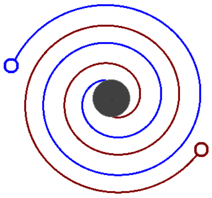
# The Spiral Proton by numbers: composite angular momentum, mass discrimination, and g-factor as 1



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**Abstract:** Angular momentum acquisition and spiral motion seems to drive particle creation. This process requires an initial momentum $m_i v_i$ having the ability to initiate spiral motion via quantized circular orbitals, while abiding by momentum conservation principles. This approach led to the discovery at [Ref[1]] that the proton was constructed from 2 opposing angular momenta $S=\hbar/2\Phi$ and $L=\hbar\Phi/2$ resulting in precisely $\pm\hbar/2$ ($\Phi$ = golden ratio). It is now found that S is linked to the proton charge, magnetic moment, and 11% of the mass via a rotating charged hollow sphere of radius 0.875 fm. On the other hand, L is associated with 89% of the proton mass centered within 0.23 fm radius. The angular velocity related to L is found 3.5 times that of S. The proton charge-to-energy ratio calculation leads to a surprising equivalence Coulomb vs. Joule.

## Introduction

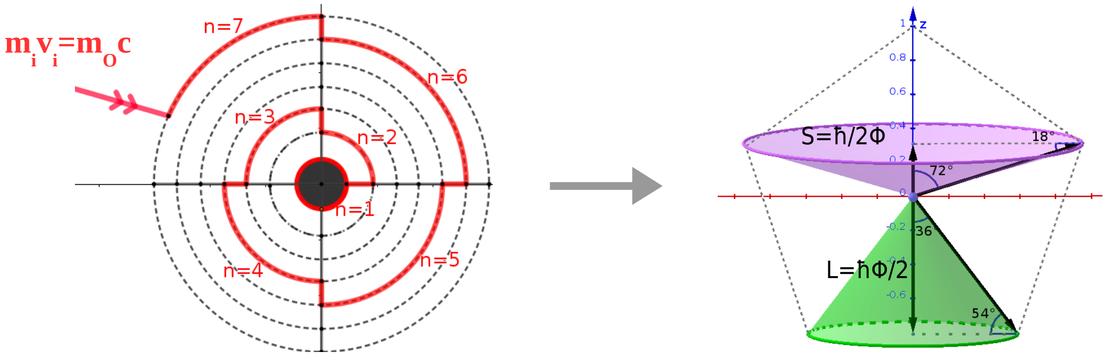
The source of the intrinsic angular momentum (spin) carried by elementary particles is not, at the moment, completely elucidated. As the matter of fact, how do quarks and gluons carry the spin of the proton is still one of the unsolved problems in physics. For lack of better interpretation, particle spin is usually accepted by modern physics as a phenomenon of pure quantum origin.

The idea that this rotational kinetic energy could proceed from a preliminary spiral motion, led to the hypothesis of an initial momentum $m_i v_i$ (charge and/or mass carrier) acquiring angular momentum under favorable initial conditions, and scaling down circular orbitals in accordance with momentum conservation and angular momentum quantization rules. This process is similar to the electron transitions between quantized energy levels around the nucleus. Therefore, it becomes natural to apprehend the particle spin as the protraction of that spiralling process.

The application of those principles to a composite particle such as the proton requires that the latter be treated as a single entity in a first approach, and then formulate the quarks/gluons sub-structure as a phenomenon emerging from the spiral process. Since quarks are not detected as free particles outside nuclei, their existence may precisely be the result of a hadron internal process.

Following these principles, it was graphically found at [Ref[1]] that the spin angular momentum for the proton was not directly $\hbar/2$, but rather $\hbar/2\Phi$ with $\Phi$ being the ubiquitous golden mean. It was then concluded that the measured spin angular momentum resulted from 2 opposing angular momenta, namely $\hbar/2\Phi$ and $\hbar\Phi/2$ whose $\Delta$ is precisely $\pm\hbar/2$. Therefore, the observed angular momentum for the proton must actually be the total angular momentum $J=L+S$, with $S=\pm\hbar/2\Phi$ and $L=\pm\hbar\Phi/2$, consequence of the spiral process from the initial momentum $m_i v_i$. This initial momentum must be equal to $m_o c=50.14394\times10^{-20}$ $\mathrm{Kgms^{-1}}$ due to momentum conservation principles. S and L carrying opposite signs, the resultant is always $\pm\hbar/2$. Further, the rotational angle of the proton along x or y can only be integer multiple of $2\pi/5$ (72°), (highlighting here the legendary number 72). Figure 1 below illustrates the findings from [Ref[1]].

