Open Journal of Applied Sciences, 2023, 13, 1289-1300
https://www.scirp.org/journal/ojapps
ISSN Online: 2165-3925
ISSN Print: 2165-3917

A Novel Explanation of the Origin of the Magnetic Field of Stars and Planets

Elie W'ishe Sorongane

Physics Department, University of Kinshasa, Kinshasa, Democratic Republic of the Congo
Email: wisheselie@gmail.com

How to cite this paper: Sorongane, E.W. (2023) A Novel Explanation of the Origin of the Magnetic Field of Stars and Planets. *Open Journal of Applied Sciences*, **13**, 1289-1300.
https://doi.org/10.4236/ojapps.2023.138101

Received: July 23, 2023
Accepted: August 18, 2023
Published: August 21, 2023

Abstract

Today, the origin of the magnetic field of stars and planets is explained by the dynamo effect. Since Cowling's anti-dynamo theorem has forbidden a purely axisymmetric dynamo, scientists are all convinced today that the fluid flow in the core of a star cannot be laminar, so it is turbulent. However, we will see in this study that the configuration in which the conductive fluid contained in the core of a star is in rapid rotation around an axis of symmetry is the one that best explains the origin of the magnetic field of stars and planets. It also explains why certain types of stars have very intense magnetic fields. Indeed, we will show here that the magnetic field of stars and planets is created by the electric current generated by the rotational movement of charged fluid particles as in an electromagnet. The lines of this magnetic field are channelled by the solid paramagnetic seed which plays the role of magnetic core in the cores of planets and stars. The seed is composed mainly of Iron and Nickel on the planets and of solid helium-3 in the stars. In this work, we will use this model of rapidly rotating fluids to introduce a new way to ionize a neutral gas and maintain it in a plasma state for indefinitely large time scales, to present a new technique for generating very intense magnetic fields, to establish a new magnetic nucleation process and to propose a new type of nuclear fusion reactor in which the plasma is perpetually rapidly rotating.

Keywords

Magnetic Field, Stars, Planets, Electromagnet, Fluid, Rotation, Plasma

1. Introduction

The source of magnetic fields of astrophysical objects (stars, planets…) is due to the dynamo effect. It is the property possessed by a conductive fluid to generate a magnetic field by its movements (by self-induction) and to maintain this field against ohmic dissipation [1]. Since Cowling's anti-dynamo theorem has forbidden a purely axisymmetric dynamo, scientists are all convinced today that the fluid flow in the core of a star cannot be laminar, so it is turbulent [2]. Hide and Palmert brilliantly generalised Cowling's theorem in a paper published in *Geophysical and Astrophysical Fluid Dynamics* [3]. However, we will see in this study that the configuration in which the conductive fluid contained in the core of a star is in rapid rotation around an axis of symmetry is the one that best explains the origin of the magnetic field of stars and planets. It also explains why certain types of stars have very intense magnetic fields. Indeed, we will show here that the magnetic field of stars and planets is created by the electric current generated by the rotational movement of charged fluid particles as in an electromagnet.

In the article entitled "The Catastrophe of Rapidly Rotating Fluids" published in the same journal, we considered a cylindrical fluid system in rapid rotation around the axis of the cylinder [4]. Furthermore, the fluid is assumed to be homogeneous, in thermodynamic equilibrium, nonmagnetized and macroscopically neutral.

In a cylindrical frame of reference ($\boldsymbol{e}_r, \boldsymbol{e}_\theta, \boldsymbol{e}_z$), the equation of motion in a steady state is given by:

$$(\boldsymbol{u} \cdot \nabla)\boldsymbol{u} = \nu \Delta \boldsymbol{u} + \frac{\|\boldsymbol{u}\|^2}{r}\boldsymbol{e}_r \tag{1}$$

where:

- $\boldsymbol{u}$ is the speed of rotation;
- ν is the kinematic viscosity.

The solution of the equation of motion (1) is given by:

$$\boldsymbol{u} = \frac{2\nu\lambda}{r(-\lambda\theta + c)}\boldsymbol{e}_\theta \tag{2}$$

With $\nu \in \mathbb{R}_+^*$, $\lambda \in \mathbb{R}^*$, $r \in \mathbb{R}^*$, $c \in \mathbb{R}$ and $\theta \in [0, 2\pi]$.

