# *Original Research Article*

# A New Compact Star—the "Triaxial Star"—and the Detection of a Cosmic Baby: A Possibility

**Abstract** :The “Triaxial Star” was first proposed by S. Chandrasekhar in 1969, but to date it has not detected. TheCosmic Baby, i.e.SwiftJ1818.0-1607, is the youngest magnetar. It’s characteristic age is $\sim$300 years, with a superfast spin period $\sim$ 1.36s and a strong surface dipole magnetic field $\sim$ 3 x $10^{14}$ G. Taking into account three facts:

i) The ambipolar diffusion in the neutron star core is expected to be the dominant mode of field decay in the early evolution of magnetar ( as long as the age much less than $\sim 10^4$ yrs) ;
ii) Magnetars’s field decay is negligible as long as the core temperature is a few times of $10^8$ K (i.e. $< 10^9$ K) ;
iii) The coupling between the decay of internal magnetic field and the cooling is so strong in the early phase of Magnetar that it significantly slows down both processes but interior magnetic fields able to remain strong enough resulting the core temperature stays higher than several times $10^8$K for thousands years (at least $10^3$ years proposed by Dall’Osso et al [40])

we suggest the swift J1818.0-1607 is a triaxialmagnetari.e. simply Triaxial Star. Significance of our study is — continuous observation thus provides an opportunity for (a) detection of existence of a real Triaxial Star, (b) understanding of the evolution from strong to ultra-strong magnetic field of a neutron star and a magnetar , (c) the bizarre properties of newly baby magnetar,d)how the fast spin period and interior ultra-strong magnetic field turn the baby magnetarinto a unique compact object possessing spontaneously broken axial symmetry and a potential source for measuring the properties of triaxially deformed neutron star (i.e. Magnetar) or triaxialstar.This author encourages the GW community to search the Triaxial Stars through electromagnetic counterparts during their observation of compact objects.

Key Words**: Gravitational Waves, Triaxial star, Neutron Star, Pulsar, Magnetar**

## 1. Introduction

Chandrasekhar proposed the concept of a “Triaxially deformed” star in 1969 [1]. The classical solution of Maclaurin spheroids and Jacobi ellipsoids for self-gravitating and uniformly rotating, incompressible fluids in equilibrium yields two models of rapidly rotating stars. When the rotation of an equilibrium configuration is increased, the sequence of triaxial Jacobi ellipsoids diverges from that of the axisymmetric Maclaurin spheroids, and the ratio of kinetic (T) to gravitational (W) energyreaches $T / |W| \sim 0.14$[2] . Becausethe configurations are no longer a precise ellipsoid in relativistic gravity or for compressible fluids, triaxially deformed rotating compact stars( or simply triaxial stars) are rather than 'ellipsoids'. This triaxial model is very important in relativistic astrophysics because it includes fluid compressibility for modeling the realistic neutron star as an axisymmetric and uniformly rotating configuration associated with the equation of state (EoS) of high density nuclear matter [3, 4].

Uryū et al [5]discovered supra-massive triaxial solutions for relatively stiff (piecewise) politropic equation of state (EoS) with tri-planar symmetry w.r.t. three orthogonal x, y, and z planes, the masses of which exceeded the maximum mass of the spherical solution but were always lower in comparison to those of axisymmetric equilibrium. They obtained the following results:

a) The difference in the maximum masses of triaxial and axisymmetric equilibrium solutions depends sensitively on the equation of states (EoSs) ;
b) In the case where this difference turns out to be only 10%, then it will be treated as strong evidence that the EoS of high density matter in the core of neutron stars becomes substantially softer [ 5].

Another crucial information about the conditions for a star collapsing into a black hole [7]is that supernova fall back accretion can spin up a freshly formed neutron star with a strong magnetic field (B) of $5 \times 10^{14}$ G as rapidly as $T / |W| \sim 0.14$ for 50 – 200s before the star collapses into a blackhole. This suggests that a triaxially deformed compact stars,, such as the recently formed neutron star discussed above, could form transiently from enormous stellar core collapse. Once such a triaxial star is produced, the massive volume of gravitational waves emitted allows us to extract attributes from high density nuclear materials. Using a realistic excess cross-power search technique the typical value [6] of the amplitude of gravitational waves produced by triaxial stars is

$$h \sim 9.1 \times 10^{-21} \left(30 \text{ Mpc} / D\right) \left(M / 1.4 M_o\right)^{3/4} \left(R / 10\text{Km}\right)^{1/4} f^{-1/5} \quad (1)$$

where D, M, R and f are the distance to source, the source mass, the mean radius, and the wave frequency in Hz , respectively. Piro and Thrane[8] estimated the detectability of gravitational waves produced by triaxially compact stars under the fall back accretion scenario for Advanced LIGO detector [ 9] ~ 17 Mpc.

A neutron star or magnetarcan be deformed into a triaxial compact star by its intrinsic ultra-strong core magnetic field [ 10-12]. In this research we investigate thetriaxiality of the magnetar Swift J1818.0-1607 taking into account theellipticity's stability and the effect of internal strong core magnetic field.

The paper is organized as follows: In Sec.2.we describe the valuable observed parameters of the cosmic baby magnetar used in this work. The ellipticity of the baby magnetar in details are presented in Sec.3. Effects of the ambipolar diffusion on heating and cooling inside the magnetar core materials, resulting effects of super-strong inner magnetic fields are discussed in Sec.4. Role of ellipticity and interior strong magnetic fields towards the formation of triaxialmagnetar are presented in Sec.5. In the end, we briefly concluded and discussed future prospects of the triaxialmagnetar in Sec.6.

## 2. Cosmic Baby

The Swift Burst Alert Telescope (BAT) on board the Neil Gehrels Swift Observatory [13] detected a typical characteristics of short burst from magnetar[14] on March 12, 2020, at 21:16:49 UT. The Swift X-ray Telescope (XRT) ultimately spotted a new uncatalogued x-ray source, Swift 1818.0–1607 which is presently known as Cosmic Baby, 64 seconds later. Table I shows the main parameters of this cosmic infant derived from the timing analysis of early data at the time of discovery.

**Table I :**Various early observed / measured parameters of Swift J1818.0 – 1607

| Instruments | Observation based on | Typical properties | Value | Reference |
|---|---|---|---|---|
| BAT Radio Telescope | 9 ms hard X-ray burst and long-lived outbursts | Characteristic age (shortest known ) | ~ 240 years | Esposito et al [15] |
| | | Surface magnetic field | $\sim 2.7 \times 10^{14}$ G | |
| | | Dipolar magnetic field at poles | $\approx 7 \times 10^{14}$ G | |
| | | Spin down Luminosity ( $\dot{E}_{rot}$) | $\sim 1.4 \times 10^{36}$ erg.s$^{-1}$ | |
| XMM Newton Telescope | | Luminosity | $\sim 8 \times 10^{34}$ erg.s$^{-1}$ | |
| | | Coherent periodicity of x-ray signal | 1.36 s | Enoto et al [16] |
| Sardini Radio Telescope | Radio observation | Spin period derivative | $\sim 8.2 \times 10^{-11}$ s.s$^{-1}$ | Champion et al [17] |
| | | Period derivative | $\sim 9 \times 10^{-11}$ s.s$^{-1}$ | |
| | | Spin Period | 0.7333920 s | |

Following a series of observations at multiple telescopes(includingTMRT and NICER) some confirmed parameters of the cosmic baby magnetars were accessible till July 27, 2020. Therotation / spin period derivative, for example, is ~ $3.74 \times 10^{-11}$ s$^{-2}$, the surface dipole magnetic field is ~ $3 \times 10^{14}$ G, the spin down luminosity is ~ $1.1 \times 10^{36}$ erg. S$^{-1}$,and so on. Although Chandra Observatory [18] began observing swift J1818.0–1607 less than a month after its discovery, its observations provided astronomers with the first high resolution x-ray picture of the cosmic baby. Nonetheless, practically all characteristics of the cosmic infant qualities varygreatly..

## 3. Ellipticity of Cosmic Baby Magnetar Swift J1818.0-1607

In 1992, Robert Duncan and Christopher Thompson [19] postulated the existence of magnetars to explain the features of transient sources of gamma rays, i.e., soft gamma repeaters (SGRs). Magnetars are isolated young neutron stars with powerful magnetic fields that generate a wide range of high-energy emissions, from huge flares to quick radio bursts. The underlying hypothesis behind these unusual high-energy sources is that they could be ultra-strong magnetized neutron stars, magnetars with surface (dipole) fields in the $10^{14}$-$10^{16}$ G range and core magnetic fields >$10^{16}$ G (at least one order of magnitude greater) [20, 21]. Because the density of the neutron star core is larger than or equal to $10^{15}$ g/cm$^3$, the compact object has an anisotropic character [22], which means that the internal pressure can be divided into two parts: radial pressure ($p_r$) and transverse pressure ($p_t$), where $p_t$ is orthogonal to $p_r$. The physical properties, stability, and structure of stellar matter are all affected by pressure anisotropy [23]. The ultra-strong internal magnetic field of stellar matter can also produce anisotropic pressure, which is the deformation of a rotating neutron star's spheroidal shape and the emission from it as a result of that deformation.

Cutler [24] initially identified the internal field structure of a neutron star as an effective and efficient source of GW emission when looking for strong gravitational wave (GW) emission. According to him, a magnetically distorted neutron star, that is, a neutron star with a strong internal toroidal field, forms a prolate shape, which has the best probability of being a strong GW emitter. As a result, the ellipticity($\epsilon$) of the magnetic deformation in the shape of star object is critical in the powerful GW source. In other word, the stellar body's triaxiality is determined by its reliance on an internal strong magnetic field, the decay of the field strength, and the dynamical shape transition to a triaxial ellipsoid form.

A magnetar is a slowly revolving solitary neutron star with an extremely strong magnetic field in its interior ranging from $10^{16}$–$10^{18}$G and even upto $10^{20}$ G [25].Amagnetar, in general, is a triaxial stellar body [26], especially in its newborn period. The geometric distortion of the neutron star (or magnetar) generated by strong toroidal magnetic field is used to estimate its internal ultra-strong magnetic field (i.e., the toroidal magnetic field is larger than at least one order of magnitude greater than its surface dipolar magnetic field). As a result, magnetarellipticity limitations can be employed to as a time or duration of GW emission. So, if the field is dipolar, then hydro-magnetic stresses, arising from non-radial gradients of the super-strong internal magnetic field, deform the magnetar (that is, between the magnetic poles and the equator ), and the fractional difference ($\varepsilon$) between the principal moments of inertia can be expressed as [26,27,28]

$$\epsilon \sim \delta p \, R^5 / I_1 \approx 2 \times 10^{-9} \, (B_{\mathrm{internal}} / 10^{10} \mathrm{T})^2 \quad (2)$$

where $\delta p$ = induced matter-density perturbation

$\sim B_{\text{internal}}^{2} / \mu_o C_s^{2}$ ,

R = the stellar radius,

$C_s$ = the isothermal sound speed ( = $3^{-1/2}$ c, c being the velocity of light),

$B_{\text{internal}}$ = the characteristic magnitude of the internal magnetic field

i) $\approx B_o$, if the internal magnetic field is confined to the stellar crust,
ii) $B_o \geq 10^{10}$ T, if it is generated deep inside the star (i.e. convective dynamo model [29],
iii) $B_o \leq 10^{9}$ T in the case of rotation powered pulsars,
$B_o$ being the neutron star surface dipolar field and T = $10^4$ G.

