Open Journal of Applied Sciences, 2023, 13, 275-287
https://www.scirp.org/journal/ojapps
ISSN Online: 2165-3925
ISSN Print: 2165-3917

The Classical Description of the Meissner Effect: Theory and Applications

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How to cite this paper: Sorongane, E.W. (2023) The Classical Description of the Meissner Effect: Theory and Applications. *Open Journal of Applied Sciences*, **13**, 275-287.
https://doi.org/10.4236/ojapps.2023.133022

Received: January 22, 2023
Accepted: March 3, 2023
Published: March 6, 2023

Abstract

When we place a superconductor above a magnet, we observe a levitation of the superconductor above the magnet. But when placing a perfect diamagnetic material above a magnet, no levitation is observed. This difference in behavior between the superconductor and the perfect diamagnetic in the presence of an external magnetic field is explained by the classical description of the Meissner effect implemented in this article. We have shown here that the Meissner effect is nothing more than an electromagnetic interaction between the magnetic field created by the superconductor and the magnetic field of the magnet. This classical description of the Meissner effect also allowed us to give a more realistic explanation of the expansion of the universe. We have shown that this expansion is a phenomenon that simply results from a Meissner effect between superconducting dark matter and the magnetic fields of stars. We also pointed out that this expansion is accelerated because the gravitational force between dark matter and the stars around it decreases as these stars move away from the superconducting dark matter. We also used this classical description of the Meissner effect to propose a new method of remote sensing in space in which the superconducting satellite is in perpetual levitation on the night side of the earth and a new and more efficient way to discover new particles through a superconducting detector levitating in the upper atmosphere.

Keywords

Meissner Effect, Levitation, Superconducting, Dark Matter, Remote Sensing, Satellite, Cosmic Radiation

1. Introduction

When a superconducting material is placed in a magnetic field, it repels all the magnetic flux coming from the outside and prevents the external magnetic field from penetrating it: this is the Meissner effect. After a thorough study of this effect, physicists concluded that in the presence of an external magnetic field, a superconductor behaves exactly like a perfect diamagnetic material [1]. However, a common phenomenon observed at low temperatures somewhat contradicts this statement. When we place a superconductor above a magnet, we notice that the superconductor rises and begins to levitate above the magnet. But when we place a perfect diamagnetic (a plastic material for example) above a magnet, nothing happens, no levitation is observed. It is therefore clear here that the behavior of a superconducting material in the presence of an external magnetic field differs from that of a perfect diamagnetic material. The classical description of the Meissner effect that we introduced in our previous article entitled "Implementation of a Semi-Classical Theory for Superconductors" published in the same journal allows us to explain this difference in behavior [2].

In the superconducting state, the spins or magnetic spin moments of the electrons (free electrons) are aligned. The coupling of these spin moments leads to the creation of a magnetic field around the superconductor. When it is placed in an external magnetic field, the magnetic field of the superconductor interacts with the external magnetic field, hence the Meissner effect appears. This interaction may be related to that observed in the experiment of the two magnetic needles. In this experiment, we notice that the two north poles (or the two south poles) of two magnetic needles repel each other [3]. This repulsion results from the electromagnetic interaction between the magnetic fields of the two needles. **The Meissner effect is therefore an electromagnetic interaction**. Moreover, recent work has shown in both cuprates and pnictides (high critical temperature superconductors) the appearance of the same magnetic signal called "resonance", precisely when the compound becomes superconducting [4]. On the other hand, when we place a perfect diamagnetic in an external magnetic field, nothing happens because the diamagnetic material does not present any magnetic field. There is therefore no electromagnetic interaction.

The Meissner effect is due to an electromagnetic interaction; we will take inspiration from another well-known electromagnetic interaction, namely the Coulomb repulsion between two electrons, to describe it. This classical description of the Meissner effect presented in the next section will then be used to explain the accelerated expansion of the universe, to propose a new method of space remote sensing and to introduce a new efficient way of discovering new particles.

