Bulgarian Journal of Agricultural Science, 18 (No 6) 2012, 819-826
Agricultural Academy

THE SCALAR PARTICLES IN CASIMIR VACUUM STATE OF THE RELATIVISTIC QUANTUM FIELD SYSTEM IN LIVING CELLS

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Abstract

TSVETKOV, Ts. D. and G. PETROV, 2012. The scalar particles in Casimir vacuum state of the relativistic quantum field system in living cells. *Bulg. J. Agric. Sci.,* 18: 819-826

The mathematical description of the Casimir world is based on the fine play between the continuity and the discrete. The discrete is more remarkable than the continuity things in this case as any one wave quantum field Casimir vacuum state defined on the involutes algebraic entities so that the quantum wave functional, i.e. the ground state, is non positive as remembers of the Hilbert space with indefinite metric and can be consider as a solution of the Schrödinger functional equation with impulse effect. The discrete things can be singularities, bifurcations and destroyed scaling behavior of the relativistic scalar quantum field system and his Casimir ground state in living cells as global properties of the quantum vacuum state interacting with external classical field modelled in our case by boundary conditions. The classical field theory is a theory of the continuity also describes the principle of the shot-range interaction in the nature. The twenty century has given the quantum field theory that is the theory of the discrete world of the quantum entities. The global effects from the quantum field theory by the interactions of the elementary particle are the studying of the phenomenon of structure of the elementary particle hadrons by deep inelastic scattering and a vacuums structure of every one quantum field system, e g. the relativistic quantum field and his vacuum state with a given boundary conditions.

The question above the possibility to find the complicate phenomenon connected with the existence of the life and the living systems his place in the mathematical frame by the intersection between the classical and the quantum describing of the world of any one concrete quantum field theory by the contemporary ground state of the theoretical biological and nanophysics problems is open by the consideration of high topographical complementarities by the London- and Casimir forces involved importantly in the highly specific and strong but purely classical physical thermodynamically and quantum physically complexity of elementary living cells by enzymes with substrates, of antigens with antibodies, etc.

The theory of the “super transportation” based on the “Einstein condensation” of the bosons particles are given strong mathematical by N.N. Bogolubov in 1946 and has been defined a quasiparticles as excitations in a so-called collective state as a superposition between an excited particles state and the ground state of the quantum system.

By the consideration of the living cells, it is necessary to consider the quantum field concepts by Casimir vacuum state in observation scalars (here called as Pterophillum scalare) of the sea relativistic quantum scalar field system.

From the new results by the contributions of the environmental freezing-drying and vacuum sublimation (Zwetkow 1985; Tsvetkov, Belous 1986, Tsvetkov et al. 1989, Tsvetkov et al. 2004 – 2012) is hopped that by the significant form expressed e.g. by the scaling behaviours of the invariant entities by the energy impulse tensor described the elementary living cells and systems will be possibly to describe the biological expressions at the standpoint of the nanophysics by means the behaviour of the concrete relativistic quantum field system, e.g. sea virtual quantum scalars in the physical Casimir vacuum with a boundary conditions on every one surface S too.

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At the molecular level (Mitter and Robaschik, 1999) the thermodynamics behaviour is considered by quantum electromagnetic field system with additional boundaries as by the Casimir effect between the two parallel, perfectly conducting square plates (side L, distance d, L > d), embedded in a large cube (side L) with one of the plates at face.

For further considerations we can suppose that the demon of Maxwell slide the moved plate with a constant velocity v and counted the seeing scalars for j = 0, …, 2n, where j is the number of the scalars with the minimum energy equal to the energy of the "zero fluctuations" levels by the hyperbolical rotation and reflection of the fixed 4-point y_0^μ from Minkowski space between the plates from the demon of Maxwell counted.

Key words: Casimir effect, living cells, lyophilization, nanophysics, singularities, scaling principle, Casimir vacuum state

Introduction

The mathematical description of the Casimir world is based on the fine play between the continuity and discrete. The discrete is more remarkable than the continuity things as any one wave quantum field Casimir vacuum state defined on the involutes algebraic field operator entities so that in this case the quantum wave functional is non positive as remembers of the Hilbert space with indefinite metric and is a solution of the Schrödinger functional equation with impulse effect too. The discrete things can be singularities, bifurcations and distortions of the scaling behaviour of the Casimir ground state of the relativistic scalar quantum field system in living cells as global properties of the vacuum state interacting with external classical field modelled in our case by boundary conditions. The classical field theory is a theory of the continuity also describes the principle of the shot-range interaction in the nature. The twenty century has given the quantum field theory that is the theory of the discrete world of the quantum field entities. The global effects from the quantum field theory by the interactions of the elementary particle are the phenomenon of the structure of the hadrons and a quantum vacuums structure of every one quantum field system defined in Hilbert space with indefinite metric, e g. the relativistic quantum field and his vacuum state with a given boundary conditions. The axiomatic algebraic quantum field methods by the description of the quantum particle physics world have important remarkable successes by the understanding of the structure of the elementary particle and the vacuum state.

To day, it is clear that hadrons are no more so elementary particles. By consideration of the non-forward Compton Effect in deep inelastic scattering, they have a structure (Petrov, 1978) as the atom has understood it. In the beginning of the twenty century was clear that the atom is no more not devisable as it has been toughed by the ancients Greeks and it is a particle with a structure. So we have to consider an important scaling principle as the scaling destroyed in longitudinal and not destroyed in the squared direction by the describing of the Casimir world based of this fine play between the continuity and the discrete where we have to consider the singularities, the bifurcations and the restructurings of the vacuum state of every one quantum field system defined on the space-time of our world interacting with a given boundary conditions on a generic surface S. It is clear also that the quantum vacuum has a structure and is no more vacuum also a void.

From the calculating of Casimir effect is clear that the Casimir force is from significant importance for the nanophysics and so also for life and living systems. If the scalars are the particles transported the interaction between the quantum ground state and the plates by the Casimir effect in the sense of the short-range interaction than the Einstein condensation can be observed for the zero impulse of the particles with a scaling behaviour in the squared direction towards the moving demon of Maxwell so that in the longitudinal direction the impulse is not zero but less then the impulse of the kinetic energy of the zero fluctuation of the vacuum and the scaling is destroyed by this scalars impulse that is equal of the impulse of the "energy of the zero fluctuations" of the vacuum. So the virtual quantum particles and the zero fluctuations of the vacuum take one meaning.

Main result

At the first, we take the reflecting and the hyperbolical turns on the mirror points in the Minkowski space

$y_{2(n-\frac{1}{2}(j-1))}^{\mu}, y_{-2(n-\frac{1}{2}j)}^{\mu}, y_{2(n-\frac{1}{2}j)}^{\mu}, y_{-2(n-\frac{1}{2}(j+1))}^{\mu}$ and the point

$x^\mu = (ct, \bar{x})$ and $y_0^{\ \mu} = (ct_0, \bar{y})$ between the plates so that

$t \in (t_{-2(n-\frac{1}{2}j)}, t_{2(n-\frac{1}{2}j)}]$, $n = 0,1,2, ..., j = 0,1,2, ..,2n$ for $x^3 \in (0, d_0]$, or $x^3 \in (d_0, L)$,

where $\mu = 0,1,2,3$, and n is the reflecting number of the seeing from the demon of Maxuel point $y_0^{\ \mu}$ from the Minkowski space-time at the time $t = t_0$ between the not moved and the moved plate with the constant velocity v so that

$y_{2(n-\frac{1}{2}(j-1))}^{\ \ 2} = y_{-2(n-\frac{1}{2}j)}^{\ \ 2} = y_{2(n-\frac{1}{2}j)}^{\ \ 2} = y_{2(n-\frac{1}{2}(j+1))}^{\ \ 2} = y_0^{\ 2} = (ct_0)^2 - \bar{y}^2 = (ct_0)^2 - \bar{y}_\perp^{\ 2} - y_0^{3\ 2} \neq 0,$

$y_0^{\ 3} \in (0, d_0], y_0^{\ 3} \in [d_0, L)$

$t_{-2(n-\frac{1}{2}j)} = t_{2(n-\frac{1}{2}(j+1))}$, $y_{-2(n-\frac{1}{2}j)}^{\ \ 3} = -y_{2(n-\frac{1}{2}(j+1))}^{\ \ 3}$, $t_{2(n-\frac{1}{2}(j-1))} = t_{-2(n-\frac{1}{2}j)}$, $y_{2(n-\frac{1}{2}(j-1))}^{\ \ 3} = -y_{-2(n-\frac{1}{2}j)}^{\ \ 3}$. Also we have a so called lexicographic order for $y_{2(n-\frac{1}{2}(j-1))}^{\ \ \mu}$ and $y_{-2(n-\frac{1}{2}j)}^{\ \ \mu}$;

