Black Holes and Parallel Universes

Zygmunt Morawski

ABSTRACT: Starting with Dirac equation the conception of parallel universes has been confirmed on the ground of quantum mechanics. It has been demonstrated that the singularity is an equivalent to the integral potential around the loop and vice versa, the loop and its potential are equivalent to the singularity. The new conception that parallel universes can mutually exchange matter and energy, has been introduced and proved. It has been demonstrated, from Landau's considerations, that in the black holes for $r < r_{go}$ the coordinates are complex, so are mass and time too. At the end the comparison of the results from this work with the results of other authors from this domain has been made.

1.1 The reason of this work has been S. W. Hawking's conception [1] that the tunnel exists which binds parallel universes through black holes.
This conception has been developed in this work.
The existence of two conjugated universes has been assumed (fig. 1). The particle foudering in a crater of potential comes to a crater of potential of the other universe at the point, at which the widths of both craters are equal. Collapsing into the crater of potential the particle achieves complex mass, which is equivalent to the velocity $v > c$.
It has been proved that parallel universes can exchange matter and energy mutually. So the potential and the universes are constructed from loops [2]. It could be important remark at the next consideration.

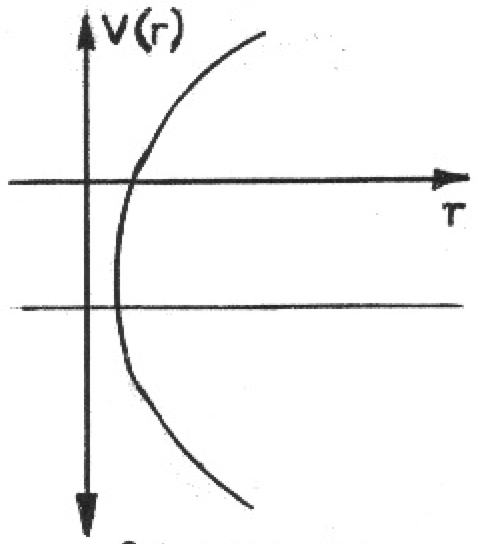

figure 1

2.1 In purpose to describe the loop we solve Dirac's equation in the cylindrical coordinate system. Becouse of symmetry of problem the φ derivative dissapears. We look for the solution of the equation in the shape

$$\Psi_1 = \Psi_2 = \Psi_3 = \Psi_4 = \Psi$$

The system of four equations is reduced to one equation. We assume the potential in the form $V(r) = \alpha' r + \frac{\beta'}{r}$

the simplest power potential with the minimum [2] . We separate the variables. The interesting equation obtains the shape:

$$i\hbar \nabla (r) \psi - E' \psi = -\left(\alpha' r + \frac{\beta'}{r}\right) \psi$$

We separate the real factor without $\hbar$

$$\nabla \psi - E\psi = -(\alpha r + \frac{\beta}{r}) \psi \qquad \alpha, \beta > 0$$

so:

$$\frac{\partial}{\partial r} \psi - E \psi = -(\alpha r + \frac{\beta}{r}) \psi$$

The solution is (after change of symbols) :

$$y = e^{-\alpha x^2 - \beta \ln x + Ex + C} \qquad (1)$$

We have the transformation:

$$x' = -\alpha x^2 - \beta \ln x + Ex + C$$

Let $\beta = 0$. We want to reject the member valid only for x positive and singular at zero. We look for an opposite transformation:

$$-\alpha x^2 + Ex + C - x' = 0$$

quadratic equation for x. We find:

$$x = \frac{E \pm \sqrt{E^2 + 4\alpha (c - x')}}{2\alpha}$$

So, two solutions correspond with two universes.

For x' and E such that $E^2 = -4\alpha(C - x')$ the universes touch, so the tunnel arises which bounds them.
If $E^2 < 4\alpha(C - x')$ we have the region with complex coordinates.
The thesis concerning parallel universes is so strong that it is implicated even by negation it after rejecting the singularity.
Let's take under consideration the transformation for any power potential

$$x' = -\alpha x^2 + Ex + C + \sum_{k=2}^{\infty} \left(\alpha_k \frac{1}{k+1} x^{k+1} + \frac{b_k}{-(k+1)} \frac{1}{x^{k+1}} \right)$$

For any k it may be written:

$$\sum_{n=0}^{n=2k+2} c_n x^n = 0$$

So we have 2k+2 roots for any k. Each root describes one universe, so for any k we have 2k+2 parallel universes.
Starting with the formalism of the loop we came to parallel universes.

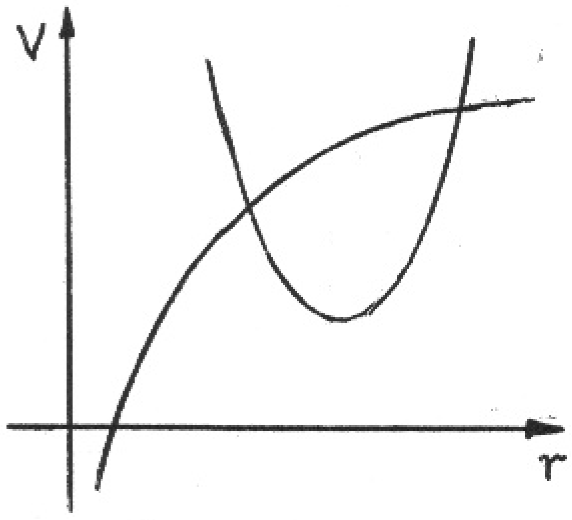

figure 2

If we didn't reject the logarithmic member, we would obtain generally two solutions at certain parameters, which is proved by the graphic solution (fig.2).
We will show now the relations between the loop and the singularity binding the universes.

If we analyse y, logarithmic member in the exponence isfinite, but all other members contain the singularities.

3.1 Let's assume that the function f(z) is singular so that it has m- pole at the point z = a. At this point the tunnelling to another universe appears corresponding with the particle creating potential f(z) with the pole.

In purpose to omit the tunnelling of the infinite system of the plasmodesms we introduce the loop on the plane (inside the loop is the point $z = a$) and an integral potential, derivative of which is the function $f(z)$. This potential is described by the formula:

$$V = \frac{1}{2\pi i} \int_C f(z)dz \tag{3}$$

C -loop

So, it evidences that the loop is bound with the particle and the loop struture of Ashtekar's spacetime corresponds with Dirac's see. It suggests that with the loop the particle loopon is connected.

Next we have:

$$\frac{1}{2\pi i} \int_C f(z)dz = res_a f(z)$$

$$res_a f(z) = \lim_{z\ a} (z-a)\, f(z) \quad dla\ m = 1$$

$$res_a f(z) = \frac{1}{(m-1)!} \lim_{z \to a} \frac{d^{m-1}}{dz^{m-1}} \left[(z-a)^m f(z) \right]$$

The limit $z \to a$ means that we have the loops with smaller and smaller radii so h-nions loops with the radius

$$R = \frac{1}{2^h}$$

The m - multiplied pole means that integral potential is m - multiplied potential.

Simply, the tunnel is substituted by an integral potential, one of many fields of potential in the space.

The loop can be connected with the integral around the loop of the function posseding residuum inside the loop and the pole is connected with residuum - so potential of point-like particle.

The question arises, why (in the work on parallel universes) we cut off the tunneling to a parallel universe, substituting it by a loop.

The answer is simple - this procedure acts in the opposite direction too, the potential describing such tunnelling (with singularity describing this tunnelling) is associated with this loop.

The potential $\frac{1}{r^{\delta}}$, δ noninteger and positive can be presented in the form:

$$\frac{1}{r^{\delta}} = \sum_{m} \frac{a_m}{r^m} , \quad m \in N$$

and to each m-th member the m-th residuum can be used, so we have the series of m potentials.
It is valid:

$$\frac{1}{r^{\delta}} = \sum_{n} \frac{a_n}{|r - r_n|^n}$$

and we can calculate each member taking n-th residuum, even for $\delta \in (0 , 1)$.
The loop is connected with each member and the loop can be common for every member (containing all r_n).

Certain potential is connected with each member but this way we get rid of singularity.
Two orientations of the loop correspond with particle and antiparticle (so the charge plus and minus) fig.3.