2. The Classical Description of the Meissner Effect

The superconducting state of a material is due to the superfluidity of the free electron gas it contains. In the article entitled "Implementation of a Classical Theory for Superfluids" published in the same journal, we demonstrated that the zero viscosity (absence of collision between particles) of the gas of free electrons was a consequence of the electromagnetic interactions between the electrons [5]. Consider two neighboring electrons in the electron gas. One of the electrons is at rest while the other is in motion. If the mobile electron moves towards the fixed electron with speed V, then its kinetic energy is given by: $E_c = \frac{1}{2} m_e V^2$ (with m_e the mass of the electron). When this mobile electron is at a distance r from the fixed electron then it undergoes a Coulomb repulsion whose energy is given by: $E_p = \frac{e^2}{4\pi\varepsilon_0 r}$ (with e the charge of the electron and ε_0 the electric permittivity of the vacuum). Two cases can then be distinguished:

- If $E_c < E_p$, then there will never be a collision (zero viscosity).
- If $E_c > E_p$, then there will be a collision (non-zero viscosity).

The critical velocity V_c is then given by:

$$E_c = E_p$$

$$\Leftrightarrow \frac{1}{2} m_e V_c^2 = \frac{e^2}{4\pi\varepsilon_0 r} \tag{1}$$

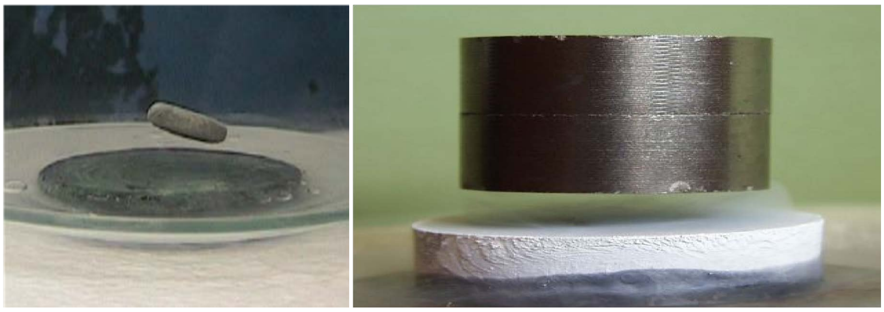
So we have:

- If $V < V_c$, then there will be no collision (superfluid state).
- If $V > V_c$, then there will be a collision (normal state).

In fact, for the viscosity to be zero during a flow of the superfluid on a fixed solid plate (*i.e.* no collision between the atoms of the superfluid and the atoms of the plate), it is necessary that the energy of the Coulomb repulsion E_p between the atoms of the superfluid and those of the plate is greater than the kinetic energy E_c of the atoms of the superfluid. In this case, the superfluid moves on the solid plate without touching it by levitating above it. This then imposes the existence of a limit flow velocity called the critical velocity above which $E_p < E_c$ and the flow becomes normal (non-zero viscosity). When the flow velocity is equal to the critical velocity, we therefore have $E_p = E_c$.

The electromagnetic interaction between the magnetic field of a superconductor and that of a magnet during a Meissner effect is basically similar to the electromagnetic interaction between two free electrons of the superfluid gas. To show this, consider the phenomenon of levitation mentioned above. A superconducting element is placed above a magnet. The superconductor rises to a certain height and remains in levitation at this height above the magnet (note here that the inverse experiment in which the magnet levitates above the superconductor is also possible) [6]. In **Figure 1**, the materials of black or chocolate colour are the magnets and those of white or grey colour are the superconductors.

Note $\boldsymbol{B}_s$ the magnetic field of the superconductor and $\boldsymbol{B}_a$ the magnetic field of the magnet. Let us call "last line of magnetic field", the line of magnetic field furthest from the source of the magnetic field. Given that it is here about an electromagnetic interaction; we are going to draw the expression of the energy of the magnetic field from that of the energy of the electromagnetic field. In classical electrodynamics, it is shown that in first approximation the energy E_t of an electromagnetic field is given by [7]:



(a) (b)

Figure 1. (a) Superconductor levitating above a magnet; (b) Magnet levitating above a superconductor.

$$E_t = \int_V \mathrm{d}^3 r \left(\frac{\varepsilon_0}{2} \left| \boldsymbol{E}(\boldsymbol{r},t) \right|^2 + \frac{1}{2\mu_0} \left| \boldsymbol{B}(\boldsymbol{r},t) \right|^2 \right) \tag{2}$$

where:

- $\boldsymbol{E}$ is the electric field;
- $\boldsymbol{B}$ is the magnetic field;
- ε_0 is the electric permittivity of vacuum;
- μ_0 is the magnetic permeability of vacuum.

