Adamenko, S. and V. Vysotskii. *The possible mechanism of creation of light magnetic monopoles in strong magnetic field of a laboratory system*. in *ICCF-14 International Conference on Condensed Matter Nuclear Science*. 2008. Washington, DC.

The possible mechanism of creation of light magnetic monopoles in strong magnetic field of a laboratory system

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Abstract

In this work the reasons and mechanism of the creation of unknown magneto-charged particles, which were observed in experiments on supercompression of condensed target in Kiev Electrodynamics Laboratory "Proton-21", are discussed. It is shown that these particles are most probably the hypothetical light magnetic monopoles that were introduced by George Lochak as magneto-excited neutrinos. The parameters of these particles (including mass of monopole and both size and binding energy of monopole-antimonopole pair) and the method of their creation are discussed and calculated.

Introduction

In our previous work [1,2] we have presented the results of observation and investigation of interaction of unknown magneto-charged particles (hypothetical magnetic monopoles) with surface of MDS (Al-SiO_2-Si) structure. We have observed the traces of ordered thermo-mechanical impact on the surfaces (Fig. 1). The length of trace was $L \approx 2$ mm. These results were observed during experiments in Kiev Electrodynamics Laboratory "Proton-21" on achieving the superdense state of matter by using the high-current electron driver [3]. In the experimental setup an impulse electron flux with a total energy about 100...200 J and duration $\tau \approx 50$ ns was used as a coherent driver in every cycle of supercompression. The energy of each electron in different experiments is about 300...400 kV, the total current - 50...70 kA .

It was shown that the source of a great specific energy release, $dQ_{tot}/dl \approx -10^6$ GeV/cm, spent on the formation of these traces, may be the processes of nuclear synthesis reactions $Al^{27}+C^{12} = K^{39}$, $Al^{27}+C^{13} = K^{40}$, which are running with the participation of MDS-structure surface nuclei and are stimulated by the action of magnetic monopoles [1,2].

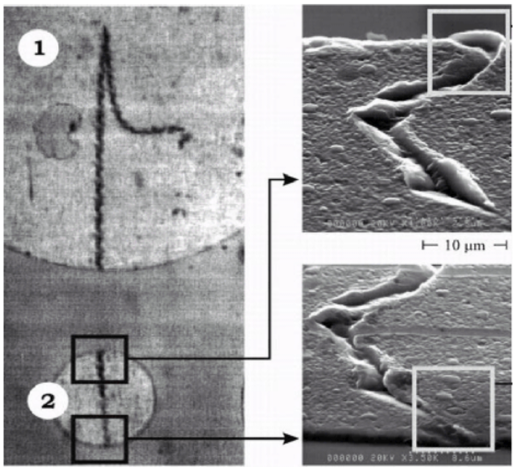

Figure 1. The general view and details of MDS-structure with the tracks

In the present work the parameters of these monopoles and the mechanisms of their creation in Earth laboratory are discussed and calculated.

1. Parameters of magneto-charged particle

In our previous work [1,2] it was shown that the process of formation of periodic tracks is connected with a magnetic interaction of magneto-charged particle with both magnetic field of anode current and multilayer MDS structure, which is the combination of diamagnetics (Si, SiO and melted ionized Al) and paramagnetic (solid Al) layers. In view of the form of a macrotrack (involving the great number of strictly periodic oscillations [1,2]), we may conclude that the controlling magnetic field is approximately the same along the entire trajectory. This corresponds to the fact that formation duration of mentioned track part is significantly less than the total duration $\tau \approx 50$ ns of the current pulse. If this duration was comparable with τ, then the period of oscillations at the beginning and at the end of the track would be essentially different.

This result allows us to assume that the duration of the formation of this part of the track with the length $L \approx 2$ mm is $\Delta t \leq 5$ ns, and the mean longitudinal velocity of motion of the hypothetical magneto-charged particle $\langle v_g \rangle$ is greater than $L/\Delta t \approx 4.10^7$ cm/s.

The maximal longitudinal velocity (in view of periodical stopping and periodical stimulation of fusion reactions along the trace [1,2]) is $v_g \geq 10^8$ cm/s.

During detailed SIMS-researches it was shown that the area of unknown particle "point of reflection" (Fig. 2) is the foreign small-size (about 10 microns) object made of Fe^{56}, Fe^{57} and Co^{59} isotopes and situated on the MDS structure.

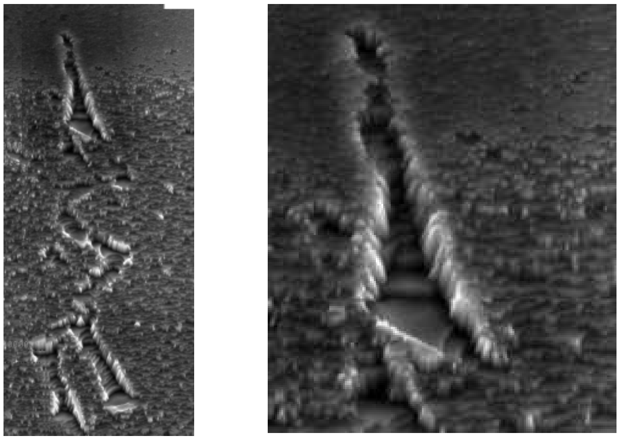

Figure 2. General view and the details of unknown particle reflection area on MDS surface.

