International Journal of Research (IJR) Vol-1, Issue-6, July 2014 ISSN 2348-6848

A Spiral Structure for Elementary Particles

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Abstract

In this paper we have tried to deduce the possible origin of particle and evolution of their intrinsic properties through spiral dynamics. We consider some of the observations which include exponential mass function of particles following a sequence when fitted on logarithmic potential spiral, inwardly rotating spiral dynamics in Reaction-Diffusion System, the separation of Electron's Spin-Charge-Orbit into quasi-particles. The paper brings a picture of particles and their Anti Particles in spiral form and explains how the difference in structure varies their properties. It also explains the effects on particles in Accelerator deduced through spiral dynamics.

Keywords: spiral, particles, intrinsic, quasi-particles;

Introduction

The approach of fitting parts of elementary particle mass involving logarithmic potential and with a constant energy $\boldsymbol{pc}$ resulting in points on a logarithmic spiral lining up under a polar angle $\boldsymbol{\theta}$ and separated by a factor ɞ as given in figure below:

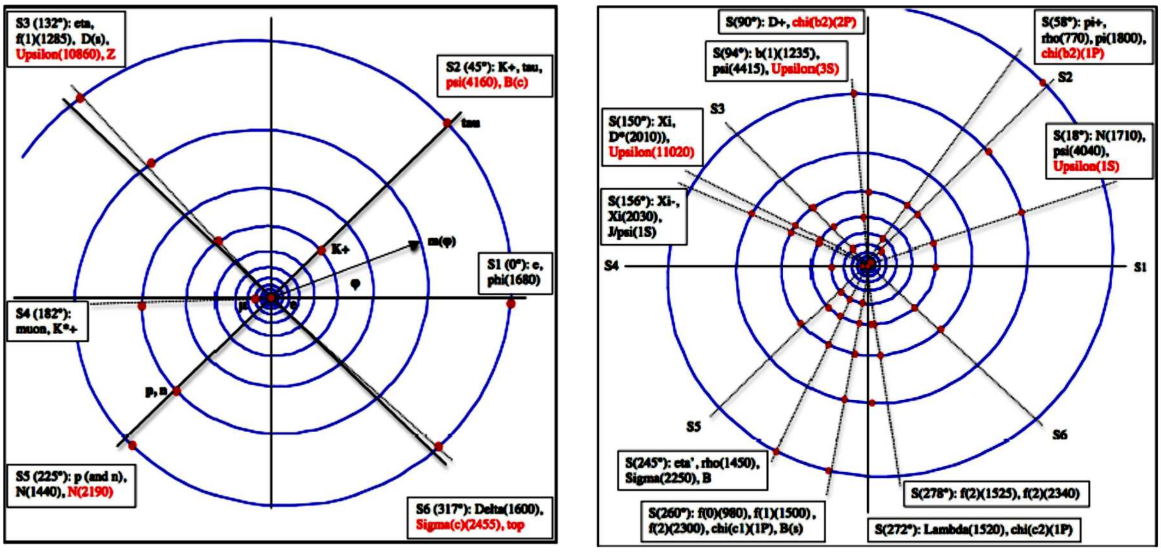


Fig 1: The masses of elementary particles placed on the spiral and listed for each resulting sequence starting from the centre. The solid lines are separated by 45 ^{0}. The red dot in the centre is the electron at 0 ^{0}. The outer limit of the spiral at 135 ^{0} is about 2 GeV in first figure

and at 80 ^{0} is about 6.5 GeV in second figure. Particles allocated on a sequence, but with masses too large for this scale are marked red in the attached listings of sequence particles. The top for example is far outside on S6 at 317 ^{0}.

This pattern of distribution along a straight line in achieved with a specific derived value of ø $= \mathbf{1.53158}$ providing symmetric and precise result. The existence of unique ø is an indication of constituent moving in a logarithmic potential resulting in an exponential quantization of elementary particle mass.

