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Highlights

- Earth's Outer Core Metal Liquid
- Elastic-Plastic Fracture Mechanics
- Relativity and Quantum Mechanics
- Twisters and Traveling Higgs Bosons

Discovering Thoughts, Inventing Future

VOLUME 25 ISSUE 1 VERSION 1.0

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Earth's Outer Core Metal Liquid Flow Generates Magnetic Field without using Geodynamo

By Angel Perez Sanchez
Comillas University (ICADE)

Abstract- The aim is demonstrating Earth's outer core liquid metal flow can create geomagnetism itself without having to resort to Geodynamo effect.

Geomagnetism Generation, is currently a mystery and leading existing theory "Earth's core and Geodynamo" hasn't yet been able to explain Earth's magnetism formation clearly.

Explore another way Earth's magnetism is formed, by electric current movement through the outer core's liquid metal flow considered as a whole and not divided into separate convection currents.

This leads us to a more straightforward geomagnetism theory without adding a sum of convection currents to create a global magnet that covers the Earth.

The result is a reasonable theory of geomagnetism that would also explain Magnetic Declination and Geomagnetic Reversal, while opening a new way on Sun's magnetism and planets magnetism research.

GJRE-A Classification: *LCC: QC809.M25*

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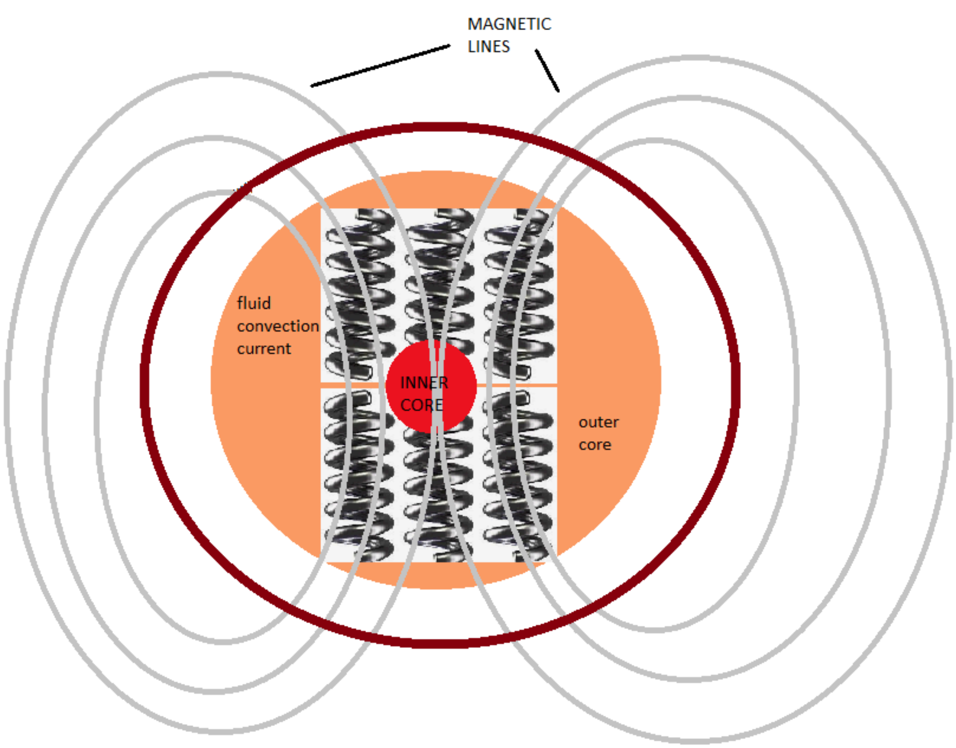
I. Earth's Magnetism

General, magnetism can be generated by:

1. *Permanent magnet*

Geomagnetism can't come from a permanent magnet because it is affected by core heat, since heat, demagnetizes permanent magnets.

2. *Dynamo effect,* (a conductor is placed around a magnet, when it rotates around the magnet, produces an electric current that generates a magnetic field.



Outer core's convection currents rotate around a pre-existing magnetic field and is difficult to explain how this pre-existing magnetic field is formed and how convection currents rotate around it; at the same time, it would be necessary to unify effect of all convection currents in a single terrestrial magnet.

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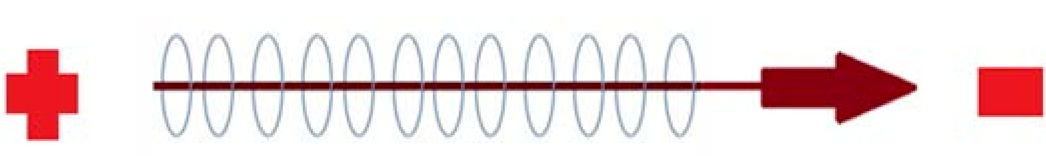
3. *Electric current*

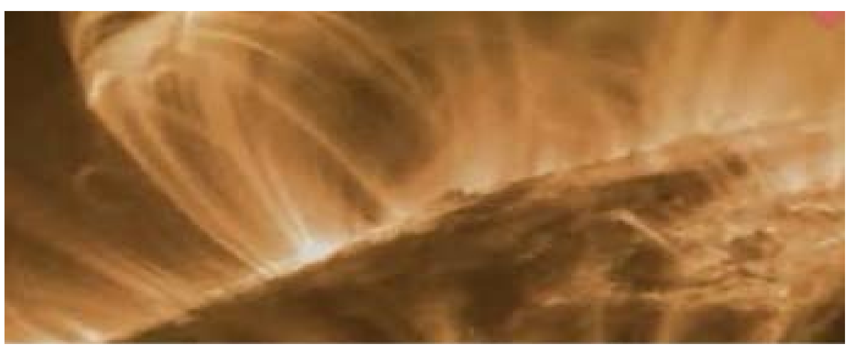
Let's start with a magnetic field generated by an electric current wire.



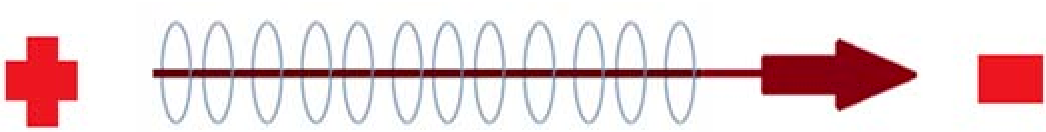
To understand geomagnetism is produced by an electric current, we must consider Earth's outer core with electrically charged liquid metal motion, which behaves like the flow of electricity in a current-carrying wire.

Can a charged liquid metal flow generate a magnetic field?

To answer this question, look at these photos of magnetic fields generated on the Sun by plasma flow. (Obtained from NASA on TV series: "The Universe" Secrets of the Sun).

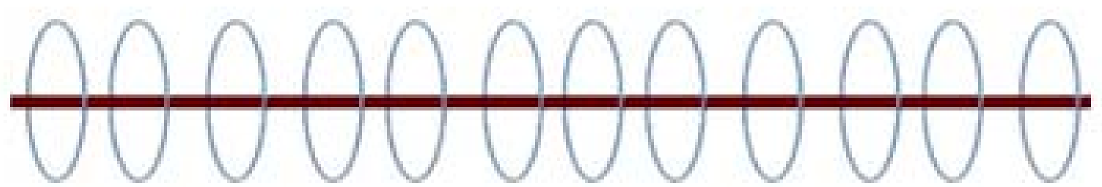


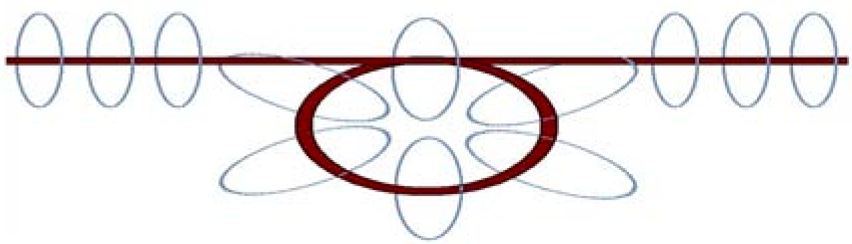
There is a similarity between the magnetic field generated by a current cable and that generated by plasma flow.

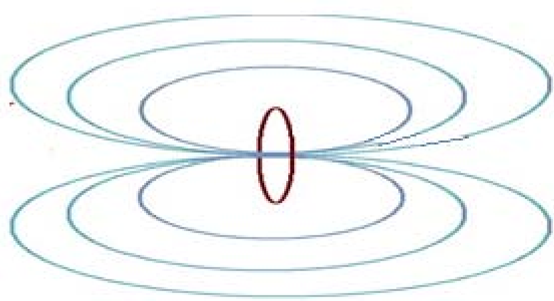


How do we go from magnetic field created by Sun charged plasma flow to magnetic field created by Earth?

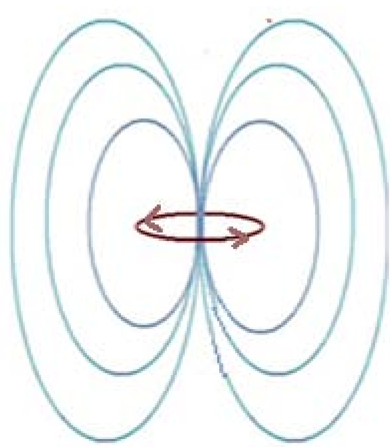
Twisting a current-carrying wire:







Magnetic field produced by current coil.



Horizontal view of magnetic field produced by current coil.

If Earth's outer core charged liquid metal flow is rotary, we obtain a magnetic field similar to a current coil.

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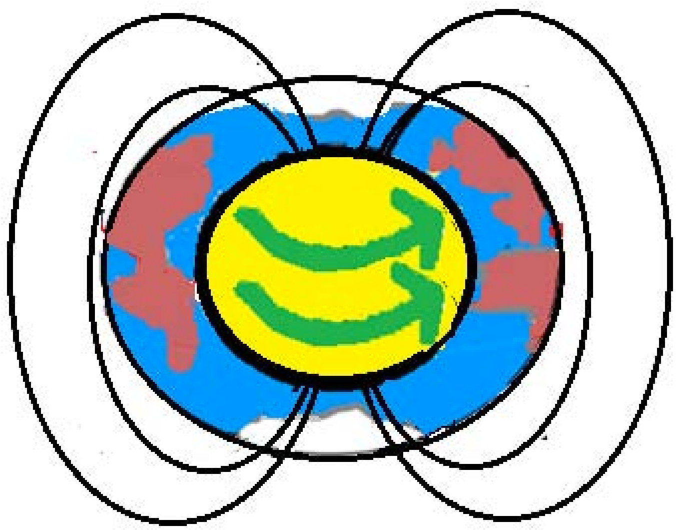


Due to Earth's rotation, charged Earth's outer core liquid metal (iron and nickel) keeps a rotary inertial motion.

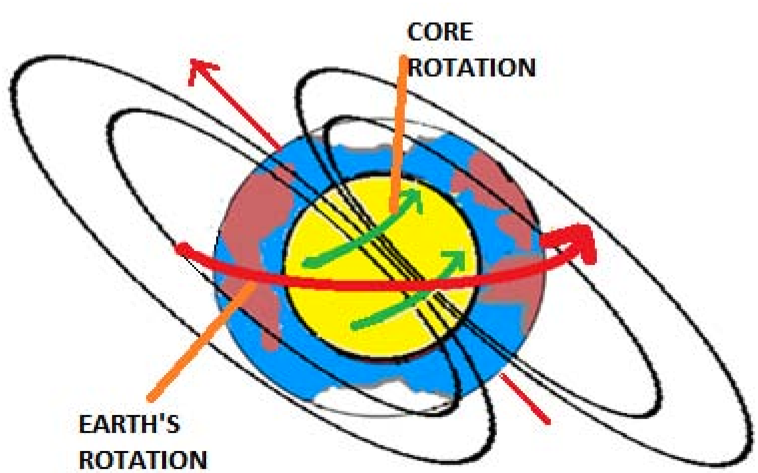
But how can this fluid metal be charged?

II. Charging by Friction Hypothesis

Electrification by friction: When we rub two neutral materials, both are charged, one with a positive charge and the other with a negative charge, so that when they separate both bodies remain with opposite charges.

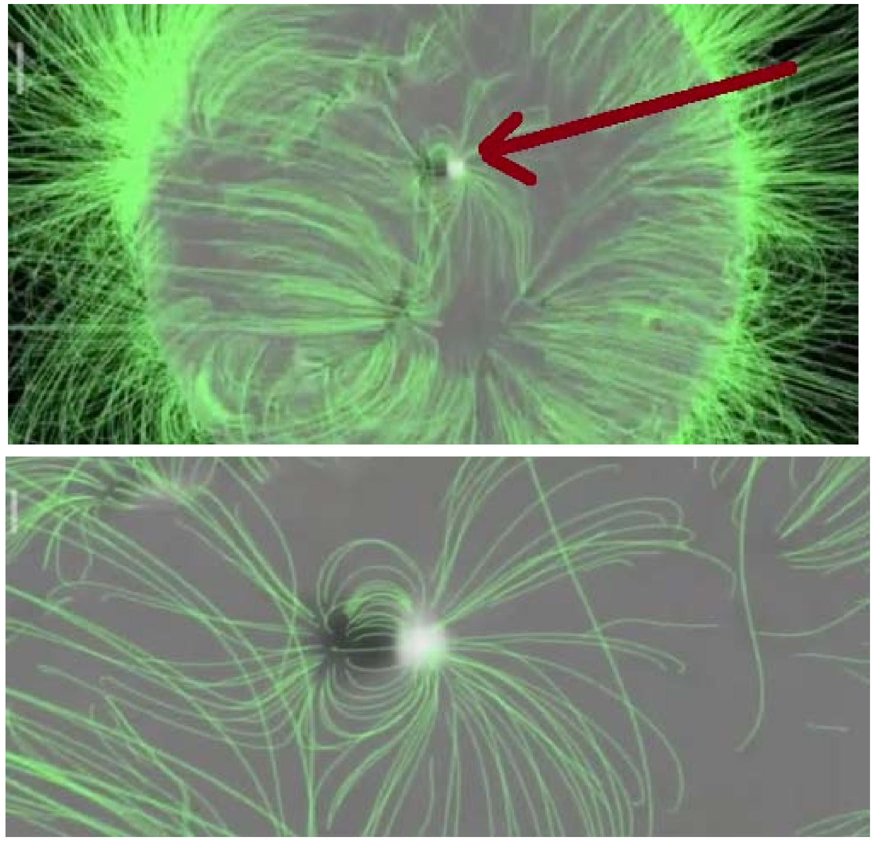
Earth's mantle rubs against metallic outer core. Due to friction, Earth's mantle atoms electrons are released and transferred to Earth's outer core, whereby mantle becomes positively charged and core negatively charged. The core's metallic fluid, once charged, produces a current coil effect when it rotates.

For this effect to occur, the outer core's spin can't be synchronized with Earth's mantle and crust rotation: This rotation must be asynchronous.



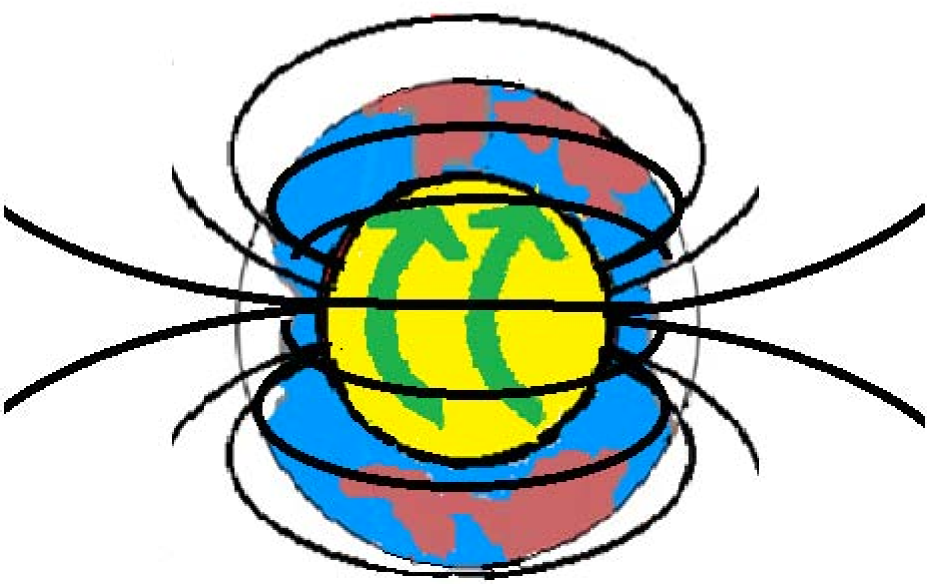
This asynchrony is produced by different density between mantle and outer core.

