Wall confinement technique by magnetic gradient inversion.

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We present experimental evidence of MHD wall confinement of an electric discharge, due to the inversion of the magnetic field gradient, as presented in a previous paper (Acta Physica Polonica 2008). The program of future experiments is evoked.

As shown below, the experiment was a complete success. The basic idea was presented in a previous paper in 2008 [15]. In a plasma, when a transverse magnetic field is applied, the electrical conductivity σ follows the matrix of figure 1, where σ_s is the scalar conductivity and β the Hall parameter.

$$\sigma = \sigma_s \begin{bmatrix} \frac{1}{1+\beta^2} & \frac{-\beta}{1+\beta^2} \\ \frac{\beta}{1+\beta^2} & \frac{1}{1+\beta^2} \end{bmatrix}$$

Fig.1 : Electrical conductivity, with transverse magnetic field

When the Hall parameter β is weak, the electrical conductivity σ is close to its scalar value σ_s. If not negligible the electrical discharge will tend to take place along a path that minimizes global electrical resistance of the current streamer. If order to have non negligible Hall parameters values, with simple solid magnets, which create a B field limited to 1000 gauss, we decided to operate in low density air, in order to damp the electron-heavy species collision frequency (in future experiments the field will be created by a system of coils). With a single magnet, the magnetic field decreases at distance from the wall, so that it blows away the electric discharge, which tends to take place where the field is weak, as shown on figure 2.

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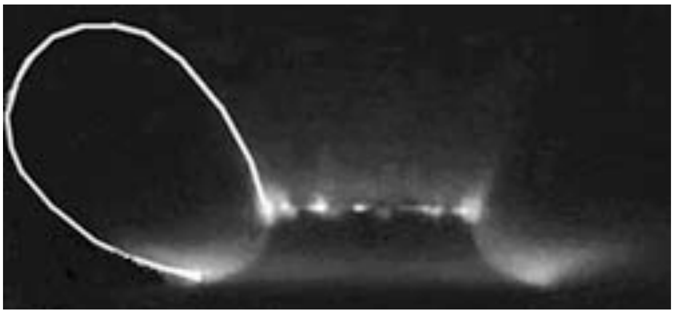

Fig2 : The electric discharge is blown away by the magnetic field gradient

Figure 3 shows the basic confinement system by inversion of the magnetic field gradient. Two smaller confinement coils modify the magnetic pattern.

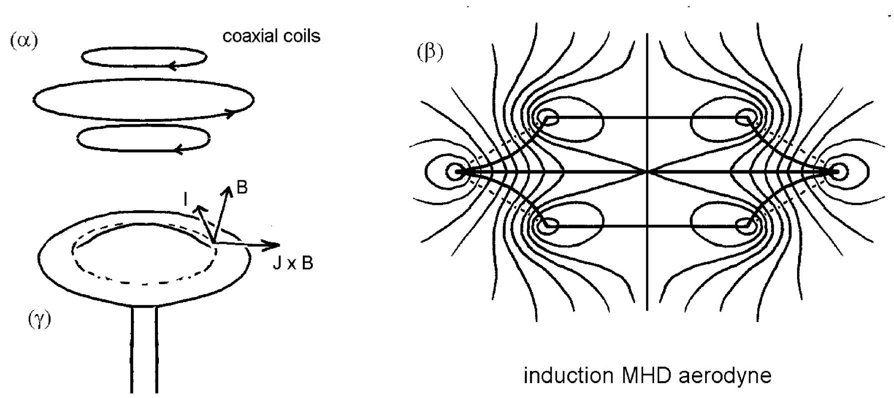

Fig.3 : Magnetic pattern with B field modified by confinement coils effect.

In this device, the magnetic field is at its minimum along a surface close to two portions of cones, containing the equatorial coil and the confinement coils. Figure 4, left, depicts a more detailed representation of the magnetic pattern. Right : confinement effect with two magnets.

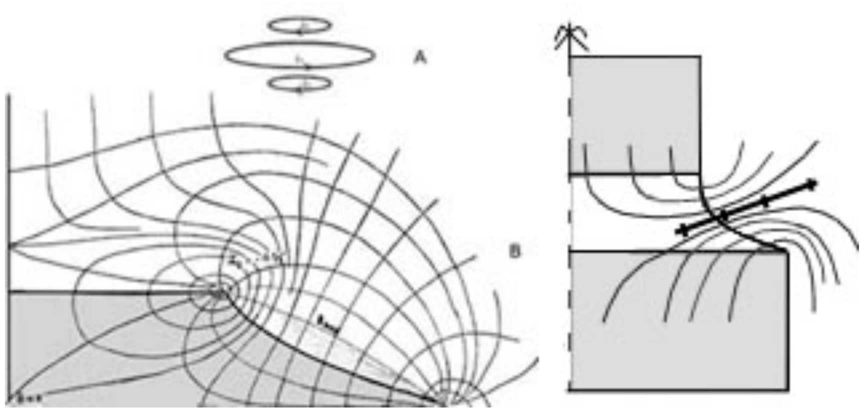

Fig.4 : Left : the magnetic field produced by a system of coils. Right, by two magnets

The left diagram of figure 5 shows the value of the magnetic field along a straight line, visible on figure 4. On the Right is the square of the magnetic field. The ratio between the maximum value, at distance of the wall, and the value at the wall is 1.4

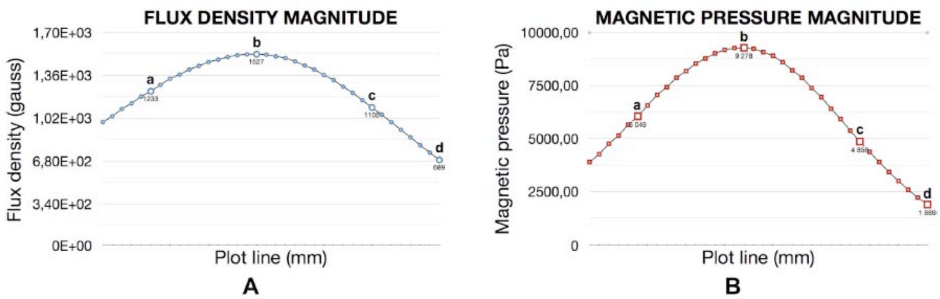

Fig.5 Evolution of B and B^2, along the line in the figure 4.