The constituent of electron has already been observed which includes Spinon (Spin), Holon (Charge) and Orbiton (Orbit) in an experiment where High Energy Resonant Inelastic X-Ray Scattering (RIXS) is incident on Mott-Insulator Sr_2CuO_3. These quasi-particles were associated with specific properties independent of others and also with different directions. The observation is provided in Fig 2:

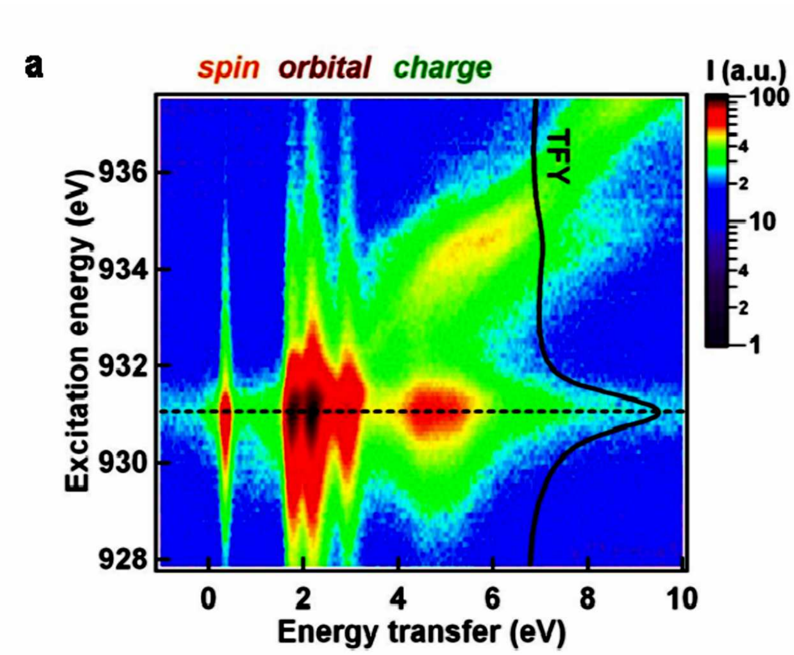


Fig 2: Energy Spectra observed for the constituent of electron i.e. Holon, Spinon and Orbiton. TFY stands for Total Fluorescent yield in experiment. Here Excitation Energy is the amount of energy required to be incident through X-Ray for the particle to get into the state where it could break into constituents. Energy Transfer represents the amount of energy emitted along with constituent particles.

But these quasi-particles were not yet been described in terms of logarithmic potential to satisfy the observation in fitting of exponential mass function. It has been tried in this paper to deduce such description. Also for validation of particles spiral dynamics model, its phenomenon to increase mass in accelerator has been explained.

<u>Mathematical structure of Spiral</u>

From reaction-diffusion equation we have,

$$\boldsymbol{ut} = \boldsymbol{D\Delta u} + \boldsymbol{f}\,(\boldsymbol{u}) \quad \text{...(1)}$$

where $\boldsymbol{u} = \boldsymbol{u}\,(\boldsymbol{r}\,, \boldsymbol{t}\,, \boldsymbol{\theta})$ is a stable variable and describes the concentration of energy fluxes. $\boldsymbol{D}$ represents the Diffusion Constant of the excitable medium. Since inside the potential well, fluxes have associated direction as well. Thus replacing the laplacian in eq. (1) with vector laplacian.

$$\boldsymbol{ut} = \boldsymbol{D}[\boldsymbol{Grad}(\boldsymbol{Div}(\boldsymbol{u})) - \boldsymbol{Curl}(\boldsymbol{Curl}(\boldsymbol{u}))] + \boldsymbol{f}\,(\boldsymbol{u}) \qquad \textbf{...(2)}$$

Here in the laplacian term, the first term describes the gradient of divergence. Since, the spiral emerges in an excitable medium as the result of wave break, open ends of broken wave evolve because of the dependence of velocity, $\boldsymbol{v}(\boldsymbol{r})$ on the curvature $\mathbf{1}/\boldsymbol{r}$, by eikonal eq.

$$\boldsymbol{v}(\boldsymbol{r}) = \boldsymbol{co} - \boldsymbol{D}/\boldsymbol{r} \qquad \textbf{...(3)}$$

Taking the wave in Fitzhugh Model which describes the spiral in a saturated system, i.e. $\boldsymbol{D} = \mathbf{1}$ and also taking $\boldsymbol{co} = \boldsymbol{c}$, we have,

$$\boldsymbol{v}(\boldsymbol{r}) = \boldsymbol{c} - \mathbf{1}/\boldsymbol{r} \qquad \textbf{...(4)}$$

