

A new simple method for generation and detection of elementary DM particles via collisions between elementary antiparticles ($e^- e^+$), ($p^- p^+$), ($e^- p^+$) in colliders

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Summary

The substantially new simple method for generating & detection of elementary particles of Dark Matter (DM) is proposed, distinguished by the fact that pairs of elementary (DM / (Ordinary Antimatter (OAM), particles like (dark electron/positron), (dark proton/antiproton) etc. could be easily created in conventional low energy colliders, *but only in collision between elementary antiparticles* (preferably positrons-positrons, antiprotons-antiprotons or positrons- antiprotons) [1]. This method is predicted by the new physical concept of DM by the author, where DM particles are intrinsically identical to our Ordinary Matter (OM) particles, but are shifted in two the nearest adjacent DM-Universes. The method can be used for calibration the proposed direct-DM-detectors by the author, using captured antiparticles - physical mediators between OM and DM [3]. The dark DM-protons p^+_{dark} etc. created in the collider via the colliding antimatter will atypically annihilate with the visible OAM antiprotons p^-_{visible} captured in the DM-detector ($p^+_{\text{dark}} p^-_{\text{visible}}$) \rightarrow ($\gamma_{\text{dark}} + \gamma_{\text{visible}}$) [3].

The Periodic Waveguided Multiverse (PWM) concept with the emergent DM-phenomenon

The underlying Periodic Waveguided Multiverse (PWM) structure [2], earlier proposed by the author, shows simultaneous emergence of pure 3D-waveguided (intrinsically identical) elementary rest mass particles like Ordinary Matter (OM), Ordinary Antimatter (OAM), elementary Dark Matter (DM) and Dark Antimatter (DAM) particles with the correspondingly emergent basic physical laws - the pure Waveguided Special Relativity (WSR), Waveguided Quantum Mechanics (WQM), weak Waveguided Newtonian Gravity (WNG) and Waveguided Equivalence Principle (WEP), deeply united and expanded in the PWM-concept. The PWM-concept *predicts matter / antimatter antigravity*, which separates and keeps of mutual annihilation *equally* presented OM+DM and OAM+DAM clusters and anti-clusters in our Universe. This new physical picture simultaneously explains cosmological miracles of DM and Dark Energy (DE) phenomena - in frames of the Gravitationally Neutral Universe (GNU) cosmology [6], where sufficiently composite and Gravitationally Neutral Multiverse (GNM) is behind the so “dark” cosmology of our Universe [2]. The proposed PWM-structure is rather simple – it is placed in global Euclidean 4D-space (x,y,z,L), and consists of physically-geometrically identical, periodically placed quasi-flat 3D- Waveguides = 3D-Universes ...; W_{-3} ; W_{-2} ; W_{-1} ; W_0 ; ; W_1 ; W_2 ; W_3 ; ... where our 3D- Universe is a 3D-waveguide W_0 by convention [2]. All these quasiflat 3D-Universes $W_n[x,y,z,nL_0 < L < L(n+1)]$, ($n = 0, \pm 1, \pm 2, \pm 3 \dots \pm \infty$) are identical quasi-flat 3D-waveguides, they have the same basic physics of the similar elementary particles (the ordinary visible W_0 -matter) [2]. The thickness $L_0 = \lambda_{\text{electronCompton}} = 2.43 \times 10^{-12} \text{m}$ is determined by the smallest (gaped) waveguided rest-mass – mass of electron [2]. If Einstein's 4D-photon Ph^{4D}_n is confined in the W_n - waveguide, it get there the naturally quantized (purely light-dynamic) waveguided (and automatically relativistic) 3D rest mass with precise properties of the quantum mechanical de Broglie wave. We assume each W_n -waveguide has two identical quasi-flat borders – two strained elastic 3D-membranes $M_n = [x,y,z,nL_0]$ and $M_{n+1} = [x,y,z,(n+1)L_0]$. It is easy to show how gravity