This expression can be interpreted as the sum of the electric field energy $\int_V \frac{\varepsilon_0}{2} |\boldsymbol{E}|^2 \mathrm{d}^3 r$ and the magnetic field energy $\int_V \frac{1}{2\mu_0} |\boldsymbol{B}|^2 \mathrm{d}^3 r$. Thus, the energy E_s of the magnetic field of the superconductor is given by:

$$E_s = \int_V \frac{1}{2\mu_0} |\boldsymbol{B}_s|^2 \mathrm{d}^3 r \tag{3}$$

And the magnetic field energy E_a of the magnet is given by:

$$E_a = \int_V \frac{1}{2\mu_0} |\boldsymbol{B}_a|^2 \mathrm{d}^3 r \tag{4}$$

During the interaction between the two magnetic fields $\boldsymbol{B}_s$ and $\boldsymbol{B}_a$, two cases can be distinguished:

- There will be Meissner effect (the superconductor levitates above the magnet) if and only if:

$$E_s > E_a$$

$$\Leftrightarrow \int_V \frac{1}{2\mu_0} |\boldsymbol{B}_s|^2 \mathrm{d}^3 r > \int_V \frac{1}{2\mu_0} |\boldsymbol{B}_a|^2 \mathrm{d}^3 r$$

$$\Leftrightarrow |\boldsymbol{B}_s| > |\boldsymbol{B}_a|$$

$$\Leftrightarrow B_s > B_a \tag{5}$$

With $|\boldsymbol{B}_s| = B_s$ and $|\boldsymbol{B}_a| = B_a$.

- There will be no Meissner effect (no levitation) if and only if:

$$E_s < E_a$$

$$\Leftrightarrow B_s < B_a \tag{6}$$

The critical field B_c of the superconductor is then given by:

$$E_s = E_a$$

$$\Leftrightarrow \int_V \frac{1}{2\mu_0} |\boldsymbol{B}_s|^2 \,\mathrm{d}^3 r = \int_V \frac{1}{2\mu_0} |\boldsymbol{B}_c|^2 \,\mathrm{d}^3 r$$

$$\Leftrightarrow B_s = B_c \tag{7}$$

The critical field of a superconductor therefore corresponds to the magnetic field it creates. By replacing B_s in (5) and (6) by its value found in (7), we find the two well-known conditions which characterize the superconducting state, namely:

- If $B_a < B_c$, the material is in the superconducting state (existence of a Meissner effect).
- If $B_a > B_c$, the material is in the normal state (no Meissner effect).

In the levitation experiment considered here, the superconductor rises above the magnet because the repulsive force which results from the interaction between the two fields $\boldsymbol{B}_s$ and $\boldsymbol{B}_a$ is greater than the weight of the superconductor. This ascent will therefore take place as long as there is interaction between the two fields, that is to say, as long as the last line of magnetic field of the superconductor and that of the magnet intersect at two distinct points. But when there is no more electromagnetic interaction between the two fields, that is to say when the last line of magnetic field of the superconductor and that of the magnet no longer intersect, the repulsion force becomes zero. The force of gravity then attracts the superconductor towards the ground, that is to say, towards the magnet. In sum, the levitation of the superconductor above the magnet is observed when the last line of magnetic field of the superconductor is tangent to that of the magnet. Note then here that if the force of repulsion resulting from the electromagnetic interaction is lower than the force of gravity, this phenomenon of levitation will never be observed. This can happen either because the weight of the superconductor is too great (it is for this reason that it is difficult for man today to levitate a train); or because the repulsion force is too small when the modulus of the magnetic field $\boldsymbol{B}_a$ is very small (it is for this reason that no superconducting element levitates above the ground under the action of the earth's magnetic field which is the order of 50 μT) [8].

