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THE BARIELECTRIC EFFECT

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Abstract. This paper presents a possible generation mechanism of magnetic field in stellar interiors
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1. Introduction. The barielectric effect in a phenomenon that occurs in fluid plasma (*gaseous* or *liquid*). It is common knowledge that plasma is a set of positive (ions), negative (electrons) particles, neutral particles and photons. In nature the gaseous plasma is to be found in the hight layers of the atmosphere, forming the ionosphere. But most of the matter of the Universe as is curently known is under the form of gaseous plasma in the stars. the liquid plasma is present under the form of melted metals and is also to be met in the incandescent core of the Earth. It is to be noticed that the existence of solid plasma is admitted as for example the crystalline networks with positive ions in the network's knots and with the electrons around those ions.

Depending on its temperature, the plasma may be completely ionized, i.e. having the ionization degree $\alpha = 1$ (temperatures over 100000K mostly) and partially ionized $(\alpha < 1)$ at temperatures below 100000K. But along with the temperature not only the ionization degree rises but also the particle speed, the so-called *thermal speed*. The speed of the gas particles (thermal speed) causes gas pressure by collisions among particles and against the recipient's walls. If the gas gets out of a recipient with a certain speed, this is due to the thermal speed of particles.

The kinetic theory of gases shows that at the same temperature the particles thermal speed is inversely proportional to the square root of their mass. So for the molecules of the gas the efficient thermal speed (the square root of the

average square speed) is $v_t = 158000(T/M)^{1/2}[cm/s]$ (1* page 1093) where T is the absolute temperature and M is a mole's mass.

Supposing we have a recipient with a gas formed of two types of particles: big mass particles and small mass particles, at a certain pressure. Supposing the recipient is placed in a very low pressure location. If we open the lid of the recipient, the particles will get out of it under the form of a jet with different speeds, but in accordance with their thermal speed: the small mass particles will have a higher speed and the big mass particles will have a smoller speed. The higher speed particles will surley knock against the slower particles and will yield up a part of their kinetic energy.

Indeed, we all know that thermal speed generates the pressure of a gas. The formula of the flowing speed of a gas between two points 0 and 1 where there is a pressure difference (2* page 337);

$$v = \sqrt{\frac{2\chi}{\chi - 1}\left(\frac{p_0}{\rho_0} - \frac{p_1}{\rho_1}\right)}$$

where:

$\chi = C_p / C_v$;

C_p = heat capacity at constant pressure;

C_v = heat capacity at constant volume;

p = pressure;

ρ = mass density.

The formula shows that the flowing speed v rises with the raise of the pressure difference and it also rises when mass density decreases. If we have a mass (quantity) of ions and a mass of electrons separated between them but submitted to the same preassure difference, the electrons will have a greater flowing speed because of lower mass density. In the mixture of ions and electrons (plasma) under p_0 and p_1 pressure, the electrons will also have the tendency of getting a higher flowing speed, generating an electric current. So that the different thermal speed and mass of the electrons and ions of the plasma may indirectly cause an electric current, when the fluid plasma shifts from a higher pressure point to a lower pressure point.

The transformation of thermal energy into electric current occurs not ounly into the plasma as above-shown. In physics the thermoelectric effect by means of which thermal energy is also transformed into electric current though the transformation process differs.

2. The barielectric effect

In the hydrogen fluid plasma, we specify hereby that the difference between the masses of component particles is considerable: the electron has a mass of 1837 times smaller than the proton. This is the cause why the termal speed of the electron is much higher than the termal speed of the proton. The thermal speed of the electron is: $v_{Te} = 4{,}19 \times 10^5 (Te/11605)^{1/2} ms^{-1}$ and the thermal speed of the proton is: $V_{T_p} = 9{,}79 \times 10^3 (Tp/11605)^{1/2} ms^{-1}$ (3* page 440). Their ratio (when at the same temperature $Te = Tp$) is $v_{Te}/v_{Tp} = 42.8$ So, at the same temperature the thermal speed of the electrons is 42.8 times higher than the thermal speed of the protons

In the case of hydrogen plasma flow the electrons seem to get a flowing speed in the same sense with the ions but much higher than term. It is true that electrons will knok against the ions (protons) which are slower and will lose part of their speed surplus, so they will face a resistance which is the electric resistance. The faster movement of the electrons is in fact an electric current whose conventional sense is opposite to that of the electrons and ions. We called this phenomenon of producing this current the *barielectric effect* because the electric current is due to the movement caused by the pressure difference.

