THIS ARTICLE IS NOT YET FINALIZED—08-2007

Flawed *quantum* atomic electrodynamics: Magnetic moments are not inversely proportional to inert mass

Johann Marinsek

johann@marinsek.com

Abstract

The neutron comprises two constituents with a magnetic moment, namely electron and proton. Because the magnetic moments of neutron and proton are allegedly three orders of magnitude smaller than the magnetic moment of the electron, confusion on the additivity of magnetic moments emerged. The origin of this trouble is the theorem that magnetic moments are inversely proportional to inert mass.

It is demonstrated that equating classical orbital angular momentum of an electron $L = r\ m_e\ v$ with the contradictory QM angular momentum $L = \hbar \sqrt{l(l+1)}$, fallaciously derives this theorem.

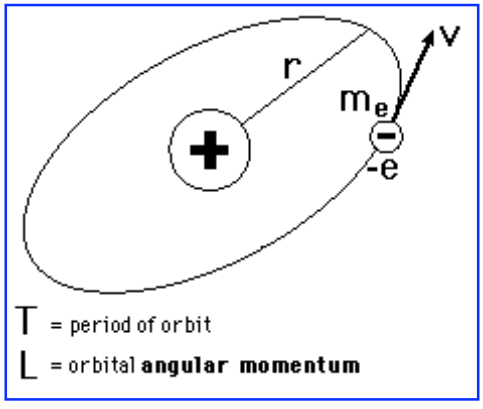
The use of the macroscopic formula for the classical angular momentum $L = r\ m\ v$ for microscopic rotations is questionable because in the former mass is based on the translational macroscopic inert mass.

An orbiting electron does not represent a conduction current I in a circular wire. This supposed current loop cannot be the basis to calculate the occurring magnetic moment according to $\mu = IA$, where A is the area of the orbit.

Dimensional analysis of the formula $\mu = IA$ makes plain that inert mass has nothing to do with magnetic moment.

Introduction

A current I in a circular loop with area A produces the magnetic moment $\mu = IA$.



But an orbiting electron represents not conduction current. The reason is that an electrical conduction in a wire is not explainable as a *current* (a *flux*) of moving charges. In a circular 'current' loop there are no circulating charges, which are comparable with Bohr's circulating electron charge at a velocity of about c/137. In the article *Electricity* the reader can find the objections to current *electrical current theory*. Therefore the derivation of the current I from an electron in a circular orbit of quantum mechanics, namely that the current is the total charge passing in the circle per second $I = ev/2\pi r$ is erroneous:

$I \neq -e/T = ev / 2\pi r$

(Figure and the following derivations from the well-known *hyperhphysics* e-textbook.) [hyp]

Because this foundation of quantum mechanics is erroneous, the calculated magnetic moments are also flawed. But in the derivation of the magnetic moment there is an *extra* error of logic.

Fallacious derivation that magnetic moments of electrons and nucleons are inversely dependent on translational inert mass

As explained before the claim is that $I = -ev / 2\pi r$, and $\mu = IA = -evr/2$
Note that μ is not dependent on the mass m_e of the electron! For a given area A, the magnetic moment depends only on *I*, and not on the inert mass of the wire or its constituents.

This formula can be rewritten as $\mu = IA = L(-e/2m_e)$ where $L = r m_e v$ is the classical expression for the angular momentum of the electron. The conservation of angular momentum is a theorem of classical mechanics. If we set in for $L = r m_e v$ we get again $\mu = IA = -evr/2$!