The local curvature near the wave ends is high, making the velocity of the end small Focussing on structure of spiral, A Spiral is described by a periodic function of phase

$\mathbb{Q}(\boldsymbol{r})$ = Defines the potential function of Spiral, $\boldsymbol{\Omega}$ = Frequency of the Spiral and $\boldsymbol{n}$ = number of arms in spiral. Thus, from the deduction of Laplacian we have,

and forcing it to rotate around the spiral core. In addition to determine the rate of autocatalysis of the spiral system of particle, we have,

$$\boldsymbol{co} = \sqrt{(\boldsymbol{yD})}$$

Taking $\boldsymbol{D} = \mathbf{1}$ and $\boldsymbol{co} = \boldsymbol{c}$, we have

$$\boldsymbol{y}\,(\boldsymbol{rate\ of\ autocatalysis}) = \boldsymbol{c}^2 \qquad \textbf{...(5)}$$

Hence, the first term of Laplacian defines the overall potential of wave responsible for spiral formation. The second term $\boldsymbol{Curl\,Curl}(\boldsymbol{u})$ represents the potential decayed to achieve satisfied stable spiral.

Thus, our laplacian term describes the potential available for the behaviours of elementary particles. With **D=1** our reaction-diffusion equation becomes,

$$\boldsymbol{ut} = \boldsymbol{\Delta u} + \boldsymbol{f}\,(\boldsymbol{u}) \qquad \textbf{...(6)}$$

Since the spiral system of particles is isolated and no reaction occurs but only the diffusion of potential fluxes takes place. Thus our equation finally becomes,

$$\boldsymbol{ut} = \boldsymbol{\Delta u} \qquad \textbf{...(7)}$$

$$\Phi = \boldsymbol{\Omega t} + \boldsymbol{n\theta} + \mathbb{Q}(\boldsymbol{r}) \qquad \textbf{...(8)}$$

$$\mathbb{Q}(\boldsymbol{r}) = \boldsymbol{Curl\,Curl}\,(\boldsymbol{u}) \qquad \textbf{...(9)}$$

$$\text{Therefore, } \boxed{\Phi = \boldsymbol{\Omega t} + \boldsymbol{n\theta} + \boldsymbol{Curl\,Curl}\,(\boldsymbol{u})} \qquad \textbf{...(10)}$$

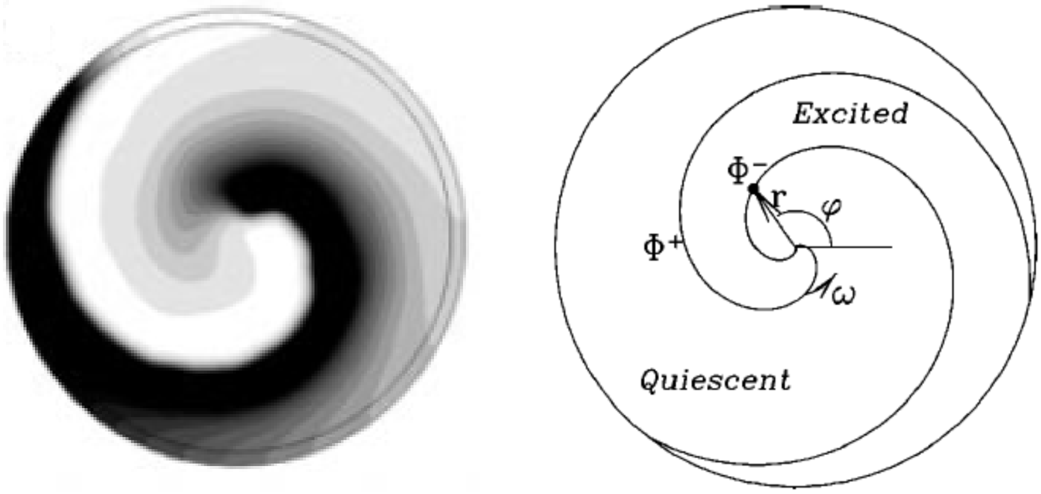


Fig 3: Sketch of the spiral geometry and coordinates. The spiral is described by the two interfaces: a wave front $\Phi^+(\boldsymbol{r})$ and a wave back $\Phi^-(\boldsymbol{r})$. These interfaces separate the medium into excited and quiescent regions. The spiral rotates with angular frequency ω. Positive ω corresponds to counter-clockwise rotation.