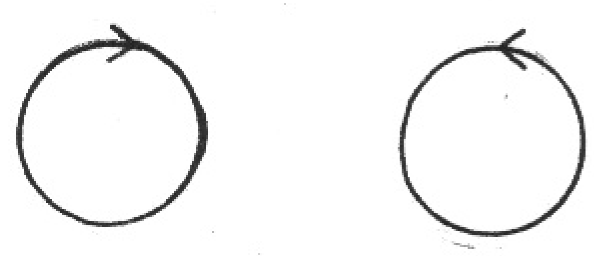

figure 3

In R^3 there are three sorts of loops connected with each model of planes xy, yz, xz and each type of the loops corresponds with the color.

Generally, in R^n there are n - models of (n-1) dimensional loops corresponding to n - poles.
We will give now the definition of n - dimensional loop.
We take the cylinder connected with each 2-dimensional loop in the planes stretched by each pair of dimensional axes. One of these loops is the cross section of each cylinder. The product of such sets is a n - dimensional loop.

4.1 Two universes are connected with the channel (analogy to an electron — positron pair). The density of matter of such a system is expressed by the formula:

$$\varrho = |\Psi_i|^2 + |\Psi_j|^2 + \Psi_i \Psi_j \tag{4}$$

The third member describes the connection of two universes. It may be complex number, which means complex density of matter and complex mass appearing at tunnelling from one universe to another.

$$\Psi_i = R_i e^{k\varphi}$$

$$\Psi_j = R_j e^{k\Theta} \qquad \text{k-complex unit}$$

$$\varrho = R_i^2 + R_j^2 + R_i R_j e^{k\varphi} e^{k\Theta} \tag{5}$$

We use Lagrange's equation:

$$\frac{d}{dt}\frac{\partial L}{\partial \dot{q}_i} - \frac{\partial L}{\partial q_i} = 0 \tag{6}$$

$$L = \dot{\Psi}_i^2 + \dot{\Psi}_j^2 + \left(\dot{\Psi}_i \Psi_j\right) + |\Psi_i|^2 + |\Psi_j|^2 + \Psi_i \Psi_j \tag{7}$$

Three first members are velocity of the flux of mass-kinetic energy. Three next - potential energy with the sign minus.

We take the R_i and R_j derivative.

Taking under consideration (5), (6), (7) we obtain:

$$2\ddot{R}_i e^{2k\varphi} + R_i(2\dot{\varphi}^2 e^{2k\varphi} - 2) + 2R_j e^{k\varphi} e^{k\Theta} (k\dot{\varphi} + k\dot{\Theta}) = 0$$

We obtain the second equation changing $R_i \rightarrow R_j$ and $\varphi \longrightarrow \Theta$.

There are two equations of conjugated oscillators, the matter is pumped between universes, φ and Θ modulate the flux of mass.

In the conjugated chain of universes the flux of mass exists.
It is an analog of the cristal lattice (of universes).
We have:

$$\psi_n = R_n e^{i(\varphi + \alpha n)} \qquad i\text{-complex unit}$$

If $\alpha n = 2k\pi$ we have a closed chain of universes with the exchange of matter between them - the cyclic flux in both directions.

5.1 The crater of potential of a black hole is composed of the cluster of dimensions, between them the tunnelling of matter exists. There are the dimensions on the periphery of the crater, creating its structure.
There are loops dimensions.
The tunnelling between dimensions happens if potential barrier $V_o < \infty$ what means practically that it isn't too much.
If $V_o = \infty$, the dimensions split into hairs, the tunnelling between them doesn't occur.
This same touches the loop dimensions if $V_o = \infty$;
The tunneling down doesn't happen and wormholes are dumb.
The conjugation between dimensions decides the tunneling.

$$E = \alpha D_1^2 + \beta D_2^2 + \gamma D_1 D_2$$

We have the relation

$$E_s + V_o = \text{const}$$

We may have the connection of the sum of dimensions:

$$E = \sum_i \alpha_i D_i + \sum_{\substack{i,j \\ i \neq j}} \gamma_{ij} D_i D_j$$

