THE COMPLETION OF THE THEORY OF MAGNETIC RESONANSE

MAGNETIC MOMENT OF THE PARAMAGNETIC AND DIAMAGNETIC GASSES

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PROLOGUE

Then a charged particle with spin L, is found into a homogeneous magnetic field B, will have magnetic moment μ and it is in force,

$$L\omega = E = -\boldsymbol{\mu} \times \mathbf{B} = -\mu B \sin\theta$$

We must determine the μ, the cyclic revolved frequency ω (Larmor frequency) and the angle θ.

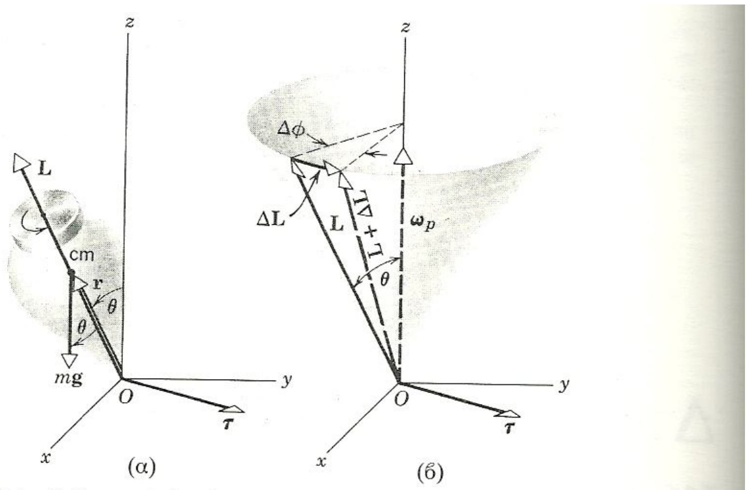
THE SIZE OF THE MAGNETIC MOMENT

A charged particle, because of spin, will have magnetic moment as,

$$\mu = iA = i\pi r^2 = \frac{e}{T} 2\pi r . r/2 = ecr/2 = eL/2m$$

THE LARMOR FREQUENCY

The axis of a rotated top, mutates in angle θ and with frequency ω and we give the theory taken of the PHYSICS by Halliday-Resnick,



Σχ. 13−1 (α) Μιά σβούρα πού ἐκτελεῖ μετάπτωση· φαίνονται ἡ στροφορμή **L**, τό βάρος *m***g** καί τό διάνυσμα **r** πού δείχνει τή θέση τοῦ κέντρου μάζας. (β) Ὁ κῶνος πού διαγράφει ὁ ἄξονας μιᾶς σβούρας πού ἐκτελεῖ μετάπτωση. Ἡ γωνιακή ταχύτητα μεταπτώσεως σχεδιάστηκε κατακόρυφη μέ φορά πρός τά πάνω.

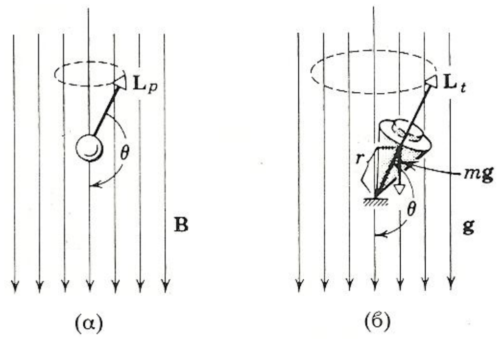
The angle $\Delta\varphi=\Delta L/L\sin\theta=\tau\Delta L/L$, where τ is the moment of force which is exercised on the center of mass of the top and if $\Delta L<<L$,

$$\Omega=\Delta\varphi/\Delta t=\tau/L\sin\theta$$

$$\tau=rmg\sin(180-\theta) \quad \text{and}$$

$$\omega=mgr/L \quad \text{and} \quad \boldsymbol{\tau=\omega x L=r x F}$$

For the charged particle has the frequency ω of mutation into the homogeneous magnetic field, as the following plan, it is in force,



Σχ. 37−17 (α) Περιστρεφόμενο γύρω ἀπ' τόν ἑαυτό του πρωτόνιο πού ἐκτελεῖ μετάπτωση μέσα σέ ἐξωτερικό μαγνητικό πεδίο καί (β) στροβιλιζόμενη σβούρα πού ἐκτελεῖ μετάπτωση μέσα σέ ἐξωτερικό πεδίο βαρύτητας. $\mathbf{L}_p$ καί $\mathbf{L}_t$ εἶναι τά διανύσματα τῶν στροφορμῶν.

$$\tau=L\omega\sin90^o=L\omega=E=-\mu B\sin\theta$$

(the vector of the magnetic moment is inverse to the vector of spin L).

Then the Larmor frequency is $\omega=(e/2m)B\sin\theta$.

For B=1T the proton has ω=47.9 MHz and the electron has ω=88 GHz.

