

Principle of Equivalence and Wave Properties Formation

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Key words: Physical information theory, structure and oscillator properties of elementary objects, charges in a potential gradient, masses in a gradient of gravitation, wave properties

Abstract: Charges in an electric gradient with wave properties formation and masses in a gradient of gravitation are compared with the statement of the principle of equivalence. Elementary objects are described by physical information, generated by action in four dimensional oscillators. For the validity of the principle of equivalence it is shown that an object in a homogeneous gradient is accelerated under exchange of virtual action and fulfils the principle of Hamilton. This is realized for a mass in a gradient of gravitation and for a charge in a homogeneous electric gradient.

1 Introduction

A charge propagating in a *decreasing* homogeneous electric potential gradient is accelerated and is forming wave properties. A mass propagating in an *increasing* gradient of gravitation is accelerated. Responsible for the behaviour of charges and masses in a gradient is in both situations the formation of a rest frame. A rest frame is also a characteristic feature of the principle of equivalence. An explanation of the effects in a rest frame is possible by an application of the new developed physical information theory, [1].

The physical information theory (PIT), [2], describes the properties of elementary objects by physical information. The physical information is formed by action in a $\mu = 0$ oscillator, contained in four dimensional structures of photons of static Maxwell fields. The $\mu = 0$ oscillator is oscillating between positive and negative sign of action. The interaction between elementary objects occurs by an exchange

of physical information and the changed properties of the objects after interaction are characterized by the changed physical information of the objects.

2 Physical Information in Maxwell fields

Using correlations obtained by transforming the Lagrange density and from covariant four dimensional commutators of quantum mechanics, [3], on Fourier space, [4, 5], structures of Maxwell photons and of scalar fields are obtained, which represent oscillators of Maxwell photons and of scalar objects. In the formalism of the PIT an object is considered to exist of oscillators forming the properties of the core containing mass and charge, and of photons and of gravitons forming the photon cloud of the elementary objects. The structure of the oscillators are formed under the conditions that for each current generated during oscillation, simultaneously a residual current must exist with the same amount and the same sign but with opposite direction. This condition is called the Principle of Simultaneous Contrary Oscillation and is abbreviated by PSCO. The PSCO justifies that for an oscillator in a rest frame the third law of Newton is valid.

For example, an electron is represented by the core containing the mass and the charge and by the photon cloud, containing the photons of static Maxwell fields and gravitons. The mass and the charge is described by scalar oscillators of masses and charges. The photons of the photon cloud and the gravitons are interacting in a common oscillation with the oscillators of the electron core. Objects are interacting by their photon cloud between each other and the result of this interaction is absorbed by the oscillators of the core of the object and processed by their oscillators into a change of canonical momenta.

The photons of static Maxwell fields are developed from the trace of the energy-momentum tensor and from covariant four dimensional commutators of communication relations of quantum mechanics. The photons of static Maxwell fields consists of two correlation structures O and X with opposite spin directions and of two oscillation states. The photons O and X of two spin directions form one O-X-photon of static Maxwell fields, which exists in two oscillation states and in different modifications: as O(+)-X(+) photons in two oscillation states Z1 and Z2 of positive charges, in two oscillation states as O(-)-X(-) photons of negative charges and as photons of static magnetic fields in a combination of photons of positive charges and negative charges and as photons with different oscillation states: M1 = OZ1(+)&XZ2(-), M2 = OZ2(-)&XZ1(+), E1 = OZ1(-)&XZ2(+) and E2 = OZ2(+)&XZ1(-). The sign in brackets describe the sign of action in the $\mu = 3$ oscillators. From the correlation structures of photons of static Maxwell fields fi-

nally are formed photons of Maxwell vacuum and of gravitons. The gravitons have the same structures as the photons of the vacuum. In fig.1 the $\mu = 0$ oscillators of the photons of static Maxwell field in their different properties is shown. As an example an O-photon in state Z1 of vacuum is depicted in the relations (1).