Therefore, we may phrase the following rule: if between two points in the plasma there is a pressure difference and as a result a movement of the plasma from the higher pressure point to the lower pressure point, then an electric current occurs; the sense of the current is opposite to the sense of movement of the plasma. It is this current that we called *barielectric current* because it is due to the pressure difference.

In order to determine the barielectric current intensity we may notice that in the case of a V volume of matter loaded with elementary electric charge, the volume which passes through a surface S in a second, the intensity of the current is: $I = N/n_c = (Vn_e)/n_c = (Svn_e)/n_c$ where N is the number of elementary charges which pass through S in second n_c the number of elementary charges for coulomb, n_e the number of elementary charges per cubic meter in the matter volume V and v is the speed of passing through surface S. In the case of the barielectric current from the plasma is easy to show that instead of speed v, we must place the speed difference between the electrons and the ions and the formula becomes:

$$I = (S\Delta v_e n_e)/n_c$$

where:

-S is the passing surface of the plasma;

- Δv_e is the difference between the average speed of the electrons and the average speed of the ions;

- n_e is the number of free electrons per m^3 from the plasma;

- $n_c = 0,624 \times 10^{19}$ electrons for a coulomb.

Of course, when causing the movement because of the pressure difference in gravitational field one must also consider height of the column according to the well-known formula of Bernoulli.

Depending on the configuration of the circuit where moves, we may distinguish two cases when producing the barielectric effect. In the first case, we suppose that the plasma moves on an open circuit, i.e. from an initial point A of the circuit to the final point B, without coming back to A. The electrons will circulate from A to B with a higher speed than the ions generating as above-shown the barielectric current. Consequently, at the point A a positive electric change appears and at the point B a negative electric charge appears. The resul is a potential difference which reduces the barielectric current until its cancellation, when the potential difference between A and B balances the barielectric effect. This may be the case with the plasma jets of the jet engines the rockets etc.

In the second case, the plasma moves on a closed circuit (the closed curve). In this case in any point of the circuit, though the electrons have a higher speed than the ions, the electrons which leave from a point are replaced by others which arrive in said point. Therefore, no accumulation of electric charges occur and the barielectric current maintains. This fact may be easily demonstrated applying Kirchhoff 's first law to the electric circuit. This is a case which occurs in the stars and in the fluid cores of the planets. The current's intensity varies depending on the electric resistance, temperature, pressure difference and other characteristics of the plasma. The barielectric effect is stronger where there are big masses of plasma at high temperatures, usually in the Sun and other heavenly bodies. We further highlight that the convective movements of the solar plasma are in fact movements due to the pressure differences and therefore they produce the barielectric effect.

The barielectric effect needs no existence of the initial magnetic field either or the existence of an electric field. For its appearance the existence of a pressure gradient in the plasma and a level difference (in gravitational field) which to allow the movement of the plasma are enough. The barielectric current produces such as any other electric current, a magnetic field which we might call barielectromagnetic field.

3. Case of Sun

One argument for the production of the barielectric effect is that the faster movement of the electrons in comparison with the protons may be actually noticed in the protons and neutrons flow given out the Sun (*the solar wind*). So in the internal radiation belt surrounding the Earth between 5600 and 2400km, the proton energy is found to be $E_p = 10^8 eV$ and the electron energy $E_e = 5 \times 10^5 eV$ (4* page 52). Starting from the energy of such particles and marking with v_p the protons'speed and with v_e the electrons'speed find that $v_e / v_p = 2,07$ this being the approximate ratio of the real speeds. This great difference between the electrons, speed and the protons'speed is possible due to the wery density of the particles.(about 10^7 particles per cubic meter). In order cases the density of the plasma particles is much higher. Thus, at the surface of the Sun the density is of 10^{23} particles per cubic meter and grows fast with depth.

The formula of the intensity of barielectric current shows that the increase of the electrons'density (n_e) may compensate the decrease of the speed difference between the electrons and ions,this being smaller because of the more numerous reciprocal collisions, in the case of a thicker plasma. So, in the case of very high densities of the fluid plasma of the heavenly bodies, a very small difference between the speed of the electrons and of the ions may generate a strong magnetic field.

In my book *Solar Magnetism and Planetary Magnetism* (5*) I brought the arguments to show that the barielectric effect is at the basis of producing the magnetic polar field of the Sun and produces also the magnetic field of the sunspots. The barielectric effect also occurs in the liquid plasma inside the Earth. I showed in the above-mentioned book, that the barielectric effect may explained the engendering of the terrestrial magnetic field and may also explain the periodical inversion of this field. The poles'inversion of the terrestrial magnetic field in the geological past of the Earth was found due to the study of the rocks making the Earth's crust.

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