According to Melatos [26], a) the hydrodynamic deformation in a magnetar is much larger in comparison to the elastic deformation arising from shear stresses in the crystalline stellar crust of a rotating neutron star; b) the principal axes of inertia in a rotating neutron star are oriented arbitrarily w.r.t.the magnetic axis of the external magnetic dipole field whereas in the case of a magnetar, the magnetic axis is approximately parallel to one of the principal axes of inertia (say $\mathbf{e}_3$ ), i.e., thealignment of magnetic axis is not exact to the inertia axis due to the complicated structure of the internal field near its generation site (i.e., a non-axisymmetry state remains).

## 4. Origin and decay of core magnetic field of Swift J1818.0-1607

Idealizing the magnetar as a neutron star with the shape of slightly deformed, homogeneous ellipsoid and having a small ellipticity

$$\epsilon = ( I_1 - I_2 ) / I_3 \qquad (3)$$

where $I_1$, $I_2$, $I_3$ are the principal moments of inertia of the neutron star such that $I_3$ is assumed to be aligned with the spin axis then using eqn. (3) we obtain the following constraint on the magnetarellipticity [30] as

$$| \epsilon | < (5 / 3G )^{1/2} \{ C R^3 P_o B_{\text{dipole}} / 2^4 \pi I \}$$

$$\cong 3 \times 10^{-4} ( B_{\text{dipole}} / 10^{14} \text{ G} ) (P_o / 1\text{ms}) \quad ( 4 )$$

withfiducially standard neutron star properties of $I = 10^{45}$ g.cm$^2$, R = 10 km, $P_o$ = initial spin period and the angle between the spin axis and the principal axis of the neutron star distortion = $\pi/2$ [31].

If we assume that magnetar’s internal toroidal magnetic field component ($B_{toroidal}$ ) is the main cause of neutron star deformation then we can constrain the average value of this component by the relation [24]

$$| \epsilon | \sim 1.6 \text{ x } 10^{-4} \ (B_{toroidal} / 10^{16} \text{ G} )^{2} \qquad (5)$$

and $B_{toroidal}$ as [30]

$$B_{toroidal} <\sim 1.4 \text{ x } 10^{16} \text{ G} \ ( B_{dipole} / 10^{14} \text{ G})^{½} \ (P_o / 1 \text{ ms} )^{1/2} \quad (6)$$

Considering the observed dipolar magnetic field strength $B_{dipole} = 7 \text{ x } 10^{14}$ G and spin period $P_o$ = 1.36s of the Swift J1818.0-1607 we estimate the ultra-strong internal toroidal field strength $B_{toroidal} <\sim 10^{18}$ G. This value is consistent with the value $10^{17} – 10^{18}$ G in the case of newly born proto-neutron stars [32 – 34] and also supports the model proposed by Dall”Osso et al [35] that the internal magnetic field must be a very large initial value ( $>\sim 10^{16}$ G) for the internal magnetic field decay.

*<u>The decay of Core Magnetic field</u>*

Studies of magnetic field decayin the neutron star core [36,37]point to three distinct mechanisms that affect the evolution and dissipation of magnetic fields in the magnetarinerior :ohmic dissipation, ambipolar diffusion and Hall drift.Specially, ohmic dissipation and ambipolar diffusion are directly active in dissipation, whereas Hall drift is indirectly active. Further research [38,39] shows that total energy conservation remains nearly the same after the Hall drift, implying that due to Hall diffusion, a new equilibrium configuration with lower total energy will arise in the magnetar interior. According to their findings, initial stable magneto-hydrodynamic configurations remain close to the new equilibrium configuration. Even yet, ambipolar diffusion in the neutron star core is projected to be the primary mechanism of internal field decay as long as magnetars are in their early phase evolution (i.e., ages less than ~$10^4$ years).

