by using an appropriately shaped cylindrical shell of a well-chosen conducting ferrite, rigidly attached to Earth. A recent experimental test [Phys. Rev. Applied **10**, 054023 (2018)] gave a null result. In the first part of the present refutation, I use today's standard electromagnetism and essentially the same model as Chyba and Hand to show in a very simple way that no device of the proposed type can produce continuous electric power, whatever its configuration or size. In the second part, I show that the prediction of nonzero continuous power by Chyba and Hand results from a confusion of frames of reference at a critical step of their derivation. When the confusion is clarified, the prediction becomes exactly zero. In the third part, I comment about the frequent invocation by Chyba and Hand of controversial legacy notions such as the existence of an intrinsic velocity of quasistatic magnetic fields.

DOI: 10.1103/PhysRevApplied.13.028001

I. INTRODUCTION

In a 2016 article [1], Chyba and Hand (C&H) proposed a new scheme to generate electric power continuously at the expense of the Earth's kinetic energy of rotation, by using an appropriately shaped cylindrical shell of a well-chosen conducting ferrite, rigidly attached to Earth, interacting with the Earth's own magnetic field. Special attention was drawn to this important unexpected prediction in a concomitant summary published in Physics [2]. In the *experimental* part of a recent publication, Veltkamp and Wijngaarden [3] demonstrated that the C&H effect is essentially zero.

In Sec. II of the present comment, I give a very simple theoretical proof that no device of the type proposed by C&H can generate continuous electric power, whatever its configuration or size. My derivation uses today's conventional electromagnetic theory [4] and essentially the same model as C&H: constant sources of the *actual* geomagnetic field rotating together with Earth and a passive device fixed to Earth, but with the "*steady state*" explicitly implying that vector fields such as **B** or **A** have settled to time-independent values *as seen by Earth-bound observers* (see Appendix).

Next, in Sec. III, I show that the prediction of nonzero electric power production in Secs. IV to IX of C&H is the consequence of a confusion of properties of frames of reference between Eq. (25) of C&H [(C&H25)] and Eqs. (C&H26) and (C&H27). When the confusion is clarified, the prediction becomes exactly zero, in agreement with my own general result and with the experimental part of Ref. [3].

Two mutually incompatible versions of nonrelativistic electromagnetic theory are used concurrently in C&H's article: (a) quantitative calculations (display equations and their derivation) follow the standard theory that has been accepted for about a century [4], albeit with unjustified replacement of the actual Earth's magnetic field by its axisymmetric component, and (b) qualitative "intuitive" predictions pervade the discussion, based on controversial interpretations of legacy notions such as the existence of an intrinsic velocity of quasistatic magnetic fields and related concepts. These deviations from today's conventional electromagnetic theory are further discussed in Sec. IV [see J. Jeener, arXiv:1712.04283 (2018), for updates].

II. PROOF THAT NO POWER PRODUCTION IS POSSIBLE BY CHYBA AND HAND'S TYPE OF DEVICE

In Ref. [1], and in the present comment, irrelevant complications are avoided by neglecting the acceleration of the Earth's center in its orbit, so that convenient inertial reference frames K or $\mathcal{Q}$ can be defined in which the Earth's center is immobile. For quasistatic processes, the $\partial \mathbf{D}/\partial t$ term in $\nabla \times \mathbf{H}$ can also be safely neglected.

For clarity, all discussions in Sec. II and in Appendix of the present comment use a single inertial frame of reference $\mathcal{Q}$ with an origin at the Earth's center and inertial reference directions, and the partial time derivatives (at

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constant position in $\mathcal{Q}$) are explicitly indexed by the relevant frame: $[\partial/\partial t]_{\mathcal{Q}}$. The z direction is chosen parallel to the angular velocity $\boldsymbol{\omega} = \omega_z \hat{\mathbf{z}}$ of Earth [5]. In the inertial frame $\mathcal{Q}$, the Lorentz force $\mathbf{F}$ acting on a charge q moving at velocity $\mathbf{v}$ is given by

$$\mathbf{F} = q(\mathbf{E} + \mathbf{v} \times \mathbf{B}) = q\left(-\nabla V - \left[\frac{\partial \mathbf{A}}{\partial t}\right]_{\mathcal{Q}} + \mathbf{v} \times \mathbf{B}\right), \quad (1)$$

where $\mathbf{E}$ is the electric field, V is the scalar electric potential, and $\mathbf{A}$ is the vector potential. The $\mathbf{B}$ field in Eq. (1) is the field generated by all sources, including eddy and other currents $\mathbf{J}$ and magnetization $\mathbf{M}$ in a ferrite device or other material, and, of course, the Earth-bound sources of geomagnetism. Equation (1) will be used close to the Earth's crust, with $\mathbf{v}$ approximated as the velocity $\mathbf{v}(\mathbf{r}) = \boldsymbol{\omega} \times \mathbf{r}$ of the solid conducting medium, neglecting the extremely small drift velocity of the mobile charge carriers with respect to this medium.