How to get proof magnetic field is produced by a circular metallic fluid current?
On following image, a circular Sun plasma stream creates a magnetic field similar sized to a planet.

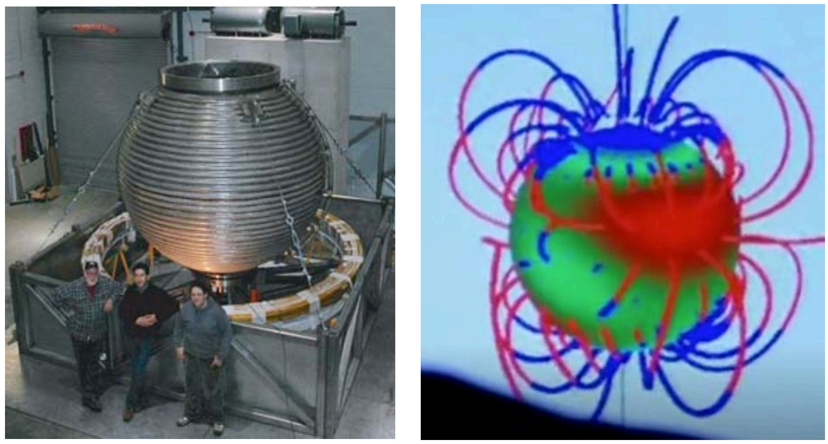


Images from NASA on the TV series: "The Universe" Secrets of the Sun

Circular motion on solar plasma flow creates a magnetic field similar to Earth's magnetic field.



Dr. Daniel Lathrop's theory explains how a liquid metal ball can generate magnetism, and he experimented with a ball in which he deposited liquid metal that rotated at 30 revolutions per second.



Images from Maryland University Geodynamo Laboratory

Dr. Laudrup doesn't get a homogeneous magnetic field like Earth's, instead he gets a chaotic one.

How can Earth's liquid metal core rotation create a homogeneous magnetic field?
The way the outer core rotates and charges itself, could be the answer.

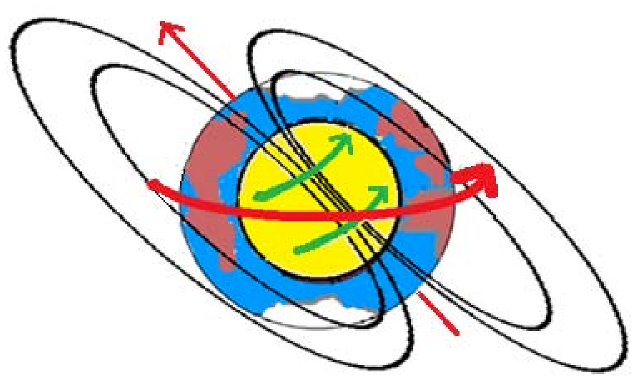
Earth's crust and mantle rotate at a certain speed, and drag the rotation of the core, but the latter, having a higher density, rotates at a slower speed than mantle, and both do not rotate in synchrony. This asynchronism is what produces charge of metallic outer core.

The way outer core rotates, acts as a uniform whole, and charges itself electrically, also acts as a uniform whole, which gives homogeneous to Earth's magnetic field, instead of creating chaotic magnetism like Dr. Daniel's experiment.

Magnetic field created by a circular solar plasma stream: are the proof of geomagnetism can be produced similarly to an electric current flow through a wire without needing Geodynamo.

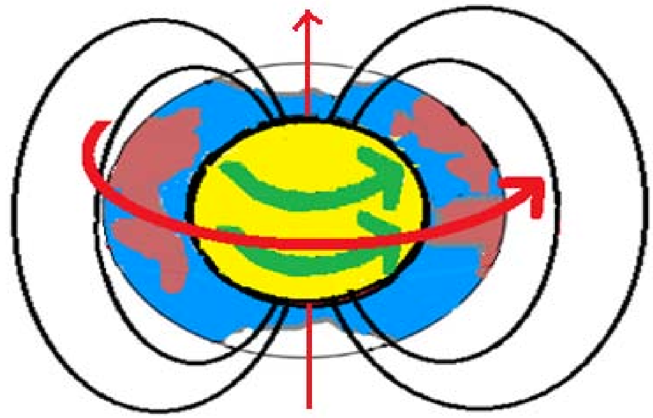
III. Secular Variation Hypothesis

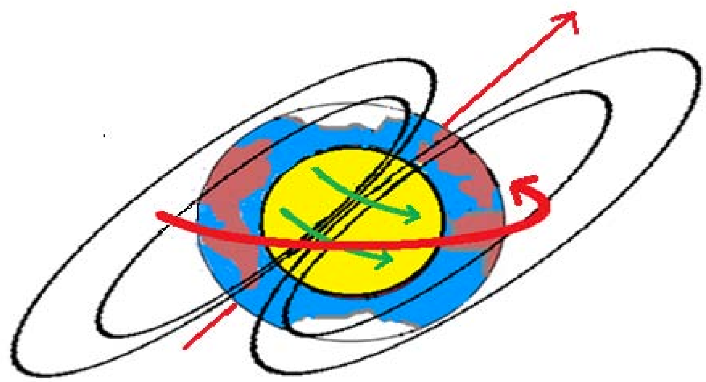
Owing to Earth's outer core fluid motion, magnetic poles are constantly Moving.



Earth's core has a different motion (green lines) than Earth's rotation (red line). Different direction and speed, is necessary for outer core to be charged by friction.

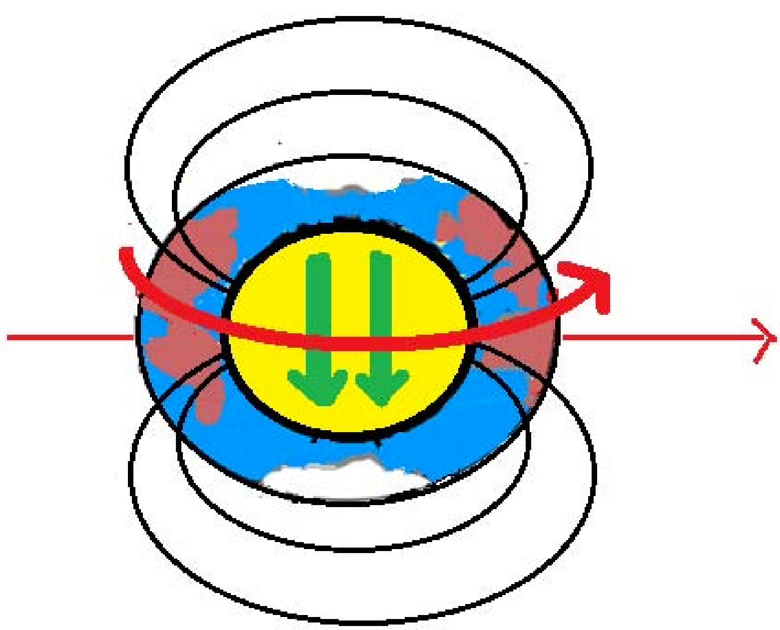
This difference between mantle and core rotation direction is the cause of magnetic declination. The hypothesis is: core is changing its plane rotation by turning it clockwise.

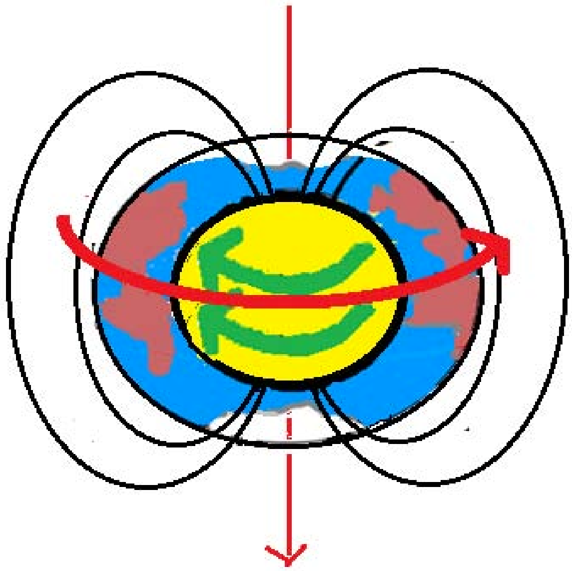




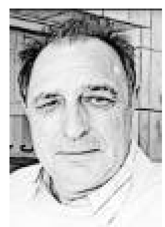
IV. Geomagnetic Reversals Hypothesis

If Secular Variation continues clockwise direction; magnetic declination can turn into a magnetic reversal.





Biography



Angel Perez Sanchez was born in 1961 in Madrid, Spain and studied at the Comillas University (ICADE) (Madrid-Spain), obtaining the title of Business Lawyer in 1986; Independent researcher, scientific writer.

Books:

- "Unveiling the Mysteries of Magnetism"
- "The Book of Evolution Evolutionary Memory"
- "Finally, a Reasonable Theory of Everything"
- "The Essence of the Crystal"

~ Member of the RSEF Royal Spanish Society of Physics.–

~ Member of the CEMAG Spanish Club of Magnetism–

***"Best Presentation" Award at the International Conference on Accelerated Universe, Dark Energy and Expansion Models ICAUDEEM in October 2023 in London with the presentation "Consideration of Starlight Waves Redshift as Produced by Friction of These Waves on Its Way through Space" "On journal "World Academy of Science, Engineering and Technology", on 2024-10-09.

***"Best Presentation" Award at the International Conference on Condensed Matter, Diamagnetism and Paramagnetism ICCMPDP in August 2023 in Barcelona with the presentation "Magnetic Lines of Force & Diamagnetism" MAGNETIC LEVITATION/Magnetic Lines of Force and Diamagnetism (waset.org)/

Other papers "Consideration of Magnetic Lines of Force as Magnets Produced by Percussion Waves" on journal: World Academy of Science, Engineering and Technology on 6-9-2024.

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Crack Tip Enrichment Functions for the XFEM Applied to the Elastic-Plastic Fracture Mechanics Taking Account for the Constraint Effect

By Jun-Hyok Ri, Hyon-Sik Hong & Kum-Chol Yun

Kim Il Sung University

Summary- In this paper, we propose a family of crack tip enrichment function for the XFEM implementation of elastic-plastic crack, based on the J - Q theory. Such a family of crack tip enrichment function consists of 9 enrichment functions in total, namely, 6 ones previously proposed based on the HRR singular field as well as 3 ones taking account for the crack tip constraint effect. 3 additional enrichment functions are the bases for the higher terms in the asymptotic expansion of elastic-plastic crack tip displacement field. The introduction of these functions into the XFEM enrichment functions enables to improve the approximation of crack tip displacement field significantly. In numerical analysis for the validation of proposed enrichment functions, crack faces are coincident with element boundaries and a crack tip is taken as a node, in order to eliminate other possible errors besides error concerned with the crack tip enrichment functions. By using the general purpose finite element software ANSYS, 2-dimensional elastic-plastic XFEM is implemented for the MBL model as well as various fracture specimens.

Keywords: *XFEM, J−Q theory, elastic-plastic fracture mechanics, crack tip enrichment function.*

GJRE-A Classification: *LCC: TA409*

CRACKTIPENRICHMENTFUNCTIONSFORTHEXFEMAPPLIEDTOTHEELASTICPLASTICFRACTUREMECHANICSTAKINGACCOUNTFORTHECONSTRAINTEFFECT

Strictly as per the compliance and regulations of:

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Jun-Hyok Ri [α], Hyon-Sik Hong [σ] & Kum-Chol Yun [ρ]

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Keywords: *XFEM, $J-Q$ theory, elastic-plastic fracture mechanics, crack tip enrichment function.*

I. Introduction

In general, fracture mechanics has been developed based on the asymptotic expansion of crack tip stress field as well as strain one and displacement one. The elastic-plastic fracture mechanics is based on the crack tip HRR field [12, 22]. Such a HRR field has been originally considered to be characterized by the J-integral in the conventional elastic-plastic fracture mechanics, so called the one-parameter fracture mechanics. The J-integral has been widely used to predict the onset of crack growth as it is a parameter characterizing the singularity of elastic-plastic crack tip field. Nevertheless, numerous experimental studies showed that the fracture toughness J_C has a remarkable difference depending on the geometry and the loading mode. Furthermore, it has been established that the elastic-plastic crack tip field could not be characterized efficiently only by the J-integral according to many numerical studies, leading to the emergency of two-parameter elastic-plastic fracture mechanics. The two-parameter elastic-plastic fracture mechanics includes the $J-A_2$ approach [5, 30] and the $J-Q$ theory [16, 17]. The $J-A_2$ approach is based on the strict mathematical formulation while the $J-Q$ theory belongs to the empirical theory proposed by the numerical studies. The first parameter J represents the singularity of elastic-plastic crack tip field whereas the second one, so called the constraint parameter, reflects the constraint effect of elastic-plastic crack tip field.

It is of great importance to calculate the J-integral as well as A_2 or Q for the assessment of safety of cracked structure by using the fracture mechanics. In general, numerical method like the finite element method has been widely used for the evaluation of J-integral as well as A_2 or Q as their analytical formulae could not be specified in most cases. The conventional FEM requires very fine mesh matched with a crack near the crack tip for the reasonable accuracy of solutions, leading to a large number of finite elements and remeshing concerning with the crack propagation.

The extended finite element method (XFEM) is one of the attractive method for the numerical fracture mechanics since it does not need to use the finer FE mesh near the crack tip and the remeshing as the crack propagates [2, 15]. The main idea of the XFEM is the addition of appropriate functions considering the displacement discontinuity on the crack faces and the displacement singularity due to the crack into the standard FE approximate

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base on the basis of the partition unity method (PUM), leading to the possibility of employment of the FE mesh mismatched with the crack geometry and the improvement of numerical accuracy for the crack analysis.

The linear elastic fracture mechanics has been primarily concerned with the XFEM. For the elastic crack, four enrichment functions have been based on the asymptotic expansion of displacement near the crack tip considering the only the singular term [2, 15]. Even though some authors suggested the enrichment functions regarding the higher terms as well as the singular term in the asymptotic expansion of displacement field near the crack tip, the effect of enrichment functions considering the higher terms was not been clarified [7, 28, 29]. Moreover, increasing the number of the enrichment function can cause the grown up of the degree of freedom, leading to the expensive cost in computation.

In recent years, although the XFEM has made a leaping progress and increasing interest is being shown in the fracture mechanics, previous investigations of the XFEM have dealt almost exclusively with the linear elastic fracture mechanics and some researchers have studed about the elastic-plastic crack [8, 31-35].

For the elastic-plastic crack, 6 crack tip enrichment functions suggested in [6, 21] are based on the HRR singular field. As mentioned above, the introduction of constraint parameter A_2 or Q makes it possible to get the more realistic safety assessment of the cracked structure on the basis of the fracture mechanics. Therefore, it is of essential importance to establish the XFEM applied to the elastic-plastic fracture mechanics taking account for the constraint effect. Nevertheless, very little is known about the XFEM on the elastic-plastic constraint effect.

In this paper, a family of the crack tip enrichment function was studied for the XFEM of the 2D elastic-plastic crack based on the $J-Q$ theory.

Three base functions for the angular distribution function of the crack tip displacement field were determined through the numerical evaluation of the higher terms of the crack tip displacements based on the modified boundary layer (MBL) by using WARP3D. These base functions give the good approximation for the crack tip displacement field. We suggested 9 crack tip enrichment functions including 6 ones based on the HRR field in the previous studies as well as the 3 ones determined by ours, reflecting the crack tip constraint effect for the XFEM applied to the elastic-plastic crack. The crack tip was coincident with the nodal point, the crack faces were matched with the element boundary and the symmetric boundary condition was not considered so that only the effect of enrichment functions on the numerical error could be studied. This enables to neglect the error due to the discontinuous enrichment as well as the numerical integration on the element with the discontinuous faces. The 2D XFEM applied to the elastic-plastic crack was implemented by using the UserElem of ANSYS, the user subroutine for defining the user element. Furthermore, the J-integral was extracted additionally by using the data that was computed by the UserElem. Through the numerical results for the MBL model and several fracture specimens having different constraint levels, we demonstrated that the enrichment functions suggested by ours can improve the numerical accuracy of the XFEM applied to the elastic-plastic crack a great deal as compared with ones proposed previously.