This object is made of iron-cobalt alloy and it is probably multi-domain magnetic material with the typical internal magnetic field $H_0 \approx 6...8$ kOe . The typical size of domain wall is about $\Delta r \approx 2$ microns. The same size has the area of magnetic field $H_{out}(r) \approx H_0 \exp(-r/\Delta r)$, outside the magnetic material. If the magnetic charge of the particle equals $g = (137...68)e$ than the magnitude of magnetic potential barrier in the area of «point of reflection» equals (see Fig. 3)

$$V_M \approx \int_0^\infty gH_{out}(r)dr = gH_0\Delta r \approx 50...30\ keV \qquad (1)$$

From these results the upper estimation of unknown magneto-charged particle mass can be made:

$$M_g < \frac{2V_M}{v_g^2} \approx 10^{-23}\ gram \qquad (2)$$

The upper limit of magnetic monopole mass is less than $M_g = 10^{-23}$ gram, that is by 10^{16} times less than previous well known cosmological estimations (10^{-7} gram) based on the grand unified theory!

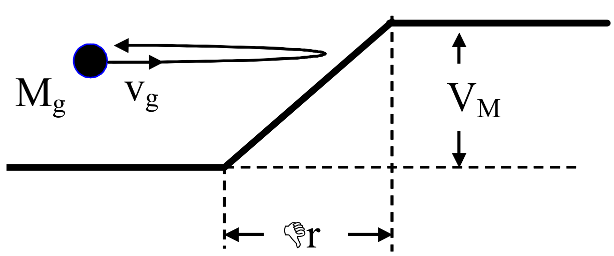

Figure 3. The scheme of reflection of magnetic charge from magnetic domain

So with a high probability the unknown particle is a light magnetic monopole that was introduced by George Lochak [4], and that is the magneto-excited neutrino.

There are two possible ways for generation (creation) of such particles during the experiments in “Proton-21” Lab:

1. These monopoles were created during nuclear processes of protonization and neutronization in collapse zone with the presence of very strong squeezed nonuniform magnetic field in the experimental setup of "Proton21" Lab. Fundamental nuclear transformation in this setup during the formation (shock implosion) and explosion of this zone is described in [3, 5-7]. A specific mechanism of the generation of magnetic charge can be related with the topological features of the collapse zone.
2. Generation of these monopoles took place during the break of stable monopole-antimonopole pair of cosmological origin in very strong squeezed magnetic field.

Let us consider the parameters of such processes.

Parameters of such pair can be calculated with the use of conservation law for its total energy

$$M(r)c^2 \equiv \sqrt{p^2c^2 + 4M_g^2c^4} - \frac{g^2}{r} \geq 0 \qquad (3)$$

and uncertainty relation

$$\overline{p^2}\ \overline{r^2}\ \geq \hbar^2/4 \qquad (4)$$

In this case the minimal meansquare size of monopole-antimonopole pair and maximal meansquare impulse of relative motion are following

$$r_{\min} \equiv \sqrt{\overline{r_{\min}^2}} \geq g^2/2M_gc^2\,, \qquad (5)$$

$$p_{\max} \equiv \sqrt{\overline{p_{\max}^2}} \geq \hbar/2r_{\min} = M_gc^2\hbar/g^2 \qquad (6)$$

From (5) it follows that $r_{\min} \geq 10^{-12}$ cm (if monopole mass M_g equals proton mass $m_p = 1.6.10^{-24}$ g) and $r_{\min} \geq 10^{-9}$ cm if monopole mass equals electron mass.

The potential energy of monopole-antimonopole pair with the size of $r_{\min}$ is

$$|V_0(r_{\min})| \approx \frac{g^2}{r_{\min}} \geq 2M_gc^2 \qquad (7)$$

The maximal kinetic energy for relativistic and nonrelativistic motion of monopole and antimonopole inside the pair is described by the equations

$$T_{\max}^{nonrel} \approx p_{\max}^2/2\mu_g\ \geq \hbar^2/4M_gr_{\min}^2 = M_gc^2(\hbar c/g^2)^2\,, \qquad (8)$$

$$T_{\max}^{rel} \approx p_{\max}c \approx \hbar c/2r_{\min} \approx M_gc^2(\hbar c/g^2) \qquad (9)$$

Here $\mu_g = M_g/2$ is the reduced mass of monopole. From last two equations it follows that the motion of monopole (antimonopole) inside the pair is nonrelativistic: $T_{\max}^{nonrel}, T_{\max}^{rel} << M_gc^2$.

