Khmelnik S.I.

The Equation of Whirlpool

Contents

Abstract

Recently, there appeared a mathematical model of oceanic whirlpools [1], which is almost identical to the models built for space black holes. The similarity between the whirlpools and black holes is found in the fact that an object that happened to be near these objects becomes involved in them and never returns. Such a distant analogy stresses (in our opinion) the fact that this mathematical model is very far from completion. In the presented paper the author attempts to build such a model. This model, as well as above mentioned one, has the same base – the relativity theory. However, the proposed model is more downlanded (or, if you want, water-landed), because in it we use the equations of hydrodynamics and the consequences of the theory of relativity, which are relevant only in the case of low Earth's gravity. Another question is also of interest – about the source of energy which enables the whirlpool to be spinning for a long time when surrounded by still waters. This issue becomes even more important due to the fact that the whirlpools (and not the Moon) are energy sources for the tide [2]. In [1] a source of energy whirlpools not analyzed. Below we show that this source is the Earth's gravitational field.

1. Introduction

In the below presented mathematical model of the whirlpool we are using a system of Maxwell-like equations of gravitation [6]. The model is based on the following assumptions. The water motion is likened to the mass currents. Mass currents in gravitation field are described by Maxwell-like equations of gravitation [6] (further denoted as MLG -equations). The interaction between moving masses is described by gravity-magnetic Lorentz forces (further denoted as GL-forces), similar to the Lorentz forces in electrodynamics, acting between moving electrical charges. GL-forces have the form:

$$F_L = J \times B, \quad (1)$$

where gravity-induction is

$$B = G\xi H, \quad (2)$$

here G is gravitational constant, ξ - gravity-magnetic permeability of the medium. It is necessary to clarify the meaning of this value. In [6] the recent results of Samokhvalov's works are analyzed. There he has conceived and carried out a series of unexpected and surprising experiments. These experiments [6] explained by the presence gravity-magnetic Lorentz forces. It is important to note that the observed effects are so significant that to explain them within the specified Maxwell-like gravitational equations they must be supplemented by a certain empirical coefficient ξ. The rough estimate of the gravitational permeability of vacuum is $\xi \approx 10^{10}$, but it changed drastically with pressure increase. It may be assumed that the air is a screen for magnetic-gravitational induction, because in it under the influence of this induction there occur mass induction currents (similar to Foucault currents). Then we may expect that in the water, where the mass water currents interact without air screen, the value of the gravitational constant is close to the specified value for the vacuum.

So, in water flows the GL-forces (1, 2) are acting:

$$F_L = G\xi(J \times H). \quad (3)$$

In the whirlpool the currents create tension; the currents together with tensions create Lorentz forces; Lorentz forces act on the mass, moving in the current, thereby changing the direction of the currents. All these processes together are described by Maxwell's equations together, from which the Lorentz force are excluded. However, these processes can be traced consistently and be linked with the Maxwell equations.

Below we shall look at this in more detail. However, the same analysis can be done for Constant Current [4].

Massive currents circulate in the whirlpool along horizontal sections and vertically. The kinetic energy of such circulation is spent on losses from internal friction. It comes from a gravitating body - the Earth. The potential energy of the whirlpool does not change, and therefore is not consumed. So in this case there is no conversion of potential energy into kinetic energy and vice versa. However, gravitating body expends its energy on creating and maintaining a massive current - see Appendix.

2. The Main Mathematical Model

It would be interesting to compare the presented mathematical model with a real whirlpool – see Fig. 0.

Fig. 0a.

Fig. 0в.

MLG equations for <u>gravity-magnetic tensions</u> H and <u>mass currents densities</u> J in stationary gravity-magnetic field have the following form:

$$\operatorname{div}(H) = 0, \tag{1}$$

$$\operatorname{rot}(H) = J, \tag{2}$$

In modelling the whirlpool we shall use cylindrical coordinates $r, \ \varphi, \ z$.

Then the MLG –equations will look as:

$$\frac{H_r}{r} + \frac{\partial H_r}{\partial r} + \frac{1}{r} \cdot \frac{\partial H_\varphi}{\partial \varphi} + \frac{\partial H_z}{\partial z} = 0, \tag{3}$$

$$\frac{1}{r} \cdot \frac{\partial H_z}{\partial \varphi} - \frac{\partial H_\varphi}{\partial z} = J_r, \tag{4}$$

$$\frac{\partial H_r}{\partial z} - \frac{\partial H_z}{\partial r} = J_\varphi, \tag{5}$$

$$\frac{H_\varphi}{r}+\frac{\partial H_\varphi}{\partial r}-\frac{1}{r}\cdot\frac{\partial H_r}{\partial \varphi}=J_z. \quad (6)$$

Besides, the currents must satisfy the condition of continuity

$$\operatorname{div}(J)=0, \quad (7)$$

Or, in cylindrical coordinates:

$$\frac{J_r}{r}+\frac{\partial J_r}{\partial r}+\frac{1}{r}\cdot\frac{\partial J_\varphi}{\partial \varphi}+\frac{\partial J_z}{\partial z}=0. \quad (8)$$

These equations describe, in fact, the processes of currents, tensions and Lorentz forces interaction, namely:

1. The intensity of the gravitational field is directed along the axis of whirlpool,

2. It creates a vertical mass flow - a mass current J_z.

3. