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THE MAGNETIC MONOPOLES GENERATION IN LASER-INDUCED DISCHARGES

V.A. Skvortsov, N.I Vogel.*)

Moscow Institute for Physics and Technology, Dolgoprudny, Russia
**) University of Technology Chemnitz, 09107 Chemnitz, Germany*

Abstract. The nonlinear phenomena in dense plasma of laser-induced discharges in vacuum and gases are considered, which accompanying by matter transition into extreme states, gamma-ray radiation, as well as by ignition of different nuclear reactions and elementary particle generation. The effect of multiple magnetic monopoles generation was observed in such discharges. The observed magnetic monopoles are the Dirac's monopoles and have an essentially electromagnetic nature. Its main physical parameters have been experimentally determined at first.

1. Introduction. This paper deals with the experimental investigation of nonlinear phenomena in dense plasma produced by picosecond laser beams in vacuum and air under conditions when effects of quantum electrodynamics may be very important. Up to day it have been concluded that for nuclear excitation it is needed the super high laser intensities $I \geq 10^{25}$ W/cm^2 (for photo-excitation of nucleus) or $I \geq 10^{18}$ W/cm^2 (for direct excitation of nucleus by accelerated ions in laser plasmas) [1]. This threshold in laser intensities can be diminished on the 3-4 order of value if the resonance self-channeling of directed energy flows [2,3] take into account. We discovered that under moderate intensities of laser beams ($I \approx 10^{14}$-10^{15} W/cm^2) due to cumulative processes of electro-magnetic fields transformation in small limited space it is possible to create unique "magnetic anvil" with help o which it is possible to disturb the vacuum and generate electromagnetic quasi particles (magnetic monopoles) which can be used in turn in processes of nuclear excitations and reactions, accompanying by the different elementary particles generation. More over, it is not possible to obtain some of theme (see, for example, [4,5]) in principal on modern accelerators. Our method of elementary particle generation (our "magnetic anvil") is different from method of mesons and neutrino generation proposed by G.A. Askar'jan [6]. Because of we initially produce the needed conditions for generation of magnetic monopoles -quasi particles with essentially electro-magnetic nature which were predicted by P. Dirac [7,8].

2. Experimental details. The scheme of experiments in vacuum was shown on Fig.1 in [9] only instead copper electrode in present work we used electrodes from tantalum-181, tungsten and aluminum. The Nd: YAG – laser was used with active synchronization of modes. The laser beam (with wavelength λ=1064 nm) was focused by spatial lens (with focus path about of 25 cm) on the surface of metallic targets - electrodes with small (~ 50 micro meters) inter-electrode gap. In one of electrode (in anode) there is small hall (with diameter equals 300 micro meters), throw which the laser radiation penetrate on cathode. The external applied voltages were varied in range: 0-3.0 kV. In some cases a more simple geometrical experimental scheme could have been used. In particular, all experiments in air have been produced with single metallic target for different other conditions (with external electric or magnetic fields and without theme). In all cases the multiple generation of magnetic monopoles takes place if energy of laser beam was grater then 50 mJ (usually, the energy of main laser pulse was about of 90-95 mJ, its duration - 100 ps, i.e. the maximum value of focusing laser beams (in the vicinity of focal spot with diameter 40 micro meters) was about of 10^{14} W/cm^2. The values of gas pressure in vacuum chamber were not higher than 10^{-7} mbar. The X-ray and gamma-ray radiation from dense laser produced plasmas were detected by using the X-ray streak camera RFR-4 [10] with golden photocathode on carbon film. The registration of X-ray (or gamma-ray) image from exit screen (fiber-optic plate) have been carried out with help of cooling CCD -camera (Cordin CCD). The external slit of photocathode of RFR-4 (with width 200 micro meters, and height 15 mm) was arranged on the distance about of 23,8 cm from surface target. The images of slit is registered in mode without sweep with total time exposition equals to 0.5- 1.0 sec. The different dielectric track detectors (CR-39, PMMA, glass) have been used for registration of energetic particles. The detectors from CR39 have been developed in 6.25 N suspension of NaOH during 20, 40, 60 minutes under temperature about of (55±10) ^{0}C. Detectors were arranged in vacuum or in air in the distance about of 1-2 usually (or 5-10 cm in a case of diamond synthesis in carbon dust under influence of magnetic poles but not by laser beam).