From formulas (7-9) it also follows that the ratio of kinetic and potential energies in each pair is very small both in nonrelativistic and relativistic cases

$$T_{\max}^{nonrelat}/|V_0(r_{\min})| \approx (\hbar c/g^2)^2/2 << 1\,, \qquad (10)$$

$$T_{\max}^{relat}/|V_0(r_{\min})| \approx (\hbar c/g^2)/2 << 1 \qquad (11)$$

This result proves that monopole-antimonopole pair is very stable neutral system.

The total mass of such system in stable bound state

$$M(r_{\min}) \equiv \sqrt{(p_{\max}^2 / c^2) + 4M_g^2} - \frac{g^2}{r_{\min} c^2} \geq \sqrt{(\hbar^2 / 4r_{\min}^2 c^2) + 4M_g^2} - \frac{g^2}{r_{\min} c^2} \approx$$

$$M_g \left(\frac{\hbar c}{2g^2} \right)^2 \leq \frac{M_g}{(137)^2} \qquad (12)$$

is very small.

In fact such pair is an invisible electro- and magneto- uncharged and extremely light object. It is possible that such objects have existed (unnoticed) in the universe from the moment of the Big Bang.

2. Break of monopole-antimonopol pair in a strong magnetic field

In Fig. 4 the structure of the potential hole of monopole-antimonopole bounded pair in the cases of presence and absence of external locally homogeneous magnetic field H_0 is presented.

Under the external magnetic field action the essential deformation of potential hole takes place. It leads to the possibility of tunneling of one monopole and to the spontaneous brake of the monopole-antimonopole pair. The probability P_H and the life-time τ_H of such tunneling effect is similar to the probability of nuclear alpha-decay

$$P_H \equiv 1/\tau_H \approx (v_{\max} / r_{\min}) e^{-2W}; \;\; v_{\max} \approx p_{\max} / M_g;$$

$$W = -\frac{1}{\hbar} \int_{r_1}^{r_2} \sqrt{2\mu_g \,| V_0(r) + V_H(r) - E_{\min} |} dr, \; E_{\min} \equiv V_0(r_1) + V_H(r_1), \qquad (13)$$

$$V_o = -g^2 / r, \; V_H = -gH_0 r,$$

r_1 and r_2 are the classical turning points for the potential energy $V(r) = V_0(r) + V_H(r)$

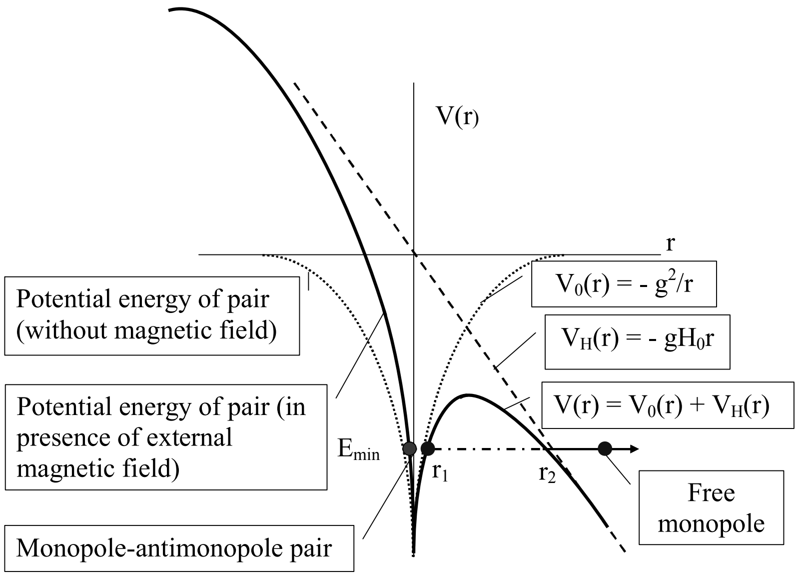

Figure 4. The structure of the potential hole of bounded monopole-antimonopole pair in the cases of presence and absence of external magnetic field.

The resulting expression for the probability of such tunneling effect is the following

$$P_H \equiv 1/\tau_H \approx 10^{12}\left(\frac{M_g}{m_p}\right)^2 e^{-2W}\,(\sec^{-1}),\;\; 2W \approx 2.10^{19}\left(\frac{M_g}{m_p}\right)^2 \frac{1}{H_0(Oe)} \tag{14}$$

Here m_p - proton mass.

For light Lochak's monopole with $M_g=m_p$ and $H_0 \approx 10^{15}$ Oe we have $\tau_H \approx 10^{230}$ years.

For light monopole with $M_g=m_e$ and $H_0 \approx 10^{10}$ Oe, $\tau_H \approx 0.1$ s.

For very light "Lochak's" monopole with $M_g c^2 \approx 1$ keV at $H_0 \approx 10^7$ Oe, $\tau_H \approx 10^{-7}$ s. Formation of such (and much more strong) magnetic field takes place in "Proton21" Lab experimental setup during fast pinch-effect of hard-current electron beam [3].

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