How is it possible to "derive" a formula where the magnetic moment depends inversely on the mass m_e of the electron? The fallacy is the following: Express the magnetic moment with the classical angular momentum $L = r m_e v$:

$\mu_{electron} = L(-e/2m_e)$ but then don't insert its classical expression $L = r m_e v$ but the quantized angular momentum $L = \hbar\sqrt{l(l+1)}$ that contradicts the classical angular momentum. Then the magnetic moment associated with an **electron** orbit is erroneously given by the formula

$$\mu_{electron} = L(-e/2m_e) \neq \hbar\sqrt{l(l+1)}\,(-e/2m_e) \neq \mu_B\sqrt{l(l+1)}$$

where e is the charge of the electron, m_e is its inert mass, $\hbar$ is Plank's constant, l is the orbital quantum number $l = 0, 1, 2, \ldots$
The z-component of the magnetic moment is: $\mu_z = -\mu_B m_l$, where m_l is the orbital magnetic quantum number that takes integer values $-l, -l+1, \ldots, +l\ldots$,
μ_B is a unit of magnetic moment, the so-called *Bohr magneton*.

Again, the fallacy consists of a simple contradiction: The classical angular momentum that is a constituent of the "derivation" is different from the quantum mechanic angular momentum: $r m_e v \neq \hbar\sqrt{l(l+1)}$. Classical angular momentum is conserved, which means that increasing radii are accompanied by a decrease of orbital velocity v. Therefore velocity times radius remains constant. Quantum "angular momentum" obviously is not conserved, it is quantised.
Don't ask the question why the Bohr model is out, why now electrons are delocalized, why some electrons possess orbital angular momentum and some (the so-called s-electrons) not. Why there is a strong determination for the magnitudes $n\hbar$ of orbital angular momentum and intrinsic angular momentum (spin) $\hbar/2$ whereas the uncertainty principle denies that we can have the knowledge of velocity and location at the same time…
Feynman for example prescribed for this despair: Don't wonder, there is nothing to comprehend… There is no *rationale* to discover in nature… Use the formulas, if they can save the phenomena, all is o.k.

Conclusion
QM derivation of magnetic moment is a fallacy. The magnetic moment is not inversely dependent on inert mass.
Obviously this must be the case because a
dimensional analysis of $\mu = IA = [QL^2/T]$ shows that mass is irrelevant for magnetic moment.

Ontological misconceptions of QM

A:

The orbiting electron is not an electrical current that generates a magnetic moment. The deduced expression for the magnetic moment that contains the inert mass of the electron is the result of a fallacy.

B:

Inert mass of the electron was introduced via the classical angular momentum:

$$L = r\, m_e\, v$$

Classical macrophysics defines angular momentum as inertial mass times velocity times radius of a rotating object. Inertial mass means the translational inertial mass.

For macrophysics it is justified to use this translational inertial mass also for rotation because radii are big. QM transferred without any justification the macrophysics concept of angular momentum into microphysics, where radii are minute. Due to this misconception inertial translational masses of particles enter into magnetic moment formulas and confuse the additivity of magnetic moments. As it is shown above, due to a fallacious derivation the translational inert mass remains in the formula for the magnetic moment and makes it inversely dependent on mass…

Electron spin magnetic moment

For extranuclear orbiting and spinning electrons there is no empirical evidence. It does not matter that current QM asserts that the Bohr model is an untrue picture; electrons are now somewhat "delocalized".

The splitting of the hydrogen spectral lines (fine structure) can be explained physically as the result of frequencies of an oscillating atom. The Stern-Gerlach experiment shows that silver atoms are tiny magnets, no more. The experiment did not confirm an electron spin.

According to quantum mechanics the electron has spin and therefore a magnetic moment. The magnetic moment of spin is:

$$\mu_{z\,spin} = S_z(-e/2m_e) \neq \pm(1/2)\ \mu_B$$

where the z-component of the spin angular momentum is $S_z = m_s \hbar$, $m_s = \pm 1/2$.

Same "derivation" and same fallacy as above, therefore the use of the inequality sign ≠ instead of = !

For the electron spin it is assumed that the mass is distributed for example in a sphere or on the surface of a sphere. But we don't know the distribution of mass. In order to show the procedure of QT we can use the simplest mass distribution.