3. Results. In mode when magnetic monopole spinning rays and tops (see for example the corresponding photos in [4,5]) were generated the gamma-ray radiation passing throw 3-3.2 mm (Fig. 1) of steel and 3 cm of lead (see Fig.2 b in [5]) have been observed. The first can be connected with the nuclear excitation of Ta-181 (for nuclei of Ta-181 there is exist the corresponding energy level, E_γ =136.3 keV with time leaving about of 30 ps [11] and probably we have gamma-ray laser pumping by magnetic monopoles [5]), and the second one - with the protons decay due to magnetic monopoles catalysis (Callan-Rubakov' s effect [12,13]) when gamma-ray radiation with energy quantum E_γ >> 1 MeV takes place. Indeed, following the Dirac' s hypothesis that the magnetic monopole is a fermion particle with spin

1/2, we can conclude now that such fermions like may be neutrino have very small mass (in our estimation approximately 2 10^{-36} g). But if they (like photons) have not a rest mass in this a case we have probably a unique experimental observation as magnetic monopole interacts with neutrino. On Fig. 2 we can see the Shredinger's "Zitterbewegung" of Dirac's particle [14]. Such a trace has been observed on CR39 plate after 20 minutes chemical etching in alkali suspension (this picture have been produced by laser scanning microscope LSM-510). It is easy to estimate the mass of Dirac's particle if the amplitude of its oscillation is $2\delta r \approx 100$ micro meters (see, for example, [14]: $m = \hbar/(2\delta r\ c) \approx 2.0\ 10^{-36}$ g (the corresponding de Broil wavelength of such particle equals to 0.8 cm). The value of magnetic charge of observed monopoles is :$\mu = n\ (137/2)\ e \approx 100\text{-}200$ SGSE, where e-charge of electron, and hence $n \approx (3\text{-}6)\ 10^{9}$ -the topological charge. Here we used the well known relationship for classic radius of monopole ([15], c.117) : $r = \mu^{2}/E_{m}$, For maximum energy of observed monopoles: $E_{m} \approx 10^{-2}$ J, and for its visible radius $r \approx 0.1\text{-}0.5$ cm (see, [4,5]). The inductance of magnetic fields on the distance r (in cm) from the magnetic monopoles is $B=\mu/r^2 = (100\text{-}200)/r^2$, in Gauss. For $r = 10^{-8}\text{-}10^{-7}$ cm we have $H = 10^{16} - 2\ 10^{18}$ Gauss. Such high values can be else only near the neutron stars. It is well known [16], that the β-decay of neutrons take place in magnetic fields with inductance $B_1 = 1.18\ 10^{14}$ Gauss, and proton decay under $B_2 = 1.23\ 10^{17}$ Gauss. Thus the generated magnetic monopoles can produced the mentioned processes as well as other nuclear reactions (see, Fig.3 on which the traces from different nuclear reactions induced by magnetic monopoles are represented). The predicted in [17] tubular-like track produced by magnetic monopoles are shown on Fig.4 (the traces of magnetic monopoles in PMMA, without chemical etching). The behavior of magnetic monopoles in applied external electric and magnetic fields have been investigated too. The demonstration of diamond synthesis by using magnetic monopoles have been produced (the diamonds with characteristic dimensions from few micro meters up to 100-200 micro meters were obtained in our experiments). This is in good agreement with results of paper [18].

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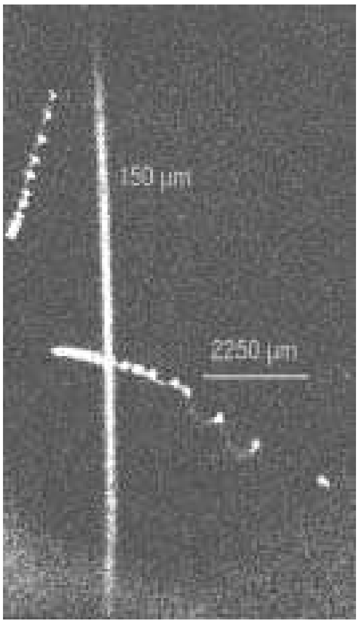

Fig.1

Fig.2

Fig. 3

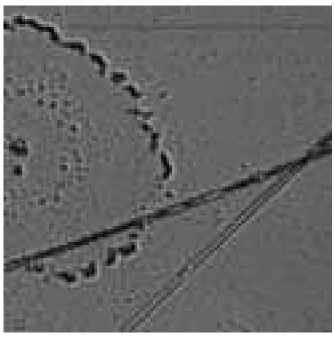

Fig.4