Quantums of magnetic flux and canonical electromagnetic angular momentum determined by the same conditional equation

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Abstract

A transformation of the conditional equation for the magnetic flux quantum $\vec{\Phi}_0 = \frac{2\pi}{e}\,\vec{\hbar}/2$ yields the conditional equation for the quantum of electromagnetic canonical angular momentum: $\frac{e}{2\pi}\,\vec{\Phi}_0 = \vec{\hbar}/2$.

1 General

If quantization of angular momentum was a universal rule it would also have to apply to canonical electromagnetic angular momentum, and its smallest theoretically possible amount would define its quantum. In [1] the author demonstrated that quantization of canonical electromagnetic angular momentum is an inevitable consequence of magnetic flux quantization. The author also derived the quantum of canonical electromagnetic angular momentum $L_{c\,0} = \hbar/2$ which emerges when an electron is located within one magnetic flux quantum. Consequently $\hbar/2$ marks off the bottom-level of canonical electromagnetic angular momentum. The analysis further revealed an intrinsic relationship among the magnetic flux quantum Φ_0 and the quantum of canonical electromagnetic angular momentum $\hbar/2$, both of which being interlaced by the same quantized entities $e, \Phi_0, \hbar$, as will be enlightened here.

2 Canonical electromagnetic angular momentum

2.1 Classical formulation

In the Lagrangian formulation of classical electrodynamics [2], canonical electromagnetic angular momentum $\vec{L_c}$ induced by a point-like electrostatic charge q located in a magnetostatic field of flux $\vec{\Phi}$ generally is

$$\vec{L_c} = \frac{q}{2\pi}\vec{\Phi} \tag{1a}$$

or equivalently

$$\vec{\Phi} = \frac{2\pi}{q}\vec{L_c} \tag{1b}$$

It is worth to note that all of the 3 variables in (1a) and (1b) are quantizable entities such that their respective quantums mark off their lowest limits.

2.2 Quantized formulation

Substitution in (1b) with $q \Rightarrow e$, $\vec{\Phi} \Rightarrow \vec{\Phi_0}$, $L_c \Rightarrow \hbar/2$ yields

$$\vec{\Phi}_0 = \frac{2\pi}{e}\vec{\hbar}/2 \tag{2}$$

as the conditional equation for the magnetic flux quantum.

3 Conclusion

The quantized formulation of canonical electromagnetic angular momentum yields the conditional equation of the magnetic flux quantum (2) and comprises a linear relationship among the same entities as in (1a) and (1b) namely magnetic flux, charge and angular momentum. By comparing (1b) with (2) it becomes evident that

$$\vec{L_{c0}} = \vec{\hbar}/2 \tag{3b}$$

is the smallest theoretically possible canonical electromagnetic angular momentum thus defines its quantum: $\hbar/2$.

4 Summary

It is demonstrated that the conditional equation for the quantum of canonical electromagnetic angular momentum $\hbar/2$ and the conditional equation for the magnetic flux quantum Φ_0 are identical. Their different physical meanings result from a conversion factor $2\pi/e$.

References

[1] http://vixra.org/abs/1703.0256

[2] I.D.Vagner et al: Quantum mechanics of electrons in strong magnetic field - http://people.clarkson.edu/ nanosci/jse/A/vol0301/vgw.pdf;

[3] ttp://isites.harvard.edu/fs/docs/icb.topic1327064.files/143bF2013Sec10.pdf

[4] L. Onsager, Phys. Rev. Lett. 7,50 (1961);

[5] http://www.feynmanlectures.caltech.edu/III$_2$1.*html*