$y_{2(n-\frac{1}{2}j)}^{\ \ \mu}$ and $y_{-2(n-\frac{1}{2}(j+1))}^{\ \ \mu}$, and we change not the $\bar{y}_\perp$ by the reflections and the hyperbolically rotations. Further we can defined by the distinguishing marks "l" = left and "r" = right the following relations between the point x between the plates and the reflecting see points

$$\begin{aligned}{}^r\tilde{x}^\mu &= x^\mu + (y_{2(n-\frac{1}{2}j)}^{\ \ \mu} y_0^{\ -2})((xy_{2(n-\frac{1}{2}j)})^2 - x^2y_0^{\ 2})^{\frac{1}{2}} - y_{2(n-\frac{1}{2}j)}^{\ \ \mu}(xy_{2(n-\frac{1}{2}j)})y_0^{\ -2} = \\ &x^\mu + y_{2(n-\frac{1}{2}j)}^{\ \ \mu}((xy_{2(n-\frac{1}{2}j)})y_0^{\ -2})((1 - x^2y_0^{\ 2}(xy_{2(n-\frac{1}{2}j)})^{-2})^{\frac{1}{2}} - 1) = \\ &x^\mu + y_{-2(n-\frac{1}{2}j)}^{\ \ \mu} f, \text{ for } t \in (t_{-2(n-\frac{1}{2}j)}, t_{2(n-\frac{1}{2}j)}] \text{ and} \\ &f = ((xy_{2(n-\frac{1}{2}j)})y_0^{\ -2})((1 - x^2y_0^{\ 2}(xy_{2(n-\frac{1}{2}j)})^{-2})^{\frac{1}{2}} - 1)\end{aligned}$$

and

$$\begin{aligned}{}^l\tilde{x}^\mu &= x^\mu + (y_{-2(n-\frac{1}{2}j)}^{\ \ \mu} y_0^{\ -2})((xy_{-2(n-\frac{1}{2}j)})^2 - x^2y_0^{\ 2})^{\frac{1}{2}} - y_{-2(n-\frac{1}{2}j)}^{\ \ \mu}(xy_{-2(n-\frac{1}{2}j)})y_0^{\ -2} = \\ &x^\mu + y^\mu_{-2(n-\frac{1}{2}j)}((xy_{-2(n-\frac{1}{2}j)})y_0^{\ -2})((1 - x^2y_0^{\ 2}(xy_{-2(n-\frac{1}{2}j)})^{-2})^{\frac{1}{2}} - 1) = \\ &x^\mu + y^\mu_{-2(n-\frac{1}{2}j)} f', f = ((xy_{-2(n-\frac{1}{2}j)})y_0^{\ -2})((1 - x^2y_0^{\ 2}(xy_{-2(n-\frac{1}{2}j)})^{-2})^{\frac{1}{2}} - \\ &-1), \text{ for } t \in (t_{-2(n-\frac{1}{2}j)}, t_{2(n-\frac{1}{2}j)}], n = 0,1,2, ..., j = 0,1,2, ..,2n,\end{aligned}$$

as a light like Minkowski space vector and $y^\mu_{2(n-\frac{1}{2}j)}$ and $y^\mu_{-2(n-\frac{1}{2}j)}$ are fixed 4-vectors of the Minkowski space-time.

Further, we define by the following relations

$\kappa x^\mu = \tau_j^{\ r}\tilde{x}^\mu + \frac{1}{2}(x + \tau_j^{\ r}\tilde{x})^\mu f_\kappa$ with

$f_\kappa = y_0^{\ -2}\frac{1}{2}(x\,\tau_j^{\ r}\tilde{x})((1 + 4\kappa^2x^2y_0^{\ 2}(x\,\tau_j^{\ r}\tilde{x})^{-2})^{\frac{1}{2}} - 1)$

for $y_{2(n-\frac{1}{2}j)}^{\ \ 2} = \frac{1}{4}(x + \tau_j^{\ r}\tilde{x})^2$, $t \in (t_{-2(n-\frac{1}{2}j)}, t_{2(n-\frac{1}{2}j)}]$, $n = 0,1,2, ..., j = 0,1,2, ..,2n$,

$\kappa' x^\mu = \tau_j^{\ l}\tilde{x}^\mu + \frac{1}{2}(x + \tau_j^{\ l}\tilde{x})^\mu f_{\kappa'}$ with

$f_{\kappa'} = y_0^{\ -2}\frac{1}{2}(x\,\tau_j^{\ l}\tilde{x})((1 + 4\kappa'^2x^2y_0^{\ 2}(x\,\tau_j^{\ l}\tilde{x})^{-2})^{\frac{1}{2}} - 1)$

for $y_{-2(n-\frac{1}{2}j)}^{\ \ 2} = \frac{1}{4}(x + \tau_j^{\ l}\tilde{x})^2$, $t \in (t_{-2(n-\frac{1}{2}j)}, t_{2(n-\frac{1}{2}j)}]$, $n = 0,1,2, ..., j = 0,1,2, ..,2n$,