$$\begin{array}{ccccccc}
B_3 & \rightarrow & +A_1 & \leftarrow & B_1 & & E_2 & \rightarrow & +\mathbf{A}_0 & \leftarrow & E_3 \\
\uparrow & & & & \uparrow & & \uparrow & & & & \uparrow \\
-\mathbf{A}_1 & & LO & & -\mathbf{A}_1 & & -A_0 & & RO & & -A_0 \\
\downarrow & & & & \downarrow & & \downarrow & & & & \downarrow \\
E_2 & \rightarrow & +A_1 & \leftarrow & \partial A_2 & \Rightarrow & +A_2 & \leftarrow & \partial A_0 & \Rightarrow & +\mathbf{A}_0 & \leftarrow & E_1 \\
& & & & \uparrow & & OZ1 & & \uparrow & & & & \\
& & & & -\mathbf{A}_2 & & 1/2 & & -\mathbf{A}_1 & & & & \\
& & & & \downarrow & & & & \downarrow & & & & \\
B_1 & \rightarrow & +\mathbf{A}_3 & \Leftarrow & \partial A_3 & \rightarrow & +A_1 & \Leftarrow & \partial A_1 & \rightarrow & +A_2 & \leftarrow & B_2 \\
\uparrow & & & & \uparrow & & \uparrow & & \uparrow & & & & \uparrow \\
-A_3 & & LU & & -A_3 & & -\mathbf{A}_2 & & RU & & -\mathbf{A}_2 & & -\mathbf{A}_2 \\
\downarrow & & & & \downarrow & & \downarrow & & \downarrow & & & & \downarrow \\
E_3 & \rightarrow & +\mathbf{A}_3 & \leftarrow & B_2 & & E_1 & \rightarrow & +A_2 & \leftarrow & B_3 & & B_3 \\
& & & & & & & & & & & & \\
& & & & & & & & & & & & \\
B_3 & \rightarrow & +\mathbf{A}_2 & \leftarrow & B_1 & & E_2 & \rightarrow & +A_3 & \leftarrow & E_3 \\
\uparrow & & & & \uparrow & & \uparrow & & & & \uparrow \\
-A_2 & & & & -A_2 & & -\mathbf{A}_3 & & & & -\mathbf{A}_3 \\
\downarrow & & & & \downarrow & & \downarrow & & & & \downarrow \\
E_2 & \rightarrow & +\mathbf{A}_2 & \Leftarrow & \partial A_2 & \rightarrow & +A_0 & \Leftarrow & \partial A_0 & \rightarrow & +A_3 & \leftarrow & E_1 \\
& & & & \uparrow & & OZ1 & & \uparrow & & & & \\
& & & & -\mathbf{A}_3 & & 0/3 & & -\mathbf{A}_0 & & & & \\
& & & & \downarrow & & & & \downarrow & & & & \\
B_1 & \rightarrow & +A_0 & \leftarrow & \partial A_3 & \Rightarrow & +A_3 & \leftarrow & \partial A_1 & \Rightarrow & +\mathbf{A}_1 & \leftarrow & B_2 \\
\uparrow & & & & \uparrow & & \uparrow & & \uparrow & & & & \uparrow \\
-\mathbf{A}_0 & & & & -\mathbf{A}_0 & & -A_1 & & -A_1 & & -A_1 & & -A_1 \\
\downarrow & & & & \downarrow & & \downarrow & & \downarrow & & & & \downarrow \\
E_3 & \rightarrow & +A_0 & \leftarrow & B_2 & & E_1 & \rightarrow & +\mathbf{A}_1 & \leftarrow & B_3 & & B_3 \\
& & & & & & & & & & & & \\
& & & & & & & & & & & & \\
\end{array}
\tag{1}$$

The static O-X-photons of charges, of gravitons and of the Maxwell vacuum consists of sixteen cubes: the four unity cubes ∂A_μ , $\mu = 0,1,2,3$ (compare fig.1) and the six E_i - and six E_i -cubes obtained from the trace of the energy-momentum tensor, and of ten sets of the vector potential $\{A_\mu, \mu = 0, 1, 2, 3\}$, five are positive and five are negative. Each O and X photon is composed from two parts (1/2) and (0/3) which represents preferentially the transversal and longitudinal components of the vector potential, respectively. The two parts must be overlap (they are depicted here separately for a better representation of the structure) to form the

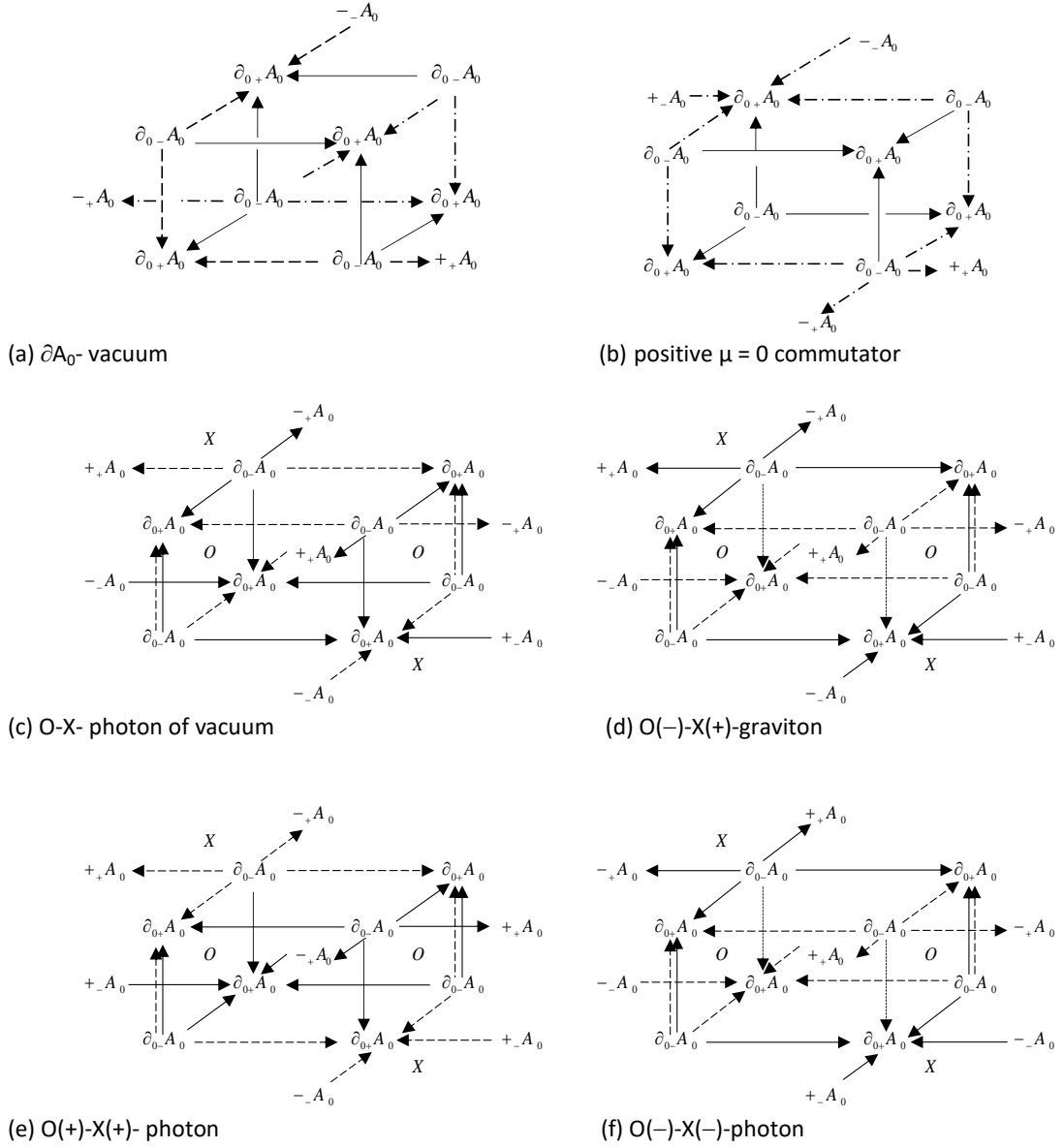


Figure 1: Structures of the $\mu = 0$ oscillator. (a) Formation of photons of vacuum with two currents of different current sign and the same circulation direction. (b) positive $\mu = 0$ commutator, (c) O-X-photon of vacuum, (d) O(-)-X(+) example for a graviton, (e) O(+)-X(+) photon of positive charge, (f) O(-)-X(-) photon of negative charge.

photon O or X photon. In (1) the arrows describe correlations, the positive components of the vector potential are described by bolt letters, the other components are negative. The O-X-photons is formed by having common a positive and a negative set of components of the vector potential. The Maxwell photons consists of two planes: the creator plane in which all creators and an annihilator plane, in which all annihilators of the components of the vector potential are located. The planes are connected with each other by the vertical correlations of the cubes. The vertical correlations of the cubes describe the changes of the components of the vector potential and can be identified with the partial derivations in the dynamic equations and in the Lagrange density.

The action generated in the $\mu = 0$ oscillator of Maxwell photons, exists in three modifications: as real action mainly describing the charges, as active virtual action, consisting as an overlap of photons O and X with equal positive and negative action and as deactivated virtual action; the photons with activated virtual action and the photons with deactivated virtual action form the Maxwell vacuum. The three modifications of action included in photons of static Maxwell fields are depicted in fig.1 at the example of the $\mu = 0$ oscillator. The structure of static Maxwell fields consisting of an equal positive and negative amount of action are forming the photons O(+)-X(-) or O(-)-X(+); these photons fulfil the properties of gravitons (Gravitation described by the Maxwell theory was early in time subject of discussion, [7, 8]). The same amount of action in photons O and X of different modifications of O-X-photons is a result of action minimization.

3 Wave properties formation

For a description of wave properties formation of a charge in a homogeneous electric potential gradient two different mechanism have to be considered: (a) the transfer between particle and wave properties by a change of sign of action in one of the photons O or X in the O-X- photons with the same sign in particle properties into different signs of action in the O and X in wave properties and (b) the absorption of virtual action of the charge from the potential into a virtual action in the scalar oscillators of the core-oscillators of the object. The change of signs of action in O-X-photons is obtained under condition of action minimization at a local position of the gradient. The acceleration of the charge under formation of wave properties according to (b) will be discussed in the following sections. Both effects are described in details in [1].

The wave-particle dualism can be described under conditions of minimization of action (Principle of Hamilton). The photons of static Maxwell fields of positive

and negative charges exists in two modifications: in particle and in wave properties. In particle properties the static O-X-photons form two different oscillation states: one with real action and with activated electric and magnetic fields E_i , B_i and one, in which action and all fields E_i , B_i are deactivated by an overlap with spin correlations. In wave properties the photons of static Maxwell fields form two different photons oscillating in two oscillations states:

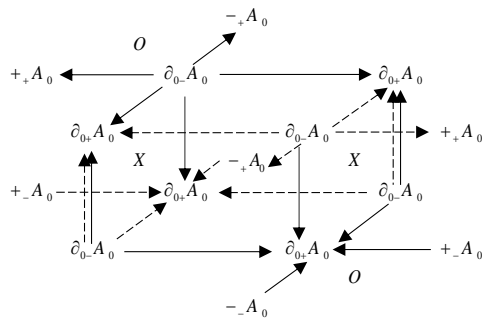
$$\begin{aligned} W1_\alpha &= \mathbf{OZ1}(+)\&XZ1(-) & W2_\beta &= OZ2(+)\&XZ2(-) \\ W1_\beta &= OZ1(-)\&XZ1(+) & W2_\alpha &= \mathbf{OZ2}(-)\&XZ2(+) \end{aligned} \quad (1)$$

In their O and X photons they contain different signs of action (in brackets) of the same amount, which neutralize the action in each photon in the rest frame. In relation to a different rest frame they have a positive action in oscillation state W1 and negative action in state W2. This is, because in state W1 negative action and in state W2 positive action are cancelled by an overlap with spin correlations.