3. Applications

3.1. The Expansion of the Universe

The universe is in perpetual expansion. In other words, the stars that populate the universe are moving away from each other. This expansion is accelerated; that is to say that the speed at which two stars move away, one with respect to the other, increases with the distance which separates them. Edwin Hubble calculated the rate of expansion of the universe H_0 (a speed divided by a distance) called the Hubble constant. H_0 is currently estimated at 71 ± 4 Km/s/Mpc, which means that two celestial bodies separated by a distance of 1 Mpc, move away from each other at a speed of 71 Km/s (1 parsec = 3.261 light years) [9]. Today, physicists explain this phenomenon by saying that the different stars move away from each other because space-time expands, in a kind of vacuum dilation. The first thing that should be remembered here is that space-time is a purely idealistic concept introduced by Albert Einstein intuitively to define gravity in his theory of general relativity. Space-time has no real existence; you can't see it let alone touch it. So how could something that actually doesn't exist expand? The expansion of the universe is a reality, the stars actually move in space away from each other. We have been content so far with this ad hoc explanation of this phenomenon because we have not yet found a better one. But the classical description of the Meissner effect presented in this work gives us a more realistic explanation of the expansion of the universe; it even explains why this expansion is accelerated.

In fact, the expansion of the universe is a consequence of the Meissner effect between superconducting dark matter and the magnetic fields of stars. We introduced this new description of the expansion of the universe in a book entitled "God Does Not Play Dice: The New Description of the Universe" published by Lambert Academic Publishing [10]. The star's light and heat are produced by nuclear fusion reactions at the star's core. An ordinary star with the same chemical composition as the sun is made up essentially of carbon when it dies out. To understand why and how, we just need to observe the different cycles of nuclear fusion reactions in an ordinary star like the sun. We distinguish a series of cycles, connected to each other, some being catalytic cycles.

- IP cycle I (60%):

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

$$\mathrm{p}+\mathrm{d}\rightarrow {}_{2}^{3}\mathrm{He}+\gamma+5.5\ \mathrm{Mev}$$

$${}_{2}^{3}\mathrm{He}+{}_{2}^{3}\mathrm{He}\rightarrow {}_{2}^{4}\mathrm{He}+\mathrm{p}+\mathrm{p}+\gamma+12.9\ \mathrm{Mev}$$

- PP II cycle (24%), the helium 3 produced above is used:

$${}_{2}^{3}\mathrm{He}+{}_{2}^{4}\mathrm{He}\rightarrow {}_{4}^{7}\mathrm{Be}+\gamma+1.6\ \mathrm{Mev}$$

$${}_{4}^{7}\mathrm{Be}+\mathrm{e}^{-}\rightarrow {}_{3}^{7}\mathrm{Li}+\nu_{\mathrm{e}}+1.1\ \mathrm{Mev}$$

$${}_{3}^{7}\mathrm{Li}+\mathrm{p}\rightarrow {}_{4}^{8}\mathrm{Be}\rightarrow 2\,{}_{2}^{4}\mathrm{He}+17.4\ \mathrm{Mev}$$

(catalyst ${}_{2}^{4}\mathrm{He}$)

- PP III cycle (1%) (variant of the previous one):

$${}_{2}^{3}\mathrm{He}+{}_{2}^{4}\mathrm{He}\rightarrow {}_{4}^{7}\mathrm{Be}+\gamma+1.6\ \mathrm{Mev}$$

$${}_{4}^{7}\mathrm{Be}+\mathrm{p}\rightarrow {}_{5}^{8}\mathrm{B}+\gamma+0.1\ \mathrm{Mev}$$

$${}_{5}^{8}\mathrm{B}\rightarrow {}_{4}^{8}\mathrm{Be}+\mathrm{e}^{+}+\nu_{\mathrm{e}}\rightarrow 2\,{}_{2}^{4}\mathrm{He}+18.4\ \mathrm{Mev}$$