The electromotive force (emf) in a closed loop, in, through, or around any such passive device, is proportional to the flux of $\nabla \times \mathbf{F}$ through the loop, as derived from Eq. (1) by noting that $\nabla \times [\partial \mathbf{A}/\partial t]_{\mathcal{Q}} = [\partial \mathbf{B}/\partial t]_{\mathcal{Q}}$ and $\nabla \times (\nabla V) = 0$:

$$\frac{1}{q}\nabla \times \mathbf{F} = \nabla \times \mathbf{E} + \nabla \times [\mathbf{v} \times \mathbf{B}] = -\left[\frac{\partial \mathbf{B}}{\partial t}\right]_{\mathcal{Q}} + \nabla \times [\mathbf{v} \times \mathbf{B}]. \quad (2)$$

For a steady rotation at the constant angular velocity $\boldsymbol{\omega} = \omega_z \hat{\mathbf{z}}$, and for a passive device fixed to Earth, the relevant electromagnetic quantities rapidly settle to their steady-state values $\mathbf{B}^s$, $\mathbf{M}^s$, $\mathbf{E}^s$, $\mathbf{F}^s$, $\mathbf{J}^s$, ..., which are seen as time independent by Earth-bound observers, and hence all satisfy Eqs. (A2) and (A5), or (A6) and (A7).

In the particular case of the steady-state $\mathbf{B}^s$, Eq. (A5) simplifies because $\nabla \cdot \mathbf{B}^s = 0$, with the result

$$-\left[\frac{\partial \mathbf{B}^s}{\partial t}\right]_{\mathcal{Q}} + \nabla \times [\mathbf{v} \times \mathbf{B}^s] = 0, \quad (3)$$

valid in the inertial frame $\mathcal{Q}$; hence $\nabla \times \mathbf{F}^s = 0$, which implies that no continuous electric power can be generated by any device of the type proposed by Chyba and Hand [1], whatever its size, material, or topology. Obviously, the same conclusion follows from Eq. (C&H7).

III. THE QUANTITATIVE CALCULATIONS IN CHYBA AND HAND'S SECS. IV to IX

In these calculations, C&H use three types of reference frame: inertial K frames in which the Earth's center is immobile, inertial K' frames in which the center of the ferrite shell is immobile at a specified time, and the noninertial frame in which the ferrite device is immobile [5].

C&H's derivation proceeds through changes of reference frame, between inertial and rotating, and often approximates a rotation around a distant axis as a translation. For devices much smaller than the Earth's radius, the error introduced by these approximations to the predicted power generation will be ignored here, in a first round of discussion, because it is negligible compared to C&H's final prediction.

In Sec. IV of C&H, emfs in closed loops are discussed casually, without clear statement about reference frames or the related contribution $-\partial \mathbf{B}/\partial t$ to $\nabla \times \mathbf{E}$. Nevertheless, C&H briefly indicate that zero emfs are induced in closed loops rigidly bound to Earth if $\nabla \times (\mathbf{v} \times \mathbf{B}) = 0$, where $\mathbf{v}$ is the loop velocity due to the Earth's rotation. This leads the authors to propose to violate this requirement with magnetically permeable material in order to recover their hope for nonzero emf in loops bound to Earth. If $\partial \mathbf{B}/\partial t$ had been properly taken into account, the general conclusion would have emerged that no continuous production of electric power is possible by the envisioned scheme (see Eq. (3)). Let me, however, pursue my scrutiny.