The fact that λ and c take any non-zero real value in this solution imparts to the rapidly rotating fluid a very impressive feature: The kinematic viscosity can reach very high values. And due to its dimensions, the kinematic viscosity is proportional to the collision frequency and to the collision cross-section. So, when the kinematic viscosity is high, the collision frequency and cross-section are also high: this is the catastrophe of rapidly rotating fluids. In this work, we will use this catastrophe phenomenon to introduce a new means of ionizing gas and maintaining it in a plasma state, to present a new technique for producing intense magnetic fields, to establish a new magnetic nucleation process and to propose to the nuclear engineer the idea of a new type of fusion reactor.

2. Plasma and Magnetic Field

One of the major problems in plasma physics today is that of maintaining the plasma. Broadly speaking, the analysis of this aspect results from a gain/loss problem. The charged species are created in volume by ionization but lost by diffusion (induced by collisions or turbulence) towards the walls of the cylinder containing the plasma (therefore on the surface), and possibly also lost in volume if charge recombination mechanisms are possible in the plasma [5]. The catastrophe phenomenon of rapidly rotating fluids brings us a solution to this problem. Indeed, if the kinetic energy of the fluid particles of neutral gas is large enough, any collision between particles can lead to their ionization. This is how we manage to create plasma by heating a neutral gas. So, if an inert gas (argon for example) contained in a cylindrical container is set in rotation at a very high speed around the axis of the cylinder until the catastrophe phenomenon occurs, plasma would be obtained. In the paper entitled "The Catastrophe of Rapidly Rotating Fluids", we said that the rotational speed must exceed the escape velocity of the earth for this phenomenon to appear [4]. But in reality, it is very likely that the phenomenon of catastrophe occurs at speeds of rotation lower than the second cosmic speed of the earth. In fact, the catastrophe phenomenon of rapidly rotating fluids occurs when the rotational speed becomes large enough that the force of gravity can be neglected in front of the centrifugal force in the equation of fluid motion. Note then that no recombination of charges is possible because of the very high frequency of collisions in the rapidly rotating fluid. Charged fluid particles describe circular paths in the cylinder. This movement of charged particles generates a magnetic field whose lines are always curved. This magnetic field therefore tends to confine the plasma, therefore, to avoid losses by diffusion of the charged particles towards the walls of the cylinder. We can therefore maintain our gas in a plasma state for indefinitely large time scales. In fact, the plasma state will be maintained as long as the conductive fluid is rapidly rotating.

Notice right away that thanks to this technique, we can generate very intense magnetic fields. An electromagnet consists of a coil wound around a piece of soft ferromagnetic material called a magnetic core. When an electric current passes through it, the coil creates a magnetic field whose lines are channelled through the magnetic core. In **Figure 1**, the coil is blue and the magnetic core is black. If the axis of the cylinder containing the plasma consists of an entirely ferromagnetic turbine, then we would obtain an electromagnet in which the turbine plays

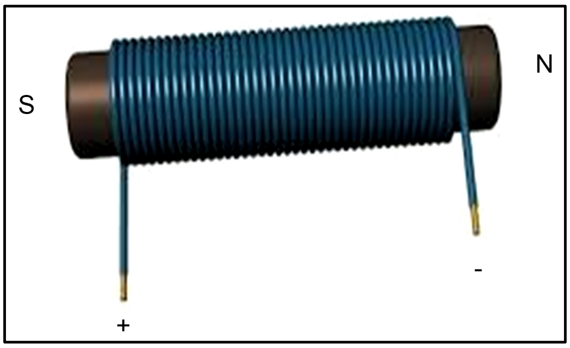

Figure 1. An electromagnet.

the role of the magnetic core and the rotating conductive fluid plays the role of the coil through which an electric current passes. We know that the intensity of the magnetic field produced by an electromagnet is proportional to the intensity of the electric current which runs through the coil and to the number of turns of the coil. We can therefore increase the intensity of the magnetic field in two ways: either by increasing the intensity of the electric current in the coil (this is how strong magnetic fields are produced thanks to superconducting coils) or by increasing the number of coil turns. It is this last means that we use here to generate strong magnetic fields. Indeed, the size of an atom is of the order of the angstrom. In other words, each turn of our fluid coil in the cylinder has a section of the order of one angstrom squared; a cubic meter of rotating plasma is identical to a coil made up of several billion turns through which a current passes. It is possible in this way to produce very intense magnetic fields by putting a large quantity of fluid in rapid rotation.