Assume that the mass is concentrated in a ring with radius r: O

Then spin is $S = m_e r^2 \omega$, where ω is angular velocity.

Obviously, the calculated spin depends on mass m_e.

Note again that the experimentally determined mass m_e is the mass for a nearly translational moving electron. Here, we have a rotating something with a nearly infinitesimal small radius. It is a failure to insert the translational electronic mass in the formula for spin.

Due to this mistake magnetic moments are inversely proportional to the translational inert mass. Therefore the magnetic moment of electron is 3 orders of magnitude greater than the magnetic moment of neutrons and protons.

As a neutral particle, the neutron should have zero magnetic moment. But they have a magnetic moment; this indicates that a neutron is made up of particles with magnetic moments. A neutron comprise a proton and an electron…

As a consequence, it is not explainable how the addition of the magnetic moments of an electron and a proton can yield the magnetic moment of neutron. The origin of this

trouble is the introduction of macroscopic translational inert mass for the particles…
Charge: the same distribution as for mass is assumed for charge. According to QT the rotating charge represents a current: $I = Q/t = e/t = e\omega/2\pi$ (because $t = 2\pi/\omega$).
Uniformly moving charges represent not an electrical current…
Now the current produces the magnetic moment $\mu_e = I\, r^2\pi$, inserting ω from spin S yields
$\mu_e = \frac{1}{2}\, e/m_e\, S$ for this arbitrarily assumed mass and charge distribution. Because quantum theorists don't know the real distribution, they declare that
$\mu_e = e/m_e\, S$
Spin S must be $S = \hbar/2$.
Therefore: $\mu_e = (\hbar/2)\, e/m_e = \mu_B$ where B is the Bohr magneton
$\mu_p = (\hbar/2)\, e/m_e\, 1840 = \mu_{nuc}$ where μ_{nuc} is referred to as nuclear magneton
The measured magnetic moment of proton did not coincide with the unjustified QT assumptions.
Therefore we cannot infer from experiments that the spin of protons is $\hbar/2$.
Also the measured magnetic moment of the neutron contradicts theory. There is a second difficulty: Below I will show that it is not possible to calculate the inert mass of a neutron that is used to calculate the magnetic moment of n.

Measurements show that the magnetic moment is not $\mu_{spin} = \pm(1/2)\ \mu_B$

No problem, insert the g-factor, g = 2.00232, the so-called gyromagnetic ratio!
And so: $\mu_{spin} = \pm(1/2)g\ \mu_B$
One comment in a textbook reads: *This is a non-classical result. You do not need to understand where the g-factor comes from. It is equal to approximately 2 for a free electron*
Or one can read otherwise that formulas *must be modified to account for the fact that electron is not a point object but a charge distribution. To do this, the charge q is multiplied by a dimensionless factor g, which is known as the gyromagnetic ratio. If the angular momentum of the electron is due to spin only, then g = 2.0023..*
QM introduced g-factors in order to correct magnetic moments. The g-factor for the electron is justified with the "fluctuating vacuum" of QED and with a possible but unknown electron substructure!
We repeat the question: Are measurements of magnetic moments of e, p and n crucial experiments of the existence of QM spins $\hbar/2$? No, this is impossible! A quotation shows that spin is not measured but supposed to be ½:
With a measured nuclear g factor and spin I= 1/2, the magnetic moment of Mg-31 is deduced. (Neyens et al. Measurement of spin and magnetic moment of M-31; Phys.Rev.Letters, PRL, 94,022501 (2005)

The magnetic moment of the proton

Because the inert mass of the proton is about $m_p = 1836\ m_e$ it was deduced that
$\mu_{proton} = \mu_{electron}/1836$

But because the magnetic does not depend on mass, this relationship is wrong:

$\mu_{proton} \neq \mu_{electron}/1836$
The measured magnetic moment of proton did not coincide with the unjustified QT assumptions.
Therefore we cannot infer from experiments that the spin of proton is $\hbar/2$.
Also the measured magnetic moment of the neutron contradicts theory. There is a second difficulty: Below I will show that it is not possible to calculate the inert mass of a neutron that is used to calculate the magnetic moment of n.
QT introduced g-factors in order to correct magnetic moments. The g-factor for the electron is justified with the "fluctuating vacuum" of QED and with a possible but unknown electron substructure!
We repeat the question: Are measurements of magnetic moments of e, p and n crucial

experiments of the existence of QT spins ħ/2? No, this is impossible! A quotation shows that spin is not measured but supposed to be ½:

With a measured nuclear g factor and spin I = 1/2, the magnetic moment of Mg-31 is deduced. (Neyens et al. Measurement of spin and magnetic moment of M-31; Phys.Rev.Letters, PRL, 94,022501 (2005)

Summary

There are no orbiting electrons; there are no spinning electrons, protons and neutrons. The "derivations" of the magnetic moments of these non-existing states are intrinsically flawed… The magnetic moments of electron, proton and neutron are not due to spin or orbital angular momentum and are not inversely proportional to the corresponding inert mass. Magnetic moments of the atomic sub particles are due to permanent magnets

QT doctrine of magnetic moments due to spinning and orbiting atomic sub particles is questionable:

1st: The transfer of the macrophysics concept of angular momentum into microphysics is not justified.

2nd: Orbital and intrinsic angular momenta are not random. Obviously, radii of orbiting charges are assumed to be determined whereas current QT claims that this is an old antiquated "picture" whereas radii are in reality random…

3rd: Orbiting charges don't represent a current.

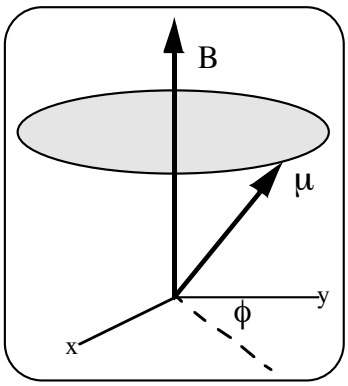
4rd: It is not plausible that bound nucleons have any spin. They are conceivable as tiny permanent magnets too.

Unfortunately the nuclear shell model of Maria Goeppert-Mayer is a failure. Predictions disagree with measurements... The model is not repairable, for instance when the rules for spins of unclosed shells are altered… The troubles get multiplied because also the rules for the aufbau of electronic shells violate the conservation of total angular momenta law.

Nature is reasonable is a useful methodic device. Orbiting and spinning nuclides, which are glued together by hypothetical forces, are surely not reasonable.

Experimentally determined g-factor

g = 2.0023… is an experimentally determined value using electron spin resonance techniques. Obviously, the gyromagnetic factor g was introduced in order to conceal the ignorance and to explain measurements. Now recall that the extended Bohr atomic model parallels a planetary system in which in addition to the orbital planetary motion, both the planet (electron) and the sun (proton) rotate about their own axes. If the parallel is a complete one, then the electron's axis should have also a precession like the axis of our globe. In the case of the spinning electron the precession of magnetic moment around a magnetic field B is:



$d\boldsymbol{\mu}/dt = (gq/2m)\ \boldsymbol{\mu} \square \mathbf{B}$. see [bradf] for details.

The famous *Larmor* frequency is defined as

$\omega_0 = d\phi/dt = (gq/2m)B$.

What is the use of the Larmor frequency?

The Larmor frequency can be measured by driving the system with a weak oscillating magnetic field B. When the drive frequency is equal to the Larmor frequency, resonance occurs and the system absorbs maximum energy from the driving field. Once this value is known, equation $\omega_0 = d\phi/dt = (gq/2m)B$ can be solved for the gyromagnetic ratio.