In Sec. V of C&H, the usual terms $-\partial \mathbf{A}/\partial t$ or $-\partial \mathbf{B}/\partial t$ reappear in the equations and the frames of reference are clearly identified. This leads first to the "advection-diffusion" equation for $\mathbf{A}$ in K, Eq. (C&H6), which is a combination of the Lorentz force equation [Eq. (1)] with Maxwell's equations and the phenomenological relations $\mathbf{J} = (\sigma/q)\mathbf{F}$ (Ohm's law) and $\mathbf{B} = \mu \mathbf{H}$, where μ is the magnetic permeability of a linear magnetizable material

$$-\nabla V - \partial \mathbf{A}/\partial t + \mathbf{v} \times (\nabla \times \mathbf{A}) = \eta \nabla \times \nabla \times \mathbf{A}, \quad \text{(C\&H6)}$$

where $\eta = (\sigma \mu)^{-1}$ [6], and $\mathbf{v}$ is the velocity of the conducting and magnetically permeable material, as measured in frame K. As indicated by C&H, the curl of Eq. (C&H6) yields the advection-diffusion equation for $\mathbf{B}$ in K (also in $\mathcal{Q}$), or the "induction equation":

$$-\partial \mathbf{B}/\partial t + \nabla \times (\mathbf{v} \times \mathbf{B}) = -\eta \nabla^2 \mathbf{B}. \quad \text{(C\&H7)}$$

Incidentally, I note that, due to Eq. (3), the left-hand side of Eq. (C&H7) is zero *in the steady state*; hence no current and no power can be generated by the device *in the steady state*, and hence the "loophole in the proof" claimed to have been found by C&H does not exist. I shall nevertheless continue my scrutiny.

In Sec. VI of C&H, the discussion is specialized to a cylindrical shell of idealized conducting ferrite, for which the calculations can be performed analytically very far by extending the results of Prat-Camps *et al.* [7] to a device translating at velocity $\mathbf{v} \neq 0$ in the inertial frame K. The resulting expressions are approximations valid for z in the central region of a finite-length shell.

Beginning in their Sec. VII, C&H pursue the discussion together in the device-bound frame of Fig. 1 of Ref. [1] (with the corresponding notation for position variables) and, for times very close to t, in a K frame whose origin coincides with that of the device frame at the exact time t. Using a convenient gauge such that $\nabla \cdot \mathbf{A} = -V/\eta$, C&H reduce Eq. (C&H6) to a single nontrivial equation for A_z in K, valid in the ferrite device of Fig. 1,

$$\partial A_z/\partial t + v\, \partial A_z/\partial y = \eta \nabla^2 A_z \qquad \text{(C\&H25)}$$

(see [8]). Next, C&H decompose A_z as $A_z = A_s + A_t$, where A_s is the steady-state component and A_t the transient component that is expected to decay extremely rapidly. For the convenience of the reader, I shall now copy six consecutive lines from C&H's article:

The solution to Eq. (C&H25) may, in general, be written as

$$A_z = A_s(\rho, \phi) + A_t(\rho, \phi, t), \qquad \text{(C\&H26)}$$

where $A_s(\rho, \phi)$ solves the steady state equation

$$v \partial A_s/\partial y = \eta \nabla^2 A_s, \qquad \text{(C\&H27)}$$

and $A_t(\rho, \phi, t)$ solves the time dependent equation

$$\partial A_t/\partial t = -v \partial A_t/\partial y + \eta \nabla^2 A_t. \qquad \text{(C\&H28)}$$

The absence of a partial time derivative term in Eq. (S&H27) for the steady-state projection $A_s(\rho, \phi)$ may seem justified because steady-state properties are time independent *as seen by device-bound observers*: $[\partial A_s/\partial t]_{\mathcal{L}} = 0$, where $\mathcal{L}$ stands for the noninertial device-bound "laboratory" frame. However, Eqs. (C&H25)–(C&H28) are valid in frame K, *not in frame* $\mathcal{L}$, and the distribution of A_s moves together with the device, at velocity $\mathbf{v}$ with respect to frame K, and hence $[\partial A_s/\partial t]_K \neq 0$ whenever A_s is not spatially uniform. In the present case, the missing term is easily evaluated as $[\partial A_s/\partial t]_K = -v \partial A_s/\partial y$ (in the usual C&H approximation of describing exact rotation by a translation), with the conclusion that $\nabla^2 A_s = 0$, and hence zero electric current circulates in the device in the steady state. This conclusion remains valid if the Earth's rotation is taken into account *exactly*, in agreement with widespread expectation, with the recent *experimental* results of Veltkamp and Wijngaarden [3], and with my own prediction in Sec. II above.