Fixing **t** and keeping Φ constant,

$$\left[\frac{\boldsymbol{dr}}{\boldsymbol{d\theta}}\right] = -\frac{\Phi\boldsymbol{\theta}}{\Phi\boldsymbol{r}} = \frac{\boldsymbol{m}}{\text{Ꝏ}'(\boldsymbol{r})} \qquad \textbf{...(11)}$$

In our model the value of $$\text{Ꝏ}'(\boldsymbol{r}) = \frac{\boldsymbol{d}\,[\boldsymbol{Curl\,Curl}\,(\boldsymbol{u})\,]}{\boldsymbol{dr}} \qquad \textbf{...(12)}$$

Also we know that, wavelength of Spiral is defined by the distance between the successive arms as:

$$\boldsymbol{\lambda}\,(\boldsymbol{r}) = \boldsymbol{r2} - \boldsymbol{r1} \qquad \textbf{...(13)}$$

$$\boldsymbol{\theta}\,(\boldsymbol{r2}\,) - \boldsymbol{\theta}\,(\boldsymbol{r1}\,) = \boldsymbol{2\pi} \qquad \textbf{...(14)}$$

We also have a definition for $\boldsymbol{\lambda}\,(\boldsymbol{r})$ as follows,

$$\int_{\theta(r)}^{\theta(r)+2\pi} \frac{\boldsymbol{dr}}{\boldsymbol{d\theta}}\, \boldsymbol{d\theta} = \int_{\theta(r)}^{\theta(r)+2\pi} \left[\frac{\boldsymbol{n}}{\frac{\boldsymbol{d}\,[\boldsymbol{Curl\,Curl}\,(\boldsymbol{u})]}{\boldsymbol{dr}}}\right] \boldsymbol{d\theta}$$

$$= \int_{\text{Ꝏ}(r)}^{\text{Ꝏ}(r)+2\pi} \left[\frac{\boldsymbol{n}}{\frac{\boldsymbol{d}\,[\boldsymbol{Curl\,Curl}\,(\boldsymbol{u})]}{\boldsymbol{dr}}}\right] \boldsymbol{d\theta} \qquad \textbf{...(15)}$$

From behaviour analysis we have from ***Fig 1***, our elementary particle masses lining up in a sequence along a straight line on the logarithmic spiral,

$$\boldsymbol{m}(\boldsymbol{\varphi}) = \boldsymbol{m_0 e^{k\varphi}} \quad \textit{where},\ \boldsymbol{k} = \frac{\boldsymbol{1}}{\boldsymbol{2\pi}}\boldsymbol{ln}\,\text{ᴓ} \qquad \textbf{...(16)}$$

One turn of Spiral corresponds to multiplying $\boldsymbol{m}(\boldsymbol{\varphi})$ by ᴓ i.e.

$$\boldsymbol{m(\varphi)} \varnothing = \boldsymbol{m(\varphi + 2\pi)} \qquad \text{...(17)}$$

Deducing the behaviour for particles, with growth in angle by $\boldsymbol{2\pi}$ the mass and consecutively the frequency increase by $\varnothing$ in case of wavelength we have, $\boldsymbol{\lambda'(r)} = \frac{\boldsymbol{\lambda\,(r)}}{\sqrt{\varnothing}}$

...(18)

Thus our phase equation becomes for increase in angle by $\boldsymbol{2\pi}$,

$$\boxed{\Phi = \boldsymbol{\Omega} \varnothing \boldsymbol{t} + (\boldsymbol{n} + \mathbf{1})\boldsymbol{\theta} + \text{Ꝏ}(\boldsymbol{r})\left(\mathbf{1} + \frac{\text{Ꝏ}'(\boldsymbol{r})}{\text{Ꝏ}(\boldsymbol{r})}\right)} \qquad \text{...(19)}$$

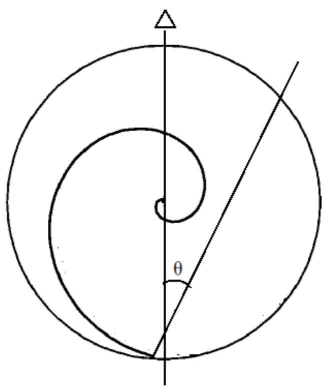
From above we have the potential i.e. $\boldsymbol{Curl\ Curl\ (u)}$ less for $\boldsymbol{m(\varphi)}$ then for $\boldsymbol{m(\varphi + 2\pi)}$ as in spiral dynamics of elementary particles, the increase of factor $\varnothing$ can be deduced by increasing an arm which consecutively increase the frequency along with mass by $\varnothing$ and decreases the radius of each spiral arm along cross section along with the wavelength, where decrease in wavelength is by a factor $\frac{\mathbf{1}}{\sqrt{\varnothing}}$.