mass symmetry for matter and antimatter (like electrostatic charges symmetry) arises in the PWM. Indeed, the 4D-photon Ph^{4D}_n , confined in the W_n -waveguide creates unilateral normal pressure on the highly strained 3D-membrane M_n and creates its very small negative membrane deformation $\delta L_n \sim (-1/r(x,y,z))$, working as exactly weak 3D-waveguided 3D-Newtonian attractive gravitational potential $U_{n(\text{gr})} \sim (-1/r)$ with the correspondingly *positive gravitational mass* $+M_{n(\text{gr})}$ in the 3D-waveguide W_n . The identical 4D-photon Ph^{4D}_{n-1} , confined in the adjacent identical W_{n-1} -waveguide, now will create the opposite orthogonal pressure – from the other side of the same membrane M_n – with its very small positive deformation $\delta L_n \sim (+1/r(x,y,z))$ and correspondingly positive Newtonian gravity potential $U_{n(\text{gr})} \sim (+1/r)$ with the resulting *repulsive* 3D-Newtonian antigravity between the Ph^{4D}_n and Ph^{4D}_{n-1} photons, working as the opposite - negative gravitational mass $-M_{n(\text{gr})}$ for the adjacent W_n - waveguide [2].

The even periodic W_{2n} -Universes are automatically material (as our W_0 -Universe) and the odd – periodic co-adjacent W_{2n+1} -Universes are antimatter Antiuniverses, since the W_n -periodicity automatically creates the known repeated $CPT_{2n/(2n+1)}$ -like symmetry between the W_{2n}/W_{2n+1} particles / antiparticles. This common fundamental CPT symmetry is emergent in the PWM and gets here an obvious (crucial for cosmology) extension – the $(+M_{(2n)\text{gr}})/(-M_{(2n+1)\text{gr}})$ gravity mass - symmetry for these W_{2n}/W_{2n+1} matter / antimatter elementary particles [2]. The corresponding cosmological gravitational behavior of our Universe W_0 in the periodic row of 3D-Universes $\dots|W_{-3}|W_{-2}|W_{-1}|W_0|W_1|W_2|W_3|\dots$ is ultimately connected with the gravitational behavior of the multi-layered (and gravitationally neutral) compound [2], [3], [5], [6] from the following components:

a) gravitationally *attracting* Ordinary Matter (OM) with weak - Newtonian gravity *within* our W_0 Universe $W_0(OM_0 \& OM_0)$; gravitationally *attracting* Ordinary Antimatter (OAM) *within* each of two the nearest Antiuniverses $W_{-1}(OAM_{-1} \& OAM_{-1})$ and $W_{+1}(OAM_{+1} \& OAM_{+1})$; gravitationally *attracting* Dark Matter (DM) *within* each of two the nearest DM-Universes $W_{-2}(DM_{-2} \& DM_{-2})$ and $W_{+2}(DM_{+2} \& DM_{+2})$; gravitationally *attracting* Dark Antimatter (DAM) *within* each of two the nearest DAM-Universes $W_{-3}(DAM_{-3} \& DAM_{-3})$ and $W_{+3}(DAM_{+3} \& DAM_{+3})$ [2];

(b) gravitationally *repulsive* weak - Newtonian *antigravity* between adjacent pairs W_{2n}/W_{2n+1} matter/antimatter OM_0/OAM_{-1} ; OM_0/OAM_{+1} ; OAM_{-1}/DM_{-2} ; OAM_{+1}/DM_{+2} ; DM_{-2}/DAM_{-3} and DM_{+2}/DAM_{+3} [2];

(c) gravitationally *attractive* weak - Newtonian *gravity* between W_{2n}/W_{2n+2} (matter & dark matter) $OM_0 \& DM_{-2}$ and $OM_0 \& DM_{+2}$; between W_{2n+1}/W_{2n+3} (antimatter & dark antimatter) $OAM_{-1} \& DAM_{-3}$ and $OAM_{+1} \& DAM_{+3}$, where the total gravitational mass density $\Sigma \rho_{\text{gr}}$ on the large-scale of the gravitationally neutral Multiverse is zero [2], [3], [5], [6].

All elementary W_n -particles are confined in the geometrically identical W_n waveguides (W_n -Universes) and are intrinsically identical to the stable W_0 mass particles of our ordinary matter (OM), confined in our W_0 -Universe. These stable W_0 quantized rest mass-particles are (visible for us electrons e^-_0 , protons p^+_0) plus massless 3D-protons ph^{3D}_0 , etc. of the Standard Model of elementary particles. There are also visible for us elementary particles of the Ordinary Antimatter (OAM) from the nearest to us Antiuniverses W_{-1} and W_{+1} (antielectrons, antiprotons

and anti-photons ($e^+_{-1}, p^-_{-1}, ph^{3D}_{-1}$); ($e^+_{+1}, p^-_{+1}, ph^{3D}_{+1}$) etc. Our W_0 waveguide has two membranes M_0 and M_{+1} conjoint with W_{-1} and W_{+1} Antiuniverses. That is why we can see these the nearest elementary antiparticles and also able to detect them [2]. All other W_n ($|n|>1$) Universes, including gravitationally attracting (W_{-2} and W_{+2})-DM-Universes have no conjoint 3D-membranes M_n with our W_0 -Universe membranes M_0 and M_1 , and so their elementary particles are electro-magnetically separated of us – are invisible and not detectable by the purely material W_0 -detectors [2], [3]. There is a cosmologically strongly dominating (two-component mixture) of dark matter (DM) from the nearest dark W_{-2} and W_{+2} DM-Universes, *gravitationally attractive* to our W_0 matter [2]. There are invisible for us dark electrons, dark protons and dark photons [$e^-_{-2}, p^+_{-2}, ph^{3D}_{-2}$, etc.] and [$e^-_{+2}, p^+_{+2}, ph^{3D}_{+2}$, etc.], physically intrinsically identical to our SM-particles. There is no direct physical (gravitational, etc.) interactions between W_{-2} and W_{+2} DM-Universes, but these two cosmologically dominating DM fractions are gravitationally coupled to our W_0 matter and form together composite galactic clusters ($W_{-2}+W_0$), ($W_{+2}+W_0$) and also mixed ($W_{-2}+W_0+W_{+2}$).

There is also an equal (to DM) amount of highly dominating Dark Antimatter (DAM) in the W_{-3} and W_{+3} Antiuniverses, they are also dark antielectrons, dark antiprotons and dark antiphotons [$e^+_{-3}, p^-_{-3}, ph^{3D}_{-3}$, etc.] and [$e^+_{+3}, p^-_{+3}, ph^{3D}_{+3}$, etc.]. They have no mutual physical (gravitational, etc.) interactions between each other, but they are gravitationally coupled - attractive to the ordinary antimatter OAM and form ($W_{-3}+W_{-1}$) and ($W_{+3}+W_{+1}$) composite antigalactic clusters. This follows from the periodic 3D-waveguided physical nature of the quantized massive elementary particles, including ordinary matter (OM_0), ordinary antimatter ($OAM_{-1,+1}$), dark matter ($DM_{-2,+2}$) and dark antimatter ($DAM_{-3,+3}$) Universes [2]. All these types of periodic matter / antimatter have our basic intrinsic physical laws (Einstein's relativity, quantum mechanics and weak-Newtonian gravity, etc.).

All *mutually dark even-matter* $2L_0$ -periodic Universes $W_{2n} = W_{\pm 2;\pm 4;\pm 6\dots}$ have their material $W_{\pm 2;\pm 4;\pm 6\dots}$ elementary particles (dark electrons $e^-_{\pm 2;\pm 4;\pm 6\dots}$, dark protons $p^+_{\pm 2;\pm 4;\pm 6\dots}$, dark massless photons $Ph^{3D}_{\pm 2;\pm 4;\pm 6\dots}$, etc), confined in the corresponding matter waveguides W_{2n} . Their $W_{\pm 2;\pm 4;\pm 6\dots}$ elementary particles have no common physical interactions with our W_0 -elementary particles, except only the *attractive* W_{-2}/W_0 and W_0/W_{+2} gravity, what clearly explains the phenomenon of DM in the PWM [2]. The correspondingly $2L_0$ -periodic, also *mutually dark odd-antimatter* 3D-Antiuniverses $W_{2n+1} = W_{\pm 1;\pm 3;\pm 5\dots}$ confine the appropriate mutually dark antielectrons $e^+_{\pm 1;\pm 3;\pm 5\dots}$, dark antiprotons $p^-_{\pm 1;\pm 3;\pm 5\dots}$, mutually dark massless antiphotons $Ph^{3D}_{\pm 1;\pm 3;\pm 5\dots}$, etc.).