- Bethe CNO cycle (15%)-catalysis by C, N and O:

$${}_{6}^{12}\mathrm{C}+\mathrm{p}\rightarrow {}_{7}^{13}\mathrm{N}+\gamma+1.95\ \mathrm{Mev}$$

$${}_{7}^{13}\mathrm{N}\rightarrow {}_{6}^{13}\mathrm{C}+\mathrm{e}^{+}+\nu_{\mathrm{e}}+1.5\ \mathrm{Mev}$$

$$^{13}_{6}\text{C} + \text{p} \rightarrow {}^{14}_{7}\text{N} + \gamma + 7.54\ \text{Mev}$$

$$^{14}_{7}\text{N} + \text{p} \rightarrow {}^{15}_{8}\text{O} + \gamma + 7.35\ \text{Mev}$$

$$^{15}_{8}\text{O} \rightarrow {}^{15}_{7}\text{N} + \text{e}^{+} + \nu_{\text{e}} + 1.73\ \text{Mev}$$

$$^{15}_{7}\text{N} + \text{p} \rightarrow {}^{12}_{6}\text{C} + {}^{4}_{2}\text{He} + 4.96\ \text{Mev}$$

During its lifetime, the star therefore transforms its hydrogen into carbon through successive nuclear fusion reactions. The dead star is therefore, to a good approximation, an enormous solid and cold mass of carbon. Since there is no longer any fusion reaction (source of heat) in the dead star, it cools down. And when its temperature becomes lower than 15 K, the star becomes superconducting because the critical temperature of carbon is 15 K [2]. The dead star then creates a magnetic field around it. When the magnetic field of the superconducting star interacts with the magnetic field of a nearby living star, a Meissner effect occurs: the living star then moves away from the superconducting star. Hence the expansion of the universe appears. It is the living star which moves away from the dead star and not the reverse because in principle, the mass of the dead star must be greater than that of the star still alive. In effect, the stability of the star is due to the fact that the force of gravity (which tends to contract the star) is counterbalanced by the force of thermal pressure (which tends to expand the star). Thus, the higher the mass of a star, the higher its internal temperature. More fusion reactions then occur in a star of relatively large mass than in a star of relatively small mass. After using all of its nuclear fusion fuel, the relatively high-mass star dies out while the relatively low-mass star continues to burn fuel through nuclear fusion reactions and emits visible light. Stars that died out in the past therefore have masses greater than those of stars that are still alive today. As in the levitation experiment described previously, the living star moves away from the superconducting star because the force of repulsion due to the Meissner effect is greater than the force of gravity acting between the two stars. However, as the force of gravitational attraction between two bodies is inversely proportional to the square of the distance between the two bodies, the speed at which a living star will move away will increase with the distance which separates it from the superconducting star. Hence the acceleration of the expansion of the universe highlighted by Edwin Hubble appears.

Contrary to what modern cosmology asserts today, the expansion of the universe cannot be unlimited or infinite. This expansion can end in two different ways:

- Either by the death of the receding star. Indeed, the magnetic field of a star is created by dynamo effect. Basically, it is the rotational motion of charged particles in the core of the star that produces this magnetic field. We described this phenomenon of rotation in the Core of the star in a book entitled "The Catastrophe of Rapidly Rotating Fluids: A Solution to the Nuclear Fusion Problem" published by Lambert Academic Publishing [11]. Thus, when the star dies, that is to say when it becomes a solid carbonaceous mass, its magnetic field disappears with the dynamo effect. There will therefore no longer be any Meissner effect and gravitational attraction will remain the only force in action between the two dead stars.

- Or by the levitation of the living star at a certain distance from the superconducting star. Indeed, as in the experiment of the levitation of a magnet above a superconductor, the living star will stop moving away from the superconducting star when its last line of magnetic field is tangent to that of the superconducting star. The living star will therefore remain in levitation at a certain distance from the superconducting star until the day of its death. After the death of the star, the Meissner effect will disappear and the force of gravity will act in such a way as to bring the two dead stars closer together. We can therefore say that there will come a time in the future when all the stars will be dead and gravity will remain the only force acting between the various bodies in the universe. It will therefore contract and collapse on itself: big crunch.