The origin of the magnetic field of stars can be explained in the same way. This hypothesis is supported by the fact that the magnetic fields of stars increase with their masses. Indeed, the greater the mass of the rotating plasma, the greater the number of turns and therefore the magnetic field produced is also more intense. Thus, the sun, which has a mass of approximately 2×10^{30} Kg has a maximum magnetic field of 1 tesla, white dwarfs which have masses up to 1.44 times the mass of the sun have magnetic fields of the order of 10^2 to 10^4 tesla and neutron stars which have masses of 2 to 3 times the mass of the sun present magnetic fields that can reach 10^8 tesla. Note also that the stronger the magnetic field, the greater the magnetic force that confines the plasma. So the greater the mass of a star is, the higher its density will be. Thus a white dwarf is denser than the sun and a neutron star is denser than a white dwarf.

In the experiments of Von Karman Sodium (VKS) in Cadarache in September 2006, a group of researchers set liquid sodium in motion in a cylindrical cavity by means of two counter-rotating turbines located at the top and bottom [6]. These researchers then affirm that in these experiments, the appearance of the dynamo effect was marked by the spontaneous appearance of a magnetic field self-sustaining by the movement of the fluid, for a speed of rotation of the discs greater than a critical speed of the order of 1000 rpm. We give here another explanation for the spontaneous appearance of this magnetic field and the existence of this critical speed of rotation. In our previous paper entitled "Implementation of a Semi-Classical Theory for Superconductors" published in the same journal, we explained why and how a metal is made up of neutral atoms bathed in a gas of free electrons [7]. So, at rotation speeds below the critical speed, the rotating fluid particles are neutral atoms. No magnetic field is therefore observed. But when the rotational speed exceeds the critical speed, the catastrophe phenomenon occurs and the atoms are ionized by collisions. Rotating fluid particles, therefore, become positive ions. Their movement then generates a magnetic field as in an electromagnet. This new explanation is confirmed by the fact that in the VKS experiments, a magnetic field was measured only with soft iron turbines and not with steel turbines [8]. Indeed, in these experiments, the soft iron turbines being ferromagnetic, they play the role of the magnetic core by channelling the lines of the magnetic field created by the fluid movement.

3. The Cores of Planets and Stars

At this level of our study, two questions come to mind, namely:

- What causes the fluid to rotate in the cores of planets and stars?
- How to explain the existence of a solid ferromagnetic seed which plays the role of the magnetic core in the cores of planets and stars?

The answer to the first question is obvious: the rotational movement of the fluid in the core of a planet or a star is induced by the rotational movement of the celestial body around itself. Thus, we can say that the fluid contained in the core rotates around the axis of rotation of the celestial body at the rotational speed of the planet (or star). This assertion is supported by numerous observations.

Notice first that the intensity of the magnetic field of the electromagnet is proportional to the intensity of the current which crosses the coil and the intensity of the magnetic field of a celestial body will be proportional to the speed of rotation of the conductive fluid in the core and therefore to the rotational speed of the celestial body. In short, the intensity of the magnetic field of the celestial body will be proportional to its mass and its speed of rotation. Thus, Jupiter being the planet with the greatest mass (*i.e.* 317.8 times the mass of the earth) and the highest rotation speed (its rotation period is 9 h 55 min) of the solar system, it also has the most intense internal magnetic field (more than 1 mT) of all the planets of the solar system. And of all the planets that have a magnetic field in the solar system (*i.e.* Mercury, Earth, Jupiter, Saturn, Uranus and Neptune), Mercury has the smallest mass (*i.e.* 0.0553 times the mass of the Earth) and the smallest rotation speed (its rotation period is 58 days and 16 hours). It therefore has the least intense magnetic field, *i.e.* 300 nT (about 1.1% of the Earth's magnetic field). Likewise, a neutron star which revolves around itself at a speed of the order of $c/6$ (with $c = 3 \times 10^8$ m/s, the speed of light in vacuum) has a more intense magnetic field than a white dwarf whose rotation period is of the order of 25 to 30 s. And the sun, which has a rotational speed of about 2 km/s, has a less intense magnetic field than neutron stars and white dwarfs [9].