$\kappa x^\mu = \tau_{2n-1}^{\ \ r}\tilde{x}^\mu + \frac{1}{2}(x + \tau_{2n-1}^{\ \ r}\tilde{x})^\mu f_\kappa$ with

$f_\kappa = y_0^{\ -2}\frac{1}{2}(x\,\tau_{2n-1}^{\ \ r}\tilde{x})((1+4\kappa^2x^2y_0^{\ 2}(x\,\tau_j^{\ r}\tilde{x})^{-2})^{\frac{1}{2}} - 1)$

for $y_1^{\ 2} = \frac{1}{4}(x + \tau_{2n-1}^{\ \ r}\tilde{x})^2$, $t \in (t_{-1}, t_1]$, so that the following bounded open domains of double cons are defined

${}^lD = {}^lD_{\kappa x,\, \tau_j^{\ l}\tilde{x}} = V^+_{\tau_j^{\ l}\tilde{x}} \cap \bar{V}_{\kappa x}$ with the basis $S_{\kappa x,\, \tau_j^{\ l}\tilde{x}}$ and the axis $[\kappa x^\mu, \tau_j^{\ l}\tilde{x}^\mu] = y_{2(n-\frac{1}{2}j)}^{\ \ \mu} f_\kappa$,

${}^rD = {}^rD_{\kappa' x,\, \tau_j^{\ r}\tilde{x}} = V^+_{\tau_j^{\ r}\tilde{x}} \cap \bar{V}_{\kappa' x}$ with the basis $S_{\kappa' x,\, \tau_j^{\ r}\tilde{x}}$ and the axis $[\kappa' x^\mu, \tau_j^{\ r}x^\mu] = y_{-2(n-\frac{1}{2}j)}^{\ \ \mu} f_{\kappa'}$.

Further we can define for the impulse Minkowski space by means of the following relation and fixed impulse four vector $k^\mu = (0, 0, 0, k^3)$ as by the P.N. Bogolubov et.al. and G. Petrov 1978

$q_\kappa^{\ \mu} = {}^r\tilde{q}^\mu + k^\mu f_\kappa$ with

$f_\kappa = k^{-2}(k\,{}^r\tilde{q})((1 + \kappa^{-2}q^2k^2(k\,{}^r\tilde{q})^{-2})^{\frac{1}{2}} - 1),$

$q_{\kappa'}^{\ \mu} = {}^l\tilde{q}^\mu + k^\mu f_{\kappa'}$ with

$f_{\kappa'} = k^{-2}(k\,{}^l\tilde{q})((1 + \kappa'^{-2}q^2k^2(k\,{}^l\tilde{q})^{-2})^{\frac{1}{2}} - 1)$ and

$q^\mu = \frac{1}{2}(q_\kappa^{\ \mu} + q_{\kappa'}^{\ \mu})$, $k^\mu = \frac{1}{2}(q_\kappa^{\ \mu} - q_{\kappa'}^{\ \mu})$, ${}^l\tilde{q}^2 = {}^r\tilde{q}^2 = 0$, $q_\kappa^{\ 2} = \kappa^{-2}q^2$, $q_{\kappa'}^{\ 2} = \kappa'^{-2}q^2$, $k^2 = -k^{3^2}$

$(\kappa^2q_\kappa^{\ 2} + \kappa^2q_\kappa^{\ 2})/2 = q^2 = q^{0^2} - q^{1^2} - q^{2^2} - k^{3^2} = m^2$, where m is the scalars mass at the rest and $k^3 = q^3$ for destroyed scaling behaviour in the longitudinal direction.

It is assumed the local quantum scalar wave field system under consideration have a boundary generic surface S for his ground state or the so called Casimir vacuum state, fixed or moved with a constant velocity v parallel by demon of Maxwell sliding towards the fixed one boundary, which do surgery, bifurcate and separate the singularity points in the manifold of the non local virtual scalars of the quantum field system from some others vacuum state as by Casimir effect of the quantum vacuum states for the relativistic quantum fields, and which has the property that any virtual quantum particle which is once on the generic surface S remains on it and fulfilled every one boundary conditions on this scalar quantum system with a non positive Casimir vacuum state as remember of the Hilbert space with infinite metric defined on the involutes algebra of the field operators A(f) for the solution f of the Klein-Gordon wave equation given by covariant statement

$$\square f(x^\mu) = (\partial^2_{ct} - (\Delta + m^2))f(x^\mu) = J(x^\mu), \qquad (1)$$

where $\square$ is a d'Lembertian and $\Delta = \partial^2_x + \partial^2_y + \partial^2_z$ is a Laplacian differential operators and $x^\mu \in M^4$ $\mu = 0, 1, 2, 3$, $(x, y, z, ct) = (x^l, x^0)$ with $l = 1, 2, 3$ is a point of Minkowski space M^4 and the J is a current of the sea virtual scalars of the sea relativistic quantum scalar fields system.

