

LETTER TO THE EDITOR

A NOTE ON THE ARTICLE

»VALIDITY RANGE OF THE MAGNETIC AHARONOV-BOHM EFFECT«

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The present note contains some corrections to the previous published work on the magnetic Aharonov-Bohm effect.

Ref. 1 contains an incomplete calculation which is corrected in the following lines.

In Section 3, the phase shift of a moving charge is calculated in the case where the source has a continuous energy spectrum. This calculation arrives at the correct contribution of the Hamiltonian to the rate of phase accumulated on each term of the system's wave function Ψ . However, the overall rate of phase accumulation on a wave function is²⁾

$$d\Phi = P \cdot dx - E dt = (P \cdot v - E) dt. \quad (1)$$

This expression has the following nonrelativistic form which is applicable to the case discussed here

$$d\Phi = (2T - E) dt = L dt \quad (2)$$

where T denotes the kinetic energy and L is the Lagrangian. It follows from this expression that the calculation carried out in Ref. 1 neglects the contribution of the kinetic energy to the phase shift. This omission is corrected here.

The calculation looks for the *difference* of the phase shift due to the interaction of the moving charge with the source. The moving charge travels in a field-free region and its kinetic energy is a constant of the motion. On the other hand, Eq. (20) of Ref. 1 proves that the source's kinetic energy varies in time and that the amount of this variation equals the quantity found in the original presentation of the Aharonov-Bohm (*AB*) effect^{3,4)}. Thus, while the system's energy E is a constant of the motion, its kinetic energy T varies in time. Using Eq. (2), one finds that the accurate rate of the required phase shift is twice as large as the quantity found by *AB*.

The consequences of this correction can be summarized in the following points:

1. Unlike stated in Ref. 1, the experiment discussed in Section 3 therein shows a nonzero phase shift.
2. The single particle calculations of *AB* are incorrect in this case. The actual phase shift is twice as large as the quantity obtained by them.
3. All the rest of the conclusions of Ref. 1 are unaffected by this correction, except for few minor verbal expressions. In particular, the corrected solution presented above to the example discussed in Section 3 therein, proves that *AB*'s topological interpretation of the magnetic effect is incompatible with fundamental properties of quantum mechanics.

References

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- 2) L. D. Landau and E. M. Lifshitz, *Quantum Mechanics*, (Pergamon, London, 1959) p. 48;
- 3) Y. Aharonov and D. Bohm, *Phys. Rev.* **115** (1959) 485;
- 4) Y. Aharonov and D. Bohm, *Phys. Rev.* **123** (1961) 1511.

BILJEŠKA O ČLANKU »PODRUČJE VALJANOSTI MAGNETSKOG AHARONOV-BOHM EFEKTA«

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Priloženi rad sadrži neke ispravke prije objavljenog rada o magnetskom Aharonov-Bohm efektu.