From eq. (15) we have, the solution of integration taking **n=1** for single arm as,

$$\frac{1}{\frac{d\,[Curl\ Curl\ (u)]}{dr}} \approx \lambda\,(r) \quad \Longrightarrow \quad \boxed{\frac{d\,[Curl\ Curl\ (u)]}{dr} \approx \frac{1}{\lambda\,(r)}} \qquad \text{...(20)}$$

The angular uniformity is maintained in the distribution is due to angle between the core and tip of the spiral being kept conserved. Finally, we know that keeping the radius constant, if we curl up to produce an additional arm with angle preserved, we have mass growth of $\varnothing$ factor . Thus we have,

$$Mass\ is\ propotional\ to\ \frac{1}{\left(\frac{dr}{d\theta}\right)}\ .$$



The term $\text{Ꝏ}'(\boldsymbol{r})$ gives the variation in potential required to increase the number of arms for a spiral.

Deducing the distribution along the spiral by the logarithmic potential due to exponential mass function of elementary particles, we can easily picture out the frequency to be the representation of the length of spiral.

Fig 4: Representation of angle preserved in exponential mass distribution.

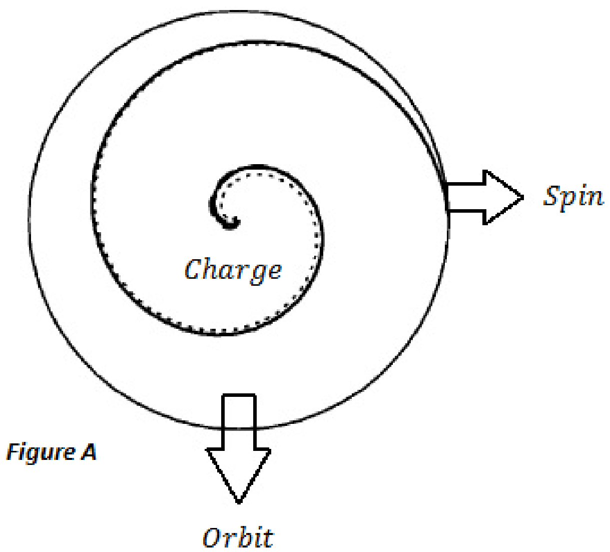
Let us assume to have a wave of constant wavelength equal to Planck's length i.e. $\boldsymbol{l}$**p = 1.616199e-35 meter**. Thus we have frequency also conserved along with wavelength. If we distribute it along the length of spiral we have a well stable architecture of the distribution of particles and anti particles satisfying the rules of quantum mechanics.

According to exponential mass function. with increase in number of arms, the length increases as well and consecutively the frequency. The frequency here is conserved by increase in angular velocity of rotation of the spiral since the wavelength is constant. And is well reflected through the decrease in spiral wavelength i.e. $\boldsymbol{\lambda}'(\boldsymbol{r})$.

<u>Physical Approach to structure of Spiral to explain the intrinsic behaviour.</u>

The deduction of quasi-particles from the elementary particles is well satisfied by the properties and structure of spirals. Before we begin to explain, let's look into some of the properties of Spirals and Anti Spirals.

1. Arms of a single Anti Spiral can break, collide and merge far from the centre.
2. New waves emerge at boundary for Anti Spiral.
3. Spiral Waves annihilate at boundaries.
4. Stable Spiral never collides.