I then present here two scientific observations that can serve as evidence for this new description of the expansion of the universe:

- First, if these superconducting stars exist, we should be able to observe effects in the universe due to their gravitational forces. Indeed, by using Newton's laws of gravity, physicists have been able to demonstrate that the visible matter that we can observe in the universe only constitutes 5% of all the mass contained in the universe. In other words, the universe is made up largely, or 95%, of invisible matter. Physicists called it "dark matter". Thus dark matter is made up of the ancient stars that are extinguished (dead stars). This assertion is supported by the fact that the masses of dead stars are greater than those of stars still alive today.

- Second, given the low temperatures of these superconducting stars, they must emit thermal radiation in the microwave or radio wave range that we should be able to observe. Indeed, a cosmic radiation at 2.7 K is observed today in all directions in the universe. The cosmic microwave background is nothing but the radiation, in the microwave range, emitted by the superconducting dark matter that contains the entire universe [12]. This radiation was first observed by chance in 1965 by two American physicists at the Bell Telephone Laboratories in New Jersey, Arno Penzias and Robert Wilson when they were testing a very sensitive microwave detector. In addition, in the late 1950s and early 1960s a survey of sources of radio waves from outer space was carried out at Cambridge by a group of astronomers led by Martin Ryle. The Cambridge group showed that most of these radio sources must lie outside our galaxy and also that there were many more weak sources than strong ones [13].

In short, dark matter is therefore made up of stars that have died out and then cooled over time until they become superconducting. They respectively emit microwaves or radio waves when their temperatures are respectively around 2.7 K or close to 0 K.

3.2. Space Remote Sensing

In the study of the phenomenon of levitation of a superconductor above a magnet, we have seen that if the force of gravity is too great, there cannot be levitation (it is for this reason that it is difficult to levitate a train above the ground). However, the force of gravitational attraction between two bodies is inversely proportional to the square of the distance between the two bodies. In other words, if we were to get far enough from the earth to reach very high altitudes where the gravitational attraction is very weak, we should be able to levitate a superconductor of great mass thanks to the electromagnetic interaction between its magnetic field and the earth's magnetic field. Indeed, the influence of the Earth's magnetic field is felt several tens of thousands of kilometers away. The magnetosphere is a layer of the atmosphere located above the ionosphere, that is to say, more than 1000 km, and subjected to the magnetic field of the earth. Its thickness is a few tens of thousands of kilometers. The magnetosphere plays an essential role in the development of life on earth by deflecting deadly particles from the solar wind and cosmic rays, thus forming one of the most magnificent natural phenomena: the aurora borealis and australia [14]. As can be seen in **Figure 2**, a solar eruption that occurs on the surface of the sun produces a solar wind that moves through the solar system to reach the Earth's magnetosphere. The solar wind being a fluid made up of charged particles is then deflected by the Earth's magnetic field.

At tens of thousands of kilometers in altitude, the force of gravity decreases enormously. We should therefore be able to levitate a satellite whose walls are entirely made from superconductors above the earth. We, therefore, introduce here a new method of remote sensing in which the satellite is in levitation and not in orbit. Note then that we will not even need to install a complex cryogenic system in the satellite to cool it. In fact, it will be enough to place the satellite on the night side of the earth to cool it. Unlike a body levitating near the surface of the ground, the satellite levitating at high altitude will not be dragged by the rotation of the earth. In effect, a levitating body near the ground is dragged by the rotation of the earth because of the very dense atmosphere of the lower atmospheric layers. But at high altitude, the density of the atmosphere is extremely low. The satellite will therefore be perpetually subjected to intense cold on the night side of the earth. In other words, once superconducting, the satellite will remain in this state indefinitely. Such a method of spatial remote sensing would have several advantages. Indeed, satellites in scroll orbit have a practical lifetime of 2 to 3 years on average, geostationary satellites 5 to 10 years. Several factors contribute to progressive deterioration of the orbit [15]:

- Atmospheric friction, although weak, leads to a drop in speed and a loss of altitude. The friction forces being proportional to the square of the speed of movement, a satellite in levitation (that is to say at rest) will not be subjected to any friction force.