THE FREQUENCY OF SPIN IS DIFFERENT

When the spin of the charged particle is found into homogeneous magnetic field, it is like an electric ring, where the charge is cyclic rotating, it is like the charge found into strong magnetic field and as the law,

$$F'=evB'=m\omega'^2r \quad \text{and} \quad \omega'=eB'/m \quad (1)$$

Of course the B′ is very high to success the spin frequency of the proton $\omega= 4.5\times10^{23}$ Hz and of the electron $\omega=2.5\times10^{20}$ Hz.

But, it may be, the F′ to be and an electric force. Either it is go on a force coming from strong magnetic field, or electric field, if we submit the particle which has the spin, into additional homogeneous magnetic field B, we will have,

$$F=F'\pm evB=m(\omega)^2r=m(\omega'\pm\Delta\omega)^2r$$

But $(\omega'\pm\Delta\omega))^2=\omega'^2+\Delta\omega^2\pm2\omega'\Delta\omega=\omega'(\omega'+(\Delta\omega^2/\omega')\pm2\Delta\omega)$,

And $(\Delta\omega^2/\omega')\cong0$, οπότε $(\omega'\pm\Delta\omega)^2=\omega'^2\pm2\omega'\Delta\omega=\omega'(\omega'\pm2\Delta\omega)$, και τότε,

$$\Delta\omega=\pm eB/2m \quad (2)$$

(ELECTROMAGNETISM Hans Ohanian).

That, of course, is the Larmor frequency and it is obvious that this difference of the vector ω, it is added or deduced to the spin frequency.

THE MAGNETIC MOMENT OF THE PROTON AND THE ELECTRON

The vector of magnetic moment is inverse to the vector of the spin and when the proton come in to a magnetic field, then,

(1), (2) bring $L=m(\omega+\Delta\omega)r^2=1.5eB/m$.

But we had seen that in nuclear magnetic resonance, the Larmor frequency is

$$\omega=(eB/2m)\sin\theta$$

and it is obvious that it is in force,

$$1.5(eB/m)\cos\theta=eB/2m$$

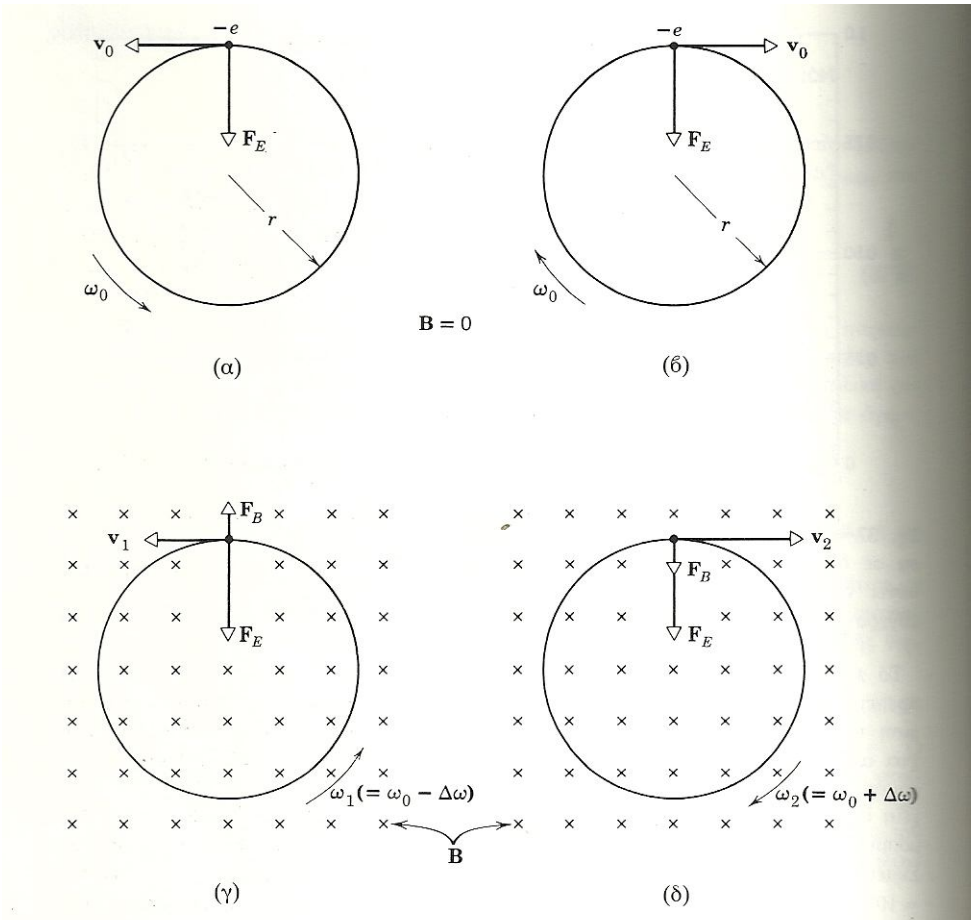
And $\theta=70.54^o$, but $\sin70.54^o=0.943$, that is very near to the unit. So the Larmor frequency for the proton is,

$\omega=47.9\sin\theta=45.2$ MHZ (experimental price 42.577 MHz) and for the electron 82.9 GHZ.