The figure 6 shows the experimental apparatus. At the top of the 40 cm diameter cylindrical chamber, an actuator moves a confinement magnet vertically and makes possible its entering into contact with the cap of the model, equipped with segmented electrodes (in order to obtain an axi-symetrical discharge). The pressure inside the bell is of the order of 20 mb.

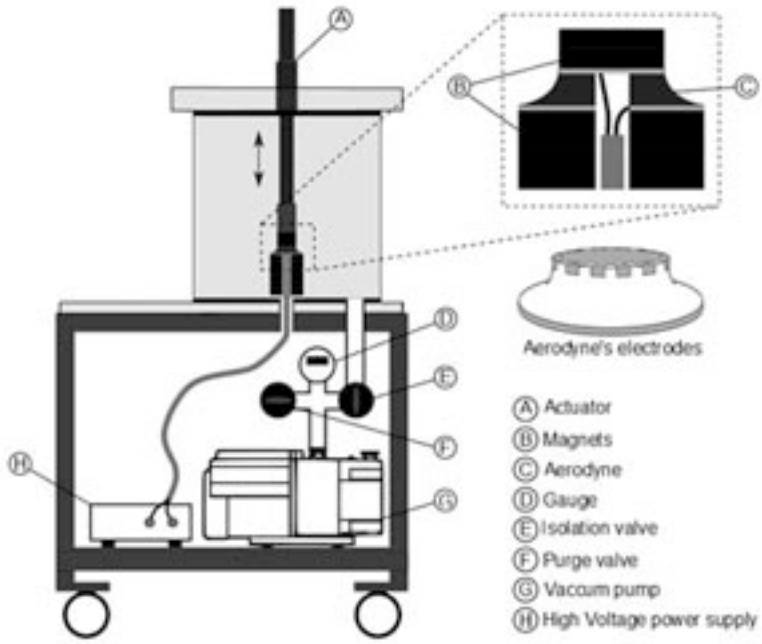

Fig.6 : Experimental device for low pressure MHD experiments.

Figure 7, depicts the apparatus. When the confinement magnet is lowered, this modifies the magnetic pattern and, subsequently, the electric discharge pattern. At the end of the course, the latter takes place at the wall of the model as shown on figure 8. This is the first step of our experimental program, using this low density MHD apparatus. In the next experiments we will deal with the Velikhov instability cancellation, by magnetic gradient, as presented in reference [13]. Then we will build up a ionization control system, located at the wall of a disk-shaped model, as mentioned in references [15] and [16]. With time-variable ionisation and B-field we will try to operate a disk-shaped MHD accelerator, and to illustrate the induced flow in low density experiments. Finally we will shift to atmospheric pressure experiments, with time-variable ionization, produced by 3 GHz microwaves coupled to a synchronized time variable B-field. An attempt will be made to show, in a short duration supersonic wind tunnel that such disk-shaped MHD aerodyne may fly in air without shock wave system and turbulence ([7], [8], [9], [10], [11], [12]), which would avoid subsequent energy loss, due to the wave and frictional drag.

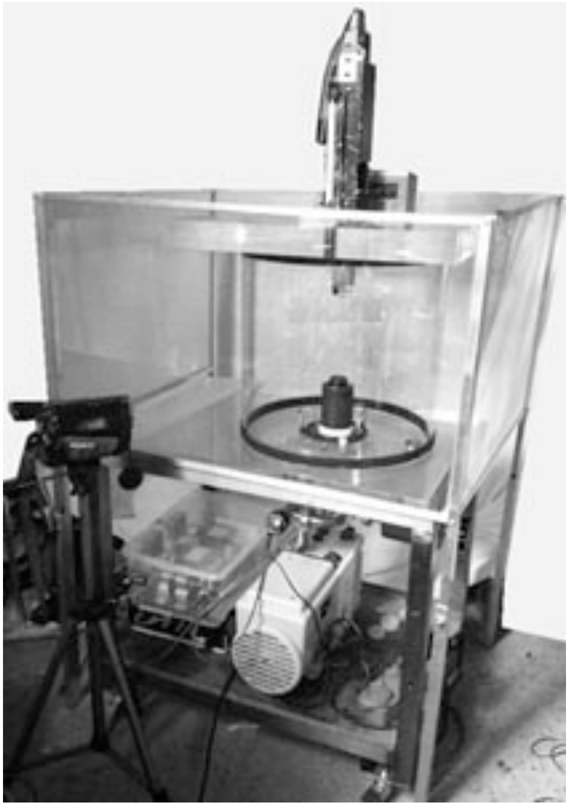

Fig.7 : Low pressure experimental device

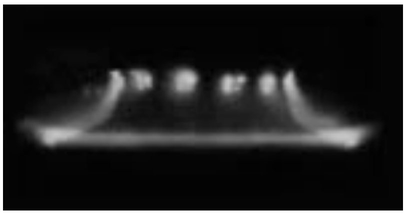

Fig.8 : Magnetic confinement of the electric discharge at the wall.

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