The contents of this paper are as follows. Section 2 gives a brief description of the $J-Q$ theory and the MBL model for modeling cracks. Section 3 describes briefly the XFEM applied to the fracture mechnics. Section 4 explains the crack tip enrichment functions considering the constraint effect and section 5 considers ANSYS implementation of our model. Numerical result for the MBL model and the two types of specimens are presented in section 6. A few concluding remarks are mentioned in section 7.

II. J-Q Theory and the MBL Model

a) $J-Q$ *Theory*

The $J-Q$ theory assumes that the material follows the Ramberg-Osgood constitutive relation as

$$\frac{\varepsilon}{\varepsilon_0}=\frac{\sigma}{\sigma_0}+\alpha\left(\frac{\sigma}{\sigma_0}\right)^n \tag{1}$$

where, n denotes the strain hardening exponent, α the material coefficient, σ_0 the yielding stress, ε_0 the reference strain and E the Young's modulus.

Within a infinitesimal strain theory, the stress field near the mode-I crack tip can be expressed as

$$\frac{\sigma_{ij}}{\sigma_0}=\left(\frac{J}{\alpha\varepsilon_0\sigma_0 I_n r}\right)^{1/(n+1)}\tilde{\sigma}_{ij}(\theta;n)+Q\left(\frac{r}{J/\sigma_0}\right)^q\hat{\sigma}_{ij}(\theta;n) \tag{2}$$

where, r and θ are the components in the polar coordinate system with a origin of crack tip and I_n is a constant which depends only on the hardening exponent n [16, 17].

In Eqs (2), the first term in the right hand is the well-known HRR field and the second one represents the non-singular term with the amplitude of non-dimensional Q parameter.

The displacement field near the crack tip is expressed as

$$\frac{u_i - u_i^0}{\alpha\varepsilon_0} = \left(\frac{J}{\alpha\varepsilon_0\sigma_0 I_n}\right)^{n/(n+1)} r^{1/(n+1)}\tilde{u}_i(\theta) + Q\left(\frac{r}{J/\sigma_0}\right)^q \left(\frac{J}{\alpha\varepsilon_0\sigma_0 I_n}\right)^{(n-1)/(n+1)} r^{2/(n+1)}\hat{u}_i(\theta) \tag{3}$$

where, u_i^0 denotes the rigid body translation.

Eqs (2) can be rewritten as

$$\sigma_{ij} = (\sigma_{ij})_{HRR} + Q\sigma_0\left(\frac{r}{J/\sigma_0}\right)^q \hat{\sigma}_{ij}(\theta; n) \tag{4}$$

where a parameter Q should be matched numerically.

Alternative expression for Eqs (4) was suggested as a parameter Q depends on the location of matching point [18, 19]. Namely,

$$\sigma_{ij} = (\sigma_{ij})_{Q=0} + Q\sigma_0\left(\frac{r}{J/\sigma_0}\right)^q \hat{\sigma}_{ij}(\theta; n) \tag{5}$$

Here, $(\sigma_{ij})_{Q=0}$ is the reference solution corresponding to $Q = 0$, which can be evaluated by the FEA of the MBL model.

In this paper, we the displacement field as follows, similar to Eqs (5).

$$u_i = (u_i)_{Q=0} + Qf(J, \alpha, \varepsilon_0, \sigma_0, I_n)r^{2/(n+1)+q}\hat{u}_i(\theta) = (u_i)_{Q=0} + (u_i)_Q \tag{6}$$

b) The MBL Model

In general, the displacement and the stress near the crack tip can be represented as

$$\begin{Bmatrix} u_1 \\ u_2 \end{Bmatrix} = \frac{K_I}{2\mu}\sqrt{\frac{r}{2\pi}} \begin{Bmatrix} \cos\frac{\theta}{2}\left(k - 1 + 2\sin^2\frac{\theta}{2}\right) \\ \sin\frac{\theta}{2}\left(k + 1 - 2\cos^2\frac{\theta}{2}\right) \end{Bmatrix} + \frac{Tr}{2(1+\nu)\mu} \begin{Bmatrix} (1-\nu^2)\cos\theta \\ -(\nu+\nu^2)\sin\theta \end{Bmatrix} \tag{7}$$

$$\begin{Bmatrix} \sigma_{11} \\ \sigma_{12} \\ \sigma_{22} \end{Bmatrix} = \frac{K_I}{\sqrt{2\pi r}} \begin{Bmatrix} 1 - \sin\frac{\theta}{2}\sin\frac{3\theta}{2} \\ \sin\frac{\theta}{2}\cos\frac{3\theta}{2} \\ 1 + \sin\frac{\theta}{2}\sin\frac{3\theta}{2} \end{Bmatrix} + \begin{Bmatrix} T \\ 0 \\ 0 \end{Bmatrix} \tag{8}$$

where, ν is the Poisson ratio, $\mu = E/2(1+\nu)$ the shear modulus and the Kolosov constant k is equal to $k = (3-\nu)/(1+\nu)$ for the plane stress and $k = 3 - 4\nu$ for the plane strain.

K_I is the stress intensity factor (SIF) and T is the so-called T-stress, which is the constraint parameter. Eqs (7) and Eqs (8) is called the MBL model.

In the boundary layer model, the elastic-plastic analysis is conducted by the finite element method, employing only the first term in the analytical displacement (7) on the circumference surrounding the crack tip with a certain radius of R [14]. The obtained numerical result can be considered approximately as the analytical solution for the crack. This implies that the first term in Eqs (7) can characterize the crack tip singularity sufficiently.

The MBL model applies the second term as well as the first one in Eqs (7) as the boundary condition, which has been widely used for the study of $J-Q$ theory [3]. By using the MBL model, arbitrary $J-Q$ filed can be easily obtained.

III. XFEM for The Crack Modeling

The XFEM enriches appropriate functions considering the displacement discontinuity on the crack faces and the displacement singularity due to the crack into the standard FE approximation for the crack modeling. Based on the PUM, the XFEM displacement can be approximated as

$$\mathbf{u}^h(x) = \sum_{i\in I} N_i(\mathbf{x})\mathbf{u}_{0i} + \sum_{j\in J} N_j(\mathbf{x})H(\mathbf{x})\mathbf{a}_j + \sum_{k\in M} N_k(\mathbf{x})\left(\sum_{\alpha} F^{\alpha}(\mathbf{x})\mathbf{b}_k^{\alpha}\right) \tag{9}$$

where I is a set containing all the nodes in the finite element model, J a subset involving nodes enriched by the Heaviside function and M a subset having nodes enriched by the crack tip enrichment functions. A component N_i is the shape function of the standard finite element method concerning with a node i and $\mathbf{u}_{0i}$ is a corresponding degree of freedom. Coefficients $\mathbf{a}_j$ and $\mathbf{b}_k^{\alpha}$ is the degree of freedom related to the Heaviside function and the crack tip enrichment functions, respectively [2, 15].

The Heaviside function $H(\mathbf{x})$ is defined as

$$H(\mathbf{x}) = \begin{cases} -1 & \phi(\mathbf{x}) < 0 \\ +1 & \phi(\mathbf{x}) \geq 0 \end{cases} \tag{10}$$

where $\phi(x)$ denotes the signed distance function from the crack (usually determined by means of the level set method, LSM).

For the elastic-plastic crack, the enrichment function $F^{\alpha}(\mathbf{x})$ considering only the HRR field is usually chosen as follows [6].

$$r^{\frac{1}{n+1}}\left\{\sin\frac{\theta}{2}, \cos\frac{\theta}{2}, \sin\frac{\theta}{2}\sin\theta, \cos\frac{\theta}{2}\sin\theta, \sin\frac{\theta}{2}\sin 2\theta, \cos\frac{\theta}{2}\sin 2\theta\right\} \tag{11}$$

$$r^{\frac{1}{n+1}}\left\{\sin\frac{\theta}{2}, \cos\frac{\theta}{2}, \sin\frac{\theta}{2}\sin\theta, \cos\frac{\theta}{2}\sin\theta, \sin\frac{\theta}{2}\sin 3\theta, \cos\frac{\theta}{2}\sin 3\theta\right\} \tag{12}$$

$$r^{\frac{1}{n+1}}\left\{\begin{matrix} \sin\frac{\theta}{2}, \cos\frac{\theta}{2}, \sin\frac{\theta}{2}\sin\theta, \cos\frac{\theta}{2}\sin\theta, \sin\frac{\theta}{2}\sin 2\theta, \cos\frac{\theta}{2}\sin 2\theta, \\ \sin\frac{\theta}{2}\sin 3\theta, \cos\frac{\theta}{2}\sin 3\theta \end{matrix}\right\} \tag{13}$$

We use Eqs (12) as the HRR enrichment functions.

IV. Enrichment Functions for the Elastic-Palstic Crack Condisering the Crack Tip Constraint Effect

Our attention mainly is focused on the determination of enrichment functions for the second term $(u_i)_Q$ in Eqs (6) since the enrichment functions for the HRR field has been suggested previously.

As shown from Eqs (6), the displacement is separated about r and θ. Moreover, the angular distribution function does not depend on the material characteristics and the magnitude of J-integral and Q-stress. Thus, the determination of base functions for the angular distribution functions of displacement field at a specific location near the crack tip is a main key for the material considered.

The finite element analysis package WARP3D is used for the computation of the reference solution corresponding to $Q=0$ as well as another solutions corresponding to different Q-stresses [10].

Figure 1 shows the FE mesh for the MBL model.

The analytical displacement near the crack tip (7) is employed on the circumference. Different $J-Q$ fields can be obtained for the fixed T-stress, increasing the stress intensity factor since the T-stress has one-to-one correspondence with the Q-stress.

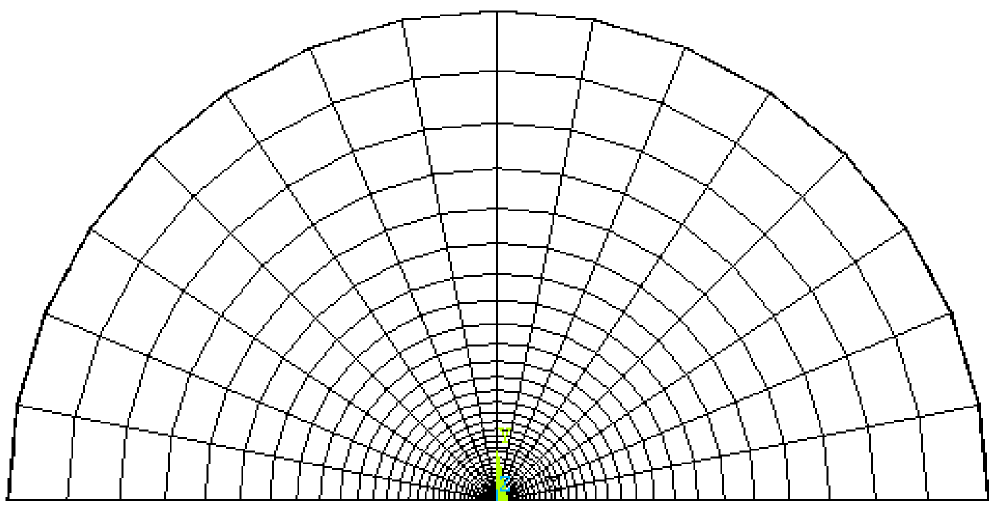

Figure 1: FE mesh for the MBL model

The base function for the second term $(u_i)_Q$ in Eqs (3) is chosen as

$$r^{\frac{2}{n+1}+t}\left\{\sin\theta, \cos\theta, |\theta+1|^{\sin|\theta|}\right\} \tag{14}$$

where, $-180^0 < \theta \le 180^0$.

The displacement field at the location of $\frac{r}{J/\sigma_0}=2$ away from the crack tip is used for the numerical evaluation of accuracy of the chosen base function. A radius of the boundary layer is taken as $R=1m$ and $n=10$, $E/\sigma_0=500$, $E=206GPa$ and $\nu=0.3$. $\frac{T}{\sigma_0}=-0.5$ and 0.5 is applied respectively and the value of J-integral is equal to $50\,KN/m$ for all cases. Based on Eqs (5), the value of Q is evaluated as -0.52 and 0.24 for $\frac{T}{\sigma_0}=-0.5$ and 0.5, respectively.

Figure 2 shows the displacement curve calculated by using WARP3D for the case of $Q=0$, -0.52 and 0.24.

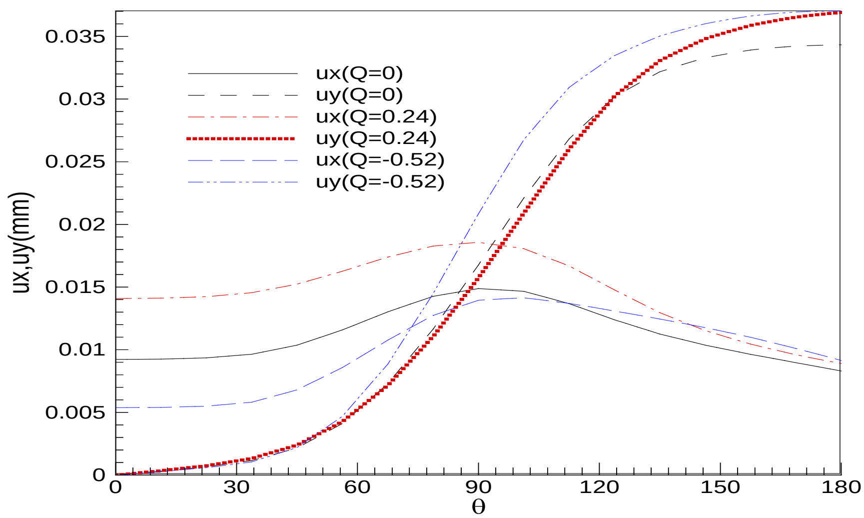

Figure 2: $(U_x, U_y - \theta)$ curves for $Q=0$, -0.52 and 0.24 at the location of $\frac{r}{J/\sigma_0}=2$

Figure 3 and figure 4 shows the comparison of the second term $(u_i)_Q$ with the numerical interpolation by the base function of Eqs (14) at the location of $\frac{r}{J/\sigma_0}=2$ for the case of $Q=0.24$ and -0.52, respectively.

As seen from these figures, the base functions according to Eqs (14) could be the good approximation for the XFEM displacement corresponding to the non-singular terms near the crack tip.

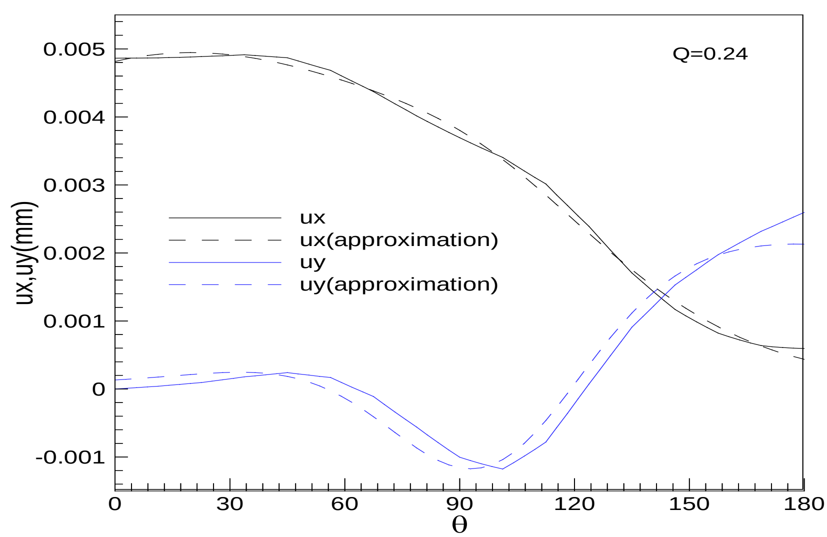

Figure 3: Comparison of the second term $(u_i)_Q$ with the numerical interpolation by the base function of Eqs (14) at the location of $\frac{r}{J/\sigma_0}=2$ for the case of $Q=0.24$

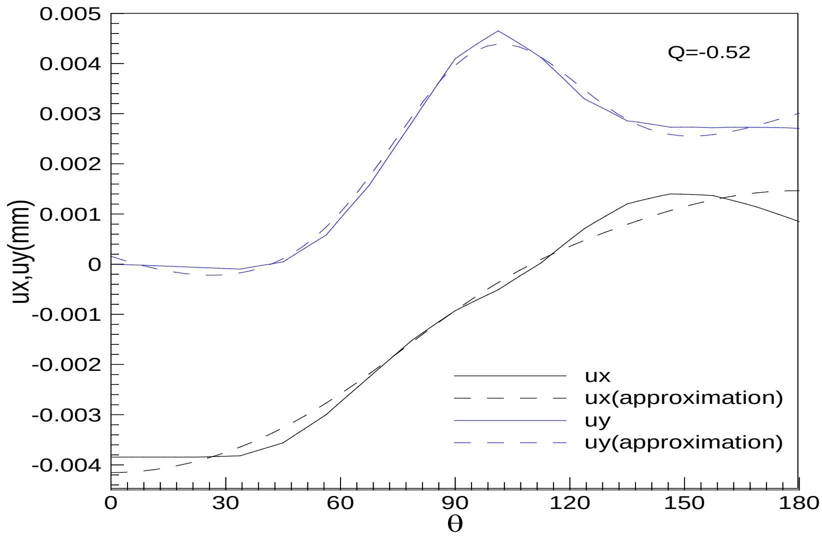

Figure 4: Comparison of the second term $(u_i)_Q$ with the numerical interpolation by the base function of Eqs (14) at the location of $\dfrac{r}{J/\sigma_0}=2$ for the case of $Q=-0.52$

Furthermore, the base function (14) corresponding to the non-singular term should be combined with the one (12) for the HRR singularity, leading to the formulation of base function for the displacement near the crack tip. Namely,

$$r^{\frac{1}{n+1}}\left\{\sin\frac{\theta}{2},\cos\frac{\theta}{2},\sin\frac{\theta}{2}\sin\theta,\cos\frac{\theta}{2}\sin\theta,\sin\frac{\theta}{2}\sin 3\theta,\cos\frac{\theta}{2}\sin 3\theta\right\},$$
$$r^{\frac{2}{n+1}+q}\left\{\sin\theta,\cos\theta,|\theta+1|^{\sin|\theta|}\right\} \tag{15}$$

Figure 5, 6 and figure 7 shows the comparison of the numerical result for the displacement corresponding to $Q=0.0$, -0.52 and 0.24 with the numerical interpolation by the base function of Eqs (15) at the location of $\dfrac{r}{J/\sigma_0}=2$, respectively.