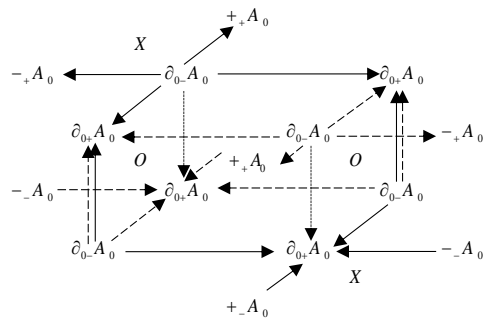
In particle properties the photons of static Maxwell fields are interacting with other photons of an interaction partner: in one oscillation state - the exchange state - real action differences (delta of action) are absorbed by the oscillators of the core of the charge and processes in the following oscillation state - the particle state - under formation of a change of canonical momenta of the object. In wave properties the two scalar oscillators form two exchange states, in which information is exchanged with the photons of the photons cloud.

4 Differences of interaction between two charges and a charge interacting in an electric potential

The interaction between different objects occurs between their static photons in the photon cloud. The objects consists of a large number of oscillators with common oscillating static photons and of oscillators of the core of an elementary object. For example an electron is formed by oscillators of the core of the electron and of the photon cloud. The oscillators of the core are described by scalar fields and the oscillators of the photon cloud are formed by the photons generated by Maxwell fields. Interaction occurs, when the static photons of the interaction partners overlap by equally directed currents, compare fig.1. An agreement with the classic field lines are obtained, when the currents in the interaction line are formed by induction and when the currents of the interacting field lines between objects are directed from the particle state to the exchange state.



Z2: O(+)-X(+)- photon



Z2: O(-)-X(-)-photon

Figure 2: Interaction of two O-X- photons according to the third law of Newton photon shown at the example of superposition of the ∂A_0 - cube of a photon of positive charge in its particle state Z2 and a negative charge in its exchange state Z2. If two O-X-photons with the same direction of currents superimpose, the O-photons is overlapping the X- photons and the X- photons the O- photons. The two O-X-photons separate under conditions of action minimization into two O-X-photons with the same action: action in one of the photons has changed by a negative delta and the other by a positive delta.

The interaction between two charges or between two masses must be distinguished from an interaction of charges in an electric potential gradient or of a mass in a gradient of gravitation. In both situations the interaction occurs, if the interaction lines of both interaction partners are parallel and equally directed, fig.2. For an interaction between two different charges in fig.2 the overlap of the correlation structures in two different oscillation states (particle in particle state Z2 and anti-particle in exchange state Z2) is shown. If two O-X-photons with different action are overlapping in an interaction of O-X and O+ Δ -X+ Δ under conditions of action minimization the two photons O+ Δ -X+ Δ and O+ Δ -X+ Δ are formed with equal action; the change of action is described by a four dimensional delta Δ of action. The formation of two photons of static Maxwell fields with the same action under conditions of the minimization of action describes the third law of Newton.

The interaction of a charge in an electric potential gradient and of a mass in a gradient of gravitation is different to the above described interaction between two charges or between two masses. The electric gradient and the gradient of gravitation have equally directed field lines in direction of the gradient. The potential of the gradient forces all photons/gravitons that is also the photons of the charge and of the gravitons of the mass, into the same action: the action of the photons/gravitons of the gradient. This can be schematically depicted for a positive charge in a positive gradient by (The arrows describe the change of state, the interaction between photons of the gradient and the photons of the charge occur vertically between the states.):

$$\begin{array}{l}
\text{State Z1 particle} \\
Z1+ \quad \longrightarrow \quad Z2+ \quad \longrightarrow \quad Z1+ \quad \longrightarrow \quad Z2+ \\
\text{State Z2 gradient} \\
Z2+ \quad \longrightarrow \quad Z1+ \quad \longrightarrow \quad Z2+ \quad \longrightarrow \quad Z1+ \\
\text{state Z2 particle} \\
Z2+ \quad \longrightarrow \quad Z1+ \quad \longrightarrow \quad Z2+ \quad \longrightarrow \quad Z1+ \\
\text{state Z1 gradient} \\
Z1+ \quad \longrightarrow \quad Z2+ \quad \longrightarrow \quad Z1+ \quad \longrightarrow \quad Z2+ \quad (2)
\end{array}$$

In the gradient from the state Z1 of a particle the state Z2 is formed by induction; the state Z2 have the same current direction as the state Z1 but opposite signs of action in the $\mu = 0$ oscillator. From the state Z2 in the same way the state Z1 is formed and so on. This occurs for the photons of the charge/of the mass and for the photons/gravitons of the gradient. State Z1 and state Z2 overlap forming a homogeneous gradient of action. The overlap of the two oscillation states of the photons of the electric gradient leads to a partial deletion of action in the gradient. During propagation of a charge or a mass through the gradient the

photons/gravitons of the gradient are absorbed by the oscillators of the core of charges or masses. This will be analysed in the following sections separately for a charge in a potential gradient and for a mass in a gradient of gravitation.