- Solar radiation exerts pressure on the satellite, zero in the shaded hemisphere, higher on the illuminated side. Repeated changes in this pressure gradually affect the quality of the orbit. A satellite levitating on the night side of the earth will never be under pressure from solar radiation.

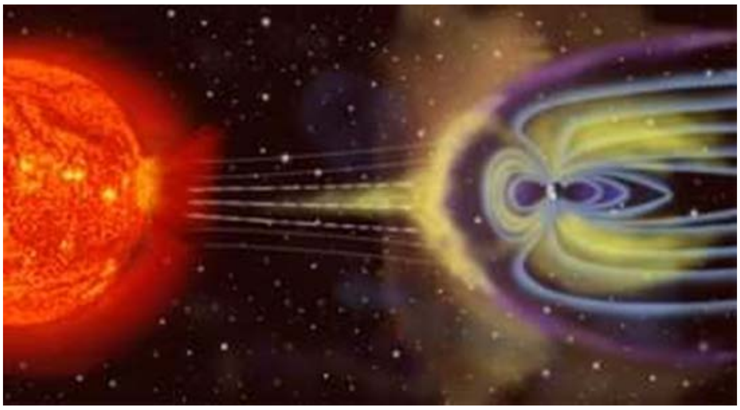


Figure 2. Deviation of solar wind particles by the magnetosphere.

- Since the earth is not a perfect sphere, the force of gravity varies with latitude. It decreases the farther one moves from the equator. This leads to precession movements in the satellite's orbit. A satellite in levitation being fixed in space will always keep its latitude and it will therefore never be subject to precession movements.

These factors act on the orbit, but also on the attitude of the satellite, that is to say, its orientation with respect to the earth that it must observe. A satellite in levitation will always have the same attitude with respect to the earth. Moreover, this method of remote sensing in which the satellite is in levitation can also be used to observe the other planets of the solar system having a magnetic field (Jupiter, Saturn, Uranus and Neptune). In addition, a space probe whose walls are entirely made up of superconducting materials would allow us to observe regions of our solar system that are increasingly distant from the earth. Indeed, the current space probes are slowed down by the gravitational fields of attraction of the planets when they travel in the solar system. But if the space probe is superconducting, the force of repulsion due to the Meissner effect will always oppose the force of gravity of the planet. The superconducting space probe will therefore not be slowed down in its course and will thus be able to reach regions very far from the earth in the solar system.

3.3. The Discovery of New Particles

Particle physicists use Einstein's famous relationship $E = mc^2$ (where E is the energy, m is the mass and c is the speed of light in vacuum) to produce new particles in particle accelerators. In these accelerators, new particles are discovered through high-energy collisions between probe particles and target particles. Einstein's relationship implies that the higher the energies of the probe particles (and target particles), the greater the masses of the particles created. The current limit in terms of energy reached by the most efficient accelerators is 20 Tev. However, thousands of particles are produced every day in the upper atmosphere as a result of the collisions of cosmic radiation particles on the nuclei or ions of the atmosphere (see Figure 3) [16].

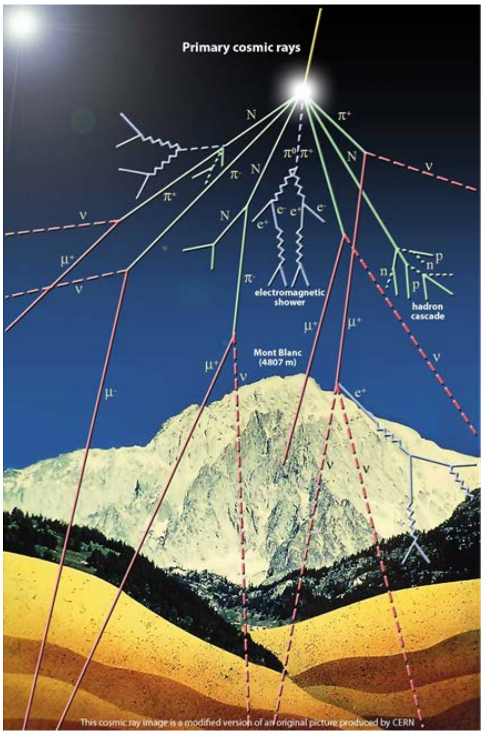


Figure 3. Interaction of a cosmic ray particle in the upper atmosphere.