**Figure 1**: The spiral process leads to 2 opposing angular momenta L and S configuration, resulting in $J=\pm\hbar/2$, and from which the proton seems to be constructed.



It will be later found that the initial momentum $m_i v_i$ requires to be the sum of two different initial momenta leading separately to S and L through a double spiral motion, with some indications referring to the internal structure of the proton and to the quarks spatial confinement.

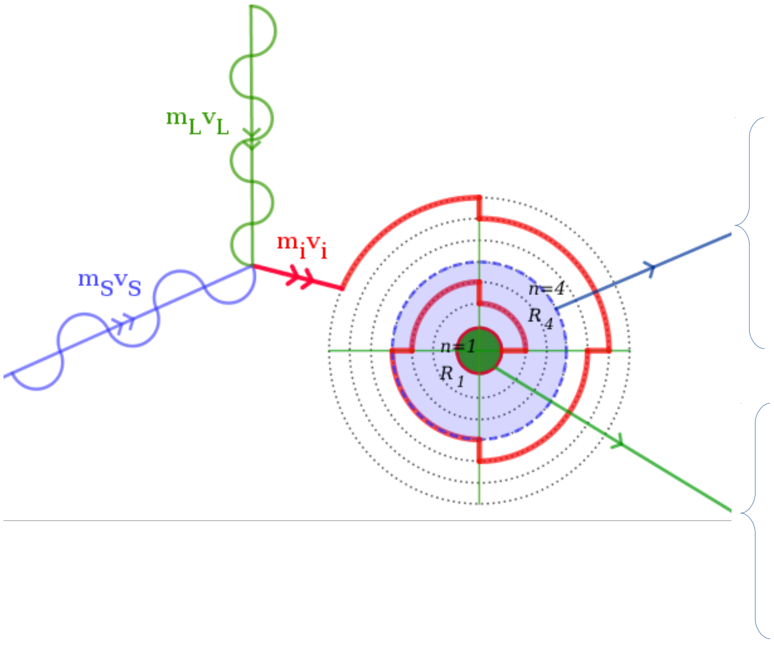
## L and S and the composite nature of the proton angular momentum

The composite nature of the proton angular momentum ±ħ/2 calls for a different approach to the baryonic internal structure, particularly in regards to the quarks/gluons sub-structure. Simple calculations indicate that S and L originate from two distinct momenta, namely $m_S v_S$ which appears electromagnetic in nature, and $m_L v_L$ for which De Broglie wavelength $\lambda = h/mv$ does not seem to apply, thus revealing a momentum of a different nature. In addition, the sum $m_S v_S + m_L v_L$ must make up the initial momentum $m_i v_i$.

Further, the angular momentum S seems to be related to the proton charge radius 0.875 fm corresponding to the angular momentum quantum number n=4, as well as to the charge of the proton +e. On the other hand, L appears to be connected to the angular momentum quantum number n=1 and carry only (or mostly) mass, in fact most of the mass of the proton. From those two considerations, simple calculations shown below lead to $m_S v_S$ (giving rise to S and Q) and $m_L v_L$ (carrying most of the proton mass), respectively equal to $12 \times 10^{-20}$ and $38.14 \times 10^{-20}$ kgms$^{-1}$. The magnetic moment being proportional to the radius, efficiency benefits from a large charge radius $r_4$ as opposed to $r_1$, while leaving the core volume ($r_1$) to the mass. Further, the De Broglie wavelength $\lambda_S = 2\pi r_4$ (5.50 fm) seems to perfectly fit the sum $m_S v_S + m_L v_L = m_O c$.

A graphical display of the results is presented in Figure 2.

**Figure 2:** The composite initial momentum $m_i v_i = m_S v_S + m_L v_L$ and the spiral motion giving rise to the opposing angular momenta S=ħ/2Φ and L=ħΦ/2. S is associated the charge +e, the proton magnetic moment μ, and ~11% of the mass. L is the source of most of the proton mass.



