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Peer Review

Review of: "Deriving the Electron Anomalous Magnetic Moment from Classical Field Angular Momentum"

Georgeta Vaman[1]

1. Independent researcher

Review of the paper "Deriving the Electron Anomalous Magnetic Moment from Classical Field Angular Momentum" by Gianfranco Spavieri et al.

The authors of this paper claim to have succeeded in obtaining the correct result for the anomalous magnetic moment of the electron using classical electrodynamics. Unfortunately, the paper has several unclear points (weak points), which is why I cannot recommend its publication in this form. Here is the list of these weak points that I have noticed:

1. The authors write, already in the abstract, that they model the electron as a toroidal charge distribution, and, at the beginning of page 4, they even introduce the aspect ratio N= R/R_{minor}. Moreover, at the end of page 3, they write about "*a charge e* " that "*circulates around the torus*", and at the end of section 2, they write about a "*magnetic field that is azimuthal around the torus*". All these pieces of information made me think of the Toroidal Solenoid Electron Model introduced by Bostick and used by Oliver Consa in the paper "*Helical Solenoid Model of the Electron*" published in Progress of Physics volume 14, p. 80 (2018) (for a critique of this work by Consa, see M.J.J. Fleury and O. Rousselle, "*Critical Review of Zitterbewegung Electron Models*", Symmetry vol 17, p. 360 (2025)).

Nevertheless, the charge density written by Spavieri et al. in eq. (10) **is by no means the charge density of a charge circulating along a toroidal solenoid, but is the charge density of a uniformly charged circular ring.** That charge density does not correspond to a charge circulating along a torus but is the charge density of a circular ring traversed by a stationary current. Not even in the approximation of an infinitely thin torus does a charge circulating along a toroidal solenoid become a stationary current circulating

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through a circular ring; rather, it becomes a charge circulating along a circular ring. **The authors must clearly specify the model they are using for the electron.**

2. The fact that in eq. (12) Spavieri et al. write the vector potential of a circular ring traversed by a stationary current, at large distances compared to the dimensions of the ring and in the plane of the ring, demonstrates that the authors model the electron as a stationary current loop. **In this case, they must abandon the claims of a toroidal model about which I wrote in point 1)**.

3. Both in the abstract and in the body of the paper, the authors write about "*electron's self-interaction*". This makes me think that Spavieri et al. want to calculate the anomalous magnetic moment of the electron as resulting from the interaction of a particle with spin with its own electromagnetic field. That would be a nice idea, similar to the calculation of the self-force and the electromagnetic mass of a spinless particle (see section 16.3 of Jackson's Electrodynamics, 3rd edition). In very simple words, we can say that a charged particle interacts not only with external electromagnetic fields but also with its own field. Because of this self-interaction, the particle is slowed down and dynamically behaves as if it had an extra bit of mass (electromagnetic mass). This self-force and the extra bit of mass are calculated rigorously starting from the equation of conservation of total momentum, that is d\vec{P}/(dt)=\vec{F}_{ext}, where \vec{P} is the total momentum of the particle + field system and is composed of the mechanical momentum of the particle + the electromagnetic momentum of the field: \vec{P}=\vec{P}_{mech}+\vec{P}_{em}.

In the same way, we can think that a particle with spin interacts with its own field, this interaction making it appear as if it had "an extra bit of spin." This correction to the spin should be calculated rigorously from the law of conservation of total angular momentum: d\vec{L}/(dt)= \vec{N}_{ext}, where \vec{L}=\vec{L}_{mech}+\vec{L}_{field}, where \vec{L}{mech} is the angular momentum of the particle (both the orbital part and the intrinsic spin part), and \vec{L}_{field} is the field angular momentum. Although this idea is attractive, I have not seen anywhere in the paper by Spavieri et al. any reference to the law of conservation of angular momentum. **The authors should specify exactly what method they have in mind for the calculation of the anomalous magnetic moment of the electron.**

4. If the authors intend to use the idea of the electron's self-interaction, they should use the electromagnetic field produced by it in the region occupied by the electron, and not at a large distance from it. **Therefore, the use in equation (12) of the vector potential of a circular current in the approximation of very large distances (far-field approximation) is inappropriate**.

5. The authors claim that, if in the formula for the field angular momentum (eq. 11) they particularize the distance r as being equal to the Compton wavelength \lambda_C, then that value of the field angular momentum at a given point in space is related to the anomalous magnetic moment of the electron (see eqs. (18) and (19)). But the fact that in equation (18) the authors have managed to force the appearance of a factor \hbar/2 (which is the intrinsic spin of the electron) does not demonstrate that there is any connection between the field angular momentum at a given point and the anomalous magnetic moment of the electron. **As long as the authors don't explain why this specific value of the field angular momentum at the Compton scale is connected with the anomalous magnetic moment of the electron, their eq. (18) remains a superficial numerical coincidence rather than a rigorous physical derivation.**

In conclusion, although the authors' intention to derive the anomalous magnetic moment through a semiclassical approach based on self-interaction is interesting, the manuscript currently suffers from major inconsistencies. The geometric confusions related to the electron model (toroidal vs. simple loop), the unjustified use of the far-field approximation for a local effect, and the lack of a formalism based on conservation laws turn the final result into a mere numerical coincidence, which makes it appear that the authors have forced the appearance of the result they desired. **Therefore, I cannot recommend the publication of the paper in this form.**

Declarations

Potential competing interests: No potential competing interests to declare.