The quantitative discussion presented in Sec. XI of C&H "Analysis in the laboratory frame" takes for granted the erroneous deduction of Eq. (C&H27) from Eq. (C&H25), and hence it does not provide a valid confirmation of the previous prediction of power generation made in Sec. VII of C&H.

IV. OTHER QUESTIONABLE ASPECTS OF CHYBA AND HAND'S ARTICLE

The notion that quasistatic magnetic fields **B** have an intrinsic velocity (somewhat like ordinary massive particles or continuous media) was originally introduced among attempts to reconcile previous conventional wisdom with new theories and experiments during the long historical controversy about the validity of special relativity, the interpretation of Maxwell's equations, and the existence of aether as a support of electromagnetic phenomena. After the abandonment of the aether hypothesis, it became doubtful that a satisfactory notion of intrinsic velocity for **B** fields could be saved. Most textbooks (e.g., Landau and Lifshitz [9,10], Reitz and Milford [11], or Jackson [12]) do not use, or even mention, this notion, and Galili and Kaplan [13] strongly advise to avoid it systematically. Later, a related notion of velocity has been successfully introduced to guide intuition in the very different context of magnetohydrodynamics (see, e.g., Spruit [14]).

In many places in their article, notably in Sec. X, C&H use the notion that quasistatic **B** fields have an intrinsic velocity to "intuitively" conclude that their device will generate continuous electric power in the steady state. The nonexistence of this power production, "intuitively" predicted by the relic notion, is a further argument to abandon it.

In Sec. XI of C&H, in a further defense of the notion of velocity of quasistatic **B** fields, the authors claim that clear conclusions concerning this velocity can be deduced from highly respected experimental results that are about one century old (C&H references [1], [15], and [19]), although these experimental results are also in perfect agreement with predictions from today's electromagnetism, which ignores and rejects the notion of intrinsic velocity of **B** fields. I have carefully checked this agreement for each of C&H's three references.

After Eqs. (C&H7) or (C&H27) and the discussion of the decay of initial transients, the next task is to predict the directly useful steady-state properties $\mathbf{J}_s$ and V_s, for instance by pursuing the method of solving the relevant partial differential (and other) equations with appropriate boundary conditions, using numerical techniques if analytic solutions are not available.

C&H use a different approach, based on the evaluation of the emf around "designated current paths" within the material of the device [see the paragraph comprising Eq. (C&H63)], apparently disregarding the facts that, for two- or three-dimensional conductors, (a) the simple "flux rule" is insufficient to predict V_s or $\mathbf{J}_s$ (see, e.g., Giuliani [15]) and (b) the current paths are constrained by the direction of the exact $\mathbf{J}_s$ and hence may not be freely "designated." The consequences of disregarding these points appear in Sec. XIII of C&H, where two different predictions are given for the voltage measured by the setup of

Fig. 1; the reader is warned that "C may choose itself under rotation" and that "experiment will show" the validity (or not) of a tentative averaging of emfs. The last sentence of Sec. XIII repeats, without appropriate explanation or reference, that half the emf around path C is measured between d and f of Fig. 1.

APPENDIX: INERTIAL EVOLUTION OF VECTOR AND SCALAR FIELDS WITH SOURCES BOUND TO THE ROTATING EARTH

In the steady state of the present model, many relevant vector and scalar fields are time independent *as seen by Earth-bound observers*. Let $\mathbf{G}^s(\mathbf{r};t)$ describe such a vector field depending on time t and on position $\mathbf{r}=x\hat{\mathbf{x}}+y\hat{\mathbf{y}}+z\hat{\mathbf{z}}$ in the inertial frame $\mathcal{Q}$ in which the Earth's center is the immobile origin of coordinates. Also let the Earth's rotation in frame $\mathcal{Q}$ be described by the rotation operator $\mathcal{R}_z(\omega_z\tau)$, which rotates vectors by an angle $\omega_z\tau$ around the z axis of frame $\mathcal{Q}$; for instance,

$$\begin{aligned}
&\mathcal{R}_z(\omega_z\tau)\hat{\mathbf{x}}=\hat{\mathbf{x}}\cos[\omega_z\tau]+\hat{\mathbf{y}}\sin[\omega_z\tau],\\
&\mathcal{R}_z(\omega_z\tau)\hat{\mathbf{y}}=\hat{\mathbf{y}}\cos[\omega_z\tau]-\hat{\mathbf{x}}\sin[\omega_z\tau],\quad \mathcal{R}_z(\omega_z\tau)\hat{\mathbf{z}}=\hat{\mathbf{z}},\\
&\mathcal{R}_z(\omega_z\tau)\mathbf{r}=\hat{\mathbf{x}}(x\cos[\omega_z\tau]-y\sin[\omega_z\tau])\\
&\qquad+\hat{\mathbf{y}}(y\cos[\omega_z\tau]+x\sin[\omega_z\tau])+\hat{\mathbf{z}}z.
\end{aligned}\tag{A1}$$