$S = \hbar/2\Phi = 3.259 \times 10^{-35}$ kgm$^2$s$^{-1}$
$Q = +e$
$r_4 = 0.8755$ fm
$\lambda_S = 2\pi r_4 \Rightarrow m_S v_S = h/2\pi r_4 \approx 12 \times 10^{-20}$ kgms$^{-1}$
$m_S = QS/2\mu = 0.185 \times 10^{-27}$ kg (~11% $M_p$)
$V_S$ equatorial = $2.875 \times 10^8$ ms$^{-1}$
$I_S = 0.70 m_S r_4^2$

$L = \hbar\Phi/2 = 8.533 \times 10^{-35}$ kgm$^2$s$^{-1}$
$r_1 = 0.224$ fm
$L/r_1 = m_L v_L \approx 38.14 \times 10^{-20}$ kgms$^{-1}$
$m_L = M_P - m_S = 1.487 \times 10^{-27}$ kg
$V_L$ equatorial = $2.56 \times 10^8$ ms$^{-1}$
$I_L = m_L r_1^2$

## S, Q, and g-factor as 1

The necessity to introduce the g-factor as a proportionality coefficient between the observed magnetic moment and the formula $\mu = (g)SQ/2M$ may result from wrong choices of S or/and M, in other words, the ratio S/M being for the proton too small by a factor of 5.586. In the present configuration, the proton composite momentum proceeding from the spiral motion seems to point at and confirm the origin of the discrepancy. As the matter of fact, considering S originating from electromagnetic momentum $m_S v_S$ and being the sole source of the charge Q, we can set the g-factor as 1 and calculate the mass associated with S (ħ/2Φ) and Q(+e) as:

(1) $m_S = QS/2\mu = 0.185\,x\,10^{-27}\,Kg$ with μ being the proton magnetic moment ($1.410\text{x}10^{-26}$ $JT^{-1}$), S=ħ/2Φ=$3.259\text{x}10^{-35}$ $Kgm^2s^{-1}$, and Q=+e=$1.602\text{x}10^{-19}$C. Coincidentally, $m_S$ corresponds to ~11% of the proton mass, a value similar to the mass contribution of all three quarks as determined by QCD theory.

Knowing $m_S$ it becomes possible to calculate the moment of inertia $I_S$ associated with S, which will allow us to determine the charge spatial geometry giving rise to μ.

(2) $S = I_S w = (k m_S r_4^2) w_S = k m_S r_4 v_S$ with k usually found between [0 - 1]

The velocity $v_S$ at equatorial radius $r_4$ can be calculated from the quantized $v^2/c^2$ formula derived at [Ref[1]] and using angular momentum quantum number n=4. The formula found was:

(3) $v_S^2/c^2 = \frac{\sqrt{n(n+1)} - (2\Phi)^{-1}}{n+1/2}$ from which the value $v_S$=$2.875\text{x}10^8$ $ms^{-1}$ is extracted.

Now the expression (2) provides $k = S/m_S r_4 v_S = 0.70$. Therefore, the moment of inertia giving rise to S and μ is defined by $I_S = 0.70\, m_S r_4^2$. This expression of $I_S$ is very close to the moment of inertia of a hollow sphere for which k is precisely 2/3≈0.67. Despite the simplicity of those calculations, the moment of inertia $I_S$ is in total agreement with the spherical charge distribution found from the proton charge radius measurements. It also reveals that the charge is mostly distributed at the surface of a sphere of radius $r_4$ ≈0.875 fm (as opposed to a solid sphere for which k=2/5). The angular frequency associated with $v_S$ is given by $w_S$= $v_S/r_4$= $3.28\text{x}10^{23}$ $rads^{-1}$.

## The momentum $m_L v_L$ giving rise to L and to the core mass of the proton ($r_1$≈0.224 fm)

The momentum $m_L v_L$ calculated from $L/r_1$=$38.14\text{x}10^{-20}$ $kgms^{-1}$ seems to be the provider of most of the proton mass, and be centered within 0.22-0.23 fm radius, corresponding to the angular momentum quantum number n=1. It was found that the value $r_1$=0.224 fm used in this study seems to fit more precisely than the value 0.232 fm calculated at [Ref [1]] .