The weightless-composite superfluid vacuum medium concept in the PWM

Importantly, the exact DE&DM and KSUSY phenomena appear together in the PWM only under the additional basic condition that all periodic 3D-waveguides *are not empty* and have certain medial properties - all adjacent 3D-waveguides W_{2n}/W_{2n+1} must be densely filled by strongly coupled charge-less, non-gravitating, spineless (bosonic) composites, consisting of e^-_{2n}/e^+_{2n+1} and p^-_{2n}/p^+_{2n+1} fermionic pairs – very strongly coupled “Cooper-like” double cells [2]. These scalar elementary-composites possess the summary positive inertial masses $2M_e$, $2M_p$ and are simultaneously chargeless, weightless, spineless and are very stable. Indeed, these coupled bosonic pairs have correspondingly huge binding energies $E_{e^+/e^-} = 2MeC^2$ and $E_{p^+/p^-} = 2MpC^2$ and are stable till

the temperatures $T_{e^+/e^-} \sim 10^{10}$ K and $T_{p^+/p^-} \sim 10^{13}$ K. These scalar bosons have small inertial masses and build together a highly stable and very dense superfluid medium, which cannot be frozen even at $T=0$ K (such as very light and always liquid helium superfluid at very low temperatures). At the same time these composite bosons are gravitationally weightless and build together very dense, but totally weightless and frictionless superfluid - the correspondingly neutral - uncharged, weightless global 3D-Vacuum medium for each bilayer W_{2n}/W_{2n+1} . Such ideal - totally balanced and weightless liquid vacuum reminiscent the well-known (but vastly non-balanced) "electron sea" of Dirac. We assume, our ordinary 3D elementary particles are, as by Dirac, the elementary "holes" - "elementary defects" in this very dense superfluid vacuum medium [2], which inertial mass density ρ_{inert} is comparable to the nuclear or neutron star density! These elementary defects-holes are also very stable and always appear in pairs - symmetrically e.g. after decoupling of the scalar electron/positron cell e^-_{2n}/e^+_{2n+1} or proton/antiproton cell p^-_{2n}/p^+_{2n+1} of the superfluid vacuum as our ordinary particles and anti-particles (electron / positron holes, proton / antiproton holes, etc.), usually created in colliders or by cosmic radiation. The necessary decay energy of the single bosonic double cell is relatively very large (e.g. much larger as bounded Cooper pair of two electrons in a superconductor) - it is the above-mentioned double-cell binding energy. We and our physical material sensors are built from these elementary defects and we physically don't feel this ideal (smooth, frictionless weightless and transparent for 3D-photons) vacuum-medium. Our sensors perceive this very dense, weightless and frictionless hidden medium paradoxically as the quasi-classical "emptiness", but we perceive there only an other 3D elementary defects (as our ordinary particles or antiparticles), their fields and the 3D-photons. This completely hidden coherent vacuum medium was historically naturally excluded from our classical physical representations (including the legendary Einstein's theory of special relativity). But the proposed above hidden vacuum medium becomes an additional crucial physical characteristics of a totally unbroken and totally hidden Composite-Supersymmetry (KSUSY) [2]. Indeed, e.g. a virtually born - divided *fermions pair* of virtual e^-_0 and e^+_1 elementary defects is supersymmetric with the hidden *bosonic* bounded double cell e^-_0/e^+_1 because both have the same summary inertial masses $2M_{e(\text{in})}$. Here's a salvatory *reformulation* of the traditional supersymmetry concept, where we do not need the hypothetical supersymmetric elementary particles at all. This new (hidden + unbroken) composite-supersymmetry is theoretically unavoidable (a) for relevance of modern quantum electrodynamics, providing exactly zero vacuum energy (being practically endless in the classical Quantum Electrodynamics) and (b) for the correspondingly relevant DE&DM cosmology with zero vacuum energy, where only the matter/antimatter antigravity creates DE and accelerative expansion of our Universe. The single supersymmetric coupled bosonic pair of this ideal superfluid vacuum can not be detected as unite, because these pairs form global coherent superfluid quantum vacuum medium and they are inseparable of it for us. This also explains why physicists could not find (also at CERN accelerators, etc.) any supersymmetric S-partners for the elementary OM-particles, predicted by the classically formulated - assumingly partially broken SUSY.