Venus does not present any magnetic field because of its rotation speed which is very low. In fact, a celestial body that revolves around itself with a relatively low rotational speed has an entirely fluid core. In other words, the core of Venus does not contain a solid seed, it is completely liquid. To understand this, we must first answer the second question, namely: how to explain the existence of a solid ferromagnetic seed in the cores of planets and stars?

The formation of a solid seed in the core of a planet is done in the following way: the metal in the liquid phase in the core is in rotation around the axis of rotation of the planet at its speed of rotation. If the rotational speed of the planet is large enough, the catastrophe phenomenon leads to the ionization of atoms by collision. The liquid made up of the rotating charged particles creates a magnetic field whose lines are always curved. The magnetic force then produces a certain pressure on the rotating liquid close to the axis of rotation. If this pressure is high enough, the fluid close to the axis of rotation can then undergo a phase transition. It therefore passes from the liquid state to the solid state and the solid seed appears. If this solid seed is ferromagnetic then it can act as a magnetic core by channeling the magnetic field lines as in an electromagnet. This is the case for all planets in the solar system that have a magnetic field. Their seeds are mainly composed of Iron and Nickel. Thus, Venus does not have a magnetic field because it revolves around itself very slowly. This low speed of rotation does not allow the catastrophe phenomenon to occur. In the Venus core, the rotating fluid is made up of neutral atoms. And so there is no creation of a magnetic field which could lead to the formation of a solid ferromagnetic seed although the core of Venus is also composed of Iron and Nickel like the core of the earth. This hypothesis is confirmed by the fact that Venus is the planet that has the smallest rotational speed (its rotation period is 243 days) in the solar system [9].

Mars also has no magnetic field due to the absence of a solid seed in its core. Indeed, it has been demonstrated today that the core of Mars is entirely liquid. However, the rotation speed of Mars is high enough for the catastrophe phenomenon to occur there (its rotation period is 24 h 37 min, of the same order as that of the Earth). Mars must therefore have had a solid seed in the past but which would have liquefied for reasons that are still unknown. The core of Mars is composed mainly of Iron and Nickel, the planet therefore had a magnetic field in the past but which disappeared during the fusion of the seed. And indeed, the magnetized rocks buried under the Martian surface prove that Mars did indeed have an active magnetic field in the past [9].

This process which leads to the birth of a solid seed in the core of a planet allows us to introduce here a new process of nucleation. The intensity of the magnetic field produced by rapidly rotating plasma in a cylinder is proportional to the mass and the rotational speed of the plasma. So, if the mass and the speed of rotation are high enough, the magnetic force will compress the plasma located near the axial turbine until a new phase (liquid or solid) appears: this is magnetic nucleation.

The formation of a solid seed in the heart of a star is more complex. For example, consider a neutron star. Since the rotation speeds of neutron stars are very high (their rotation periods are on the order of 1.56 ms to 8.5 s), the catastrophe phenomenon certainly occurs in the core of a neutron star. The core of a neutron star is composed mainly of neutrons but it also contains protons and electrons in lesser quantity and in equal proportions (*i.e.* the density of protons is equal to the density of electrons). We can explain this composition using the binding cord approach of electromagnetic interaction that we introduced in the article titled "Electromagnetic Interaction: A New Theoretical Approach" published in the same journal [10]. In this paper, we have shown that any particle with nonzero spin is normally unstable. Thus, the neutron having non-zero spin (1/2) is unstable. But we also highlighted the fact that certain elementary particles of non-zero spins are stable because they are always in a bound state (this is the case of the quark) or in a state of movement at very high speed (this is the case of the photon and the neutrino). Similarly, the neutron can also become stable when it is found in a bound state as in the nucleus of an atom or when it is in a state of very high speed motion as in neutron stars (the rotational speed of a neutron star is of the order of *c*/6, with *c* the speed of light in vacuum). On the other hand, the catastrophe phenomenon involves a very high collision frequency between fluid particles. When a neutron collides with another particle (a neutron or a proton), it can transmit all or a large part of its kinetic energy to the other particle. The neutron is then at rest or very slow in its movement. It then disintegrates according to the reaction:

$$\mathrm{n} \rightarrow \mathrm{p} + \mathrm{e} + \bar{\nu}.$$

This is the decay β^-. It is a transformation of a neutron into a proton with the emission of an electron and an antineutrino [11]. Note then here that the phenomenon of catastrophe in a neutron star allows us to affirm that at the end of its life, a neutron star is transformed into an ordinary star by emitting a large number of antineutrinos. This could explain the detection of antineutrinos associated with the 1987 supernova (SN1987A) in the Large Cloud of Magellan although no neutron star was detected in the remnants of this supernova [12]. At present, out of just over 200 supernovae identified in our galaxy, observations would indicate only about ten associations with neutron stars [13]. This anomaly could be explained by the fact that several neutron stars associated with different supernovae are at the end of their life. They, therefore, transformed into ordinary stars by emitting antineutrinos like those which were detected in 1987. Note also that the phenomenon of catastrophe in a neutron star allows us to refute the hypothesis of the existence of a superfluid in the neutron star [12]. In fact, a superfluid is a fluid system that exhibits zero viscosity [14]. But in solution (2), we clearly see that the viscosity of a rapidly rotating fluid is proportional to its rotational speed. This speed is very high for a fluid contained in a neutron star, it is impossible for the neutron star to contain a superfluid.

After several decays β^-, the core of the neutron star contains a fairly large number of protons. The first two nuclear fusion reactions of IP cycle I can then lead to the production of helium-3 nuclei in the core of the star [15]:

$$\mathrm{p} + \mathrm{p} \rightarrow \mathrm{d} + \mathrm{e}^+ + \nu_\mathrm{e} + 0.42\ \mathrm{Mev} \quad (\text{followed by } \mathrm{e}^+ + \mathrm{e}^- \rightarrow 2\gamma + 1\ \mathrm{Mev}).$$

$$\mathrm{p} + \mathrm{d} \rightarrow {}^3_2\mathrm{He} + \gamma + 5.5\ \mathrm{Mev}.$$

The helium-3 located near the axis of rotation of the star is then subjected to a strong pressure because of the magnetic field which compresses the plasma. This magnetic field is created by the rotational motion of charged fluid particles. The gaseous helium-3 near the axis of rotation then undergoes a transition of state and it becomes solid. In the cores of the planets, it is the solid seed composed mainly of Iron and Nickel which plays the role of magnetic core. Iron and Nickel are ferromagnetic below the Curie temperature. Above this temperature, Iron and Nickel become paramagnetic. Since the temperature in the cores of the planets is very high (higher than the Curie temperatures of Iron and Nickel), the seed is paramagnetic. It is therefore magnetized in the presence of an external magnetic field and thus it can play the role of magnetic core in the cores of the planets. In the core of a neutron star, the solid seed is made of helium-3. Solid helium-3 is antiferromagnetic below the Néel temperature. Above this temperature, solid helium-3 becomes paramagnetic [16]. Since the temperature in the core of a neutron star is very high (higher than the Néel temperature of solid helium-3), the seed composed of solid helium-3 is paramagnetic. It is therefore magnetized in the presence of an external magnetic field and it is it which plays the role of magnetic core in the core of a neutron star. And since the first two fusion reactions of IP cycle I occur in all ordinary stars, we can affirm that all stars contain a paramagnetic seed made of solid helium-3 which acts as a magnetic core by channeling the lines of the magnetic field produced by the motion of the rotating charged fluid particles.