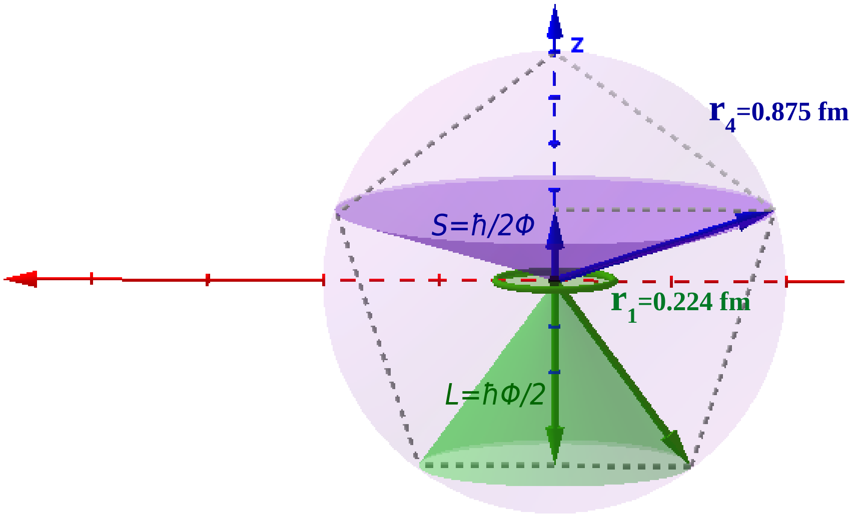
The mass carried by the momentum $m_L v_L$ can be determined by the Δ between the proton mass $M_P$ and $m_S$ calculated above, and therefore $m_L = M_P - m_S$=$1.487\text{x}10^{-27}$ Kg, which corresponds to ~89% of the proton rest mass. Further, the equatorial velocity $v_L$ at radius $r_1$ is deducted from $m_L v_L/m_L$ giving $v_L$ = $2.56\text{x}10^8$ $ms^{-1}$ for which the ratio $v_L^2/c^2$=0.729. Coincidently this ratio corresponds to ≅ $\alpha 10^2$, with α being the fine structure constant. The ratio $v_L^2/c^2$ can also be determined using formula (3) giving 0.737, which is within 1% and therefore in excellent agreement with the value above.

The velocity $v_L$ at radius $r_1$ produces an angular velocity $w_L$=$11.4\text{x}10^{23}$ $rads^{-1}$, which is 3.47 times faster than $w_S$. Further, $w_L$ translates into a period T=2π/$w_L$=$5.5\text{x}10^{-24}$ s. This timescale ($10^{-24}$-$10^{-23}$ sec) is typically and precisely given as the interaction time of the strong force [Ref[2]].

When we try to determine the moment of inertia $I_L$ associated with L by applying the same reasoning as previously carried out for $I_S$ a value of k≈1 is obtained. This result implies that $I_L = m_L r_1^2$, and therefore the spatial geometry around the core mass appears non-spherical. This could be the case for example with a circular loop, a double cone, etc.

Figure 3 is a graphical representation of the spatial geometry found in the spiral proton. The value of ħ is arbitrarily taken as unit, and does not necessarily represent the actual extension of the angular momenta magnitudes inside the spherical cavity of radius $r_4$. More importantly are the ratio $r_4/r_1$=3.9, the opposing momenta L and S configuration, the hollow spherical charge of radius $r_4$ giving rise to S, Q and μ, and the confinement of 89% of the mass within $r_1$. It is more than likely that the mass located within $r_1$ harbors the sub-structure quarks/gluons. This approach would convey 89% of the proton mass to the quarks, instead of the few % provided by QCD theory. On the other hand, it is a striking coincidence that the mass $m_S$ associated with S is about the same magnitude (11% of the proton mass) as that found by QCD.

**Figure 3:** Graphical representation of the proton internal structure, showing the the two opposing angular momenta S and L, the charged spherical cavity of radius $r_4$ giving rise to S, Q, $m_S$ and μ, the circular loop of radius $r_1$ giving rise to L and 89% of the proton mass $m_L$. It is believed that the quarks/gluons sub-structure is confined within $r_1$. In that graph, ħ amplitude is arbitrarily given the $r_4$ value, but it could be smaller.