5 Properties of a Charge in an Electric Gradient and of a Mass in a Gradient of Gravitation

For an interaction of a charge in an electric potential gradient it is assumed that the charge will have in the gradient wave properties, which is connected with O-X-photons in the photon cloud with different signs of action in the O and X-photons and an oscillation of scalar oscillators in two exchange states with wave properties. The O-X-photons of the gradient are oscillating in two oscillation states and are containing an amount of action which is higher by a four dimensional delta of action in both photons O and X in relation to the the oscillators of the core of the charge. In contradiction to the interaction between the two photons in the photon cloud with different amount of action, which results in photons, in which only one delta is contained in the O-X-photons after interaction, in the gradient the potential will force all photons of the gradient with the same amount of action, being locally different to the action of the charge by a delta of action in both photons O and X.

The same can be expected for the masses in a gradient of gravitation, where the gravitons in the gradient will in an interaction with oscillators of a mass have an amount of action by a delta of action higher in both photons O and X in relation to the gravitons of the oscillators of the mass. For a mass in a gradient of gravitation similar properties has to be expected, as in the photons of a charge in wave properties, because the gravitons have a similar structure as the photons and scalar oscillators with wave properties: the two photons O and X of the gravitons have also different signs of action in the O and X-photons.

6 Charge in an electric gradient

The interaction of a **particle in a positive electric gradient** is analysed in two exchange states for the longitudinal oscillators with wave properties (the correlation structures of scalar μ -oscillators with wave properties of appendix C4 in [1] are used.). The photons in the gradient have the following properties (The sign in brackets describe the sign of the action in the oscillator and the arrow up describe the positive circulation direction and the arrow down the negative circulation di-

rejection of currents in the (1/2) part of the photon.):

$$\begin{aligned} \text{Z1: } \mu = 0: & \text{ O}\uparrow(+)\text{-X}\downarrow(+), \mu = 3: \text{ O}\uparrow(+)\text{-X}\downarrow(+), \\ \text{Z2: } \mu = 0: & \text{ O}\downarrow(-)\text{-X}\uparrow(-), \mu = 3: \text{ O}\downarrow(+)\text{-X}\uparrow(+). \end{aligned}$$

First the $\mu = 0$ oscillator of a particle is analysed; it has in wave properties of scalar oscillators the following properties:

$$\begin{aligned} \text{Z1: O1: } & \text{ O}\uparrow(-)\text{-X}\downarrow(+); \text{ O2: O}\downarrow(+)\text{-X}\uparrow(-) \\ \text{Z2: O1: } & \text{ O}\downarrow(+)\text{-X}\uparrow(-); \text{ O2: O}\uparrow(-)\text{-X}\downarrow(+). \end{aligned}$$

As was discussed, in the gradient always the two oscillation states exists and they interact with the photons of the positive charge in two oscillation states. In state Z1 of the photons of the charge the delta of the photons of the gradient

$$\text{Z1\&Z2 } \Delta: [\text{ O}\uparrow(+)\text{-X}\downarrow(+), \text{ O}\downarrow(-)\text{-X}\uparrow(-)]$$

leads to the interaction

$$\text{Z1: O1: O}\uparrow(-)\text{-X}\downarrow(+); \text{ O2: O}\downarrow(+)\text{-X}\uparrow(-) + \Delta: [\text{ O}\uparrow(+)\text{-X}\downarrow(+), \text{ O}\downarrow(-)\text{-X}\uparrow(-)]:$$

which results in (overlap of equally directed currents)

$$\begin{aligned} \text{Z1: O1: } & \text{ O}\uparrow(-)\text{-X}\downarrow(+), \text{ O2: O}\downarrow(+)\text{-X}\uparrow(-) + \Delta: [\text{ O}\uparrow(+)\text{-X}\downarrow(+), \\ \text{Z1: O2: } & \text{ O}\downarrow(+)\text{-X}\uparrow(-), \text{ O2: O}\uparrow(-)\text{-X}\downarrow(+). \end{aligned}$$

that is in O1:O \uparrow a subtraction and in O1:X \downarrow an addition occurs and in O2:O \downarrow a subtraction and in O2:X \uparrow an addition of the delta take place.

For the following state Z2 the interaction:

$$\begin{aligned} \text{Z2: O1: } & \text{ O}\downarrow(+)\text{-X}\uparrow(-), \text{ O2: O}\uparrow(-)\text{-X}\downarrow(+), \\ \text{Z2: O2: } & \text{ O}\uparrow(-)\text{-X}\downarrow(+), \text{ O2: O}\downarrow(+)\text{-X}\uparrow(-). \end{aligned}$$

leads in the O1:O \downarrow to a subtraction and in O1:X \uparrow to an addition, while in O2:O \uparrow a subtraction and in O2:X \downarrow an addition of the delta occurs.

In the $\mu = 0$ oscillator, during two oscillation states, action of the absorbed delta is always added to the absorbed X-photon either of negative action of the delta to negative action of the currents in the oscillators or added of the positive delta to

the positive delta of the absorbed photons of the charge. Contrary to that from the absorbed O-photon at the same time the action of the delta is always subtracted: a positive delta from a negative action of the absorbed photon or a negative action of the delta from the positive action of the absorbed O-photon. The same amount is simultaneously either added or subtracted; the action is always virtually stored in scalar oscillators.