The straight physical consequences of the periodicity of the W_n -structure and the "hole-like" nature of the W_n elementary particles are (a) electrostatic, etc. isolation of the $DM_{-2,+2}$ from OM_0 by the $W_{-1,+1}$ Antiuniverses in the periodic W_n -row $\dots|W_{-2}|W_{-1}|W_0|W_1|W_2|\dots$, but still remained (b) gravitational interaction between the $OM_0/DM_{-2,+2}$ with the manifest existence of two gravitationally, etc. mutually independent DM-components DM_{-2} and DM_{+2} [2]. The cross-sections of the $DM_{-2}&DM_{-2}$ - collisions and $DM_{+2}&DM_{+2}$ - collisions (following the periodic W_n -structure) are comparable with the cross-section of the ordinary $OM_0&OM_0$ - collisions, but the cross-section of the $DM_{-2}&DM_{+2}$ collisions (as $DAM_{-3}&DAM_{+3}$ collisions) is equal to zero, because they have no any mutual physical interactions, including gravity. These two symmetrical

layers of DM will fly through each other without friction. The predicted above two-component DM properties [2] explain controversial results, observed in DM & DM-clusters collisions [4].

The PWM versus the periodic ST-branes Multiverse.

The quasi-classical, 4D-electrodynamic (3D-waveguided) representation of the periodic 4D-Multiverse externally reminds the 4D-structure of periodically placed parallel 3D-branes in the String Theory (ST). But there are big differences between the PWM and ST-branes concepts. Indeed, the ST (a) artificially adopts the classical theory of are located in the same 3D-bran. The resulting physics of the 3D-brane ultimately predicts *gravitational attraction between matter and antimatter* and unable to explain corresponding DE&DM phenomena (naturally arising in the PWM). On the contrary, the proposed periodic 3D-waveguided structure is *self-enough* to create, unite and *extend* the basic physics laws, *simultaneously emergent* in this very simple global 4D-structure. The PWM creates the correspondingly unites physical properties of the 3D-massive elementary particles, including the OM, OAM, DM, DAM, etc. and predicts matter/antimatter antigravity (as the multiversal physical nature of the cosmological Dark Energy (DE) phenomenon and the recently discovered accelerating Universe expansion [7], [8]). Those basic physical properties are the straight result of the 4D-electrodynamic behavior of 4D-photons Ph^{4D}_n in the proposed Periodic Waveguided Multiverse (PWM) structure [2]. This electrostatically and Gravitationally Neutral Multiverse (GNM) structure predicts (pure waveguided by the physical nature) weak-Newtonian *attracting gravity* between two the nearest *mutually dark* W_{2n}/W_{2n+2} Universes, including $OM_0 \& DM_{-2,+2}$, $OAM_{-1} \& DAM_{-3}$ and $OAM_{+1} \& DAM_{+3}$ and the corresponding *repulsive antigravity* between two adjacent Universes/Antiuniverses W_{2n}/W_{2n+1} , including $OM_0/OAM_{-1,+1}$, DM_{-2}/DAM_{-3} and DM_{+2}/DAM_{+3} [2], [6]. These gravitational / anti-gravitational cosmological properties of the composite PWM explain the interconnected physical nature of the cosmological Dark Energy (DE) and Dark Matter (DM) phenomena and have cosmological consequences, radically rebuilding the basic paradigms of contemporary cosmology, like the Cosmological Principle (CP) , Equivalence Principle (EP) and Einsteinian General Relativity (GR) [2], [4], [6].

Description of the method

The proposed method [1] involves the collision between antiparticles (positrons-positrons, antiprotons-antiprotons or positrons-antiprotons) in the collider as the source, generating the elementary DM-particles. Electron, positron and the DE-electron have the same positive inertial mass $M_{electron}$. Proton, antiproton and the DE-proton also have the same positive inertial mass M_{proton} . The collision energy must be so large that this creates at least one additional pair of (antielectron + electron) holes or (antielectron + DE-electron) holes, assumingly with equal probability. This needs a small kinetic impact collision energy $E_{collision} > 2M_{electron} C^2 \sim 1MeV$ for the (antielectron + DE-electron) pair creation and for (antiproton + DE-proton) pair creation $E_{collision} > 2M_{proton} C^2 \sim 2000MeV$. We show schematically below collisions between two positrons (Examples 1a, a*, b, b*), collisions between two antiprotons (Examples 2a, a*, b, b*) and (for comparison) collisions between two electrons (examples 3a, b) and between two protons (examples 4a, b):

