Electrons clusters and magnetic monopoles

M.Rambaut
57H rue De La Hacquinière, 91440, Bures-sur-Yvette, France
m.rambaut@wanadoo.fr

It is shown that there does exist a possibility of producing bursts of magnetic monopoles using properties of largely ionised condensed media, where electron accumulations or clusters are used to born. A spontaneous gauge symmetry breaking occurs when the electrons, constituting the cluster, are sufficiently close together for opening the way to the creation of a topological defect which, as it is known, has in this case, the properties of a magnetic monopole. Those properties of magnetic monopoles, grounded in this way, in tthe frame of quantum theory of fields, are not contradictory with the initial concept proposed by Dirac, but conversely complete this model, showing the possibility of producing monopoles and to observe them in laboratory, with relatively low energy devices.

Introduction: — The electrons accumulation, or cluster is a macroscopic entity put into evidence firstly in Russia by G.A.Mesyats [1] as early as during the sixties of the twentieth century, which he named "Ecton". Secondly in the United States, during the eighties, by Kenneth Shoulder [2] and named by latin words "Electrum validum" ("Strong Electron").

According specific experiments, the shape of an electrons accumulation is spherical and a typical cluster of radius 3μm may contain as many as $2x10^{10}$ electrons [3]. But for performing Coulomb barrier screening, and obtaining D-D nuclear fusions, some 10^3 electrons may be sufficient [4]. The mean distance between electrons in the cluster is typically in the range of the electron Compton wave length ($2.426\ 10^{-12}$ m). The most typical way of obtaining electron clusters seems to have been the use of rough surfaces of electrodes in a discharge device [1]. For accounting the transitory cohesion of electron clusters, it seems sufficient to take into account the interaction between the spin of electrons, another cause such as the Casimir effect seeming to be ruled out [5].

The electron clusters seemed at first to be only interesting for their great energy density. But the capacity they have of producing "screening" of two colliding charges particles, opened the way for a new use of those macroscopic entities in physics experiments [4]. It seems that the role and efficiency of electron clusters is being progressively recognized as being primordial in low energy transmutation processes. In many experiments, for example, which are known as not involving any thermonuclear process, but leading nevertheless to fusion reactions, one can invoke the role of electron clusters as being primordial. But in some experiments, when photographic emulsions were used, strange tracks appeared. Given their large transversal dimension and their length, they could correspond to any charged particles. The first who has proposed officially that those tracks could be due to magnetic monopoles is L.I. Urutskoev et al [7]. Their experiments were successfully reproduced in two other laboratories [8-11]. Given the shape of those abnormal tracks they were called "caterpillar" in a picturesque and vivid way. But, some years before, there was at least one experiment where similar tracks were observed and curiously called also "caterpillar" without any mention to magnetic monopole, by I.Dash et Al [12]. The experiments consisted of making nuclei to react in a glow discharge chamber, the plasma being rich in electrons. Those experiments were in fact very close to the ones of L.I.Urutskoev, if we consider them from the point of view of electrons accumulation (5-6). In another terms, there does exist several laboratories where it seems that the same phenomenon has been observed separately: a particle track having the shape of a "caterpillar" in a film. The magnetic monopoles production in plasmas becomes an heuristic hypothesis.

Process of electrons cluster formation — There are many ways of creating electrons accumulations. The life of those accumulations is typically comprised between 10 ns and 10 μs. For example, G.Mesyats makes a rough cathode which produces bursts of electrons, owing to the roughness of this cathode. But there is another method which consist to create, from a plasma, a LPS ("Large Poincaré System"), according the terminology of Ilya Prigogine [13]. A lot of various resonances occur in a LPS. One has to emphasize that the expression LPS was made up initially for energies at the atom level, but seems well suited for larger ones, typically some kev to some tens of kev, and perhaps above. This way is precious in the case of monopole creation, as it is shown further. Given the