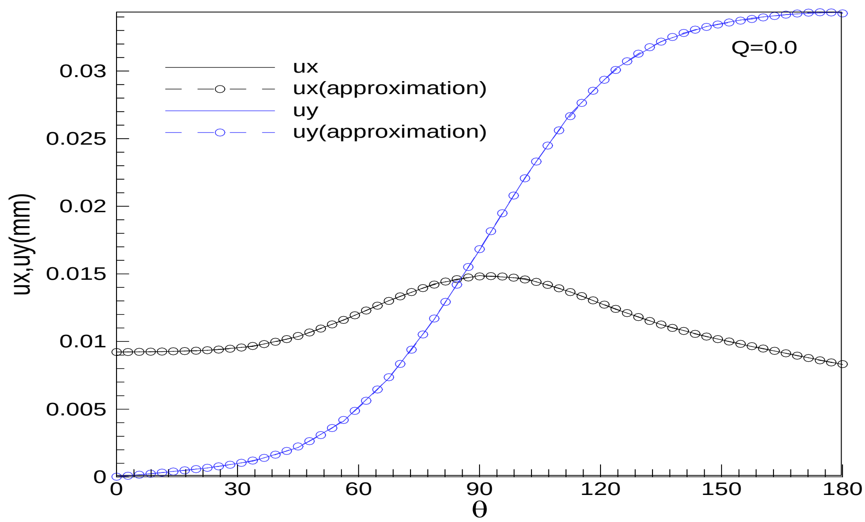

Figure 5: Comparison of the numerical result for the displacement corresponding to $Q = 0.0$ with the numerical interpolation by the base function of Eqs (15) at the location of $\frac{r}{J/\sigma_0} = 2$

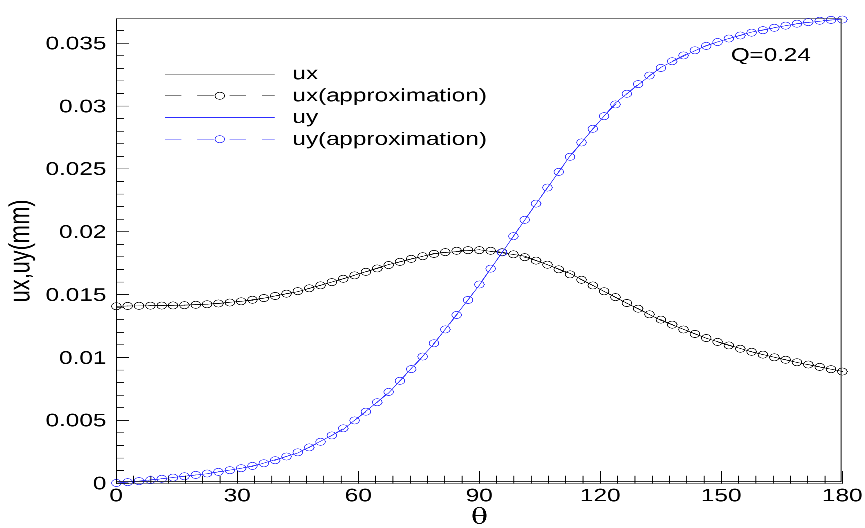

Figure 6: Comparison of the numerical result for the displacement corresponding to $Q = 0.24$ with the numerical interpolation by the base function of Eqs (15) at the location of $\frac{r}{J/\sigma_0} = 2$

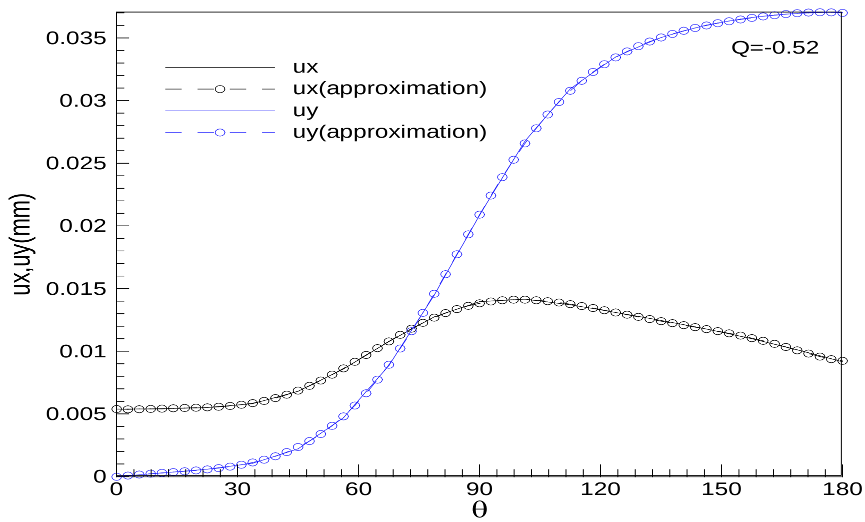

Figure 7: Comparison of the numerical result for the displacement corresponding to $Q = -0.52$ with the numerical interpolation by the base function of Eqs (15) at the location of $\frac{r}{J/\sigma_0} = 2$

As shown from these figures, the base functions in Eqs (15) can be a very good approximation for the XFEM applied to the elastic-plastic crack considering the crack tip constraint effect.

V. Implementation of XFEM Applied to the Elastic-Plastic Crack by using ANSYS

The XFEM can not be directly implemented by using the general finite element package as the enriched degrees of freedom are added besides the standard displacement.

In ref [4], Visual C++ has applied for the XFEM implementation. The 2D XFEM package has been developed [20]. The 2D and 3D XFEM has been implemented by using the user-defined element in ABAQUS [9, 25] and Dynaflow has been used for the XFEM implementation [11, 26]. Previous XFEM implementations were aimed to the elastic crack.

In this paper, the 2D elastic-plastic XFEM was implemented based on the UserElem in ANSYS. 4-node quadrilateral elements were used and the 49-point Gauss-Legendre quadrature was employed. The FE mesh was generated by using ANSYS and the elastic-plastic constitutive relation was obtained by calling the ElemGetMat. The UserElem converts the stress at the Gauss point into the nodal stress so that the nodal stress and strain in the user-defined element can be used for the postprocessor, respectively.

The J-integral can be evaluated as follows.

$$J = \int_A \left(\sigma_{ji} \frac{\partial u_i}{\partial x_1} \frac{\partial q}{\partial x_j} - W \frac{\partial q}{\partial x_1} \right) dA \tag{16}$$

Here, x_i is the components of the local Cartesian coordinates where x_1 is parallel to the crack faces and the origin locates at the crack tip and u_i is the displacement in the x_i-direction. σ_{ij}, ε_{ij} and W is the stress, the strain and the strain energy density, respectively. q is a arbitrary smooth function where takes zero on the outer boundary of the integration zone and 1 at the crack tip.

Although ANSYS has the function for calculating the J-integral, it is impossible to apply that function for the user-defined elements. The UserElem writes all the quantities necessary for the evaluation of J-integral into the data file for every load steps. The J-integral could be extracted by the numerical integration of Eqs (16) based on read the data file generated by the UserElem.

VI. Numerical Validation

In this paper, we conducted the numerical simulation for the MBL model, SE(T) and DE(T) in order to validate the effectiveness of the enriched functions suggested by ours taking account for the crack tip constraint effect.

In convenience, we call the enrichment function in Eqs (12) as the HRR enrichment function and the one in Eqs (15) as the $J-Q$ enrichment function. The 1-layer enrichment and the 2-layer one will be selected for the enriched zone. Parameter q will be adopted as in ref [24].

a) *The MBL Model*

The T -stress depends on the stress intensity factor K_I linearly as

$$T = B\frac{K_I}{\sqrt{\pi a}} \tag{17}$$

where, B is a biaxiality parameter ranging from -0.5 to 2.0 and a is a crack length [1].

The nodes on the boundary layer with a radius R are imposed by the $K-T$ field as

$$\begin{Bmatrix} u_1 \\ u_2 \end{Bmatrix} = \frac{K_I}{2\mu}\sqrt{\frac{R}{2\pi}}\begin{Bmatrix} \cos\frac{\theta}{2}\left(k-1+2\sin^2\frac{\theta}{2}\right) \\ \sin\frac{\theta}{2}\left(k+1-2\cos^2\frac{\theta}{2}\right) \end{Bmatrix} + B\frac{K_I}{\sqrt{\pi R}}\frac{R}{2(1+\nu)\mu}\begin{Bmatrix} (1-\nu^2)\cos\theta \\ -(\nu+\nu^2)\sin\theta \end{Bmatrix} \tag{18}$$

where, a radius of the boundary layer R is taken as a crack length a.

The stress intensity factor K_I lies between 0 and $300MPa\sqrt{m}$ and a biaxiality parameter B is chosen as -0.5, 0.0 and 1.0, respectively. The material characteristics is assumed as $n=5$, $E/\sigma_0 = 800$, $E = 206GPa$ and $\nu = 0.3$. The reference solution of J -integral is computed by using WARP3D whose the FE model contains 6119 8-node brick elements.

The element size of the XFEM for the boundary layer model is about $R/25$. Figure 8 shows the FE mesh for the boundary layer model.

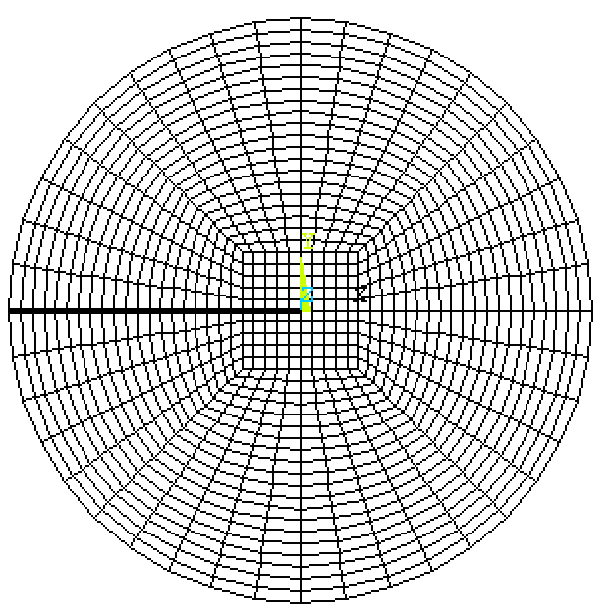

Figure 8: FE mesh of the XFEM for the boundary layer model

Figure 9~figure 11 compares the J -integral computed by using WARP3D with the one by using the XFEM corresponding to various enrichments, varying the applied SIF for the biaxiality parameter B of -0.5, 0.0 and 1.0, respectively.

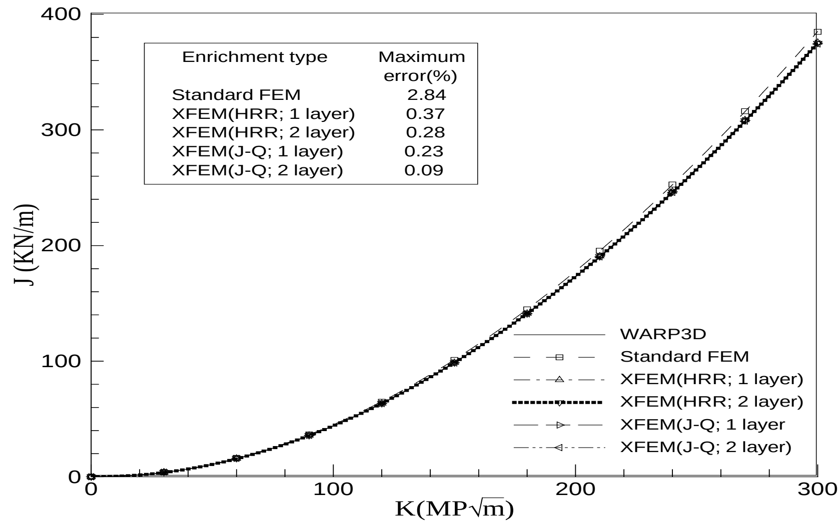

Figure 9: Comparison of the J -integral computed by using WARP3D with the one by using the XFEM for the biaxiality parameter B of -0.5

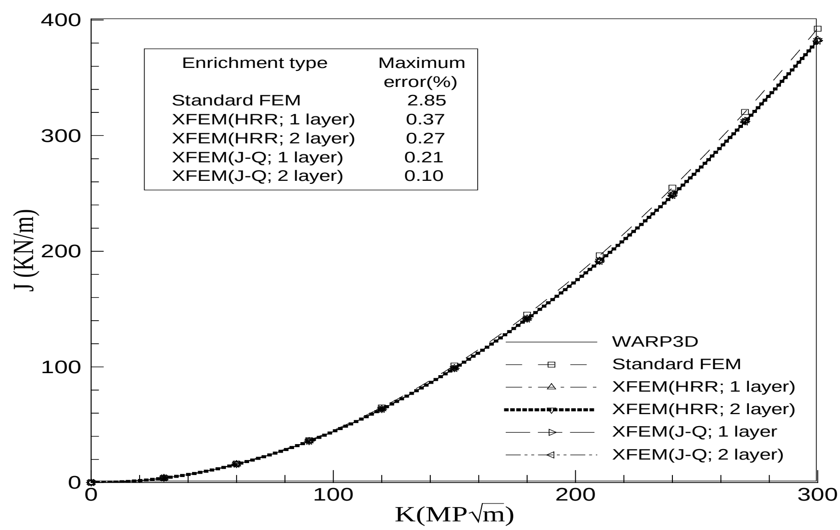

Figure 10: Comparison of the J -integral computed by using WARP3D with the one by using the XFEM for the biaxiality parameter B of 0.0

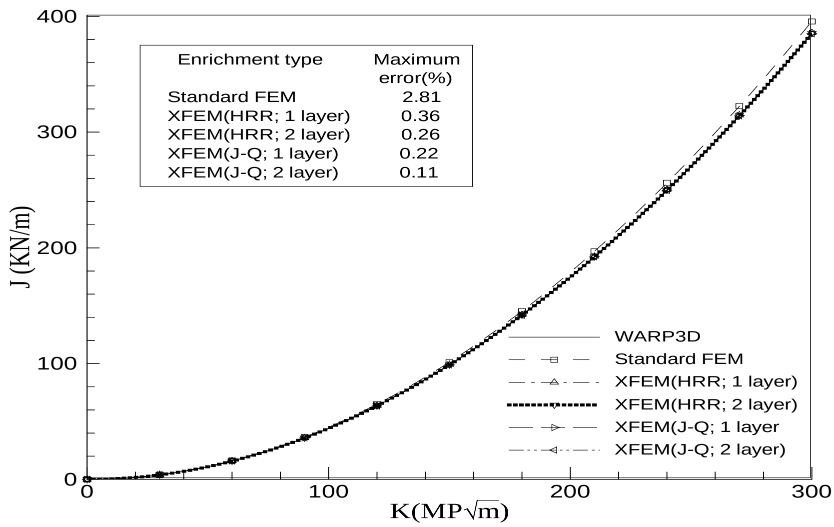

Figure 11: Comparison of the J-integral computed by using WARP3D with the one by using the XFEM for the biaxiality parameter B of 1.0

As shown these figures, the $J-Q$ enrichment gives more accurate result for the J-integral as compared with the HRR one. Moreover, even the $J-Q$ enrichment with 1-layer improve the numerical accuracy for the J-integral than the HRR one with 2-layer.