The magnetic field of a celestial body rotates with it around its axis of rotation at its speed of rotation. Indeed, when we put a magnet in rotation, we notice that its magnetic field also rotates at the same speed and in the same direction as it [17]. In **Figure 2**, a magnet is rotated at speed ω_0. The magnet in its rotation creates a rotating magnetic field which drives the magnetic needle (mounted on a pivot) at the same speed ω_0.

Given that the core of a celestial body rotates around its axis of rotation at its rotational speed, the paramagnetic seed behaves like a rotating magnet. It, therefore, creates a magnetic field rotating at the rotation speed of the celestial body around its axis of rotation. To highlight this phenomenon in the case of the earth's magnetic field, let us consider an observer at rest on the surface of the earth provided with a compass. The magnetic needle of the compass being subjected to the magnetic field of the earth, it indicates the magnetic north pole of

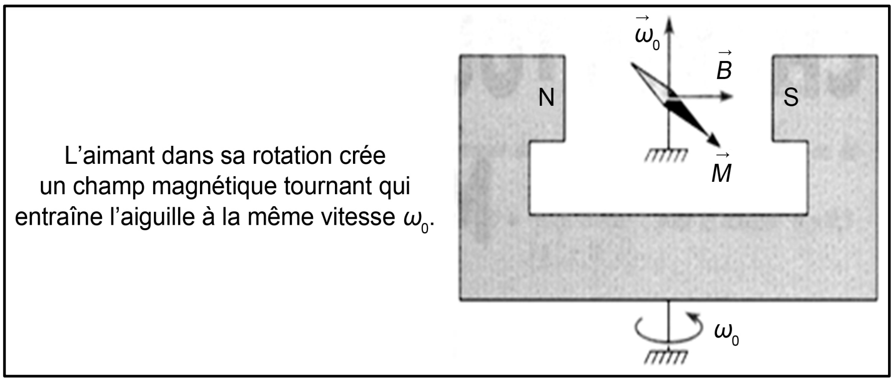

Figure 2. Rotating magnet.

the earth. If the two magnetic poles of the earth were fixed, since the observer is driven by the rotation of the earth in one direction, the needle should rotate in the other direction at the speed of rotation of the earth. But we all know very well that the needle of a compass always points to the magnetic north pole of the earth without moving. This is only possible if and only if the two magnetic poles of the earth rotate around its axis of rotation at its rotational speed. In other words, the earth's magnetic field is rotating and it rotates around the earth's rotation axis at the rotational speed of the earth. This phenomenon is rather difficult to observe when the angle between the magnetic axis and the axis of rotation of the celestial body is relatively small (the angle between the magnetic axis and the axis of rotation of the earth is 11˚) [18]. But when this angle is relatively large, the rotating magnetic field of a star can be easily observed. Neptune has a strongly inclined magnetic axis with respect to its axis of rotation at 47˚ and is offset by approximately 13,500 km from the physical center of the planet (see **Figure 3**). This is how we were able to measure the period of rotation of the magnetic field of Neptune and we noticed that it was equal to the period of rotation of the planet, *i.e.* 16 h 7 min [9]. The period of rotation of the magnetic field of Neptune is proof of the veracity of the new explanation of the origin of the magnetic field of a celestial body introduced in this study. This phenomenon of the rotating magnetic field of a celestial body could also be easily observed in the case of Uranus, which also has a strongly inclined magnetic axis with respect to its axis of rotation at 58.6˚ and offset by approximately 10,000 km from the physical center of the planet (see **Figure 3**).

4. The Nuclear Fusion Reactor

The energy at the heart of the star is produced by nuclear fusion reactions. Fusion has always been the first source of energy on earth through solar energy. Since the explosion of the first thermonuclear bomb in 1952, it has been a dream