Also the ground states of the local quantum scalar fields system defined in the Minkowski space-time fulfilled every one boundary conditions interact with the boundary surface S by the help of the non local virtual scalars and so the Casimir vacuum state has a globally features, e.g. the energy of the "zero fluctuations"[1] and hens the so called Casimir effect with calculable Casimir force inversely proportional to the 4-th grade of the distance between the plates.

Examples of such boundary surfaces S of importance for the living cells are those in which is the surface of a fixed mirror at the initial time t = 0 in contact with the local quantum scalar fields system in his simple connected vacuum region – the bottom of the sea of the virtual non local massless scalar quantum field particles, for example given by the 4-impulse $\tilde{q}_\tau$ and the generic free surface of the parallel sliding mirror moved, e.g. by demon of Maxwell at the time t_0 and with a constant velocity v towards the fixed one or the free vacuum surface of the local quantum scalar wave field in contact with the mirror parallel moved towards the fixed one – the free vacuum region with j = 2n-1 scalars, described by the impulse Schrödinger wave functional

$$\Psi_{\alpha_\kappa}(\varphi, t) = \Psi(f_\kappa, t), \text{ by } t \in (t_{-2(n-½j)}, t_{2(n-½j)}],\ n = 0, 1, 2, \ldots;\ j = 0,1,2,\ldots,2n;$$

$$t_{-2(n-½j)} = t_0,\ t_{2(n-½j)} = t_1 \text{ for } j = 2n\text{-}1,\ t_{-2(n-½(j-1))} = t_{-1},\ t_{2(n-½j)} = t_0 \text{ for } j = 2n$$

and by given fulfilled operators equation in the case of the canonical Hamiltonian local quantum scalar field system in a statement of equally times.

$$x^0 = ct = \kappa x^0 = ct_{2(n-½(j-\kappa))} = (\kappa^2 x^2 + \mathbf{y}_\perp{}^2 + (y^3{}_{2(n-½(j-\kappa))})^2)^{½}$$

and

$$x^0 = ct \to \kappa' x^0 = ct_{-2(n-½(j-\kappa'))}. = (\kappa^2 x^2 + \mathbf{y}_\perp{}^2 + (y^3{}_{-2(n-½(j-\kappa'))})^2)^{½}$$

$$\text{with } 0 \le \kappa' < \tau < \kappa \le 1,\ \mathbf{x}_\perp \to \mathbf{y}_\perp \qquad (2)$$

By the definition the canonical non local field $\varphi(\kappa x)$ and impulse $\pi(\kappa x)$, $\kappa x^\mu \in M^4$, $\mu = 0, 1, 2, 3$, corresponding to implicit operator valued covariant field tempered functional $A(f_\kappa)$, where $f_\kappa \in S_R(\mathbf{R}^4)$ is a test function of this reel Swartz space, fulfilled all axioms of Whitman and acting in the functional Hilbert space $\hat{H}$ with infinite metric and a Fok's space's construction, e.g. a direct sum of symmetries tensor grade of one quantum field's particle space $\hat{H}_1$:

$$\hat{H} = \hat{H}_F(\hat{H}_1) = \times_{n=0}^{\infty} \text{sym}\ \hat{H}_1{}^{\times n}$$

can be given for physical representation of the scalar quantum field system by the formulas,

$$\varphi(\alpha_\kappa) = A(f_\kappa), \qquad (3)$$

$$\pi(\alpha_\kappa) = A(\partial_{ct} f_\kappa), \qquad (4)$$

for $\alpha_\kappa = \alpha_\kappa(x^1, x^2, y^3{}_{2(n-½(j-\kappa))}, ct_{2(n-½(j-\kappa))})$, with $y^3{}_{2(n-½(j-\kappa))} = \kappa x^3$ and $y^0{}_{2(n-½(j-\kappa))} = \kappa x^0$ by fulfilled Klein-Gordon equation in a covariant statement for massive and massless scalar fields

$$K_m A(f_\kappa) = A(K_m f_\kappa) = A(J)$$

$$KA(f) = A(Kf) = 0. \qquad (5)$$

It is knowing that matrix elements of the current $\langle\varphi| J(\tilde{q}_\tau)|0\rangle$, i.e. for j = 0 have a singularities at $\tilde{q}_\tau^{\,2} = 0$ which can be interpreted as a presence in Hilbert space $\hat{H}$ of