Another significant result was foundin ref [38,39] aboutambipolar diffusion at high temperature in the core of a neutron star (i.e. magnetar). Ambipolar diffusion actually drives a slow motion of charged particles (located amid neutrons in the core of a neutron star )that is in opposition to. In the stable neutron star medium, particle friction and chemical potential gradients work together. Inside the core two forms of ambipolar diffusion are active depending on their effect on chemical composition. Inside the core, two forms of ambipolar diffusion are active in terms of chemical composition: a) solenoid mode — onlyparticle friction is used to counteract without disturbing chemical equilibrium. b) irrotational mode — disrupts the chemical equilibrium but does not evolve on time scales less than the β-reaction time-scale. Because the core magnetic field of neutron star (i.e. magnetar) is $10^{18}$ G (which is greater than $10^{16}$G), the temperature in the magnetar core material will be greater than $10^9$ K. The field degradation is not frozen in this scenario. This meansan that in the high-temperature zone, an equilibrium condition between heating and cooling maydevelop.

Using the relation for heating rate per unit volume through field decay

$dU^{+} /dt = (B^{2} / 4\pi\ t_{decay}{}^{(early)} \approx 3.69 \text{ x } 10^{19}\{ B_{16}{}^{4} / T_{9}{}^{2} (\rho_{15})^{2/3}\}$ erg.cm$^{-3}$. s$^{-1}$ (7)

and the relation for cooling rate per unit volume through modified URCA reaction

$dU^{-} /dt \cong 9.6 \text{ x } 10^{20} .( T_{9} )^{8} . (\rho_{15})^{2/3}$ erg.cm$^{-3}$.s$^{-1}$(8)

and then equating the two rates Dall'Osso et al [40] found the equilibrium temperature as

$T_{eq} \cong 6.6 \text{ x } 10^{8} .( B / 10^{16} \text{ G})^{2/5} . (\rho_{15}/ 0.7)^{2/3}. (L / 2 \text{ km})^{-1/5}$ K(9)

Where $B_{16}$, $T_{9}$ , $\rho_{15}$are in their usual notations, 'L' and 'a' are the characteristic scale of variation of the Lorentz force and the chemical potential, respectively, with $(L/a) \approx 9.6\ T_{9}{}^{4}(\rho_{15})^{-1/3}$ ( L / 2 km) [37]. Comparing the obtained $T_{eq}$ with the transition time $T_{tr} \approx 5.73 \text{ x } 10^{8} (\rho_{15}/ 0.7 )^{1/12}$ K ( i.e. when β-reaction are very efficient in deleting the chemical equilibrium imbalance ) they found $T_{eq}$ is higher than $T_{tr}$ ( i.e. $T_{eq}>T_{tr}$ ) at magnetar interior core field environment where field decay occurs on the same time scale in both active modes. This means that magnetar core fields larger than that would be able to i) dissipate enough energy and ii) balance neutrino cooling in the early phase under the effective solenoidal and irrotational modes,which are still degenerate. It can be said that the field decay is negligible as long as the temperature is high enough ( e.g. > $T_{9}$ ) and when the time scale of field decay occurs on the same time scale in both two modes. The significance of ambipolar diffusion is that it becomes active soon after the formation of magnetar and can prevent the cooling of magnetar core below a temperature ~ $10^{9}$ K for a period of thousands yrs ( at least $10^{3}$ yrs ) [40]. This means the decay of an internal magnetic field >= $10^{16}$ G couples with the magnetar cooling at the early stage.

## 5. Ellipticity and Triaxiality of Swift J1818.0-1607

Theoretically, a rotatingneutron star will break its axial symmetry spontaneously when the rotational kinetic energy to gravitational binding energy ratio i.e. T / |W| exceeds the critical value. When arotating compact star is born from a core collapse supernova, it can also have alarger value of T/|W|. The ratio T / |W| of a triaxial neutron star is basically constant, as is the triaxial sequence for increased compactness [41]. Except for swift J1818.0-1607, 30magnetarshave been detected to date. The spin or rotational durations of these 30 magnetarsrange from 2 – 10 s and their surface dipolar fields (derived from the periods, period derivatives) are $10^{13}$ – $10^{15}$ G [42]. However, Jawor and Tauris [43] demonstrated that magnetar'sinitial period must be shorter than 2s. According to data analysis,magnetars are young, with most of them having characteristic spin down ages of less than a million years [44]. Because they are slow rotators, spin down energy losses are insufficient to power their emission.