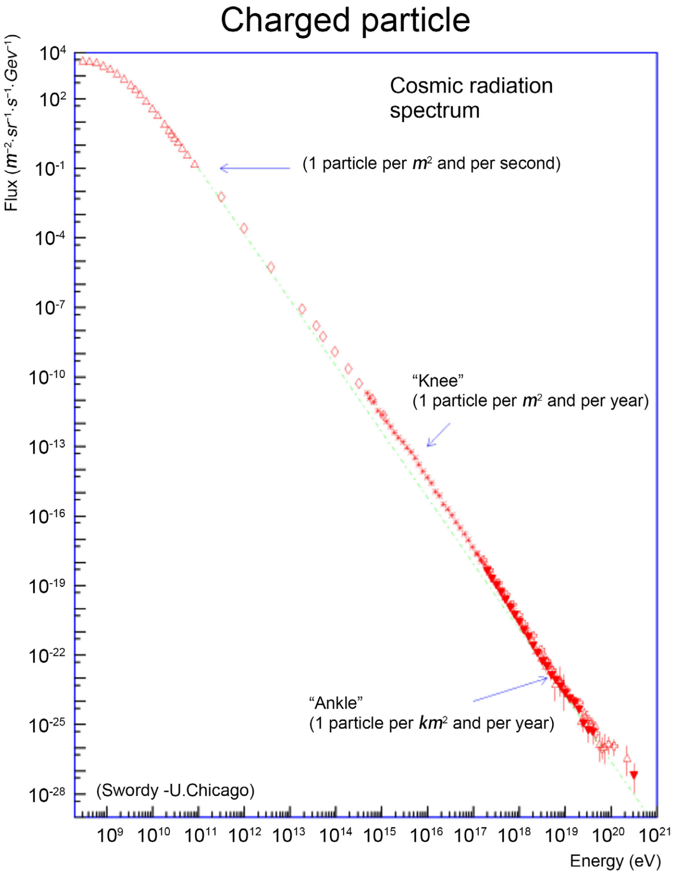


Figure 4. Energy of the charged component of cosmic radiation.

The charged component of cosmic radiation is made up of nearly 90% protons, just under 10% α particles and only a few percent electrons. Their energies can exceed the Pev (see **Figure 4**) [16]. The neutral component of cosmic radiation is made up of very high energy photons and neutrinos. Today, cosmic radiation and its interactions in the upper atmosphere are studied using detectors that are sent to high altitude using balloons (vectors). These detectors have a relatively short lifetime in the atmosphere because very often the balloon deteriorates and the detector falls. But if we sent a detector made entirely from superconductors to high altitude, it could remain indefinitely in levitation on the night side of the earth like the superconducting satellite mentioned above. We could then discover new particles in the upper atmosphere twenty-four hours a day, seven days a week.

4. Conclusion

The classical description of the Meissner effect implemented in this article allowed us to explain why the behavior of a superconductor differs from that of a perfect diamagnetic material in the presence of an external magnetic field. The levitation of the superconductor above the magnet is explained by the fact that the Meissner effect is actually an electromagnetic interaction between the magnetic field of the superconductor and that of the magnet. This classical description of the Meissner effect also allowed us to give a more realistic explanation of the expansion of the universe. We have shown that this expansion is a phenomenon that simply results from a Meissner effect between superconducting dark matter and the magnetic fields of stars. We also pointed out that this expansion is accelerated because the gravitational force between dark matter and the stars around it decreases as these stars move away from the superconducting dark matter. We also used this classical description of the Meissner effect to propose a new method of remote sensing in space in which the superconducting satellite is in perpetual levitation on the night side of the earth and a new and more efficient way to discover new particles through a superconducting detector levitating in the upper atmosphere.

Conflicts of Interest

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

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