If the vector field $\mathbf{G}^s(\mathbf{r};t)$ is immobile as seen by Earth-bound observers, then its projections on $\hat{\mathbf{x}}$, $\hat{\mathbf{y}}$, $\hat{\mathbf{z}}$ at time t, and on $[\mathcal{R}_z(\omega_z\tau)\hat{\mathbf{x}}]$, $[\mathcal{R}_z(\omega_z\tau)\hat{\mathbf{y}}]$, $\hat{\mathbf{z}}$ at time $t+\tau$ satisfy

$$\begin{aligned}
&\hat{\mathbf{x}}\cdot\mathbf{G}^s(\mathbf{r};t)=[\mathcal{R}_z(\omega_z\tau)\hat{\mathbf{x}}]\cdot\mathbf{G}^s(\mathcal{R}_z(\omega_z\tau)\mathbf{r};t+\tau),\\
&\hat{\mathbf{y}}\cdot\mathbf{G}^s(\mathbf{r};t)=[\mathcal{R}_z(\omega_z\tau)\hat{\mathbf{y}}]\cdot\mathbf{G}^s(\mathcal{R}_z(\omega_z\tau)\mathbf{r};t+\tau),\\
&\hat{\mathbf{z}}\cdot\mathbf{G}^s(\mathbf{r};t)=G^s_z(\mathcal{R}_z(\omega_z\tau)\mathbf{r};t+\tau),
\end{aligned}\tag{A2}$$

and the corresponding partial time derivative of $\mathbf{G}^s(\mathbf{r};t)$ in the inertial frame $\mathcal{Q}$ is easily evaluated from the systematic expansion of Eqs. (A2) in power series of τ (limited to first order). For instance, the first line of Eqs. (A2) gives, successively, with due reference to Eqs. (A1),

$$\begin{aligned}
G^s_x(\mathbf{r};t)&=[\hat{\mathbf{x}}+\omega_z\tau\hat{\mathbf{y}}+\cdots]\cdot\mathbf{G}^s\big[\hat{\mathbf{x}}(x-\omega_z\tau y+\cdots)\\
&\quad+\hat{\mathbf{y}}(y+\omega_z\tau x+\cdots)+\hat{\mathbf{z}}z;t+\tau\big]\\
&=G^s_x(\mathbf{r};t)+\omega_z\tau G^s_y(\mathbf{r};t)\\
&\quad+\omega_z\tau\left(-y\frac{\partial G^s_x}{\partial x}+x\frac{\partial G^s_x}{\partial y}\right)+\tau\frac{\partial G^s_x}{\partial t}+\cdots,
\end{aligned}\tag{A3}$$

and the complete result can be written as

$$\begin{aligned}
\left[\frac{\partial\mathbf{G}^s}{\partial t}\right]_{\mathcal{Q}}=\omega_z\Big\{&\hat{\mathbf{x}}\left(+y\frac{\partial G^s_x}{\partial x}-x\frac{\partial G^s_x}{\partial y}-G^s_y\right)\\
&+\hat{\mathbf{y}}\left(+y\frac{\partial G^s_y}{\partial x}-x\frac{\partial G^s_y}{\partial y}+G^s_x\right)\\
&+\hat{\mathbf{z}}\left(+y\frac{\partial G^s_z}{\partial x}-x\frac{\partial G^s_z}{\partial y}\right)\Big\},
\end{aligned}\tag{A4}$$

where all quantities in Eq. (A4) are evaluated at $(\mathbf{r};t)$. The terms $-G^s_y$ and $+G^s_x$ in Eq. (A4) arise from the rotation of the Earth-bound reference directions (see Eqs. (A1) and (A2)). With $\mathbf{v}=(\omega_z\hat{\mathbf{z}})\times\mathbf{r}$, Eq. (A4) can be written under the more convenient compact form

$$\left[\frac{\partial\mathbf{G}^s}{\partial t}\right]_{\mathcal{Q}}=\nabla\times(\mathbf{v}\times\mathbf{G}^s)+\mathbf{v}\,(\nabla\cdot\mathbf{G}^s).\tag{A5}$$