Figure 12 depicts the distribution of the Von-Mises equivalent stress computed by the XFEM corresponding to the $J-Q$ enrichment with 2-layer for the $B=-0.5$ and $K_I = 300MPa\sqrt{m}$.

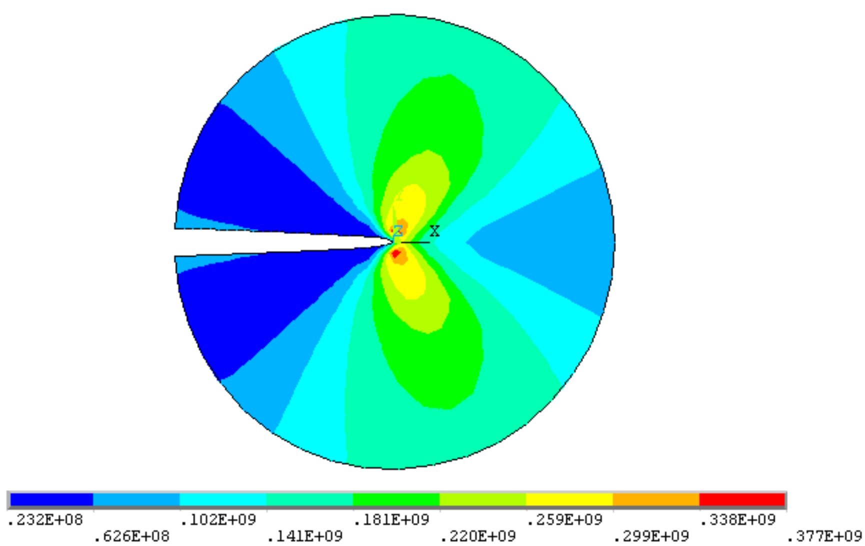

Figure 12: Distribution of the Von-Mises equivalent stress computed by the XFEM corresponding to the $J-Q$ enrichment with 2-layer for the $B=-0.5$ and $K_I = 300MPa\sqrt{m}$

b) SE(T) and DE(T)

The J-integral can be composed as the sum of the elastic part and the plastic one as follows [23].

$$J = J_e + J_p \tag{19}$$

Here, J_e is the elastic part which is expressed as

$$J_e = f\frac{P^2\pi a}{E^*} \tag{20}$$

where, f is the shape factor depending on the loading mode and the crack geometry, P is the far-filed applied load, a is a crack length and E^* is the Young's modulus representing $E^* = E$ for the plane strain and $E^* = E/(1-\nu^2)$ for the plane strain. It should be noted that the plasticity-corrected J_e has to be used due to the crack tip yielding.

In general, J_p is expressed as

$$J_p = \alpha\varepsilon_0\sigma_0 g\lambda\left(\frac{P}{P_0}\right)^{n+1} \tag{21}$$

where, g is a constant depending on the crack geometry, λ a parameter related with the crack geometry and the strain hardening exponent and P_0 is the limit load.

All the analytical formula are taken as in ref [23, 27].

i. *SE(T) specimen*

Figure 13 shows the geometry of SE(T) specimen.

The material characteristics is assumed as $n = 10$, $E/\sigma_0 = 500$, $E = 206GPa$ and $\nu = 0.3$. The plane strain is assumed with $W = 1m$ and $L = W$. The element size is taken as $W/40$ for all the cases. The full model with the relative crack length of $a/W = 0.25$, 0.5 and 0.75 is used, respectively.

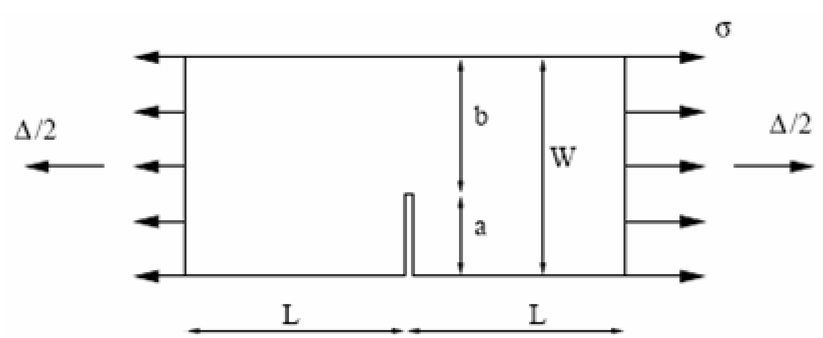

Figure 13: Geometry of SE(T) specimen

Figure 14~figure 16 shows the comparison of the analytical J-integral with the numerical one by the XFEM for the various crack length increasing the external load σ, respectively.

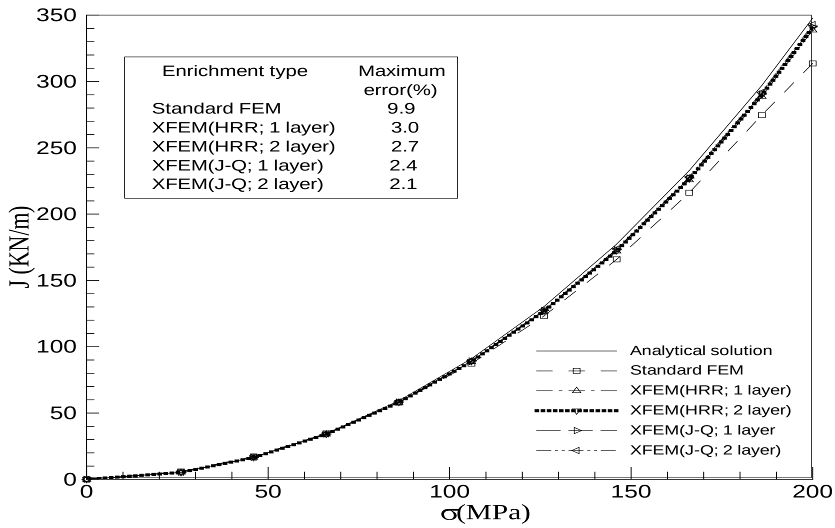

Figure 14: Comparison of the analytical J-integral with the numerical one by the XFEM for the SE(T) specimen with the relative crack length of $a/W = 0.25$

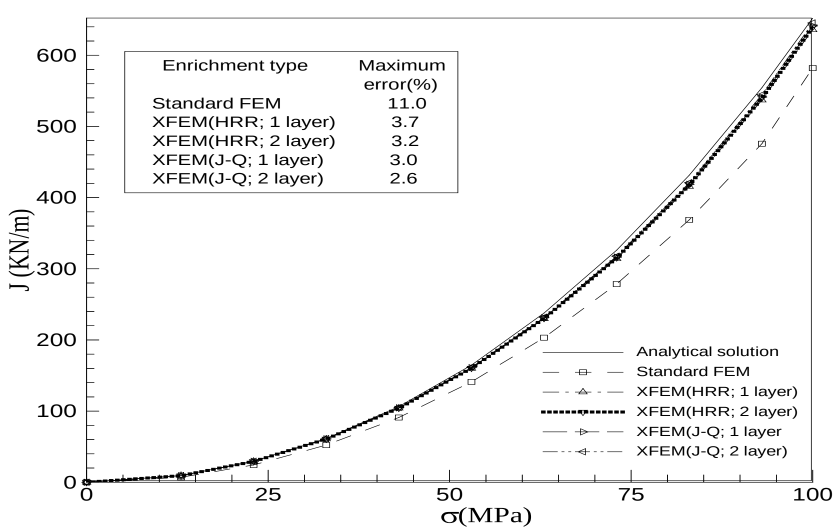

Figure 15: Comparison of the analytical J-integral with the numerical one by the XFEM for the SE(T) specimen with the relative crack length of $a/W = 0.5$

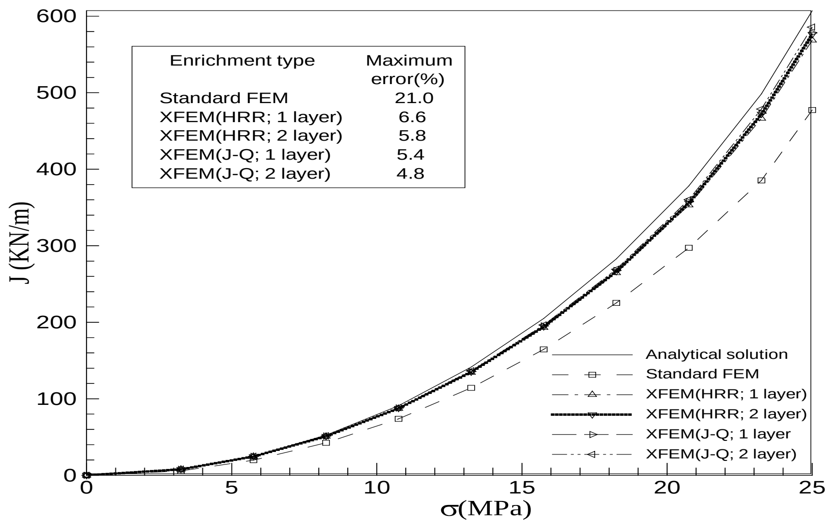

Figure 16: Comparison of the analytical J-integral with the numerical one by the XFEM for the SE(T) specimen with the relative crack length of $a/W = 0.75$

As shown these figures, the $J-Q$ enrichment gives more accurate result for the J-integral as compared with the HRR one. The $J-Q$ enrichment improves the numerical accuracy of the J-integral by about 0.6% for the SE(T) specimens with the relative crack length of $a/W = 0.25$ and 0.5 and by 1~1.2% for the one of $a/W = 0.75$ as compared with the HRR enrichment when employing the same enriched layers.

Moreover, even the $J-Q$ enrichment with 1-layer improve the numerical accuracy for the J-integral than the HRR one with 2-layer.

ii. *DE(T) Specimen*

Figure 17 shows the geometry of DE(T) specimen.

Two material properties are assumed as follows;

$$n = 5,\ E/\sigma_0 = 800,\ E = 206GPa \text{ and } \nu = 0.3$$

$$n = 20,\ E/\sigma_0 = 300,\ E = 206GPa \text{ and } \nu = 0.3$$

The plane strain is assumed with $W = 1m$, $L = 1.5W$ and $a/W = 0.5$. The element size is taken as $W/40$ for all the cases. The half model is used due to the symmetry about the middle plane perpendicular to the crack line. The topological enrichment with 1-layer and 2-layer is employed for the region near the crack tip.

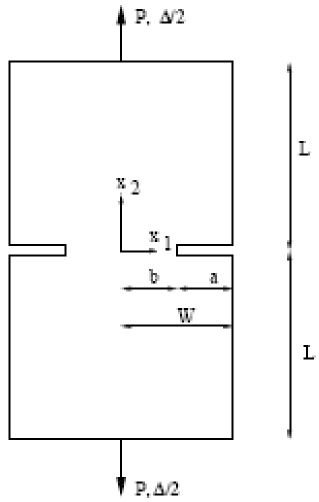

Figure 17: Geometry of DE(T) specimen

Figure 18 and figure 19 compares the analytical solution with the numerical one done by the XFEM with different enrichments for the DE(T) specimen with the strain hardening exponent of $n = 5$ and $n = 20$, respectively.

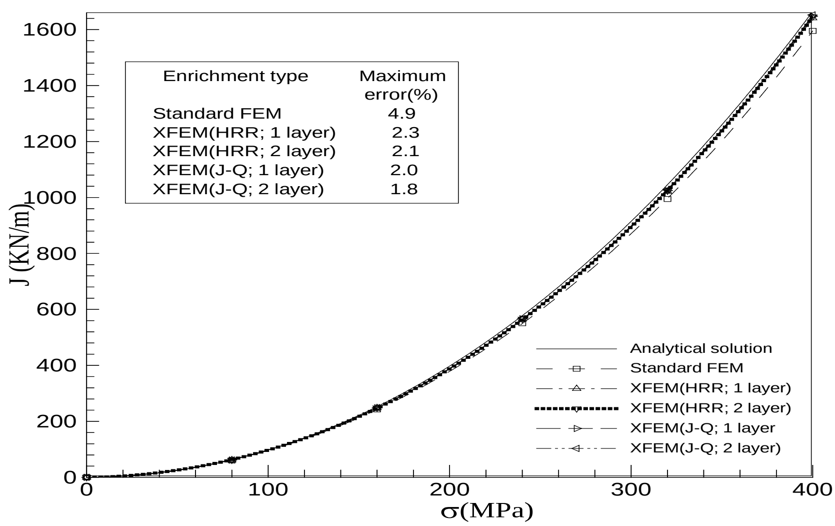

Figure 18: Comparison of the analytical solution with the numerical one done by the XFEM with different enrichments for the DE(T) specimen with the strain hardening exponent of $n = 5$

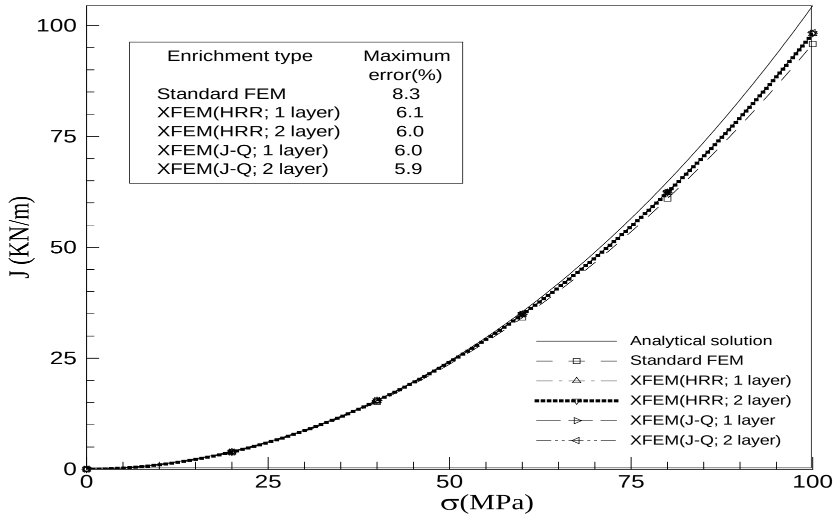

Figure 19: Comparison of the analytical solution with the numerical one done by the XFEM with different enrichments for the DE(T) specimen with the strain hardening exponent of $n = 20$

As seen these figure, the $J - Q$ enrichment gives more accurate result for the J-integral as compared with the HRR one like the SE(T) specimen.

Furthermore, even the $J - Q$ enrichment with 1-layer improve the numerical accuracy for the J-integral than the HRR one with 2-layer.

VII. Conclusion

In this paper, we proposed a family of crack tip enrichment function for the XFEM implementation of elastic-plastic crack, based on the $J - Q$ theory. Such a family of crack tip enrichment function consists of 9 enrichment functions in total, namely, 6 ones previously proposed based on the HRR singular field as well as 3 ones taking account for the crack tip constraint effect. The FEA of the MBL model by using WARP3D was conducted in order to the higher terms for the crack tip displacement field, leading to the suggestion of 3 additional enrichment functions which gave the good estimation for the higher terms in the asymptotic expansion of elastic-plastic crack tip displacement field as well as the global crack tip displacement field. The introduction of these functions into the XFEM enrichment functions enables to improve the approximation of crack tip displacement field significantly.

In numerical analysis for the validation of proposed enrichment functions, crack faces were coincident with element boundaries and a crack tip is taken as a node, in order to eliminate other possible errors besides error concerned with the crack tip enrichment functions. By using the general purpose finite element software ANSYS, 2-dimensional elastic-plastic XFEM was implemented for the MBL model as well as various fracture specimens. Numerical result showed that the enrichment functions suggested by ours could improve the accuracy of fracture parameters significantly as compared with ones based on HRR field. Moreover, even the $J - Q$ enrichment with 1-layer improved the numerical accuracy for the J-integral than the HRR one with 2-layer.