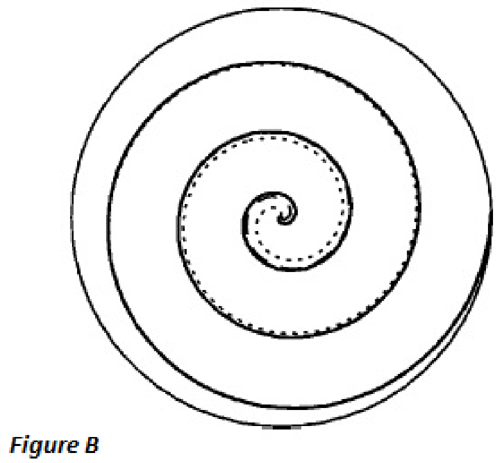


Fig 5: Possible Representation of intrinsic properties in accordance with the quasi-particles observed in the experiment of RIXS treatment of mott- insulator.

Let the Anti Spiral above be a representation of electron. From the quasi 1D mott insulator experiment, we have spectra map for the constituents or quasi-particles of electron given in **Fig 2**.

The relation between the spectra map and spiral structure can be explained as on the basis of penetration energy required to get in the spiral and secondly to associate the deconfined behaviour of these independent quasi-particle in their separate degree of freedom with the independent variables describing the fluxes i.e. radius for orbiton, angle for holon and time for spin :

$Spin$ ($0.8\ eV$): The spin of the particle is determined by the count of the tip of the spiral. It provides details of the portion of wave considered in spiral. Studying the pattern revealed for the spiral structure to describe the different particles family of Standard Model, we have integer spin bosons represented along the wavelength of stationary wave with wavelength$\boldsymbol{\lambda/2}$ having two tips, unlike fermions which are represented by half of the boson wavelength i.e. $\boldsymbol{\lambda/4}$ having single tip**.** These illustrations of the waves are provided below:

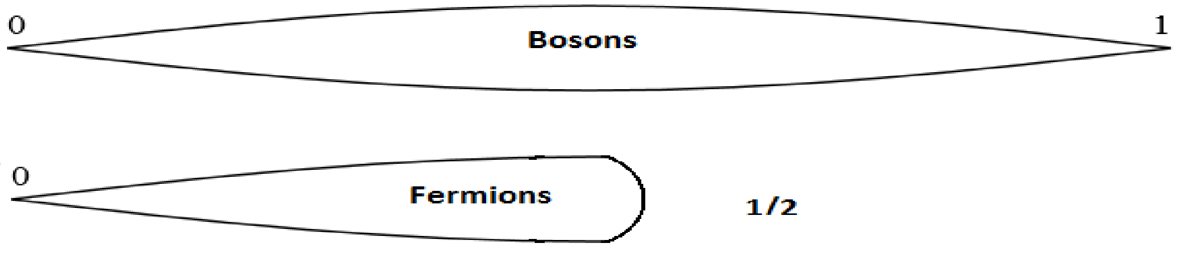


Fig 6: Represents the portion of wave responsible for formation of spiral and Antispiral and also determining the spin of the particle.

$Orbit$ ($2 -\ 3.5\ eV$): The orbit of the particle is determined by the mass – energy quantisation of particle determined in spiral dynamics by $\boldsymbol{\frac{dr}{d\theta}}$as discussed earlier.

$Charge$ ($4.3 - 5.6\ eV$): The Charge of the particle is determined by the direction of curl provided by the potential i.e. $\boldsymbol{\frac{d\ [Curl\ Curl\ (u)]}{dr}}$**.** And its quantization is done on the basis of angle of curl i.e. if the angle of Curl is

Table 1: Angle of Curl for different charges.

Charge	**Angle of Curl (in ^{0})**
0	0
1	180
1/3	60
2/3	120

The charges of 1/3 and 2/3 are not able to achieve the stable structure. Hence, these particles always exist as composite particles.

Proceeding further, the charges along the complete potential defines the characteristic of the particles as given in the below table and represented in the diagram below:

Table 2:Structure for Particle and Anti Particle.

Character	***Structure***
Antiparticle	Spiral
Particle	Antispiral

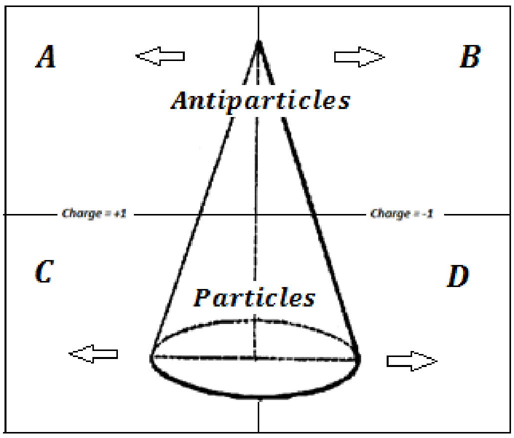


Fig 7: Representation of charge deviation of particle. If the particle is positive charged it takes clockwise rotation and if it's negatively charged it takes anti-clockwise direction. This is vice versa for the Anti Particles. The horizontal separation divides among the Particles and Antiparticles.