LPS, existence, charged particles, that is atom nuclei and electrons, can be considered as being quasi-free. Their 3D distribution is ruled by Poisson law. Thus the P_p probability for a micro-volume V, containing p nuclei, μ being the mean number of nuclei per V-volume, reads:

$$P_p = e^{-\mu} (\mu^p/p!) \qquad (1)$$

Considering this V-micro-volume leads to evaluate the order of range of the-mean number of trapped electrons ν around two colliding nuclei. The interesting sites of this distribution are the ones where it occurs two nuclei collisions. The probability of finding two nuclei in the V volume reads,

$$P_2 = e^{-\mu} (\mu^2/2!) \qquad (2)$$

Given the high electron mobility in comparison with the one of nuclei, the coming closer of two nuclei builds a small potential well, which prompts a transitory electron accumulation [4]. And the ratio between the probability of filling a V micro-volume by one unique nucleus, and the probability of filling it by two nuclei is equal to the number of electrons ν surrounding two colliding nuclei (whose distance is inferior to the Bohr atom radius)

$$\nu = 2/\mu \qquad (3)$$

This model, primitively built to account of non-thermonuclear fusion reactions in a plasma, seems to be pertinent for other technical processes which put a condensed medium into condition in a cold way (Figure 1):

1) Cells for cold fusion (Fleischman and Pons).
2) Beams of D^2O impinging on a metallic target filled with D nuclei (Brookhaven national lab during the eighties).
3) Pulsed currents through a condensed and deuterated medium (NRL, Kiel, during the eighties and seventieths, and others).

This model is grounded on two specific particularities [4 – 6] :

a) The use of specific dimensional relationship replacing the "Lawson criterion", which is only valuable for the thermonuclear process.
b) The fractal dimension of the two nuclei colliding space, deduced from use of the Poisson statistic.

Moreover this model is not restricted to fusion reactions, as it is in agreement with pulsed low energy transmutations, for example those which have been put into evidence in experiments performed in the Kourtchatov Institute [7-11].

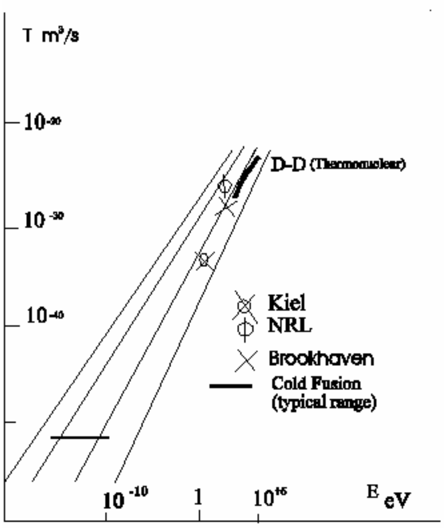

Figure 1: Representative points of typical non- thermonuclear experiments, showing the specific place of Cold Fusion. Each straight line corresponds to a specific electron number.

Monopole creation—One has to underline the difference with the customary theoretical thought processes about the magnetic monopole problem. In our case, one has to describe the system, inside the electrons accumulation, by mathematical entities which are as much as possible faithful to the reality, in the frame of the quantum theory of fields, whereas from the pure theoretical point of view, people is "free" to choose, for example any gauge group, which ensures the success in any way of theoretical magnetic monopole creation but without any other requirement.

Let's go on keeping the hypothesis that the electrons which constitute a transitory accumulation are initially taking part of LPS: they are quasi free as it has been mentioned before. Considered from the quantum field theory point of view, the Hamiltonian at some x site remains quasi-constant as long as it not submitted to a local interaction, particularly to the field gradient around two colliding nuclei. From a pure experimental point of view, as long as the spatial distribution of electrons is sufficiently loose for neglecting their interaction, a gauge group G is ruling the space structure at this specific x place. Apparently, for describing a non interacting electron, one has to take into account only the rotations, no matter is the interval between electrons, if one can suppose they don't interact. The evident choice is thus SO(3), the continuous group of all proper rotations in 3D Euclidean space.