Of course, with these prices, L= h/2.

THE PARAMAGNETISM AND THE DIAMAGNETISM OF DIATOMIC GASSES

When one material found into a magnetic field, the spins of the particles are orientated in relation to the field and we give orientations of paramagnetic and diamagnetic materials, of the plan of physics by Halliday-Resnick,



Σχ. 37−7 (α) Ἠλεκτρόνιο περιφερόμενο μέσα σέ ἄτομο. (б) Ἠλεκτρόνιο περιφερόμενο κατά τήν ἀντίθετη φορά. (γ) Τό μαγνητικό πεδίο πού ἐφαρμόζεται μειώνει τή γραμμική ταχύτητα τοῦ ἠλεκτρόνιου στό (α), δηλαδή $\upsilon_1 < \upsilon_0$. (δ) Τό μαγνητικό πεδίο αὐξάνει τή γραμμική ταχύτητα τοῦ ἠλεκτρόνιου στό (б), δηλαδή $\upsilon_2 > \upsilon_0$.

We sign that in diamagnetic materials the vector of spin is inverse to the vector of the field and opposite for the paramagnetic materials. Here we report, that the orientation of the diamagnetic materials spins, it is determined by an immaterial plan which is in force in these materials spins, plan by God.

So, the $+\Delta\omega$ is in force for the paramagnetic materials and the $-\Delta\omega$ is in force for the diamagnetic ones.

In diatomic gasses, the spins of two atoms are neutralized, as their magnetic moments. But, when it exercises to their magnetic field, then the atoms of the molecules have magnetic moment. The one have

$\mu= +kh(eB/2m)\sin\theta$ and the other $- kh(eB/2m)\sin\theta$

(i.e. for the diatomic molecule of the hydrogen).

Then the molecule will have total magnetic moment

$$\mu= kh(eB/m)\sin\theta+ kh(eB/2m)\sin\theta- (kh(eB/m)\sin\theta- kh(eB/2m)\sin\theta)$$

so $\mu= kh(eB/m)\sin\theta$

and $\omega=2\Delta\omega$

That is, the paramagnetic or the diamagnetic materials, have negative or positive magnetic moment or cyclic frequency, for their rotated molecules, coming from the orientated spins.

THE MACROPHYSICS RELATIONS OF MAGNETISM AND THE MOMENT

$\mathbf{M} = \chi\mathbf{H}$, $\mathbf{B}=\kappa_m \mathbf{H}$, $\mathbf{B}=\mathbf{B_o}+\mathbf{B_m}= \mu_o(\mathbf{H}+\mathbf{M})$, $\kappa_m=\mu_o(1+\chi)$ και χ=magnetic susceptibility of the material, which is into tubular coil, where flows magnetic field B. M is the magnetization of the material, H the magnetic field strength, κ_μ is the magnetic permeability and when $\mathbf{B}=\mathbf{B_o}=\mu_o \mathbf{H}$.

It conclusion is

$1/\chi = (\mathbf{B}/\mu_o\mathbf{M})-1$ and

$$\mathbf{M}= (\chi/(1+\chi)\mu_o)\, \mathbf{B}$$

But, the magnetization is macrophysics' size which is owed of the orientation of the microphysics magnetic moments, then for the gasses the microphysics magnetization is

$$M/N_A=2.77\text{x}10^{-24} \text{ (Amp-met)lit}=6.21\text{x}10^{-26}\text{Amp-met}^2=\mu_L$$

This magnetic moment is owed to the external magnetic field and it is owed of the mutation of the Larmor frequency.

And here is in force,

$$\Theta=\cos^{-1}(\mu_L/\mu)$$

And it is in force,

$$\theta = \cos^{-1} \frac{\chi}{(1+\chi)\mu_0} \frac{1}{N_A} \frac{1}{\mu} \qquad \text{for } B=1$$

If the oxygen has 2.1×10^{-6} and $\mu=13.9/\pi=4.42\times10^{-23}$ Amp-met^2 , $\theta=89.9^o$ and $\sin\theta= 0.9999$.

EPILOGUE

For the molecule of oxygen, the magnetic moment into magnetic field 1T, is

$\omega=\mu/h/2=$ 187 MHz

This is the frequency k(e/m) and k=0.00214.

The experiment will show if it is absorbed the frequency 187 MHz on the oxygen atom, with the acceptance of the constant of its magnetic susceptibility.

The $\Delta\omega$ means, that when the material is magnetized, momentary and before start the Larmor frequency, it is added the $\Delta\omega$ on the spin frequency, where momentary the vector of the spin, is parallel to the exercised field.

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