## Charge-to-momentum ratio

It becomes evident that for a composite particle such as the proton, only a fraction of the mass, or more precisely a fraction of the initial momentum may give rise to the charge. Therefore the true charge-to-mass ratio may sometimes be difficult to estimate.

In the case of the spiral proton, the charge-to-momentum is easily determined using the values of $m_S$ ($0.185 \text{x} 10^{-27}$ Kg) and $v_S$ ($2.875 \text{x} 10^{8}$ $ms^{-1}$) associated with S. And therefore,

(4) $$\frac{+e}{m_S v_S} = \frac{1.602\, x\, 10^{-19} C}{0.532\, x\, 10^{-19} Kgms^{-1}} = 3.01 \;\; C/Kgms^{-1}$$

It is worthwhile noticing that this ratio is almost exactly 3. Divided by the speed of light c, the charge-to-energy ratio is precisely 1.004 C/Joule. This result is astonishing, for it reveals that it takes 1 joule to produce a positive charge of 1 coulomb within the proton. This result could be the first example of such an astonishing equivalence.

Further, this value is several orders of magnitude smaller than the equivalent from the electron to generate the charge -e. It may indicate that the charge -e is easier to produce than it's counterpart +e, or it shows the extraordinary efficacy for the electron in generating the charge -e (and it's large magnetic moment).

## Conclusion

Angular momentum acquisition and spiral motion seems to drive particle creation, including composite particle such as the proton. The creation phase necessarily requires an initial momentum $m_i v_i$ which has the ability to initiate spiral motion via quantized circular orbitals, while obeying momentum and energy conservation rules. It obviously offers some logics to the existence of the particle intrinsic angular momentum, if we consider it as a protraction of a preliminary spiral motion. This approach is not necessarily in conflict with the quarks/gluons theory of QCD, if we apprehend the latter as a sub-structure originating from a proton internal process, since quarks are only seen inside hadrons.

This approach led to the conclusion that the proton was constructed from 2 opposing angular momenta $S=\hbar/2\Phi$ and $L=\hbar\Phi/2$ whose resultant is precisely $\pm\hbar/2$. In this paper, it is further concluded that those two angular momenta originate from two different momenta called $m_Sv_S=12\times10^{-20}$ Kgms$^{-1}$ and $m_Lv_L=38.14\times10^{-20}$ Kgms$^{-1}$, which sum makes up the initial momentum $m_iv_i=m_Oc=50.14\times10^{-20}$ Kgms$^{-1}$. It also appears that $m_Sv_S$ is electromagnetic in nature and give rise to S, to the charge +e, to the proton magnetic moment μ, and to about 11% of the mass. Coincidently, this percentage corresponds to the total contribution of the 3 quarks to the mass of the proton. On the other hand, $m_Lv_L$ seems to be a mass carrier of a different nature and gives rise to L and to 89% of the mass.

The determination of the moment of inertia $I_S$ associated with S pinpoints to a hollow spherical geometry of radius $r_4$=0.875 fm and superficial charge +e. On the other hand, the calculated moment of inertia associated with L led to a non-spherical spatial geometry located within 0.224 fm from the proton mass center. The angular velocity associated with L was found ~3.5 times the angular velocity of the spherical cavity associated with S.

It is recognized in this paper that the need for a g-factor as a proportionality constant may originate from a wrong selection of M or/and S. The existence of a composite angular momentum within the proton seems to be confirming the source of this discrepancy. The use of a g-factor=1 associated with S seems to fit the calculations.

Simple calculations of charge-to-energy-ratio lead to the striking equivalence Coulomb vs. Joule with regards to the +e charge of the proton and the energy-momentum associated with it. It looks as if the electron is several orders of magnitude more efficient at producing the -e charge.

This paper may trigger fundamental questions regarding the nucleosynthesis of primordial elements.

## References

*[1] Angular Momentum Acquisition and Spiral Motion, a Requisite for Particle Creation. A Case Study, the Proton. Bruno R Galeffi, ViXra : 1809.0594*

*[2] Chopin GR, Lijensin J-O, Rydberg J, Radiochemistry and Nuclear Chemistry, Butterworth-Heinemann, 2001, 1-323-288*