5.2 The metric of a globe made from the dust has the shape [3]

$$ds^2 = d\tau^2 - e^{\eta(\tau,R)} dR^2 - r^2(\tau,R)(d\theta^2 + \sin^2\theta d\varphi^2) \qquad (8)$$

If $\Lambda(\tau,R)$ is a complex number then the oscillating function describing an analog of crystal lattice overlaps the space-time interval.
If $r(\tau,R)$ is described by complex function, then another crystal lattice appears which is modulated by the coordinates Θ and φ.
r has the sense of the radius of the circle. The complex radius means the radius in the perpendicular plane. So we have a globe in the 4 - dimensional spacetime.
Let's take under consideration the metric of a black hole [3].

$$ds^2 = \left(1 - \frac{r_g}{r}\right) c dt^2 - r^2(\sin^2 \Theta d\varphi^2 + d\Theta^2) - \frac{dr^2}{1 - \frac{r_g}{r}} \tag{9}$$

For $r < r_{go}$ the regions exist, where $ds^2 < 0$.
Really:

$$\left(1 - \frac{r_g}{r}\right) c^2 - \frac{r^2}{dt^2} (\sin^2 \Theta d\varphi^2 + d\Theta^2) - \frac{v^2}{r - \frac{r_g}{r}} < 0$$

It means for $r < r_{go}$.

$$\left(1 - \frac{r_g}{r}\right)^2 c^2 - \frac{r^2}{dt^2} \left(1 - \frac{r_g}{r}\right) (\sin^2 \Theta d\varphi^2 + d\Theta^2) - v^2 > 0$$

$v = \text{const}$.
For r enough small inequality is completed.
Let's analyse two possibilities:

I $v < c$; so as above mentioned
II $v > c$, then dr and dt complex and ds^2 not only negative but even complex.

Let's analyse the metric: [3]

$$ds^2 = \frac{1 - \frac{r_g}{r}}{1 - f^2} \left(c^2 d\tau^2 - f^2 dR^2 \right) - r^2 \left(d\Theta^2 + \sin^2\Theta \, d\varphi^2 \right) \tag{10}$$

f - fixed

Let's take under consideration four cases:

I $f^2 < 1$ and $r < r_g$

II $f^2 < 1$ and $r > r_g$

III $f^2 > 1$ and $r < r_g$

IV $f^2 > 1$ and $r > r_g$

The cases I and IV are especially interesting becouse then $ds^2 < 0$ and s is a complex number.
$f=1$ means singularity .

The case IV means the singularity with arising for $r > r_{go}$, then $ds^2 \to \infty$ for $r > r_{go}$ and $f \to 1$. It means the explosion of black hole, so it is white hole which takes the energy from a parallel universe.
The case II when collapse for $r = 0$, $f \to 1$, normal black hole.
In the black holes all moves with the velocity $v > c$ for certain $r_{go} < r$, what corresponds with the fact that all coordinates are complex, more precisely - the space-time interval is complex. It means that the process of tunnelling through the barrier $v > c$ in the direction of the velocity $v > c$ begins to dominate the opposite process when we come to $r = r_{go}$.

And it is the dominating process and the only one for $r < r_{go}$.

Certain potential exists, which makes impossible the tunnelling to the velocity $v < c$ for $r < r_{go}$.

The optic complex potential is this potential appearing in the condensations giving complex mass and complex energy to the particles.
We have:

$$E = E_{kin} + V_{opt} = \frac{m_o}{\sqrt{1 - \frac{v^2}{c^2}}} + V + iW$$

and:

$$E_{tot} = \frac{m'_o}{\sqrt{1 - \frac{v'^2}{c^2}}} \quad \text{and } v' > c$$

5.4 The transition from the velocity $v > c$ to $v < c$ is realized by uncertainty princciple, but differently

$E_{tot} = E_{kin} + V_{int}$

and it may happen that $E_{tot} = 0$

Then it is real energy subordinated to Heisenberg relation and the interception to the real energies exists.

For $r < r_{go}$ all particles move with the velocity $v > c$.

We have :

$$\frac{\varrho v^2}{2} + p = const \qquad (11)$$

When the particles fall down $r < r_{go}$ then their velocity increases to $v > c$ and p decreases. It means the tunnelling to the parallel universe. Then p decreases and the force aspirating the matter from the parallel universe appears. The oscillating exchange of matter between conjugated universes exists which is supported by the results from the chapter 4.1.
If wormholes are blind the passagies through the boundary $r = r_{go}$ is stopped.