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Twisters and Traveling Higgs Bosons, Unify General Relativity and Quantum Mechanics, and Explain Dark Matter

By Angel Perez Sanchez
Comillas University (ICADE)

Abstract- Objective: To understand the ultimate functioning of gravity, and not to stay on its behavior through formulas and field theories.

Main theories: Loop quantum gravity, Strings, Twistor (Penrose), Einstein's Relativity, Newton "Universal Gravitation", etc.

How to start the research? Looking for a common natural phenomenon in our world that produces attraction; Tornados and possibility of extending it to atom behavior to understand how this conduct can produce attraction.

The results obtained are discovery of a reasonable theory of gravity. And a surprise: this theory (Twisters and Traveling Higgs Bosons) is able to explain in a logical way Dark Matter mystery.

Cosmological implications would produce a Quantum Gravity theory.

GJRE-A Classification: LCC: QC178

TWISTERSANDTRAVELINGHIGGSBOSONSUNIFYGENERALRELATIVITYANDQUANTUMMECHANICSANDEXPLAINDARKMATTER

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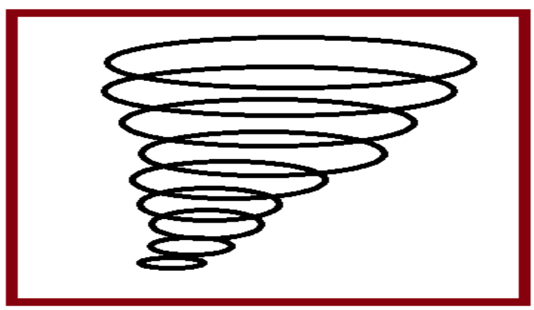
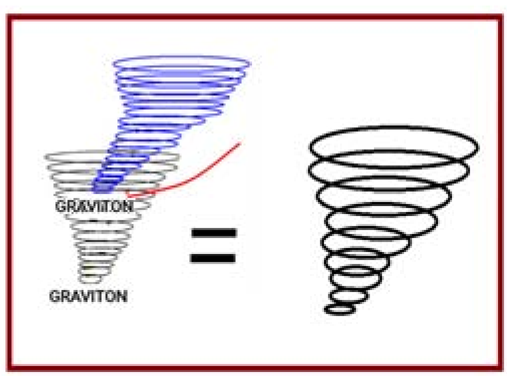
I. Higgs Bosson as a Twister

To begin with, let us look for a natural phenomenon that produces, attraction.
After years going around it, I remembered a natural phenomenon that produces attraction: Twisters.



Considering Higgs Boson as a twister capable of attracting what it has around; if two Higgs Boson intersect, they would unite their tornadoes into a more powerful one.



And so on indefinitely, in such a way, if a large number of Gravitons join, we would have a Planet, Star or a Black Hole.

This system would lead us to a new problem, "Lumps" would form Gravitational foci everywhere, and this is not how we observe existent reality in our environment.

Which brings back to started point.

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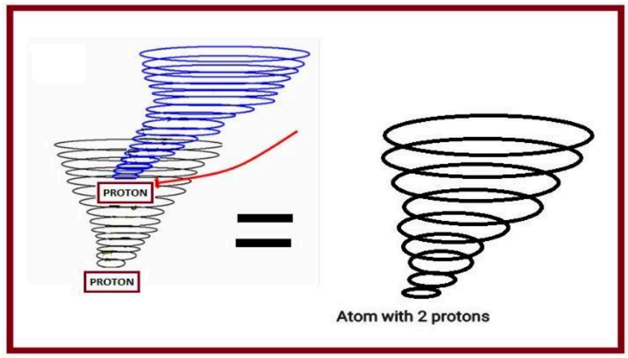
Consequently, Higgs boson as a twister idea must be abandoned, however Twisters can be applied to another nature force: "ATOMS".

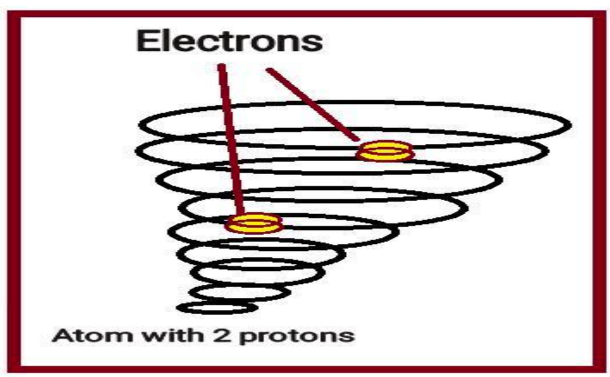
II. Atom as a Twister

Imagine a proton is a rotating particle (with spin) and creates twisters or spiral around it, capable of attracting particles on its environment.

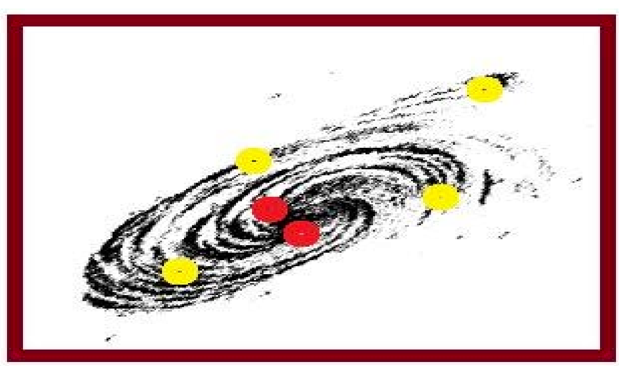
The reasoning would be similar as presented previously with Higgs Boson:



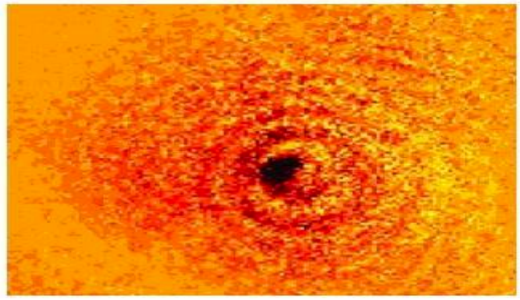
This would be a graph of formation process on stars of Helium element by fusing two hydrogen atoms.
Atoms would capture in their tornado a number of electrons proportional to Tornado's force.



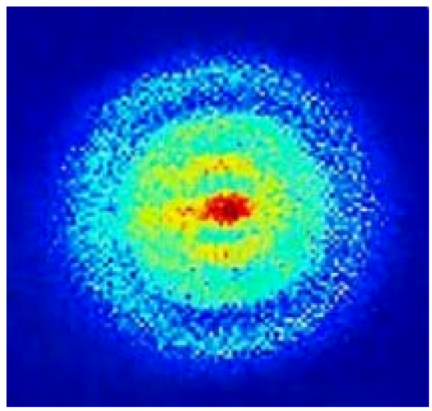
Observation of atomic tornado from above and its spiral shape. Protons in red color and electrons in yellow.



Spiral shape fits with latest atoms observations:
"Ytterbium photo of atom obtained at Griffiths University in Brisbane, Australia."



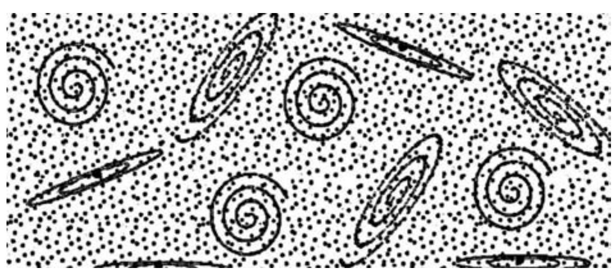
"Quantum microscope," by Aneta Stodolna, of the FOM Institute for Atomic and Molecular Physics (AMOLF) in the Netherlands and her colleagues.



III. Higgs Boson Covers Universe

"Standard Model": Affirms the existence of a tiny particle that carries gravity and today we call Higgs Boson. Entire Universe would be full of these Higgs Bosons, since gravity force is manifested throughout them.

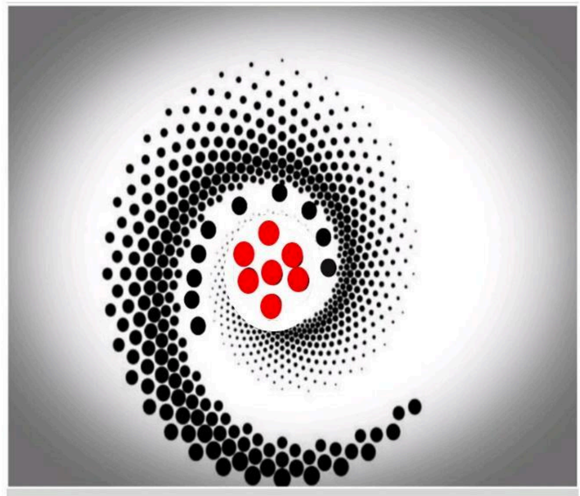
In Black Holes vicinity, there would be a large number of Higgs Bosons, and in empty space, there would be a minimal number of these Higgs Bosons. The Higgs Boson would be present as a blanket that would cover the entire Universe.



This blanket would reach not only intergalactic empty space, but also stars and planets; it would wrap everything around us and ATOMS that make up matter.

IV. Gravity Mechanics

As we have previously described, atomic nucleus's protons form Twisters, which not only attract electrons to their atomic spiral, but also attract Higgs Bosons. Let us see it graphically:



(Protons in red on atomic nucleus center). We observe how an atom with its spiral drags Higgs Bosons inside it. Collects them on higher density side and transports them to opposite side.

These Bosons hit atomic nucleus protons on the opposite side to which they were collected, and hitted protons modify their position and due to its spin, atomic spiral moves to the side from which Bosons were initially captured.

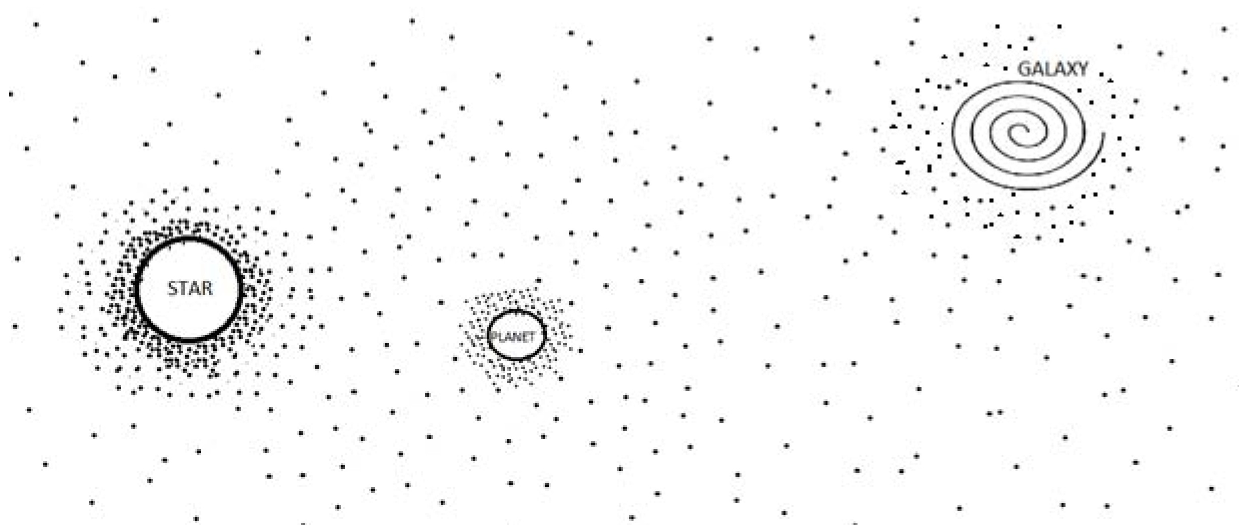
This simple and graphic mechanism is what explains Gravitational Attraction.

Higgs Bosons roam the physical medium and are captured by the atom on area of highest density and hit the nucleus protons from the opposite side producing attraction.

The atom is thus capturing on one side and expelling excess Bosons on the other.

Atoms, molecules and materials, thus become binders of Higgs Bosons so that in the vicinity of objects with atoms and molecules, whether they are planets, stars, Black Holes, there is a higher density of Bosons expelled from the atoms and wandering around their surroundings.

Higgs bosons concentration is dispersed and decreases as they move away from gravitational foci: (Stars, planets, etc.)



That is why I have called this Theory "TWISTORES AND TRAVELER HIGGS BOSONS".

Bosons would also wander through what we call Empty Space, although there, for reasons of distance from atomic foci, they would have lower density than on vicinity of stars and planets.

Stars, planets and galaxies, move at great speed through Cosmos. (Our own planet circles Milky Way center, traveling enormous distances).

During their journey, these stars and galaxies are agglutinating in their environment Higgs Bosons that they collect with their atomic spirals along the way.

But can this theory fit with current experimental physics?

The first deduced consequence is that Gravity would only affect atoms and not empty space that didn't contain atoms. This idea has not been my invention, but it is a consequence of the proposed theory, that led as to consider that gravity only affects bodies made of atoms.

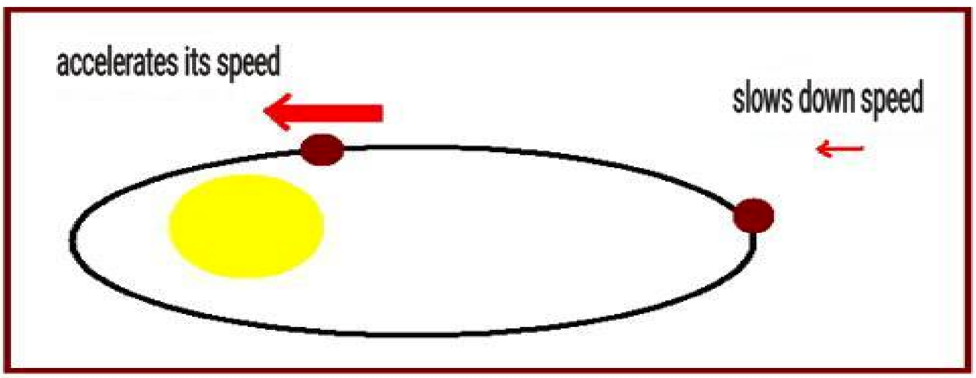
The other fundamental consequence would be that this "Twisters and Traveling Higgs Bosons Theory" would not only explain Gravity but would also reveal one of main mysteries of current Astrophysics, such as Dark Matter.

V. Dark Matter

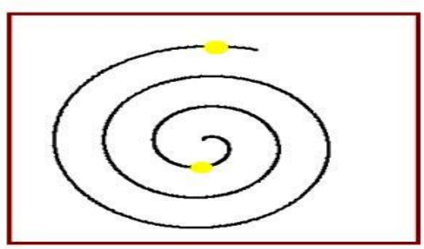
Dark Matter was proposed by Fritz Zwicky, in 1933.

According to Kepler, Solar System planets travel an elliptical orbit; when approaching Sun, they accelerate their speed, and when moving away they slow down their speed.

This occurs due to the greater gravitational attraction exerted by the Sun in its proximity and less attraction in the distance.



The same should happen in galaxies and distant stars from the center should rotate around galactic center at a slower speed than nearby ones, since there is a super Black Hole in the galactic center that acts as the Sun on Solar System.

