Reply to "Comment on 'Experimental proof of standard electrodynamics by measuring the self-force on a part of a current loop'"

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Our paper [Phys. Rev. E **58**, 2505 (1998)] described experimental results that brought into agreement standard theory and experiment, in contrast to two previous experiments that claimed disagreement. The shape of our circuit was designed to improve knowledge of the electric flux lines. Such a shape required numerical calculations to predict the relevant force on the mobile part of the circuit.

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The main purpose of our work [1] was to repeat in a more accurate way the experiment performed by Pappas [2] and, later, by Phipps and Phipps [3]. Actually, both Pappas and Phipps claimed that their experiments regarding the force on part of a circuit and due to all the circuit were in agreement with the predictions of Ampère's elementary law and not with those of Grassmann's law (also called the "Biot-Savart law," i.e., standard electrodynamics). We wrote in our Introduction that "some of us [4] have shown that the Ampère and Biot-Savart elementary laws lead to the same result even for the force on a part of a circuit and due to the whole circuit." However, since two experimental works [2,3] challenged the theoretical equivalence, we thought it important to perform a relevant careful experiment and to show the experimental flaws in Refs. [2,3].

Since the forces that come into play are very small, the spurious forces due to the mercury surface and the Earth's magnetic field must be carefully subtracted. The contribution to the total force due to the short sections immersed in the mercury troughs required a long Appendix and the relevant calculations were not performed in the previous paper [5] quoted by Assis [6]. Moreover, the sixfold integral on the effective semicircular part of the circuit is impossible to perform analytically. Both Moyssides [5] and Assis and Bueno [7] calculated sixfold integrals for straight sides with rectangular cross sections. If they succeeded in calculating the magnetic force on the effective side used in our experiment (circular cross section and axis shaped as a semicircular arc), it would be worthwhile publishing such a result. Our chosen shape allowed us to accurately predict the current flux lines which, because of the absence of angles and/or small radius of curvature, are uniformly distributed to within 0.1%. On the contrary, in the rectangular shapes of the circuits considered by Moyssides [5] and Assis and Bueno [7] and used by Pappas [2] and Phipps and Phipps [3], there is an appreciable crowding of flux lines along lines with shorter perimeters. Moreover, the current flux lines are curved in the neighborhoods of the sharp angles of the rectangular circuit, with a strong crowding toward the center of the circuit. Since both Moyssides [5] and Assis and Bueno [7] considered a uniform distribution of flux lines that would have implausibly sharp angles, their approximation is worse than ours. However, our configuration required the use of a modern computer to calculate the magnetic force and to overcome some problems of numerical analysis. That is why another Appendix was dedicated to such calculations.

Finally, in the Introduction of our paper we showed that Laplace's first elementary law [which together with Laplace's second elementary law leads to the Grassmann (or Biot-Savart) law] is a nonrelativistic approximation of the expression for the magnetic field derivable from the Lienard-Wiechert expression.

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