

**LETTERS TO PROGRESS IN PHYSICS**

**Addenda to My Paper “New Possible Physical Evidence of the Homogeneous Electromagnetic Vector Potential for Quantum Theory. Idea of a Test Based on a G. P. Thomson-like Arrangement”**

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This is addenda to my paper entitled “New Possible Physical Evidence of the Homogeneous Electromagnetic Vector Potential for Quantum Theory. Idea of a Test Based on a G. P. Thomson-like Arrangement”, which was published in *Progress in Physics*, 2014, v. 10, Issue 3, 196–200.

**1 On the special coil able to create a homogeneous vector potential  $\mathbf{h} - \vec{A}$**

Some experimenters potentially interested in evaluating the test suggested in my article communicated me comments like:

- ‘It is practically difficult to realize with a desired level of geometrical accuracy the special annular coil designed in [1]. Then it arises the question if it is possible to imagine another system (of coils) able to create also a  $\mathbf{h} - \vec{A}$  and which can be manufactured more easily and with a required precision’ .★

Here we wish to note shortly that a system of alluded type can be devised in form of a set consisting in two parallel flat coils pictured below in Fig. 3b. Each such a coil has the aspect shown in Fig. 3a. Note that here we were indexing figures and equations by the consecutive numbers from [1].

In the case of coils system from Fig. 3b the expression of the  $\mathbf{h} - \vec{A}$  in an interior point  $P$  is given by

$$A = A_z(P) = \mu_0 \cdot I \cdot n \cdot d \tag{11}$$

where  $n$  denote the number of conductors per unit length along the coil (in direction of  $Ox$  axis).

The expression (11) can be achieved through a set of several simple calculations and the reasoning done in the following sequence of items

- $\alpha$ : Taking into account the equation (6) and its motivation from [1] as starting elements;
- $\beta$ : Imagining a scheme of infinitely long conductors, located in  $xOz$  plane and mutually parallel with the  $Oz$  axis. The conductors are crossed by currents of same value  $I$ ;
- $\gamma$ : Evaluation of the  $\mathbf{h} - \vec{A}$  field generated by the respective currents in a point  $P$  situated on the  $Oy$  axis at some distance  $h$  of  $xOz$  plane;
- $\delta$ : The respective evaluation can be done by integration over the  $Ox$ -axis and using formula (2.733) from [2];

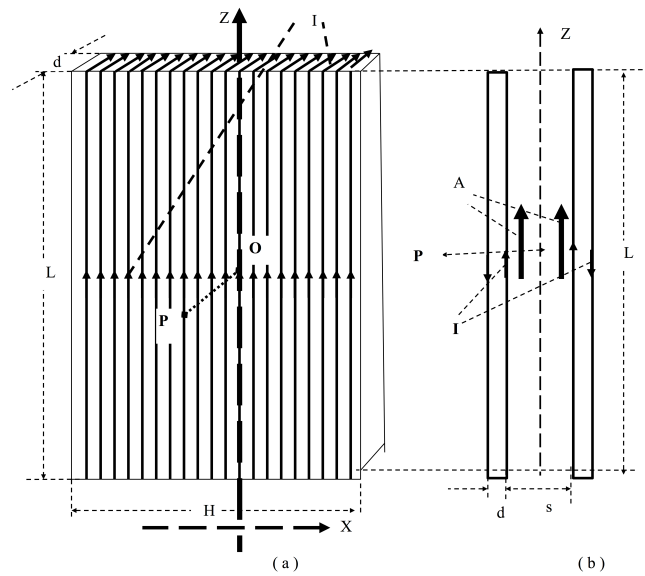


Fig. 3: Schemas with special flat coils. (a) Frontal image of a single coil. (b) Side view of a couple of coils

$\eta$ : Consideration in Fig. 3 that the quantities  $L$  and  $H$  are much larger than the dimensions  $d$  and  $s$  specific to the set of flat and finite coils from Fig. 3b. One requires also that the respective coils to satisfy the conditions specified in note “From the ideal coil to a real one” from [1];

$\tau$ : Then, through some modest calculations, by using the evaluation mentioned in item  $\delta$  one obtains the formula (11).