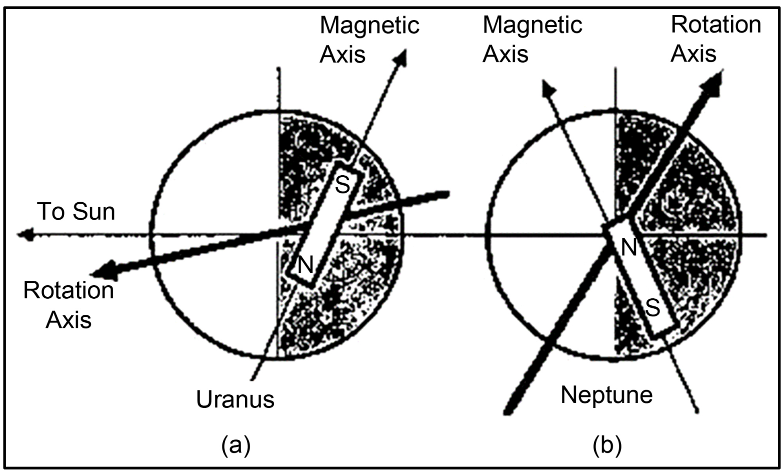

Figure 3. (a) Inclination of the magnetic axis relative to the axis of rotation in the case of Uranus and (b) Inclination of the magnetic axis relative to the axis of rotation in the case of Neptune.

of humanity to master this form of energy, cleaner than fission, whose resources are inexhaustible over historical times (in 300 liters of seawater, there is 1 gram of deuterium; sea water would ensure the energy consumption of humanity over times of a billion years). It is particularly frustrating that, unlike fission which was mastered within a few years of its discovery, fusion is still in the prospective stage 70 years after its first terrestrial use. Today, the phenomenon of Catastrophe of rapidly rotating fluids may bring us a solution to this problem.

We are thinking here of a reactor comprising a cylindrical cavity whose axis consists of a turbine with a large number of blades. We fill the cylinder with a nuclear fuel gas (e.g. helium). We then put this fluid in rapid rotation thanks to the axial turbine so that the catastrophe phenomenon occurs. After a certain time, the gas is completely ionized by collisions and the resulting plasma is made up of nuclei and electrons. Any collision between two nuclei could then lead to a nuclear fusion reaction. A certain quantity of heat is therefore produced in the cylindrical cavity. For such a reactor to operate for time scales large enough to vaporize the water contained in the steam generator, it is imperative that the amount of heat produced in the cavity cannot melt the turbine and the walls of the cylinder. A condition of critical mass is therefore imposed here, which must never be exceeded, similar to that found in nuclear fission reactors. Indeed, the quantity of heat produced in the reactor increases with the mass of the fluid contained in the cylindrical cavity. The greater this mass, the more nuclei there will be and the more fusion reactions there will be. This explains why the greater the mass of a star, the higher its temperature. So, the mass of the fluid contained in the reactor must always be lower than a certain critical value so that the quantity of heat produced by the fusion reactions cannot melt the cylinder.

One of the biggest advantages of this type of reactor will be the longevity of the confinement time. Indeed, as long as there is fuel in the reactor, there will be collisions between different nuclei and therefore energy production. Thus, for example, the fusion of two hydrogen nuclei will give helium, the fusion of two helium nuclei will give beryllium, the beryllium, after the fusion reaction, will be transformed into lithium and so on. Another advantage is that of cost. Unlike the tokamak, the price of which amounts to several billion dollars [15], this reactor will cost much less and this is due to its simplicity.

5. Conclusions

The dynamics of slowly rotating fluids differ enormously from the dynamics of rapidly rotating fluids. In a configuration where the fluid is in rapid rotation, *i.e.* the rotational speed of a fluid particle is very high so that the force of gravity is neglected in front of the centrifugal force in the Euler equation, the solution of the fluid motion equation presents a kinematic viscosity which depends not only on the position and the speed of the fluid particles but also on two real non-zero random variables. These give the rotating fluid a viscosity that can reach very high values: This is the catastrophe of rapidly rotating fluids. In this work, we have used this catastrophe phenomenon to show that the configuration in which the conductive fluid contained in the core of a celestial body is in rapid rotation is the one that best explains the origin of the magnetic field of stars and planets. It also explains why certain types of stars have very intense magnetic fields. Indeed, we have shown that the magnetic field of stars and planets is created by the electric current generated by the rotational movement of charged fluid particles as in an electromagnet. The lines of this magnetic field are channelled by the solid paramagnetic seed which plays the role of magnetic core in the cores of planets and stars. The seed is composed mainly of Iron and Nickel on the planets and of solid helium-3 in the stars. The new explanation of the origin of the magnetic field of stars and planets introduced in this article can be summarized in these three laws:

- A star whose core is entirely fluid has no magnetic field;
- The magnetic field of a celestial body rotates around its axis of rotation at its rotational speed;
- The intensity of the magnetic field of a celestial body is proportional to its mass and its speed of rotation.