For the $\mu = 3$ oscillator of a particle in wave properties follows

Z1.1: O1: $O\uparrow(+)-X\downarrow(-)$; O2: $O\downarrow(-)-X\uparrow(+)$

Z1.2: O1: $O\downarrow(-)-X\uparrow(+)$; O2: $O\uparrow(+)-X\downarrow(-)$

The interaction in a positive potential gradient with photons of the delta $\Delta:[O\uparrow(+)-X\downarrow(-)+O\downarrow(+)-X\uparrow(+)]$ in an interaction with scalar oscillators

Z1.1: O1: $O\uparrow(+)-X\downarrow(-)$ + O2: $O\downarrow(-)-X\uparrow(+)$ results in

O1: $O\uparrow(+)-X\downarrow(-)$ + $\Delta:[O\uparrow(+)-X\downarrow(+)]$

O2: $O\downarrow(-)-X\uparrow(+)$ + $\Delta:[O\downarrow(+)-X\uparrow(+)]$

This leads in O1: $O\uparrow$ in addition and in O1: $X\downarrow$ in subtraction, in O2: $O\downarrow$ to a subtraction, in O2: $X\uparrow$ to an addition.

In state Z1.2 of the charge: O1: $O\downarrow(-)-X\uparrow(+)$; O2: $O\uparrow(+)-X\downarrow(-)$ follows

O1: $O\downarrow(-)-X\uparrow(+)$ + $\Delta:[O\downarrow(+)-X\uparrow(+)]$;

O2: $O\uparrow(+)-X\downarrow(-)$ + $\Delta:[O\uparrow(+)-X\downarrow(+)]$

The interaction leads in O1: $O\downarrow$ to subtraction, in O1: $X\uparrow$ to addition, and in O2: $O\uparrow$ addition and in O2: $X\downarrow$ subtraction.

During the two oscillation states of the charge in the potential gradient a similar behaviour for the $\mu = 3$ oscillator is obtained, as for the $\mu = 0$ oscillator, with the difference that if in O1 the delta is added to positive action in the O-photon and subtracted from the X-photons, the addition will occur in X of the O2 oscillator and subtraction occurs in the O-photon. In each oscillation state action is stored virtually.

The results of interaction between a positive charge and a positive electric gradient are summarized in the table 1. A similar interaction will take place for a

Table 1: Results of interaction of a positive charge in an electric positive potential gradient

$\mu = 0$	O1	O2	addition of	subtraction of
Z1	$O\uparrow(-)-X\downarrow(+)$	$O\downarrow(+)-X\uparrow(-)$		
Δ	$O\uparrow(+)-X\downarrow(+)$	–	O1: $X\downarrow(+)$	O1: $O\uparrow(+)$
Δ	–	$O\downarrow(-)-X\uparrow(-)$	O2: $X\uparrow(-)$	O2: $O\downarrow(-)$
Z2	$O\downarrow(+)-X\uparrow(-)$	$O\uparrow(-)-X\downarrow(+)$		
Δ	$O\downarrow(-)-X\uparrow(-)$	–	O1: $X\uparrow(-)$	O1: $O\downarrow(-)$
Δ	–	$O\uparrow(+)-X\downarrow(+)$	O2: $X\downarrow(+)$	O2: $O\uparrow(+)$
$\mu = 3$	O1	O2	addition in	subtraction in
Z1.1	$O\uparrow(+)-X\downarrow(-)$	$O\downarrow(-)-X\uparrow(+)$		
Δ	$O\uparrow(+)-X\downarrow(+)$	–	O1: $O\uparrow(+)$	O1: $X\downarrow(-)$
Δ	–	$O\downarrow(+)-X\uparrow(+)$	O2: $X\uparrow(+)$	O2: $O\downarrow(+)$
Z1.2	$O\downarrow(-)-X\uparrow(+)$	$O\uparrow(+)-X\downarrow(-)$		
Δ	–	$O\uparrow(+)-X\downarrow(+)$	O2: $O\uparrow(+)$	O2: $X\downarrow(+)$
Δ	$O\downarrow(+)-X\uparrow(+)$	–	O1: $X\uparrow(+)$	O1: $O\downarrow(+)$

negative charge in a negative electric gradient. The interaction of charges in a homogeneous electric potential gradient leads to a virtual accumulation of action.

7 Mass in a gradient of gravitation

Now a **particle in a gradient of gravitation** is considered. The following interaction occurs in the two exchange states Z1 and Z2 of a particle in oscillators O1 and O2:

For the oscillation properties of a scalar $\mu = 0$ and $\mu = 3$ oscillators of a particle with wave properties (table C4 in [1]) the following conditions are used:

$$\begin{array}{ll}
 \mu = 0 & \mu = 3 \\
 \text{Z1:O1:O}\uparrow(-)\text{-X}\downarrow(+); \text{O2:O}\downarrow(+)\text{-X}\uparrow(-) & \text{Z1.1:O1:O}\uparrow(+)\text{-X}\downarrow(-); \text{O2: O}\downarrow(-)\text{-X}\uparrow(+ \\
 \text{Z2:O1:O}\downarrow(+)\text{-X}\uparrow(-); \text{O2:O}\uparrow(-)\text{-X}\downarrow(+ & \text{Z1.2:O1:O}\downarrow(+)\text{-X}\uparrow(-); \text{O2: O}\uparrow(-)\text{-X}\downarrow(+
 \end{array}$$

For the gravitons of the gradient of gravitation for the $\mu = 0$ and $\mu = 3$ oscillator the following properties are applied:

Z1.1: $\mu = 0$: $O\uparrow(+)$ - $X\downarrow(-)$, $\mu = 3$: $O\uparrow(-)$ - $X\downarrow(+)$
Z1.2: $\mu = 0$: $O\uparrow(-)$ - $X\downarrow(+)$, $\mu = 3$: $O\uparrow(+)$ - $X\downarrow(-)$
Z2.1: $\mu = 0$: $O\downarrow(-)$ - $X\uparrow(+)$, $\mu = 3$: $O\downarrow(+)$ - $X\uparrow(-)$
Z2.2: $\mu = 0$: $O\downarrow(+)$ - $X\uparrow(-)$, $\mu = 3$: $O\downarrow(-)$ - $X\uparrow(+)$

The computations are performed in the same way as for a positive charge in a positive electric gradient. This leads to the results summarized in table 2 and 3.

In tables 2 and 3 the results of interaction of the gravitons Z1.1&Z1.2 (table 2) and the gravitons Z2.1&Z2.2 (table 3) with the longitudinal scalar oscillators O1 and O2 in their states Z1 and Z2 are summarized. The gravitons Z1.1&Z1.2 are distinguished from the gravitons Z2.1&Z2.2 by the direction of circulation and in the sign of action. In the interaction between the gravitons and the mass oscillators O1&O2 the delta of the gravitons O-X are introduced into one of the scalar oscillators O1 or O2. Because the deltas of the O-X gravitons are with different sign enclosed in both O and X photons, the deltas are always virtual. If the deltas of the gravitons are added and subtracted in one oscillation state in the oscillator O1, in the next oscillation state the same process will occur in the oscillator O2. The two longitudinal oscillators have different signs in the gravitons and in the scalar oscillators, the same process will also occur simultaneously with opposite sign of action in both longitudinal oscillators. The virtual action enclosed in the gravitons is virtually store between the two scalar oscillators and between their two longitudinal oscillators. If the oscillators of the mass O1 and O2 are interacting at the same time with the gravitons Z1.1&Z1.2 and Z2.1&Z2.2, both oscillators O1 and O2 will simultaneously absorb virtual action. During two oscillation states for both gravitons Z1.1&Z1.2 and Z2.1&Z2.2 in a gradient of gravitation the scalar oscillators are completely changed by the same delta of virtual action.

8 Principle of Equivalence

In frame of our formalism the weight mass and the inert mass must be the same, because a change of properties of objects occurs always by a change of action: masses and charges are characterized by the number of oscillators and by the content of action in oscillators. For a change of properties all oscillators must be supplied by the same amount of action. This is independent from the method how the action is supplied to the objects. For changing the speed of an object by a horizontal force to a specific value, the same action must be applied to the object in gravitational field to change the speed to the same value. The amount of action in the scalar mass oscillators describe the relative speed of the object.

Table 2 Interaction of the $\mu = 0$ and $\mu = 3$ oscillator of the particle in state Z1 with the graviton in state Z1.1: $O\uparrow(+)-X\downarrow(-)$ and in state Z2 with the state Z1.2: $O\uparrow(-)-X\downarrow(+)$ of the graviton.

$\mu = 0$	O1	O2	addition of	subtraction pf
Z1	$O\uparrow(-)-X\downarrow(+)$	$O\downarrow(+)-X\uparrow(-)$		
Δ	$O\uparrow(+)-X\downarrow(-)$	–		O1: $O\uparrow(-)-X\downarrow(+)$
Δ	$O\uparrow(-)-X\downarrow(+)$	–	O1: $O\uparrow(-)-X\downarrow(+)$	–
Z2	$O\downarrow(+)-X\uparrow(-)$	$O\uparrow(-)-X\downarrow(+)$		
Δ	–	$O\uparrow(-)-X\downarrow(+)$	O2: $O\uparrow(-)-X\downarrow(+)$	–
Δ	–	$O\uparrow(+)-X\downarrow(-)$	–	O2: $O\uparrow(-)-X\downarrow(+)$
$\mu = 3$	O1	O2	addition of	subtraction of
Z1.1	$O\uparrow(+)-X\downarrow(-)$	$O\downarrow(-)-X\uparrow(+)$		
Δ	$O\uparrow(-)-X\downarrow(+)$	–		O1: $O\uparrow(-)-X\downarrow(+)$
Δ	$O\uparrow(+)-X\downarrow(-)$	–	O1: $O\uparrow(+)-X\downarrow(-)$	–
Z1.2	$O\downarrow(+)-X\uparrow(-)$	$O\uparrow(-)-X\downarrow(+)$		
Δ	–	$O\uparrow(-)-X\downarrow(+)$	O2: $O\uparrow(-)-X\downarrow(+)$	–
Δ	–	$O\uparrow(+)-X\downarrow(-)$	–	O2: $O\uparrow(+)-X\downarrow(-)$

Table 3 Interaction of the $\mu = 0$ and $\mu = 3$ oscillator of the particle in state Z1 with the graviton in state Z2.1: $O\downarrow(-)-X\uparrow(+)$ and in state Z2 with the state Z2.2: $O\downarrow(+)-X\uparrow(-)$ of the graviton.