So, if one uses the coils-system from Fig. 3b, for evaluating the quantity  $i_{eff}^{dB}$  ( $A$ ) mentioned in relation (5) from [1], become of interest the result (11). This means that for the value of  $\mathbf{h} - \vec{A}$  must be taken the value  $A = \mathfrak{K} \cdot I$  with  $\mathfrak{K} = \mu_0 \cdot n \cdot d$ . Then instead of relation (5) from [1] the

test in question has to check the formula

$$\frac{1}{i_{eff}^{dB}(A)} = \frac{a\sqrt{2me}}{hD} \sqrt{U} + \frac{ae}{hD} A = \frac{a\sqrt{2me}}{hD} \sqrt{U} + \frac{ae\mathfrak{R}}{hD} I. \quad (12)$$

The last formula points out the fact that the quantity  $(i_{eff}^{dB})^{-1}$  (inverse of effective interfringe distance) shows linear dependence of the value of the  $\mathbf{h} - \vec{A}$  (and of course of the current  $I$  which crosses the coils set). Such a fact can be significant in checking the plausibility of the proposed test.

## 2 On the G. P. Thomson-like arrangement

As instrument for testing the possible distinct physical signification of  $\mathbf{h} - \vec{A}$  in [1] we suggested to use a G. P. Thomson-like arrangement. Such an arrangement can be designed and manufactured as a new apparatus specially dedicated to the concerned test. But one can appreciate that for such a device it is possible to use with sufficient confidence some scientific equipments already existent on the specialized market. As example of such an equipment can be taken into account the set “*Electron diffraction P2511300*” manufactured by the PHYWE company [3]. The main piece of the alluded set is in fact a G. P. Thomson-like device. In the respective device the role of diffraction grating (crystal lattice) mentioned in [1] is played by a graphite foil with interatomic spacing  $a$  and  $D$  as distance between crystalline foil and observational screen.

Usually [3] the respective device is used for measuring the diameter  $Q$  of the first (and eventually of second) smallest diffraction ring at different anode voltages  $U$ . Note that, in terms used by us in [1], the diameter  $Q$  of first such a ring is twofold of interfringe width  $i$  that is  $Q = 2 \cdot i$ . The interplanar spacing of graphite used in [3] is nothing but the interatomic spacing  $a$  in the crystal lattice (diffraction grating) mentioned in Fig.1 from [1]. Also a quantity  $D$  plays the role of distance between graphite foil and observational screen.

Notice: Putting into practice the test [1] by using the PHYWE-device can be performed by eluding the concrete values of  $a$  and  $D$ . Such a performance can be done as follows. In a first step is completed a measurement in absence of  $\mathbf{h} - \vec{A}$  field (i.e. when in (12)  $A = 0$  and  $I = 0$ ). From the respective measurement is possible to evaluate a couple of values  $U_0$  and  $Q_{eff}^{dB}(0)$  for the quantities  $U$  and  $Q$ . So accordingly with (12) can be calculated device parameter

$$\Gamma = \frac{a}{hD} = \left[ Q_{eff}^{dB}(0) \sqrt{\frac{meU_0}{2}} \right]^{-1}. \quad (13)$$

Take into account the fact that in the case of the PHYWE-device the values of quantities  $a$ ,  $D$  and  $\Gamma$  as well as the permitted range for the voltages  $U_0$  and  $U$  are predetermined by manufacturer. The respective fact must be considered when one operates with the alluded device and the set of numerical estimations from Section 4 of [1] are not important.

With the aid of parameter  $\Gamma$  the relation (12) can be transcribed as

$$\left[ Q_{eff}^{dB}(A) \right]^{-1} = \Gamma \sqrt{\frac{meU}{2}} + \Gamma \frac{eA}{2} = \Gamma \sqrt{\frac{meU}{2}} + \Gamma \frac{e\mathfrak{R}}{2} I. \quad (14)$$

By using the above relations the mentioned PHYWE-device can be put in practice in order to check the proper evidence of the  $\mathbf{h} - \vec{A}$  field.

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## References

1. Dumitru S. New possible physical evidence of the homogeneous electromagnetic vector potential for quantum theory. Idea of a test based on a G. P. Thomson-like arrangement. *Progress in Physics*, 2014, v. 10, issue 3, 196–200.
2. Gradshteyn I.S., Ryzhik I.M. Table of Integrals, Series, and Products. Seventh Edition, Elsevier, 2007.
3. Electron diffraction P2511300, Physics University Experiments, Oct. 2013, PHYWE Systeme GmbH and Co. KG. [http://www.phywe.com/index.php/fuseaction/download/lrn\\_file/TEP\\_2013\\_Final\\_low2.pdf](http://www.phywe.com/index.php/fuseaction/download/lrn_file/TEP_2013_Final_low2.pdf)