Furthermore, we used the catastrophe of rapidly rotating fluids to introduce a new way to ionize a neutral gas and maintain it in a plasma state for indefinitely large time scales, to present a new technique for generating very intense magnetic fields, to establish a new magnetic nucleation process and to propose a new type of nuclear fusion reactor in which the plasma is perpetually rapidly rotating.

Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

References

[1] Fauve, S. (2005) Effet dynamo: de la production industrielle d'électricité au champ magnétique des étoiles. *La jaune et la rouge • août-septembre* 2005, 56-59.

[2] Shneider, C. (2011) Cowling's Theorem. Leiden University, Leiden.

[3] Hide, R. and Palmert, T.N. (1982) Generalization of Cowling's Theorem. *Geophysical and Astrophysical Fluid Dynamics*, **19**, 301-309. https://doi.org/10.1080/03091928208208961

[4] Sorongane, E.W. (2022) The Catastrophe of Rapidly Rotating Fluids. *Open Journal of Applied Sciences*, **12**, 469-480. https://doi.org/10.4236/ojapps.2022.124032

[5] Rainbault, J.-J. (2011) Introduction to Plasma Physics. Paris-Sud University, Paris.

[6] Berhanu, M., Bourgoin, M. and Chiffaudel, A. (2007) The VKS 2 Experiment: Observation of a Turbulent Dynamo and Erratic Magnetic Field Reversals. *Reflections of Physics*, **3**, 14-16.

[7] Sorongane, E.W. (2022) Implementation of a Semi-Classical Theory for Superconductors. *Open Journal of Applied Sciences*, **12**, 1243-1253. https://doi.org/10.4236/ojapps.2022.127084

[8] Nore, C., Guermond, J.-L., Léorat, J. and Luddens, F. (2014) Dynamo Effect in Cylindrical Geometries. *Electrical Engineering Symposium*, Gif-sur-Yvette, 8-10 July 2014, 7-9.

[9] Bell, J. (2013) The Space Book: From the Beginning to the End of Time, 250 Milestones in the History of Space and Astronomy. Sterling Publishing Co., New York.

[10] Sorongane, E.W. (2022) Electromagnetic Interaction: A New Theoretical Approach. *Open Journal of Applied Sciences*, **12**, 491-500. https://doi.org/10.4236/ojapps.2022.124034

[11] Cohen, Y. (1962) A New Class of Drugs: The Radioactive Isotopes. Saclay Nuclear Studies Center, Gif-Sur-Yvette.

[12] Sourie, A. (2017) Superfluid Models of Neutron Stars in General Relativity: Applications to Pulsar Dynamics. Paris Observatory, Paris.

[13] Channel, N. (2004) Entrainment in the Shell of a Neutron Star. Pierre and Marie Curie University, Paris.

[14] Sorongane, E.W. (2022) Implementation of a Classical Theory for Superfluids. *Open Journal of Applied Sciences*, **12**, 1254-1261. https://doi.org/10.4236/ojapps.2022.127085

[15] Basdevant, J.-L., Rich, J. and Spiro, M. (2002) Nuclear Energy. Editions de l'Ecole polytechnique, Paris.

[16] Landesman, A. (1970) Propriétés de l'hélium solidehélium solide: Propriétés générales et résonance magnétique dans l'hélium trois. *Journal of Physics Colloquia*, **31**, 55-66. https://doi.org/10.1051/jphyscol:1970305

[17] Guettafi, A. (2001) Concept of the Rotating Field in Alternating Current Electrical Machines: Windings. University of Batna, Batna.

[18] Dubois, J., Diament, M. and Cogné, J.P. (2011) Geophysics: Course and Corrected Exercises. Dunod, Paris.