The point is that there is **no g factor** because there is no orbiting and spinning electron. The claim that with the measurement of the Larmor resonance frequency the existence of this free electron is proven is an error. The only fact that is shown is that the atom possesses a further electromagnetic resonance frequency and that the atom must be an electromagnetic oscillator with many degrees of freedom.

Zeeman and fine structure splitting troublesome for gyroscopic g-factor of electron spin

The Zeeman effect shows another line splitting. It is due to magnetic fields exerted on the atoms. Jackson [jak] described the troubles of the *ad hoc* invented electron spin with *fine structure* and *Zeeman splitting:* If the g-factor of the electron is 2 then the *anomaly* Zeeman effect and the existence of multiplet splitting is explainable but the observed fine structure splitting is only half the theoretical ones!

If the g-factor is set for 1 then one obtains the correct fine structure splitting but the Zeeman effect is now the so-called *normal* Zeeman effect. According to Jackson, Dirac's relativistic electron theory explains consistently spins, g-factor and spin-orbit interaction. There is no obligation for me to go in the details of quantum theory troubles and endless *ad hoc* inventions (for example the Thomas precession) because the existence of an extra nuclear orbiting and spinning electron is physically impossible and was never empirically corroborated.

Experiments show only that atoms consist of minute magnets. It is possible that these magnets are permanent ones. According to the duality theory of matter and waves the electron should be also a standing wave. In the quantum theory literature no efforts are made to explain the magnetic moment of the spinning electron in terms of a standing wave! According to the complementary principle one can arbitrarily choose between the two pictures. In fact, all calculations, even wave mechanics, have the particle picture as their ontological basis.

Outlook

As a tentative assumption we propose that the magnetic moments are of the same order of magnitude for electrons, protons and their sub-particles. Also the size of those particles is assumed to be of the same order of magnitude. Particles are hypothesized as elemental ring magnets. Bonds are by magnetic coupling. Atoms are oscillators.

State of our ignorance: we don't know how we could calculate a proton's magnetic moment. We don't know how the constituent particles of proton are arranged… Proton-proton collision experiments show an e^+e^- sub particle and many fragments. Why should a bound proton have a spin? It is possible that nature has permanent elemental magnets. A conserved spin $\hbar/2$ for the proton would represent a *perpetuum mobile* that is physically not explainable.

Electron mass revisited

First of all it is commonly accepted that the inert mass of an electron is about 1836 times smaller than the proton's inert mass. But I am convinced that the calculation of the charge to mass ratio of an electron is questionable because this calculation is based on flawed inertial physics in a vacuum space. [*Electron mass*, this website] Regarding the electron's motion in an *electromagnetic medium* the erroneously so-called inert mass is a different one. Recall that the electron's inert mass is a calculated one and not a directly measured one! Mass spectrometry yields masses for the ions of all elements and their isotopes but not for the electron.

References

[hyp] Nave, R., hyperphysics, e-book,

http://hyperphysics.phyastr.gsu.edu/hbase/quantum/orbmag.html

[Aspden1] Aspden, H., Energy Science Essay No. 6,

www.energyscience.co.uk/essays/

[Aspden2] Aspden, H., Energy Science Essay No. 10,
www.energyscience.co.uk/essays/
[garr] B.M. Garraway, S. Stenholm, Observing the spin of a free electron,
Phys.Rev. A 60, 63, (1999)

[franklin] Franklin, A., Appendix 5: Right Experiment, Wrong Theory: the Stern-Gerlach Experiment, Stanford Encyclopedia of Philosophy, Supplement to Experiment in Physics, http://plato.stanford.edu/entries/physics-experiment/app5

[Purcell] E.M. Purcell, Research in Nuclear Magnetism, Nobel lecture 1952,
www.nobel.se

[rug] http://rugth.30phys.rug.nl/quantummechanics/stern
[jak] Jackson, J.D., Klassische Elektrodynamik, Berlin, New York 1983
[young] Young P.R., Organic Chemistry online, 1996,
www.homework.uic.edu/web1/ocol/toc