6.1 It is necessary to see yet what are the relations of these considerations to what other authors did.

As the result of change of the space-time topology by the quantum-gravitational tunnelling, the wormhole arrises connecting different regions of the space-time, so different universes [4].

In purpose the wormholes have the character of tunneling solution the following conditions must be satisfied:

$$\dot{a} \rightarrow 0, \quad \dot{H} \rightarrow 0$$

This period is periodic, its periods are determinated by natural numbers:

$$mT_a = nT_H$$

If the relation $T_a \setminus T_H$ is a rational number, we have an infinite number of the wormholes determinated by integers m,n.

The space-time cristal lattice changes into the lattice of wormholes (with the infinite number of tube) binding the parallel universes. It is a confirmation of the earlier considerations.

The folded string collapses into black holes [5].

The solutions describing the longitudinally oscillating string must be placed in the lattice-like regions of the space of the world.

The tunnelling of the string exists to the region of pure singularity placed outside the bla k hole.

The string coming to the black hole meets it and doesn't fall into it but passes to another space.

So the black holes are tunnel binding parallel universes.

The degree of degeneracy of black hole is 2^{4n} in SO(n) supergravity [6].

We consider the Schwarzschild metric and its singularity, going to the nonsingular Euclidean section defined by $t = i\tau$ ($0 \leqslant \tau \leqslant 8\pi GM$). It is gravitational analog of the Yang-Mills instantons. We have against the correlation: complex time - singularity tunnel (instanton).

We have periodic time dependence with period $8\pi GM$ becouse the Euclidean Schwartzschild metric is periodic in τ with period $8\pi GM$.
I don't agree with an author, that this solution should be rejected. It is the proof that inside the black hole the lattice inducing interactions exists.
The particle falling down to the black hole comes in the closed universe of itself [7]. The closed universes can branch off and join on.
The branch of the small closed universe leads to the infinite number of the effective interactions [8].
If $\tau = it$, the metric arises with two asymptotic Euclidean regions connected with the wormhole with the radius. τ complex means $v > c$ and next means m complex.

More and more intensive interactions lead to the universes with bigger and bigger number of particles. The more intensive interactions mix the universes of single particle causing their fusion.
The divergences mean the phase transition and the tunnelling to another universe. This implicates the correspondence of complex time in the statistical physics and the black holes, where the tunnelling to another universe exists connected with the interaction leading to complex values.
The instantons create tachyon field. The loops overlap on the configuration of instantons.
The black hole and the primary preatom, from which the Big Bang arose, have this common feature that through them the tunnelling to another universe through Hawking's channel of complex time occurs.
The difference consist in that the black hole is a connection with another universe and preatom is the end of dendrite of such universes.
The strings and loops create whirls being superloops with which the supersingularities correspond [9].
The lattices are made from loops- lattice version of Abelian Higgs model.

The monopoly- antymonopoly pair is connected by the string which plays the role of a wormhole binding two universes (so as the conjugations string-instanton are possible). There is an infinite number of classic spaces communicating by quantum tunneling. The instantons are correct only in the mass case.
The singularities existing in a certain instanton, which describes the field string theory mean the possibility of tunnelling.
In the result of connection with the instanton the string becomes superinstanton, through which the tunnelling is realized. The analogical singularities exist in the case of Yang-Mills instanton in the theory of strings.
Wave function of the set of interacting baby universes is introduced in the work [10]. The parental universe is described by the mixed state, although the initial state was pure.
Gravitational instanton is conjugated to axions. The gravitational instantons describe the creation and annihilation of the baby universe by the parent universe. The conjugation axions - instanton-baby universe appears. The axion charge arises. The axion charges of intanton are related to the tunnelling amplitudes. Against the correlation : charge-singularity-tunnelling.
When two universes are connected by wormholes, the smooth geometry and topology are disturbed by densly packed wormholes, what leads to the singularities.
The wormholes connect our universe with other universes in the very small scale but these universes govern with the same laws [11].
Baby universes also carry certain value of any conserved charge coupled to gauge fields. In the theory admitting ungauged continues symmetries baby universes can carry nonzero values of the associated charges.
Each type of charge means new wormholes gemmating from byby universe - superhairs. Many wormholes fall off the black hole [12].