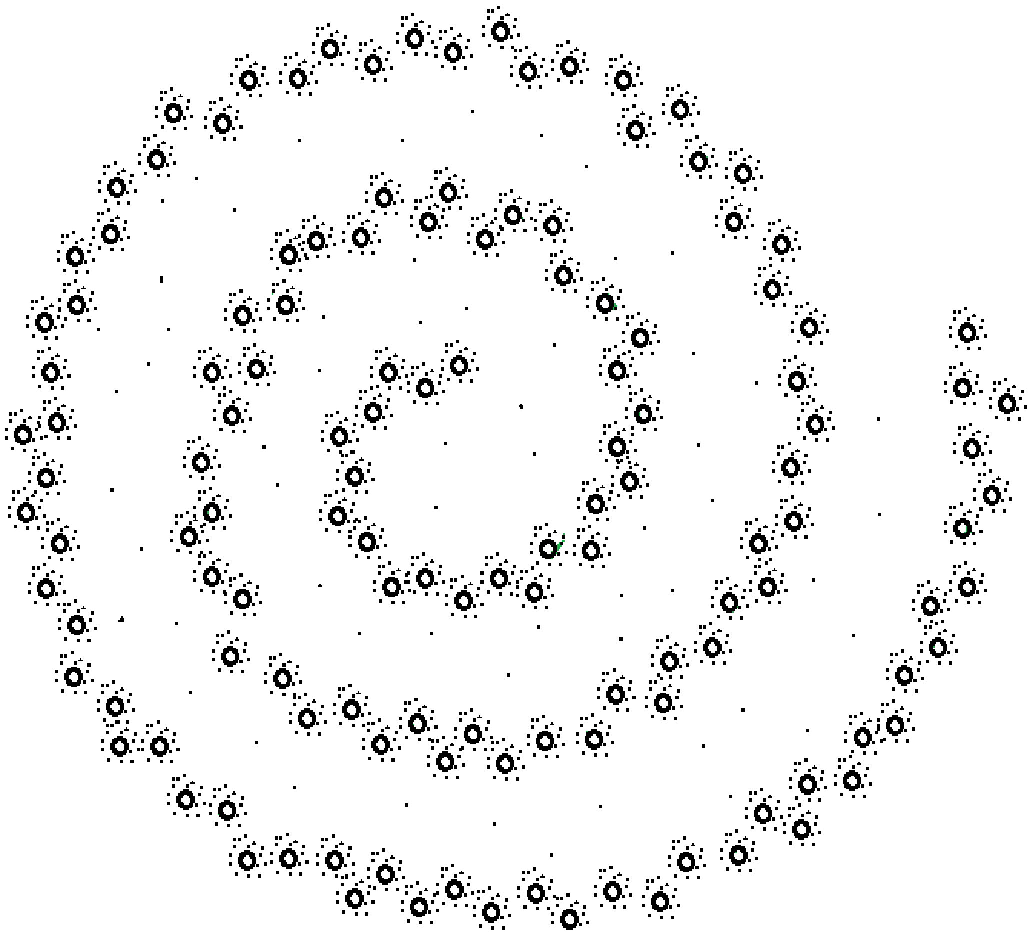


Around the year 1970; The astronomer Vera Rubin was surprised to observe the rotation of the galaxies, stars rotate around the center in reverse in terms of speed: faster those far away and slower those close to the center.

Most of the scientific community said that this was due to existence of unobservable matter on Galaxies that are not stars and that produces necessary attraction for stars in the galaxy to behave like this (Dark Matter).

"Twisters and Traveling Higgs Bosons" would give a more reasonable explanation for this phenomenon: Higgs Bosons would travel from centers of greatest concentration; planets, stars, galaxies, Black Holes and they would blur into empty space. In such a way that they would arrive from one star to another in little concentration, but in an enormous extension of Space. The nearby star would detect this huge expanse of Higgs Bosons in low concentration from the other nearby star and would be oriented towards it.

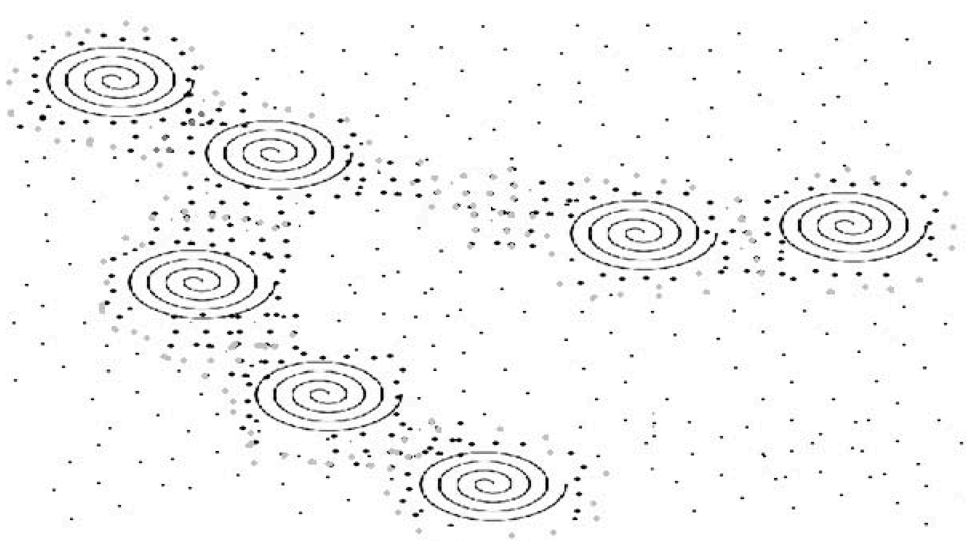
This would be the explanation of why the outer stars of the Galaxy would move faster, they would simply be oriented and anchored to the Higgs Bosons coming from the closest stars.



Galactic arm schematic formation

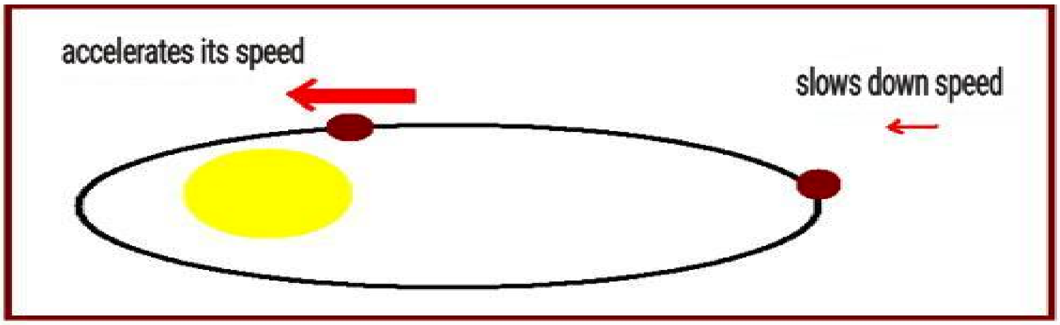
VI. Galaxy Filaments

This would also occur at Galactic level: Galaxies would detect little concentration, but much extension of Traveling Higgs Bosons coming from nearest Galaxy and despite little concentration, it would be oriented towards it or rather, both would be oriented towards the nearby galaxy leaving both anchored to each other on its movement. This would be ultimate cause of Galactic Filaments formation.



VII. Historical Reviews of Gravity

Isaac Newton presented his law: "Two bodies attract with a force directly proportional to product of their masses and inversely proportional to distances square that separate them", and Kepler used Newton's Law to correctly describe planets motion around the Sun.



But this system seems to have failed in certain cases, since Mercury orbit, was more eccentric than derived from Newton's Law.

This orbit aberration was studied by Einstein who with his "Space-Time Fabric" was able to adequately formulate this behavior and thus extend Newton's Law to proximity of massive foci.

It seemed that formulas that described Gravity were already completed with Einstein and could be applied to entire Universe.

Gravity described by Einstein was very precise and was constantly being verified with countless experimental observations, but suddenly DARK MATTER appeared, but instead of questioning Einstein's space-time fabric; matter observed on sky where questioned. There had to be a matter that was not seen and supported stars in their Galactic motion.

Newton's and Einstein's gravitational attraction formulas: were made without considering gravity's ultimate causes, and cannot explain Dark Matter.

However, "Twisters and Travelling Higgs Bosons" theory, first investigates gravity's ultimate causes and applies them to atom and the Universe, and fits with gravity's behavior on both.

"Twisters and Travelling Higgs Bosons" theory solve Dark Matter mystery without thinking a priori about such a problem, and Dark Matter mystery's solution supports this theory.

"Twisters and Travelling Higgs Bosons" theory explain planet's orbit on Solar System, eccentricity of Mercury's orbit and galaxy's outer Stars motion as well as galactic filaments.

In other words, it would encompass Newton's Laws, Quantum Mechanics, Einstein's General Relativity, and Dark Matter.

New Universal Gravitation Law would be:

"A body is attracted by surrounding medium with a force directly proportional to density of Higgs bosons around it".

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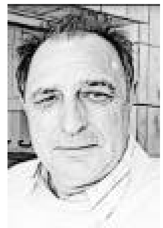

Angel Perez Sanchez was born in 1961 in Madrid, Spain and studied at the Comillas University (ICADE) (Madrid-Spain), obtaining the title of Business Lawyer in 1986; Independent researcher, scientific writer.

Books:

- "Unveiling the Mysteries of Magnetism"
- "The Book of Evolution Evolutionary Memory"
- "Finally, a Reasonable Theory of Everything"
- "The Essence of the Crystal"

~ Member of the RSEF Royal Spanish Society of Physics.

~ Member of the CEMAG Spanish Club of Magnetism–

***"Best Presentation" Award at the International Conference on Accelerated Universe, Dark Energy and Expansion Models ICAUDEEM in October 2023 in London with the presentation "Consideration of Starlight Waves Redshift as Produced by Friction of These Waves on Its Way through Space" "On journal "World Academy of Science, Engineering and Technology", on 2024-10-09.

***"Best Presentation" Award at the International Conference on Condensed Matter, Diamagnetism and Paramagnetism ICCMPDP in August 2023 in Barcelona with the presentation "Magnetic Lines of Force & Diamagnetism" MAGNETIC LEVITATION/Magnetic Lines of Force and Diamagnetism (waset.org)/

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Certificate, LoR and Momento 2 discounted publishing/year **Gradation** of Research 10 research contacts/day 1 **GB** Cloud Storage **GJ** Community Access	**Certificate,** LoR and Momento **Unlimited** discounted publishing/year **Gradation** of Research **Unlimited** research contacts/day 5 **GB** Cloud Storage **Online Presense** Assistance **GJ** Community Access	**Certificates,** LoRs and Momentos **Unlimited** free publishing/year **Gradation** of Research **Unlimited** research contacts/day **Unlimited** Cloud Storage **Online Presense** Assistance **GJ** Community Access	**GJ** Community Access

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3. Ensure corresponding author's email address and postal address are accurate and reachable.
4. Manuscript to be submitted must include keywords, an abstract, a paper title, co-author(s') names and details (email address, name, phone number, and institution), figures and illustrations in vector format including appropriate captions, tables, including titles and footnotes, a conclusion, results, acknowledgments and references.
5. Authors should submit paper in a ZIP archive if any supplementary files are required along with the paper.
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7. Manuscript submitted *must not have been submitted or published elsewhere* and all authors must be aware of the submission.

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Unless specified in the notification, the Editorial Board's decision on publication of the paper is final and cannot be appealed before making the major change in the manuscript.

Acknowledgments

Contributors to the research other than authors credited should be mentioned in Acknowledgments. The source of funding for the research can be included. Suppliers of resources may be mentioned along with their addresses.

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Preparing your Manuscript

Authors can submit papers and articles in an acceptable file format: MS Word (doc, docx), LaTeX (.tex, .zip or .rar including all of your files), Adobe PDF (.pdf), rich text format (.rtf), simple text document (.txt), Open Document Text (.odt), and Apple Pages (.pages). Our professional layout editors will format the entire paper according to our official guidelines. This is one of the highlights of publishing with Global Journals—authors should not be concerned about the formatting of their paper. Global Journals accepts articles and manuscripts in every major language, be it Spanish, Chinese, Japanese, Portuguese, Russian, French, German, Dutch, Italian, Greek, or any other national language, but the title, subtitle, and abstract should be in English. This will facilitate indexing and the pre-peer review process.

The following is the official style and template developed for publication of a research paper. Authors are not required to follow this style during the submission of the paper. It is just for reference purposes.

Manuscript Style Instruction (Optional)

- Microsoft Word Document Setting Instructions.
- Font type of all text should be Swis721 Lt BT.
- Page size: 8.27" x 11'", left margin: 0.65, right margin: 0.65, bottom margin: 0.75.
- Paper title should be in one column of font size 24.
- Author name in font size of 11 in one column.
- Abstract: font size 9 with the word "Abstract" in bold italics.
- Main text: font size 10 with two justified columns.
- Two columns with equal column width of 3.38 and spacing of 0.2.
- First character must be three lines drop-capped.
- The paragraph before spacing of 1 pt and after of 0 pt.
- Line spacing of 1 pt.
- Large images must be in one column.
- The names of first main headings (Heading 1) must be in Roman font, capital letters, and font size of 10.
- The names of second main headings (Heading 2) must not include numbers and must be in italics with a font size of 10.

Structure and Format of Manuscript

The recommended size of an original research paper is under 15,000 words and review papers under 7,000 words. Research articles should be less than 10,000 words. Research papers are usually longer than review papers. Review papers are reports of significant research (typically less than 7,000 words, including tables, figures, and references)

A research paper must include:

a) A title which should be relevant to the theme of the paper.
b) A summary, known as an abstract (less than 150 words), containing the major results and conclusions.
c) Up to 10 keywords that precisely identify the paper's subject, purpose, and focus.
d) An introduction, giving fundamental background objectives.
e) Resources and techniques with sufficient complete experimental details (wherever possible by reference) to permit repetition, sources of information must be given, and numerical methods must be specified by reference.
f) Results which should be presented concisely by well-designed tables and figures.
g) Suitable statistical data should also be given.
h) All data must have been gathered with attention to numerical detail in the planning stage.

Design has been recognized to be essential to experiments for a considerable time, and the editor has decided that any paper that appears not to have adequate numerical treatments of the data will be returned unrefereed.

i) Discussion should cover implications and consequences and not just recapitulate the results; conclusions should also be summarized.
j) There should be brief acknowledgments.
k) There ought to be references in the conventional format. Global Journals recommends APA format.

Authors should carefully consider the preparation of papers to ensure that they communicate effectively. Papers are much more likely to be accepted if they are carefully designed and laid out, contain few or no errors, are summarizing, and follow instructions. They will also be published with much fewer delays than those that require much technical and editorial correction.

The Editorial Board reserves the right to make literary corrections and suggestions to improve brevity.

Format Structure

It is necessary that authors take care in submitting a manuscript that is written in simple language and adheres to published guidelines.

All manuscripts submitted to Global Journals should include:

Title

The title page must carry an informative title that reflects the content, a running title (less than 45 characters together with spaces), names of the authors and co-authors, and the place(s) where the work was carried out.

Author details

The full postal address of any related author(s) must be specified.

Abstract

The abstract is the foundation of the research paper. It should be clear and concise and must contain the objective of the paper and inferences drawn. It is advised to not include big mathematical equations or complicated jargon.

Many researchers searching for information online will use search engines such as Google, Yahoo or others. By optimizing your paper for search engines, you will amplify the chance of someone finding it. In turn, this will make it more likely to be viewed and cited in further works. Global Journals has compiled these guidelines to facilitate you to maximize the web-friendliness of the most public part of your paper.

Keywords

A major lynchpin of research work for the writing of research papers is the keyword search, which one will employ to find both library and internet resources. Up to eleven keywords or very brief phrases have to be given to help data retrieval, mining, and indexing.

One must be persistent and creative in using keywords. An effective keyword search requires a strategy: planning of a list of possible keywords and phrases to try.

Choice of the main keywords is the first tool of writing a research paper. Research paper writing is an art. Keyword search should be as strategic as possible.

One should start brainstorming lists of potential keywords before even beginning searching. Think about the most important concepts related to research work. Ask, "What words would a source have to include to be truly valuable in a research paper?" Then consider synonyms for the important words.

It may take the discovery of only one important paper to steer in the right keyword direction because, in most databases, the keywords under which a research paper is abstracted are listed with the paper.

Numerical Methods

Numerical methods used should be transparent and, where appropriate, supported by references.

Abbreviations

Authors must list all the abbreviations used in the paper at the end of the paper or in a separate table before using them.

Formulas and equations

Authors are advised to submit any mathematical equation using either MathJax, KaTeX, or LaTeX, or in a very high-quality image.

Tables, Figures, and Figure Legends

Tables: Tables should be cautiously designed, uncrowned, and include only essential data. Each must have an Arabic number, e.g., Table 4, a self-explanatory caption, and be on a separate sheet. Authors must submit tables in an editable format and not as images. References to these tables (if any) must be mentioned accurately.

Figures

Figures are supposed to be submitted as separate files. Always include a citation in the text for each figure using Arabic numbers, e.g., Fig. 4. Artwork must be submitted online in vector electronic form or by emailing it.

Preparation of Eletronic Figures for Publication

Although low-quality images are sufficient for review purposes, print publication requires high-quality images to prevent the final product being blurred or fuzzy. Submit (possibly by e-mail) EPS (line art) or TIFF (halftone/ photographs) files only. MS PowerPoint and Word Graphics are unsuitable for printed pictures. Avoid using pixel-oriented software. Scans (TIFF only) should have a resolution of at least 350 dpi (halftone) or 700 to 1100 dpi (line drawings). Please give the data for figures in black and white or submit a Color Work Agreement form. EPS files must be saved with fonts embedded (and with a TIFF preview, if possible).