The dissipation and re-arrangement of their magnetic energy is thought to be another source. Magnetar interior structure,particularly the equation of state (EoS) and the cooling process in the presence of high density, strong gravity, and a strong magnetic field are significant in definingmagnetarshape deformation and triaxial value [45 – 47 ].

According to numerical calculations, a newly created magnetar will have a strong magnetic field and a rapid rotation, resulting in stellar deformation[48,49]. As a result, a magnetar can release detectable gravitational waves; for example, a baby magnetar will spin down due to a magnetic dipole torque and gravitational wavequadrupole radiation. Electro-magnetic radiation.Is also produced by the magnetar's spin-down evolution. In other words, the dynamic evolution of magnetarspin down is related to the theoretical breaking index (n) in such a way that

a) $n = 3$ when magnetic dipole radiation (i.e. electromagnetic phenomena ) dominates the spin down of the magnetar ;
b) $n = 5$ when the GW radiation dominates the magnetar spin down.

The comparison of the observed spin-down light curves and their related models, on the other hand, allows us to restrict the neutron star's initial spin period ($P_o$), dipole magnetic fields ($B_{dipole}$) and ellipticity ( $\epsilon$) (i.e. magnetar). Magnetars with initial period $P_o \sim 1$ ms and surface dipole magnetic field $B_{dipole} \sim 10^{14} - 10^{15}$ G, for example, often have the ellipticity$\epsilon \sim 10^{-3}$. However, the magnetar'stheoretical minimum rotation period is ~ 0.3–0.5 ms [50]. The most appropriate relationships [51] include

$\log\epsilon = 3.79^{+0.52}_{-0.43} + ( 2.19^{+0.17}_{-0.15} ) \log P_o$ (10)

and $\log\epsilon = - 22.50^{+2.15}_{-2.22} + (1.29^{+0.15}_{-0.14} ) \log B_{dipole}$(11)

suggest that

a) magmetar having a stronger magnetic field and / a slower spin period corresponds to the longer ellipticity;
b) a longer rotation period corresponds to possession of a stronger magnetic field;
c) the neutron star deformation is related to its surface dipole magnetic field to some extent.

But it is argued [52,53] instead of dipole magnetic field neutron star deformation may be induced by a strong internal magnetic field ($B_{int}$) in the stellar core through the relation

$\epsilon \approx 10^{-8} (B_{int} / 10^{12}\ G)$ (12)

This relation hints the possession of a very strong internal magnetic field (i.e. $B_{int} \sim 10^{16} - 10^{17}$ G) is needed in order to obtain the ellipticity$\epsilon \sim 10^{-3} - 10^{-4}$ and also the required strength of the internal core magnetic field which should be at least 1 – 2 order of magnitude greater than the surface (i.e. external ) magnetic field ( $B_{dipole} \sim 10^{15}$ G ).

### *The Triaxiality of Swift J1818.0-1607*

At the time of its discovery on 12th March 2020 the Swift J1818.0 – 1607 was appeared to the astronomers as a new un-catalogued x-ray source. Presently it is a confirmed magnetar [52]. The follow up observations suggest the following properties :

i) rotational period = 1.36s
ii) surface dipolar magnetic field = $3 \times 10^{14}$ G
iii) surface magnetic field at poles = $7 \times 10^{14}$ G
iv) spin down luminosity ~ $1.1 \times 10^{36}$erg.s$^{-1}$
v) characteristic age ~ 300 years

Using equ. (4), (5), (6) and (12) and with the above parameters — as input we calculate the ellipticity, internal core magnetic field of Swift J1818.0-1607 and found ~ $9 \times 10^{-3}$ and $8.9424 \times 10^{17}$ G, respectively.