Now let $\mathcal{G}^s(x,y,z;t)$ describe a *scalar field* that is time independent as seen by Earth-bound observers:

$$\begin{aligned}
\mathcal{G}^s(x,y,z;t)=\mathcal{G}^s\big(&x\,\cos[\omega_z\tau]+y\,\sin[\omega_z\tau],\\
&y\,\cos[\omega_z\tau]-x\,\sin[\omega_z\tau],z;t+\tau\big).
\end{aligned}\tag{A6}$$

Hence,

$$\left[\frac{\partial\mathcal{G}^s}{\partial t}\right]_{\mathcal{Q}}=-\omega_z\left(y\frac{\partial\mathcal{G}^s}{\partial x}-x\frac{\partial\mathcal{G}^s}{\partial y}\right)=\mathbf{v}\cdot(\nabla\mathcal{G}^s),\tag{A7}$$

where all quantities in Eq. (A7) are evaluated at $(x,y,z;t)$.

The time independence of $\mathbf{G}^s$ as seen by Earth-bound observers implies that $[\partial\mathbf{G}^s/\partial t]_{\mathcal{L}}=0$, where $\mathcal{L}$ stands for a noninertial frame bound to the rotating Earth. If a vector field $\mathbf{G}$ is *not time independent* as seen from frame $\mathcal{L}$, then $[\partial\mathbf{G}/\partial t]_{\mathcal{L}}\neq 0$ and inspection shows that Eqs. (A5) and (A7) become

$$\left[\frac{\partial\mathbf{G}}{\partial t}\right]_{\mathcal{Q}}=\left[\frac{\partial\mathbf{G}}{\partial t}\right]_{\mathcal{L}}+\nabla\times(\mathbf{v}\times\mathbf{G})+\mathbf{v}(\nabla\cdot\mathbf{G}),\tag{A8}$$

$$\left[\frac{\partial\mathcal{G}}{\partial t}\right]_{\mathcal{Q}}=\left[\frac{\partial\mathcal{G}}{\partial t}\right]_{\mathcal{L}}+\mathbf{v}\cdot(\nabla\mathcal{G}).\tag{A9}$$

[1] Christopher F. Chyba and Kevin P. Hand, Electric Power Generation from Earth's Rotation through its own Magnetic Field, Phys. Rev. Appl. **6**, 014017–1–18 (2016).

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[3] Bastiaan Veltkamp and Rinke J. Wijngaarden, Attempting to Extract Power from Earth's Rotation: An Experimental Test, Phys. Rev. Appl. **10**, 054023–1–9 (2018).

[4] This means Maxwell's equations, special relativity (in the weakly relativistic approximation whenever convenient), the Lorentz force equation (1) with **B**, **E**, **F**, and the velocity **v** of the charge q measured in the same inertial frame, and the usual phenomenological relations: Ohm's law ,. . ., as discussed in detail by, e.g., Landau and Lifshitz [9,10], Reitz and Milford [11], or Jackson [12].

[5] The standard notation x, y, z, ρ, ϕ is used in two different contexts in the present discussion: (a) for the position variables of the inertial frame $\mathcal{Q}$ in Sec. II and the Appendix of the present comment, and (b) as position variables in the device-bound frame defined in Fig. 1 of Ref. [1]. No explicit symbols are assigned for the position variables of frame K in Ref. [1]. This may lead to ambiguity, notably in Eq. (C&H26).

[6] The MnZn ferrite (MN60 material) suggested by C&H manifests conspicuous nonlinearity and hysteresis at low fields, and hence it is not a linear magnetizable material. This, however, does not affect the final conclusion about continuous electric power generation.

[7] J. Prat-Camps, C. Navau, D.-X. Chen, and A. Sanchez, Exact analytical demagnetizing factors for long hollow cylinders in transverse fields, IEEE Magn. Lett. **3**, 0500104 (2012).

[8] There seems to be a misprint in Ref. [1] on line 11 after Eq. (C&H25): $v\partial A_z/\partial t$ should be replaced by $v\partial A_z/\partial y$. There is a similar misprint on line 14.

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