The Hamiltonian H of two electrons constituting a non interacting system is the sum of the Hamiltonians H_1 and H_2 of two electrons:

$$H = H_1 + H_2 \qquad (4)$$

Thus G, the gauge group, is the product of the combination law, between of two elements of SO(3):

$$G = SO(3) \times SO(3). \qquad (5)$$

But when the electrons accumulation is sufficiently formed, a gauge symmetry breaking occurs and the only invariance which remains, is ruled by SO(3) alone, subgroup of SO(3) x SO(3).

There are two causes for gauge breaking. Firstly the repulsive Coulomb forces of the negatively charged electrons. Secondly the spin-spin interaction whose range is shorter [5-6].

According to the general scheme, topologically non-trivial field configurations are classified according to the second homotopy group $\pi_2(G/SO(3))$. Moreover, in this specific case, one has the equality (6), SO(3) being considered as containing the U(1) of electromagnetism [14]:

$$\pi_2 (G/SO(3)) = \pi_1 (SO(3)) = Z_2 \qquad (6)$$

π_1 is the first homotopy group.

Thus, given (5), there is, in this case, one specific sort of monopole with the first and the second homotopy group being identical

In this process one unique sort of monopole is produced. It corresponds to the element -1 of Z_2.

This case, involving an electron accumulation, is thus different from the one considered by t.'Hooft and A.M.Polyakov [15]. According to their model, magnetic monopoles, which are are considered a being extended field configurations [14], arise when a simply connected group G is broken to the U(1) of electromagnetism. The topology relationship between homotopy groups is different from the preceding one:

$$\pi_2 (G/U(1)) = \pi_1 (U(1)) = Z \qquad (7)$$

Z is the group of addition of positive and negative numbers. It means that the topological defect which constitutes the monopole may be considered as being made of an infinity of curves [15]. One shows that such a magnetic monopole carries a quantum number ν, which is an integer positive or negative. This η number is called the "winding number". The group structure of Z shows that this η quantum number is conserved. Thus, in the 't Hooft case, two monopoles can fuse together to form a monopole whose quantum number is the sum of the two quantum numbers (η+ η'). As for the magnetic moment g, it is proportional to the winding number and inversely proportional to the electric charge:

$$g = - (\eta/e)\, \alpha \qquad (8)$$

α being the fine structure constant.

In our case of magnetic monopole creation by electron accumulation, there is only one sort of monopole which can annihilate only in pairs. And the absolute value of g is unique:

$$g = (1/e)\, \alpha \qquad (9)$$

Those relationships giving g are somewhat in agreement with the point of view of Dirac who demonstrated, with the help of the classical formalism, and supposing each pole to be at the end of an unobservable string, that:

$$g = - (\nu/e)\, \alpha/2 \qquad (10)$$

In fact, various experiments show that the multiplying factor should be $\alpha/6$ [value quoted in Ref.16]. To proof the monopole existence in the most direct and convincing way, consists to use the Dirac equation which has been, primitively, devoted to describing relativistic electrons. As it has been shown by G.Lochak, this equation admits not only one local gauge invariance, but two, and no more [16]. Moreover, the magnetic monopole could be a magnetically excited neutrino. But this way does not seem to give the possibility to describe any monopole creation channel.

Energy and mass: — 't Hooft and Poliakof utilise a relativistic Lagrangian density to get an evaluation of the monopole energy and mass. This Lagrangian is useful in the domain of particle physics. They obtain for the mass:

$$M_m = (4\pi/c^2)\, M_w\, C(\beta) \qquad (11)$$

$C(\beta)$ depends not much of β: it varies between 1.1 and 1.4 for $0.1<\beta<10$ [14]. M_w is the mass of the intermediate vector boson, and $M_m \sim 137\, M_w$.