Anumerical study [53] of magnetized deformation of neutron stars shows an interesting consequence for neutron stars with low masses, i.e., the effect of magnetic field is more prominent for internal magnetic fields> $4 \times 10^{18}$ G. The equilibrium between gravity and magnetic field is notably different for different directions in the case of a modest mass rather than a big neutron star, according to Rizaldy and Sulakseno [53]. Even the magnetic field's gravitational force on the z-axis is substantiallylarger than on the other axes, resulting in the oblate-shape seen in low mass neutron stars. The oblate form is quite tiny in the case of a large neutron star compared to a less massive one. To put it another way, the internaltoroidalmagnetic field outperforms the poloidal field. The poloidal field's deformation ( $B_p \approx 10^{14}$ and $10^{15}$G) and the accompanying adjustment in ellipticity (i.e.~ $10^{-4}$ – $10^{-2}$ , respectively) are negligible [54].

Although the contemporary perspective of magnetized deformation of neutron stars (i.e. magnetars ) is owing to the action of both the toroidal and the poloidal magnetic fields i.e. a mixed magnetic field, we only investigate the effect of a toroidal magnetic field in this. Our primary goal is to examine the ellipticity and stability of the deformed neutron star,magnetar Swift J1818.0–1607. In a realistic situation Heras [55] discovered the initial magnetic fields in the interior of a young neutron stars lay in the range $10^{14}$–$10^{16}$ G in a comparative investigation of pulsars and magnetars. Becauseambipolar is active, it inhibits both the decay of inner magnetic fields and the cooling of the neutron star i.e.,the magnetar (because the effect is same for magnetarsand neutron stars' magnetic fields, i.e., a mixed magnetic field). such that magnetar core temperature stays higher than several times $10^{8}$ K for a period of few thousands of years ( at least $10^{3}$ years) . This ellipticity of new born magnetar might not be changed too much during the period of thousand years. As the characteristic age of the Swift J1818.0 – 1607 is only ~ 300 years i.e. the baby phase compare to thousands years it will verycertainly exhibit triaxility, i.e.,triaxial behavior, at least up to its age 1000years.

This magnetar’s estimated ellipticityis within the range for triaxiality, and it will remain at that value for several thousands of years if it exhibits triaxiality. As a result, we believe Swift J1818.0 – 1607 is a triaxialmagnetar or simply a triaxial star.

## 6. Conclusion

If the ratio T/W surpasses a certain threshold, a freshly formed revolving neutron star can spontaneously violate its axial symmetry. Magnetars are an uncommon kind of somewhat slow-rotating neutron stars with extremely strong magnetic fields. A magnetic field with a component parallel to the rotation axis breaches circular conservation and introduces spontaneous symmetry breaking as a non-dissipative mechanism. The Swift J1818.0-1607 is a 300-year-old baby magnetar with an extremely powerful internal core magnetic field of 8.9424 x $10^{17}$G. It has the shortest spin or rotating period of the 31 magnetars discovered, measuring 1.36 seconds. Its magnetic fields are not perpendicular to the rotational axes. The Swift J1818.0-1607's aforesaid features indicate that it is a good triaxialmagnetar (compact object) for testing or studying the discovery of a triaxial star and its odd properties. Although its internal core magnetic field is too powerful, it has at least one slow decay mode via ambipolar diffusion that becomes active soon after its birth. Because this process can prevent the magnetar core from cooling below a few times $10^{8}$ K (i.e., less than $10^{9}$ K) for thousands of years, continuous observation of Swift J1818.0 - 1607 will allow us to better understand the evolution of magnetar magnetic fields

The frequency of the produced continuous gravitational waves would be quite low because the spinning period of this magnetar is 1.36 s, which is within the range of 1-10 s [56-59]. This author asks the Gravitational Wave Community to regularly observe this triaxial infant magnetar (i.e., Swift J1818.0-1607) while observing compact objects via electromagnetic equivalents.

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**Ethical conduct :**Not applicable

**Reference :**

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