[1] Actually, this property is a consequence of the basic assumption by local quantum wave field theory that the wave front of the local quantum wave field system by his ground state propagate on the light hyperplane in any contact space (called "dispersions relations" too) and can be described mathematically as a non local virtual topological deformation or zero fluctuation which depends continuously on the time t.

the massless scalars Goldstones bosons and the appearance of the action at the distance. But this resemblance is only formal and by going to the physical representation the scalar Goldstones bosons disappears. That is one of the indications of the Higgs-mechanisms, e.g. effect of the mass preservation from the vector fields by spontaneous destruction of the gauge group (or the scalar Goldstones bosons are "swallowing up") and so it is to observe, that the Casimir force is to be observed only by quantum electromagnetic field system with a massless real photon and asymmetrical Casimir vacuum state where the scaling behaviour by the fermions fields is destroyed.

For simplicity here, we have considered a domain of space-time containing any one massless scalar field φ(x) defined at the point of the Minkowski space-time at the fixed time t. Further a concrete massless field $\varphi(t,\bar{y})$ is considered as a Banach valued vector state obeying the impulse wave equation in a Banach space, defined over the space $\Omega_t^3 \subset M$ at the time $t = t_0$ and $y^3 = y^3_0$ in the Minkowski space-time M. By imposing suitable boundary conditions for any one quantum field system considered as any one relativistic quantum field φ(x) fulfilled the Klein-Gordon equation, the total fields energy in any domain at the point $(ct,\bar{x})$ from the Minkowski space-time can be written as a sum of the zero mode energy for

$t \in (t_{-2(n-½j)}, t_{2(n-½j)}]$, n = 0,1,2, ..., j = 0,1,2, ..,2n and $x^3 \in (0, d_0]$, $x^3 \in [d_0, L)$,

n = 0,1,2, ..., j = 0,1,2, ..,2n so that $|\bar{x}_\perp| \leq .\ R = ((ct)^2 - (x^3)^2)^{½}$

is fulfilled and the ground state of this concrete quantum field system must be conformed by this suitable boundaries and so we can modelled the interaction of the concrete quantum field system to the external classical field by means of this suitable boundaries.

Our interest is concerned to the vacuum and especially the physical Casimir vacuum conformed by the suitable boundary conditions.

Nevertheless, the idea - that the vacuum is like a ground state of any one concrete relativistic quantum field system - is enormously fruitful for the biological systems in the nanophysics and cellular cryobiology too, i.e. it is to consider the time arrow in the systems with a feedback.

The obviously necessity to take in consideration the quantum field concepts by observation macroscopically objects present from infinity significant number of particles and to be found by low temperatures is following from the elementary idea. Consider e.g. the Casimir vacuum present from n level of the energy of "zero fluctuations" and occupied by j = 2n-1 virtual scalar bosons to be found in a volume V. In so one vacuum state every virtual scalars is surrounded closely from the neighbouring particles so that on his kind get a volume at every vacuum energy level of the order V/n $\sim ((|\bar{y}_\perp|^2 + (y^3_{2(n-½j)})^2)^{½})^3$ Also every virtual scalar at the state with the smallest energy possess sufficient energy of the "zero fluctuations" given elementary by

$$m = E_0 \sim (2m)^{-1} ((|\bar{q}_\perp|^2 + k^{3^2})^{½})^3 \sim (2m)^{-1}((|\bar{y}_\perp|^2 + (y_{2(n-½j)}{}^3)^2)^{½})^{-3} \sim (2m\ )^{-1}(n/V\ )^{⅔},$$

$$\text{for } k^3 = q^3 \text{ and } \quad |\bar{q}_\perp|^2 \rightarrow 0 \text{ and for}$$

$$n \rightarrow \infty \text{ and } |\bar{y}_\perp|^2 \rightarrow \infty \text{ the } \lim |\bar{y}_\perp|^2/2y^3_{2(n-½j)} = = \text{const} \in [0, 1], \qquad (6)$$

In addition, the distance between the ground state and the first excited level of the single see massless scalar will be of the some order that is for E_0 too. It follows that if the temperature of the vacuum state of the relativistic sea quantum field system is less then the some one critical temperature T_c of the order of the temperatures of the Einstein condensation, than in the Casimir vacuum state there are not the excited one-particle states.