In the case of monopole creation by electron accumulation, the Lagrangian density is surely different and largely lesser than 137 M_w. If one consider the typical ν electron number equal to 10^4, in an accumulation, for example, the necessary energy for building an electron accumulation is typically in the range of some tens of Kev, to 100 Kev. For a 50 Gev typical value of the intermediate boson mass, the ratio between the two quantities of energy, the one of the device, the other the monopole mass, is in the range of 10^7. This discrepancy is evidently an elementary evidence that the mass and monopole energy are much lesser in the case of an electron accumulation. Thus the choice of a Lagrangian density is primordial for computing mass and energy in the case of monopole creation by electron accumulation: it will deserve a specific calculation.

Possible bursts of magnetic monopoles: — By the way one has to mention that it is possible to get experimentally an important magnetic monopole number, if they are generated in electron accumulations which are on the sites of the two-nuclei collisions. Supposing it is so, each electron accumulation would prompt a magnetic monopole, With this hypothesis, n being the number of electrons per volume unit, the ($\mu^2 n/2$) term is equal to the magnetic monopole number which are generated in the volume unit. This volume being supposed turned into a unique LPS. For example, if the mean number of nucleon per V volume reads,

$$(V = \text{Bohr radius})^3 = (0.529\times10^{-8}\ \text{cm})^3$$

$n = 10^{22}$ nuclei/cm^3 $\mu = 10^{-3}$ $e^{-\mu}\cong 1$, $\nu = 2\times10^3$
($\mu^2 n/2$)= 5×10^{15}
$n = 10^{23}$ nuclei/cm^3 $\mu= 2\times10^{-3}$ $e^{-\mu}\cong 1$, $\nu = 10^3$
($\mu^2 n/2$) = 2×10^{17}

Suppose the magnetic monopole generation is taking place during the trailing edge of a pulse current, like in the case where an electron accumulation prompts fusion reactions by lowering of Coulomb barrier, one gets what one can call a "burst" of 5×10^{15} - 2×10^{17} magnetic monopoles per cubic centimeter. But one has to emphasize on the hypothesis: the whole volume must be supposed turned into a LPS, and that every electron accumulation prompts a magnetic monopole.

Experimental evidences — We dispose of two kinds of results: firstly the ones relating the working of electron accumulations as screening device for lowering Coulomb barrier and prompting low energy nuclear reactions. Secondly the ones relating its working as magnetic monopole creation. One has to emphasize on the fact that the results one has at this time, are pointing out that one gets in a equal footing low energy nuclear reactions and bursts of magnetic monopoles, if one succeed to create in a condensed medium, what we have called a Large Poincaré System [5-6]. Systematic experiments are still necessary, to understand if there could exist a probability of magnetic monopole production, versus a low energy nuclear reaction probability, and perhaps of simultaneous production, which one has no reason to exclude.

From a pure experimental point of view, one can only put forward the fact that transmutation at atom level energies is used to show up when a capacitor bank is discharged through a metallic foil and a volume of liquid, connected in serial. The liquid can be ordinary tap water. It has been sufficient to use a 4.8 kV, 5O kJ capacitor bank [7]. So one can use a very simple experimental device. The simultaneous occurrence of atom level transmutations and of plasma-like sphere, or ball-lightning, is the mark of a well working experiment [7 to 11] [17].

It is relatively simple also to detect transmutations by picking up the remains of the foils, inside which it occurs atom energy transmutations, and to analyse them afterwards by mass spectrometry. It seems, given their creation process, that the interaction of magnetic monopoles with matter is rather different from the one with charged particles. But the simple use of nuclear films has been sufficient, during the first experiments to estimate that the process is completely repetitive [7-11].

Conclusion: — This simple analysis confirm that the process of magnetic monopoles creation is possible in a laboratory, concurrently with low energy nuclear reactions production. This possibility is new in the "magnetic monopole hunting". In fact, for putting the device into condition, one would need "only" to ionise a condensed medium and to initialise a LPS, to let electrons to crowd together. So particle physics could benefit from a low energy device of a condensed medium, with new experimental possibilities.

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