$\mu = 0$	O1	O2	addition of	subtraction of
Z1	$O\uparrow(-)-X\downarrow(+)$	$O\downarrow(+)-X\uparrow(-)$		
Δ	–	$O\downarrow(-)-X\uparrow(+)$	–	O2: $O\downarrow(-)-X\uparrow(+)$
Δ	–	$O\downarrow(+)-X\uparrow(-)$	O2: $O\downarrow(+)-X\uparrow(-)$	–
Z2	$O\downarrow(+)-X\uparrow(-)$	$O\uparrow(-)-X\downarrow(+)$		
Δ	$O\downarrow(-)-X\uparrow(+)$	–	–	O1: $O\downarrow(-)-X\uparrow(+)$
Δ	$O\downarrow(+)-X\uparrow(-)$	–	O1: $O\downarrow(+)-X\uparrow(-)$	–
$\mu = 3$	O1	O2	addition of	subtraction of
Z2.1	$O\uparrow(+)-X\downarrow(-)$	$O\downarrow(-)-X\uparrow(+)$		
Δ	–	$O\downarrow(+)-X\uparrow(-)$	–	O2: $O\downarrow(+)-X\uparrow(-)$
Δ	–	$O\downarrow(-)-X\uparrow(+)$	O2: $O\downarrow(-)-X\uparrow(+)$	–
Z2.2	$O\downarrow(+)-X\uparrow(-)$	$O\uparrow(-)-X\downarrow(+)$		
Δ	$O\downarrow(+)-X\uparrow(-)$	–	O1: $O\downarrow(+)-X\uparrow(-)$	–
Δ	$O\downarrow(-)-X\uparrow(+)$	–	–	O1: $O\downarrow(-)-X\uparrow(+)$

In an extension of this statement the principle of equivalence says that in each rest frame the same laws of physics are valid, [6]. The only law used in the present formalism for the description of the properties of objects and their interactions is the principle of Hamilton, which we use as a condition of minimization of action. Applying this law to the propagation of a charge in an electric gradient and to a mass propagating in a gradient of gravitation, this is realized by the obtained results that in an interaction between the charge/the mass with the gradient always virtual action is supplied from the gradient to the charge, so that at each local four dimensional point of the gradient no change of real action occurs. The relation of the principle of equivalence to the wave properties formation is visible in same properties of a charge moving through the electric gradient under formation of wave properties as the propagation of a mass in a gradient of gravitation: the condition for the formation of a rest frame in a gradient is the supply of virtual action. Under conditions of the rest frame the principle of Hamilton (minimization of action) is valid.

9 Summary and Discussion

A charge is accelerated in a decreasing homogeneous potential gradient and is forming wave properties, because action from the photons of the gradient is supplied to the scalar oscillators forming the core of the charge. The action is stored in the oscillators of the charge simultaneously by absorption of positive and negative action in the memories of the absorbed photons O and X, in the two longitudinal oscillators and in the scalar oscillators O1 and O2. After leaving the potential gradient the charge has wave properties and the amount of action is equal to the amount of action in the original potential.

A mass is accelerated in an increasing gradient of gravitation, because from the gravitons of the gradient virtual action is deposited into the absorbed photons O and X of the mass oscillators. The action of the O-X-gravitons with opposite sign in the photons O and X is simultaneously absorbed in the two scalar oscillators O1 and O2 and in the two longitudinal parts of the absorbed O-X-photons. At each position of the gradient the difference of action in relation to the starting position determines the relative speed of the mass.

For an acceleration of a charge in an electric potential gradient to a relative speed in relation to the original rest frame the same amount of virtual action is needed, as for the acceleration of a mass in a gradient of gravitation with the same relative speed in relation to the original rest frame. This is because the amount of action in the scalar oscillators of masses and charges determines the relative change of

speed of masses and charges.

At each local position for a mass in a gradient of gravitation and at each local position of a charge in an electric gradient the rest frame is formed by the deposition of virtual action. The interaction occurs in both cases by a simultaneous deposition of the same amount of positive and negative action. This is in difference to the interaction between single masses and between single charges, where during interaction real action is exchanged, during which the acceleration is in addition controlled by currents in vertical correlations of the absorbed photons. A rest frame and the validity of the principle of equivalence is always realized, when currents in the oscillators of charges and masses are in an equilibrium. A rest frame is the precondition for the validity of the laws of physics, the laws of physics are represented in the present formalism by the condition of minimization of action, which in classic physics is the principle of Hamilton.

Systems of objects which fulfil the condition of minimization of action (the principle of Hamilton) are systems in a rest frame. The commutators of communication relations of quantum mechanics are fulfilling the conditions of the PSCO in case they are not generating action. In general they generate real action and if this is the case they form currents in the vertical correlations of the photons of static Maxwell fields and included in scalar oscillators this causes a change of canonical momenta and a change of movement in space-time. If an object is in a rest frame, action generated in its commutators is compensated so that the residual action is zero and the PSCO is realized. In such an object all currents in vertical correlations are compensating each other. If in interaction real action in form of a delta is introduced into the oscillators of such an object, sources of action generate changes of currents in vertical correlations and the object is accelerated out from its rest frame. If sources of action are introduced into the scalar oscillators in a form so that the whole action is compensated and the residual action is virtual, similar as this is on homogeneous gradients, and if the system after interaction still fulfils the conditions of the PSCO, action change causes a change of canonical momenta, but the object remain in a rest frame. The fact that it is possible to introduce virtual action into objects in a way so that they remain in a rest frame is the precondition for an evolution of ordered systems.

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This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.