Example 1a:	Example 1a*:
W_2	$W_2 + e^-_{+2}$ (invisible)
$W_1 e^+_{+1} e^+_{+1} \rightarrow e^+_{+1} e^+_{+1} + e^+_{+1}$ (visible)	$W_1 e^+_{+1} e^+_{+1} \rightarrow e^+_{+1} e^+_{+1} + e^+_{+1}$ (visible)
$W_0 + e^-_0$ (visible)	W_0

Example 1b:	Example 1b*
W_0 + e^-_0 (visible)	W_0
W_{-1} $e^-_{-1} e^-_{-1} \rightarrow e^-_{-1} e^-_{-1} + e^-_{+1}$ (visible)	W_{-1} $e^+_{-1} e^+_{-1} \rightarrow e^+_{-1} e^+_{-1} + e^+_{-1}$ (visible)
W_{-2}	W_{-2} + e^-_{-2} (invisible)

Example 2a:	Example 2a*:
W_2	W_2 + p^+_{+2} (invisible)
W_1 $p^-_{+1} p^-_{+1} \rightarrow p^-_{+1} p^-_{+1} + p^-_{+1}$ (visible)	W_1 $p^-_{+1} p^-_{+1} \rightarrow p^-_{+1} p^-_{+1} + p^-_{+1}$ (visible)
W_0 + p^+_0 (visible)	W_0

Example 2b:	Example 2b*:
W_0 + p^+_0 (visible)	W_0
W_{-1} $p^-_{-1} p^-_{-1} \rightarrow p^-_{-1} p^-_{-1} + p^-_{-1}$ (visible)	W_{-1} $p^-_{-1} p^-_{-1} \rightarrow p^-_{-1} p^-_{-1} + p^-_{-1}$ (visible)
W_{-2}	W_{-2} + p^+_{-2} (invisible)

Example 3a:	Example 3b:
W_1 + e^+_{+1} (visible)	W_1
W_0 $e^-_0 e^-_0 \rightarrow e^-_0 e^-_0 + e^-_0$ (visible)	W_0 $e^-_0 e^-_0 \rightarrow e^-_0 e^-_0 + e^-_0$ (visible)
W_{-1}	W_{-1} + e^+_{-1} (visible)

Example 4a:	Example 4b:
W_1 + p^-_{+1} (visible)	W_1
W_0 $p^+_0 p^+_0 \rightarrow p^+_0 p^+_0 + p^+_0$ (visible)	W_0 $p^+_0 p^+_0 \rightarrow p^+_0 p^+_0 + p^+_0$ (visible)
W_{-1}	W_{-1} + p^-_{-1} (visible)

Manifestations of the created elementary DM-particles could be registered by the conventional detectors of elementary charged particles (e.g., by the spectrometer, by the Wilson cloud chamber) in the collision area of the collider. The main signs of the appearance of the DM-electron is an unusual - only one-sided-visible bubbles-train of ordinary visible antielectron in the (antielectron + **DE-electron**) pair (Examples 1a* 1b*) and one-sided-visible bubbles-train of ordinary visible antiproton in (antiproton + **DE-proton**) pair (Examples 2a*, 2b*). The two symmetrical conventional visible tracks of the born (electron + antielectron)-Pairs (Example 3a, 3b) in the electron-electron collision and (proton + antiproton) pairs (example 4a, 4b) in the proton-proton collisions show no birth of the elementary DM-particles.

It may also used a direct-detector of the elementary DM-particles, earlier proposed by the author [2], [3]. Its basic sensor consists of accumulated antiparticles, captured in a conventional vacuumed penning trap (for positrons or antiprotons). The easily controllable production volume of the DM-particles in the collider can be used for calibration of this direct-detector.