By the calculation of the energy of the "zero fluctuations" of the Casimir vacuum state the Green function as solution of massless Klein-Gordon equation with the δ-function as a source play an important role.

$$(\partial^2_{ct} - \Delta)D(x^\mu) = \delta(x^\mu)$$

$$\text{and } D(\cdot) = \sum_{n=0}^{\infty} (D(x - y_{2n}) + D(x - y_{-2n}) - - D(x - y_{2n-1)}) - D(x - y_{-2n-1)})) \qquad (7)$$

$$\text{where } D(x - y_{2n}) = \int d^4\tilde{q}\, \exp[-i\tilde{q}(x - y_{2n})/(\tilde{q}^2 - i\varepsilon) = - i(2\pi)^{-2} (x - y_{2n})^{-2}.$$

Therefore, the temperature for Casimir effect is not from significances.

The Higgs Mechanism

Gauge symmetry seems to prevent a vector field from having a mass.

This is obvious once that can be realized a term in the Lagrangian like $m^2A_\mu A^\mu$ is incompatible with gauge invariance.

However, certain physical situations seem to require massive vector fields. This happened for example during the 1960s in the study of weak interactions. The Glashow model gave a common description of both electromagnetic and weak interactions based on a gauge theory with group SU(2)×U(1) but, in order to reproduce Fermi's four-fermions theory of the β-decay it was necessary that two of the vector fields involved would be massive. Also it can be suppose that in condensed matter physics massive vector fields are required to describe certain systems, most notably in supertransportation.

The way out to this situation is found in the concept of spontaneous symmetry breaking. The consistency of the quantum theory requires gauge invariance, but this invariance can be realized as a Nambu-Goldstone relativistic local quantum field system. When this is the case the full gauge symmetry is not explicitly present in the effective action constructed around the particular vacuum chosen by the theory. This makes possible the existence of mass terms for gauge fields without taking a risk for the consistency of the full theory, which is still invariant under the whole gauge group.

To illustrate the Higgs mechanism it is possible to study the simplest example, the Abelian Higgs model: a U(1) gauge field coupled to a self-interacting charged complex scalar field φ with Lagrangian

$$L = -\tfrac{1}{4}F_{\mu\nu}F^{\mu\nu} + ((\partial_\mu - ieA_\mu)\varphi)^2 - \lambda^{-4}(|\varphi|^2 - \mu^2)^2, \quad (8)$$

where $\partial_\mu - ieA_\mu$ is the covariant derivative with e the electric charge. This theory is invariant under the gauge transformations

$$\varphi \to e^{i\alpha(x)}\varphi,\ A_\mu \to A_\mu + \partial_\mu\alpha(x). \quad (9)$$

The minimum of the potential is defined by the equation $|\varphi| = \mu$. So there is a continuum of different vacua labelled by the phase of the scalar field. None of these vacua, however, is invariant under the gauge symmetry

$$\langle\varphi\rangle = \mu e^{i\vartheta_0} \to \mu e^{i\vartheta_0 + i\alpha(x)} \quad (10)$$

and therefore the symmetry is spontaneously broken. In addition, it is the case where the ground state of the relativistic quantum field system is asymmetrical and the scaling behaviour of the scalar field is destroyed. Let it be now the theory around one of these vacua, for example $\langle\varphi\rangle = \mu$, can be studied by writing the field φ in terms of the excitations around this particular vacuum

$$\varphi(x) = [\mu + (1/\sqrt{2})\sigma(x)]e^{i\vartheta(x)} \quad (11)$$

Independently of whether it is expanding around a particular vacuum for the scalar field it is to keep in mind that the whole Lagrangian is still gauge invariant under (9). This means that performing a gauge transformation with parameter $\alpha(x) = -\vartheta(x)$ can be get rid of the phase in Eq. (11). Substituting then $\varphi(x) = \mu + (1/\sqrt{2})\sigma(x)$ in the Lagrangian it can be find

$$L = -\tfrac{1}{4}F\mu\nu F^{\mu\nu} + e^2\mu^2.A_\mu A^\mu + \tfrac{1}{2}\partial_\mu\sigma\partial^\mu\sigma - \tfrac{1}{2}\lambda\mu^2\sigma^2 - \lambda\mu\sigma^3 - \lambda^4\sigma^4 + e^2\mu A_\mu A^\mu\sigma + e^2A_\mu A^\mu\sigma^2. \quad (12)$$

What are the excitation of the theory around the vacuum $\langle\varphi\rangle = \mu$? First, it can be finding a massive real scalar field σ(x). The important point however that is the vector field A_μ now has a mass given by

$$m_\gamma^2 = 2e^2\mu^2. \quad (13)$$

The remarkable thing about this way of giving a mass to the photon is that at no point can be given up gauge invariance. The symmetry is only hidden. Therefore in quantizing the theory it can still enjoy all the advantages of having a gauge theory but at the same time it have managed to generate a mass for the gauge field.