They can be blind but they can make possible the tunnelling from one black hole to a bigger number of universes.
Extreme Reissner-Nordström black holes can support a superhair [13]. The form of a possible exact solution (black hole) of the O(2) supergravity theory possesses mass, central charges as well as a supercharge thereby obtained.
The existence of a charge is the condition of the existence of hairs, so the charge is the source of hairs. An additional condition e = M assures connection hairs with instantons which makes possible the tunnelling.
The logarithmic merons have singularities in action at the infinity, so there is the tunneling to another universe, where the divergences are countermanded.
The classical ground state of QCD is infinitely degenerated and the true quantum mechnical vacuum is an adherent superposition of the classically degenerated vacuums.
The role of multiple instanton field configuration is to give the dominant contribution to the summary over histories path that travel from one classical vacuum to another.
The tunnelling is proportional to the density of instantons.
Essentially, there exist many distinct paths to tunnel between the degenerate vacuum.
Nonnormalisation means the singularities corresponding with the superconductivity. The Dirac's unempty vacuum is connected with the universes parallel to ours one, where an interaction, similalarly as in the superconducting cristal, leads to arising the superconductivity.
More precisely: two by the wormholes conjugated universes for the pairs particle-antiparticle.

7.1 Recapitulation

The singularities in theoretical physics are unwanted child but they can be an enfant prodigy.
They appear in the General Relativity as well as in the case of point potential what corresponds with the conception that each particle treated as the point is a black hole.

Let's analyse the potential energy of the singularity:

$$E = -\frac{\alpha}{r}$$

The singularity would mean an infinite energy and this means the breaking of the energy conservation law, becouse something can be added to the infinity and the infinity rests.

It is not so, however. The singulatity means the collapse into the crater of potential and tunnelling to another universe, whose energy with opposite sign countermands the singularity and this energy is conserved in the super-universe:

$$E_{tot} = E_1 + E_2 = -\frac{\alpha}{r} + \frac{\alpha}{r} = 0$$

Einstein's equation with cosmologic constant has a stable solution, which can be used to the description of the Megaverse.

The considerations in this work correspond fully with the Dirac-Einstein equation [15].

In this work the following ideas have been unified:

- the singularities can be valuable
- the elementary particles are forms of black holes
- inside black holes there is something unusual
- the idea of Hawking, concerning bubbling universes connected by the channels of the complex time and parallel universes obtained from Dirac's equation
- energy conservation law.

References:

[1] S.W. Hawking, Phys. Rev. D vol.37 no.4 (1988) p. 904

[2] Z. Morawski, 'Equation of Objects and Equation of Field', this website

[3] L.D. Landau, E.M. Lifszic, 'Theory of Field'

[4] Soo Jong Rey, 'Nuclear Physics B' 336 (1990) p.146

[5] I. Bars, J. Schutz, Phys. Rev. D vol.51 no.4 Feb.1995

[6] Tamiaki Yoneya, Phys. Rev. D vol.17 no.10 (1978) p.2567

[7] S.W. Hawking, Phys. Rev. D vol.37 no.4 (1988) p. 904

[8] S.W. Hawking, R. Lanflamm, Phys. Lett. B vol.209, no.1 1988 p. 39

[9] A. Patrasciaiu. Phys.Rev. D vol.17 no.10 p.2764

[10] S. B. Giddings, A. Strominger, Nuc. Phys. B307 (1988) p.854

[11] S.W. Hawking, Phys. Lett. B195 (1987) p.277

[12] R. Güven, Phys. Lett. B vol.212 no.3, (1988) p. 277

[13] R. Güven, Phys. Rev. D vol.25 no.12 (1982)

[14] C.G. Callan, J.R. Dashen, D.J. Gross, Phys. Rev. D vol.17 no.10 (1978) p.2717

[15] Z. Morawski, 'Attempt at Unification of Interactions and Quantisation of Gravitation', this website