Characteristics of particles in different quadrants above:

- Particle annihilates with diagonal quadrant i.e. A annihilates with D. Thus we can say A is the Antiparticle of D. Similarly B is the antiparticle of C and annihilates on interaction.
- Particle adjacent horizontally attract each other like in C and D also in A and B. Since they are both of same structure i.e. either Particle or Antiparticle with having opposite direction, they attract each other and can exist closer by.
- Particle adjacent vertically repel each other like in A and C also in B and D. Since they are both of opposite structure with having same direction, they repel each other and because of this we don't have annihilation.

The last two characteristics can be easily observed in different physical system like gear mechanics, etc. The distribution of properties in **Fig 5** also holds as the Spin and Orbit are phenomenon of Angular Momentum.

In the spiral dynamics of particles, the excitation energy absorbed by the particle tends to increase the length or thickness of spiral. Conserving the quantity $\frac{dr}{d\theta}$ which represents the main structure of spiral and also the length of the spiral, the absorbed energy is emitted out in the form of photon or transfer energy in concerned experiment.

It must also be noted that the conserved particle's structure can be altered only by the photon through resonance. The energy map or spectra map is produced due to energy being emitted off from different parts of spiral. The different parts are presented in the ***Fig. 5.***

Some notable points deduced are:

1. Since quarks have spin similar to electron. The structure would be same with

$$\frac{dr(quark)}{d\theta} < \frac{dr(electron)}{d\theta}$$

This is because the mass of quark is more than that of electron an as presented earlier in this paper, Mass is inversely proportional to $\frac{dr}{d\theta}$.

2. Similarly, for Neutrinos having spin similar to quarks and electrons.

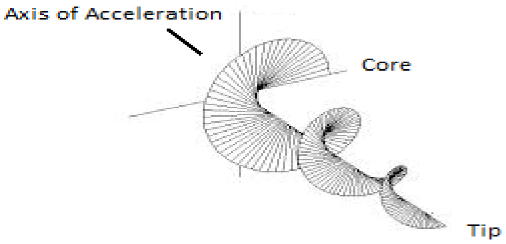
$$\frac{dr(quark)}{d\theta} < \frac{dr(electron)}{d\theta} \ll \frac{dr(neutrinos)}{d\theta}$$

Illustration of Acceleration of Particles in Spiral Dynamics.

Some of the basic facts which we know for particle acceleration are as:-

1. The mass increases with velocity.
2. The velocity in any case can't reach the speed of light i.e. particles can never become photon.

In Spiral Dynamics, as we increase the velocity of particles closer to the speed of light, the core of the spiral curls around the axis of acceleration and the tip coincides with the axis of acceleration. This can be visualized from the figure below:



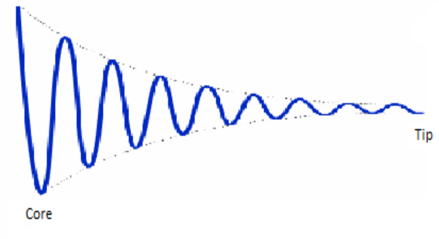


Fig 8: Representation of structure of Antispiral when accelerated with velocity closer to speed of light.

Once the spiral is completely curled up on the axis of acceleration, further increase in velocity decreases the quantity $\frac{dr}{d\theta}$. Hence, increases the mass of the particle. Also this phenomenon never allows particle to attain a straight waveform free from curl to behave as photon, since from observations we know that the acceleration also preserves the curls in the waveform at some extent and can never get free from it.

Conclusion.

As per the study conducted above, we can easily deduce the existence of the particle through spiral dynamics and many of the properties of particles. It is also interesting that now the dynamics of spirals for galaxy structure can also be used for elementary particles. Our further study tries to fit the picture of these micro spirals of elementary particles into the macro spirals of Cosmos which can help us to deduce the definition of Dark Potentials. This can also be a basic ingredient for unified theory.

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