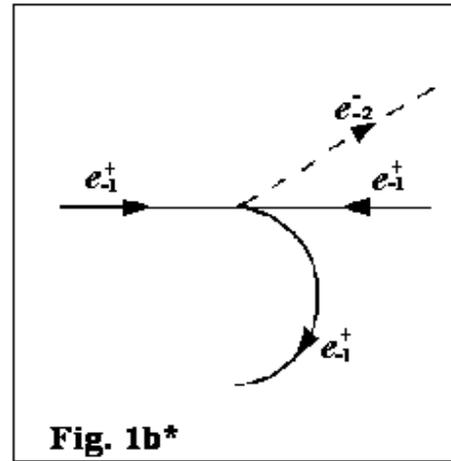
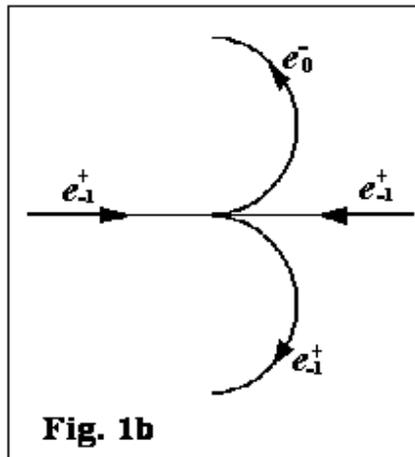
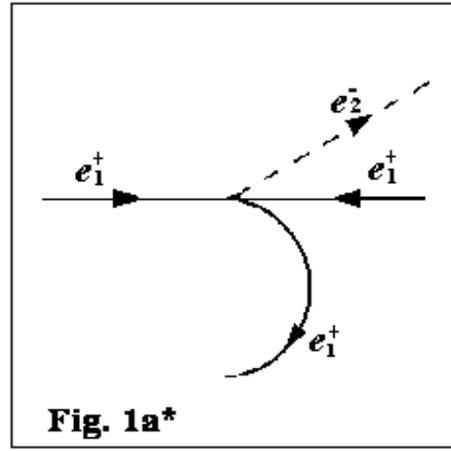
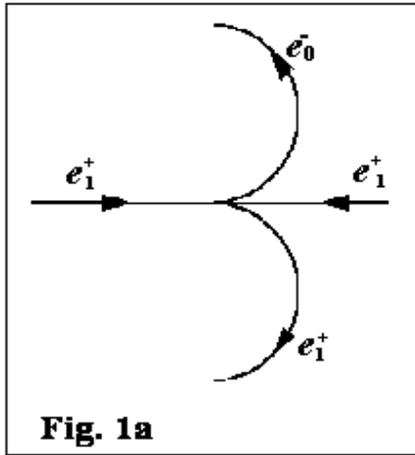


Fig. 1a shows the collision of two positrons $e_1^+ e_1^+ \rightarrow e_1^+ e_1^+ [e_1^+ e_0^-]$ with two visible symmetrical paths of the born $[e_1^+ e_0^-]$ -pair (in the magnetic field H_0 of the W_0 -material Wilson cloud chamber). The magnetic field vector H_0 is perpendicular to the plane for all figures and is not shown.

Fig. 1a* illustrates the collision of two positrons $e_1^+ e_1^+ \rightarrow e_1^+ e_1^+ [e_1^+ e_2^-]$ - only with a visible (e_1^+)-positron-trajectory of the born $[e_1^+ e_2^-]$ -pair in the W_0 -Wilson cloud chamber. The dotted (e_2^+)-trajectory of dark e_2^+ -electron is shown schematically and is invisible. Dark e_2^+ -electron has no interaction with the W_0 -Wilson cloud chamber and with the magnetic field H_0 , so, its dotted path is a straight line.

Fig. 1b shows the collision of two positrons $e_{-1}^+ e_{-1}^+ \rightarrow e_{-1}^+ e_{-1}^+ [e_{-1}^+ e_0^-]$ with the two visible $[e_{-1}^+ e_0^-]$ -trajectories of the born $[e_{-1}^+ e_0^-]$ -pair in the W_0 -Wilson cloud chamber.

Fig. 1b* shows the collision of two positrons $e_{-1}^+ e_{-1}^+ \rightarrow e_{-1}^+ e_{-1}^+ [e_{-1}^+ e_{-2}^-]$ with a visible (e_{-1}^+)-(positron)-trajectory in the W_0 -Wilson cloud chamber. The dotted (e_{-2}^+)-trajectory of the born dark e_{-2}^+ electron is invisible. Dark e_{-2}^+ electron has no interaction with the W_0 -Wilson cloud chamber and with the magnetic field H_0 and its dotted path is shown schematically as a straight line.

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