It is surprising, however, that in the Lagrangian (12) it did not found any massless mode.

Since the vacuum chosen by the scalar field breaks the U(1) generator of U(1) it is to expect one massless particle from Goldstone's theorem. To understand the fate of the missing Goldstone boson it is to revisit the calculation leading to Eq. (12). Where it is to deal with a global U(1) theory, the Goldstone boson would correspond to excitation of the scalar field along the valley of the potential and the phase $\vartheta(x)$ would be the massless Goldstone boson. However it is to keep in mind that in computing the Lagrangian is managed to get rid of $\vartheta(x)$ by shifting it into A_μ using a gauge transformation. Actually, by identifying the gauge parameter with the Goldstone excitation, it is to fixe completely the gauge and the Lagrangian (12) does not have any gauge symmetry left.

A massive vector field has three polarizations: two transverse ones plus a longitudinal one. In gauging away, the massless Goldstone boson $\vartheta(x)$ is transformed it into the longitudinal polarization of the massive vector field. In the literature, this is usually expressed saying that the Goldstone mode is "swallowing up" by the longitudinal component of the gauge field. It is important to realize that in spite of the fact that the Lagrangian (12) looks different from the one started with not lost any degrees of freedom. It is started with the two polarizations of the photon plus the two degrees of freedom associated with the real and imaginary components of the complex scalar field. After symmetry, breaking it is end up with the three polarizations of the massive vector field and the degree of freedom of the real scalar field $\sigma(x)$.

The Abelian Higgs model discussed here can be regarded as a toy model of the Higgs mechanism responsible for giving mass to the $W^{\pm}$ and Z^0 gauge bosons in the Standard Model. In condensed matter physics the symmetry breaking described by the relativistic version of the Abelian Higgs model as a quantum field system can be used to characterize the onset of a super transportation phase in the BCS theory, where the complex relativistic quantum scalar field φ with the Casimir vacuum state is associated with the Cooper pairs. In this case, the parameter μ^2 depends on the temperature. Above the critical temperature T_c, $\mu^2(T) > 0$ and there is only a symmetric vacuum $<\varphi> = 0$ but by given boundaries it is to keep in mind the Casimir force acted at the distance, i.e. the existence of massless Goldstone particles . When, on the other hand, $T < T_c$ then $\mu^2(T) < 0$ and symmetry breaking takes place. The onset of a nonzero mass of the photon (13) below the critical temperature explains the Meissner effect: the magnetic fields cannot penetrate inside superconductors beyond a distance of the order$1/m_\gamma$.

Conclusion

It is to suppose that is impossible to transport interactions energy by the vacuum state by temperature $T < T_c$. However, by nearing consideration it is clear that so one possibility is given by the collective excitations as by the Casimir vacuum state as solution of the impulse Schrödinger functional equation. This states can be described by the quantum field methods use the state of the single see scalar as a superposition of the ground state and the see excited particles states that is also that his amplitudes are small by way of comparison with the amplitude of the ground state. The volume V of the total see relativistic quantum scalar field system will define the distance between the energy levels corresponding to these collective excitations.

The connection to the radiation of the dark body and other properties of the interacting matter with the relativistic quantum field system is obvious.

But in one case to take in account the attraction between two scalars by the presence of the repulsed boundary conditions must be lead to phenomenon of new significant property: the state of the scalars system every from them is to be found in a ground state of the relativistic quantum field system must be not obligatory a state with the smallest energy equally to the energy of the "zero fluctuations". The presence of a few scalars can lead to lessening of the middle quantity of the Casimir energy from the distance between the scalars depended so that this lessening more will compensate for the increase of the middle kinetically energy of the "zero fluctuations" which is connected with the coming of those collective states.

The supposing that by the absence of the attraction between the scalars the ground state total will be a state in which all scalars "are condensate" in a state with impulse $\bar{k}_\perp = \bar{q}_\perp = 0$ and taking in account the small attraction at the distance, i.e. the Casimir Force, between the scalars in Casimir vacuum state lead to so one ground state of the system in which in this case in a single particle state appear mixture of the excited states with impulse $q^3 = k^3 \neq 0$.

In 1946 the shift for scalar field $\varphi(x) = const + u(x)$ in the theory of microscopically suppertransportation was given by N.N Bogolubov.

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Received April, 2, 2012; accepted for printing September, 2, 2012.