For scanned images, the scanning resolution at final image size ought to be as follows to ensure good reproduction: line art: >650 dpi; halftones (including gel photographs): >350 dpi; figures containing both halftone and line images: >650 dpi.

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Tips for Writing a Good Quality Engineering Research Paper

Techniques for writing a good quality engineering research paper:

1. Choosing the topic: In most cases, the topic is selected by the interests of the author, but it can also be suggested by the guides. You can have several topics, and then judge which you are most comfortable with. This may be done by asking several questions of yourself, like "Will I be able to carry out a search in this area? Will I find all necessary resources to accomplish the search? Will I be able to find all information in this field area?" If the answer to this type of question is "yes," then you ought to choose that topic. In most cases, you may have to conduct surveys and visit several places. Also, you might have to do a lot of work to find all the rises and falls of the various data on that subject. Sometimes, detailed information plays a vital role, instead of short information. Evaluators are human: The first thing to remember is that evaluators are also human beings. They are not only meant for rejecting a paper. They are here to evaluate your paper. So present your best aspect.

2. Think like evaluators: If you are in confusion or getting demotivated because your paper may not be accepted by the evaluators, then think, and try to evaluate your paper like an evaluator. Try to understand what an evaluator wants in your research paper, and you will automatically have your answer. Make blueprints of paper: The outline is the plan or framework that will help you to arrange your thoughts. It will make your paper logical. But remember that all points of your outline must be related to the topic you have chosen.

3. Ask your guides: If you are having any difficulty with your research, then do not hesitate to share your difficulty with your guide (if you have one). They will surely help you out and resolve your doubts. If you can't clarify what exactly you require for your work, then ask your supervisor to help you with an alternative. He or she might also provide you with a list of essential readings.

4. Use of computer is recommended: As you are doing research in the field of research engineering then this point is quite obvious. Use right software: Always use good quality software packages. If you are not capable of judging good software, then you can lose the quality of your paper unknowingly. There are various programs available to help you which you can get through the internet.

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6. Bookmarks are useful: When you read any book or magazine, you generally use bookmarks, right? It is a good habit which helps to not lose your continuity. You should always use bookmarks while searching on the internet also, which will make your search easier.

7. Revise what you wrote: When you write anything, always read it, summarize it, and then finalize it.

8. Make every effort: Make every effort to mention what you are going to write in your paper. That means always have a good start. Try to mention everything in the introduction—what is the need for a particular research paper. Polish your work with good writing skills and always give an evaluator what he wants. Make backups: When you are going to do any important thing like making a research paper, you should always have backup copies of it either on your computer or on paper. This protects you from losing any portion of your important data.

9. Produce good diagrams of your own: Always try to include good charts or diagrams in your paper to improve quality. Using several unnecessary diagrams will degrade the quality of your paper by creating a hodgepodge. So always try to include diagrams which were made by you to improve the readability of your paper. Use of direct quotes: When you do research relevant to literature, history, or current affairs, then use of quotes becomes essential, but if the study is relevant to science, use of quotes is not preferable.

10. Use proper verb tense: Use proper verb tenses in your paper. Use past tense to present those events that have happened. Use present tense to indicate events that are going on. Use future tense to indicate events that will happen in the future. Use of wrong tenses will confuse the evaluator. Avoid sentences that are incomplete.

11. Pick a good study spot: Always try to pick a spot for your research which is quiet. Not every spot is good for studying.

12. Know what you know: Always try to know what you know by making objectives, otherwise you will be confused and unable to achieve your target.

13. Use good grammar: Always use good grammar and words that will have a positive impact on the evaluator; use of good vocabulary does not mean using tough words which the evaluator has to find in a dictionary. Do not fragment sentences. Eliminate one-word sentences. Do not ever use a big word when a smaller one would suffice.

Verbs have to be in agreement with their subjects. In a research paper, do not start sentences with conjunctions or finish them with prepositions. When writing formally, it is advisable to never split an infinitive because someone will (wrongly) complain. Avoid clichés like a disease. Always shun irritating alliteration. Use language which is simple and straightforward. Put together a neat summary.

14. Arrangement of information: Each section of the main body should start with an opening sentence, and there should be a changeover at the end of the section. Give only valid and powerful arguments for your topic. You may also maintain your arguments with records.

15. Never start at the last minute: Always allow enough time for research work. Leaving everything to the last minute will degrade your paper and spoil your work.

16. Multitasking in research is not good: Doing several things at the same time is a bad habit in the case of research activity. Research is an area where everything has a particular time slot. Divide your research work into parts, and do a particular part in a particular time slot.

17. Never copy others' work: Never copy others' work and give it your name because if the evaluator has seen it anywhere, you will be in trouble. Take proper rest and food: No matter how many hours you spend on your research activity, if you are not taking care of your health, then all your efforts will have been in vain. For quality research, take proper rest and food.

18. Go to seminars: Attend seminars if the topic is relevant to your research area. Utilize all your resources.

19. Refresh your mind after intervals: Try to give your mind a rest by listening to soft music or sleeping in intervals. This will also improve your memory. Acquire colleagues: Always try to acquire colleagues. No matter how sharp you are, if you acquire colleagues, they can give you ideas which will be helpful to your research.

20. Think technically: Always think technically. If anything happens, search for its reasons, benefits, and demerits. Think and then print: When you go to print your paper, check that tables are not split, headings are not detached from their descriptions, and page sequence is maintained.

21. Adding unnecessary information: Do not add unnecessary information like "I have used MS Excel to draw graphs." Irrelevant and inappropriate material is superfluous. Foreign terminology and phrases are not apropos. One should never take a broad view. Analogy is like feathers on a snake. Use words properly, regardless of how others use them. Remove quotations. Puns are for kids, not grunt readers. Never oversimplify: When adding material to your research paper, never go for oversimplification; this will definitely irritate the evaluator. Be specific. Never use rhythmic redundancies. Contractions shouldn't be used in a research paper. Comparisons are as terrible as clichés. Give up ampersands, abbreviations, and so on. Remove commas that are not necessary. Parenthetical words should be between brackets or commas. Understatement is always the best way to put forward earth-shaking thoughts. Give a detailed literary review.

22. Report concluded results: Use concluded results. From raw data, filter the results, and then conclude your studies based on measurements and observations taken. An appropriate number of decimal places should be used. Parenthetical remarks are prohibited here. Proofread carefully at the final stage. At the end, give an outline to your arguments. Spot perspectives of further study of the subject. Justify your conclusion at the bottom sufficiently, which will probably include examples.

23. Upon conclusion: Once you have concluded your research, the next most important step is to present your findings. Presentation is extremely important as it is the definite medium though which your research is going to be in print for the rest of the crowd. Care should be taken to categorize your thoughts well and present them in a logical and neat manner. A good quality research paper format is essential because it serves to highlight your research paper and bring to light all necessary aspects of your research.

Informal Guidelines of Research Paper Writing

Key points to remember:

- Submit all work in its final form.
- Write your paper in the form which is presented in the guidelines using the template.
- Please note the criteria peer reviewers will use for grading the final paper.

Final points:

One purpose of organizing a research paper is to let people interpret your efforts selectively. The journal requires the following sections, submitted in the order listed, with each section starting on a new page:

The introduction: This will be compiled from reference matter and reflect the design processes or outline of basis that directed you to make a study. As you carry out the process of study, the method and process section will be constructed like that. The results segment will show related statistics in nearly sequential order and direct reviewers to similar intellectual paths throughout the data that you gathered to carry out your study.

The discussion section:

This will provide understanding of the data and projections as to the implications of the results. The use of good quality references throughout the paper will give the effort trustworthiness by representing an alertness to prior workings.

Writing a research paper is not an easy job, no matter how trouble-free the actual research or concept. Practice, excellent preparation, and controlled record-keeping are the only means to make straightforward progression.

General style:

Specific editorial column necessities for compliance of a manuscript will always take over from directions in these general guidelines.

To make a paper clear: Adhere to recommended page limits.

Mistakes to avoid:

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- Separating a table, chart, or figure—confine each to a single page.
- Submitting a manuscript with pages out of sequence.
- In every section of your document, use standard writing style, including articles ("a" and "the").
- Keep paying attention to the topic of the paper.

- Use paragraphs to split each significant point (excluding the abstract).
- Align the primary line of each section.
- Present your points in sound order.
- Use present tense to report well-accepted matters.
- Use past tense to describe specific results.
- Do not use familiar wording; don't address the reviewer directly. Don't use slang or superlatives.
- Avoid use of extra pictures—include only those figures essential to presenting results.

Title page:

Choose a revealing title. It should be short and include the name(s) and address(es) of all authors. It should not have acronyms or abbreviations or exceed two printed lines.

Abstract: This summary should be two hundred words or less. It should clearly and briefly explain the key findings reported in the manuscript and must have precise statistics. It should not have acronyms or abbreviations. It should be logical in itself. Do not cite references at this point.

An abstract is a brief, distinct paragraph summary of finished work or work in development. In a minute or less, a reviewer can be taught the foundation behind the study, common approaches to the problem, relevant results, and significant conclusions or new questions.

Write your summary when your paper is completed because how can you write the summary of anything which is not yet written? Wealth of terminology is very essential in abstract. Use comprehensive sentences, and do not sacrifice readability for brevity; you can maintain it succinctly by phrasing sentences so that they provide more than a lone rationale. The author can at this moment go straight to shortening the outcome. Sum up the study with the subsequent elements in any summary. Try to limit the initial two items to no more than one line each.

Reason for writing the article—theory, overall issue, purpose.

- Fundamental goal.
- To-the-point depiction of the research.
- Consequences, including definite statistics—if the consequences are quantitative in nature, account for this; results of any numerical analysis should be reported. Significant conclusions or questions that emerge from the research.

Approach:

- o Single section and succinct.
- o An outline of the job done is always written in past tense.
- o Concentrate on shortening results—limit background information to a verdict or two.
- o Exact spelling, clarity of sentences and phrases, and appropriate reporting of quantities (proper units, important statistics) are just as significant in an abstract as they are anywhere else.

Introduction:

The introduction should "introduce" the manuscript. The reviewer should be presented with sufficient background information to be capable of comprehending and calculating the purpose of your study without having to refer to other works. The basis for the study should be offered. Give the most important references, but avoid making a comprehensive appraisal of the topic. Describe the problem visibly. If the problem is not acknowledged in a logical, reasonable way, the reviewer will give no attention to your results. Speak in common terms about techniques used to explain the problem, if needed, but do not present any particulars about the protocols here.

The following approach can create a valuable beginning:

- o Explain the value (significance) of the study.
- o Defend the model—why did you employ this particular system or method? What is its compensation? Remark upon its appropriateness from an abstract point of view as well as pointing out sensible reasons for using it.
- o Present a justification. State your particular theory(-ies) or aim(s), and describe the logic that led you to choose them.
- o Briefly explain the study's tentative purpose and how it meets the declared objectives.

Approach:

Use past tense except for when referring to recognized facts. After all, the manuscript will be submitted after the entire job is done. Sort out your thoughts; manufacture one key point for every section. If you make the four points listed above, you will need at least four paragraphs. Present surrounding information only when it is necessary to support a situation. The reviewer does not desire to read everything you know about a topic. Shape the theory specifically—do not take a broad view.

As always, give awareness to spelling, simplicity, and correctness of sentences and phrases.

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This part is supposed to be the easiest to carve if you have good skills. A soundly written procedures segment allows a capable scientist to replicate your results. Present precise information about your supplies. The suppliers and clarity of reagents can be helpful bits of information. Present methods in sequential order, but linked methodologies can be grouped as a segment. Be concise when relating the protocols. Attempt to give the least amount of information that would permit another capable scientist to replicate your outcome, but be cautious that vital information is integrated. The use of subheadings is suggested and ought to be synchronized with the results section.

When a technique is used that has been well-described in another section, mention the specific item describing the way, but draw the basic principle while stating the situation. The purpose is to show all particular resources and broad procedures so that another person may use some or all of the methods in one more study or referee the scientific value of your work. It is not to be a step-by-step report of the whole thing you did, nor is a methods section a set of orders.

Materials:

Materials may be reported in part of a section or else they may be recognized along with your measures.

Methods:

- Report the method and not the particulars of each process that engaged the same methodology.
- Describe the method entirely.
- To be succinct, present methods under headings dedicated to specific dealings or groups of measures.
- Simplify—detail how procedures were completed, not how they were performed on a particular day.
- If well-known procedures were used, account for the procedure by name, possibly with a reference, and that's all.

Approach:

It is embarrassing to use vigorous voice when documenting methods without using first person, which would focus the reviewer's interest on the researcher rather than the job. As a result, when writing up the methods, most authors use third person passive voice.

Use standard style in this and every other part of the paper—avoid familiar lists, and use full sentences.

What to keep away from:

- Resources and methods are not a set of information.
- Skip all descriptive information and surroundings—save it for the argument.
- Leave out information that is immaterial to a third party.

Results:

The principle of a results segment is to present and demonstrate your conclusion. Create this part as entirely objective details of the outcome, and save all understanding for the discussion.

The page length of this segment is set by the sum and types of data to be reported. Use statistics and tables, if suitable, to present consequences most efficiently.

You must clearly differentiate material which would usually be incorporated in a study editorial from any unprocessed data or additional appendix matter that would not be available. In fact, such matters should not be submitted at all except if requested by the instructor.

Content:

- Sum up your conclusions in text and demonstrate them, if suitable, with figures and tables.
- In the manuscript, explain each of your consequences, and point the reader to remarks that are most appropriate.
- Present a background, such as by describing the question that was addressed by creation of an exacting study.
- Explain results of control experiments and give remarks that are not accessible in a prescribed figure or table, if appropriate.
- Examine your data, then prepare the analyzed (transformed) data in the form of a figure (graph), table, or manuscript.

What to stay away from:

- Do not discuss or infer your outcome, report surrounding information, or try to explain anything.
- Do not include raw data or intermediate calculations in a research manuscript.
- Do not present similar data more than once.
- A manuscript should complement any figures or tables, not duplicate information.
- Never confuse figures with tables—there is a difference.

Approach:

As always, use past tense when you submit your results, and put the whole thing in a reasonable order.

Put figures and tables, appropriately numbered, in order at the end of the report.

If you desire, you may place your figures and tables properly within the text of your results section.

Figures and tables:

If you put figures and tables at the end of some details, make certain that they are visibly distinguished from any attached appendix materials, such as raw facts. Whatever the position, each table must be titled, numbered one after the other, and include a heading. All figures and tables must be divided from the text.

Discussion:

The discussion is expected to be the trickiest segment to write. A lot of papers submitted to the journal are discarded based on problems with the discussion. There is no rule for how long an argument should be.

Position your understanding of the outcome visibly to lead the reviewer through your conclusions, and then finish the paper with a summing up of the implications of the study. The purpose here is to offer an understanding of your results and support all of your conclusions, using facts from your research and generally accepted information, if suitable. The implication of results should be fully described.

Infer your data in the conversation in suitable depth. This means that when you clarify an observable fact, you must explain mechanisms that may account for the observation. If your results vary from your prospect, make clear why that may have happened. If your results agree, then explain the theory that the proof supported. It is never suitable to just state that the data approved the prospect, and let it drop at that. Make a decision as to whether each premise is supported or discarded or if you cannot make a conclusion with assurance. Do not just dismiss a study or part of a study as "uncertain."

Research papers are not acknowledged if the work is imperfect. Draw what conclusions you can based upon the results that you have, and take care of the study as a finished work.

- You may propose future guidelines, such as how an experiment might be personalized to accomplish a new idea.
- Give details of all of your remarks as much as possible, focusing on mechanisms.
- Make a decision as to whether the tentative design sufficiently addressed the theory and whether or not it was correctly restricted. Try to present substitute explanations if they are sensible alternatives.
- One piece of research will not counter an overall question, so maintain the large picture in mind. Where do you go next? The best studies unlock new avenues of study. What questions remain?
- Recommendations for detailed papers will offer supplementary suggestions.

Approach:

When you refer to information, differentiate data generated by your own studies from other available information. Present work done by specific persons (including you) in past tense.

Describe generally acknowledged facts and main beliefs in present tense.

The Administration Rules

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References	Complete and correct format, well organized	Beside the point, Incomplete	Wrong format and structuring

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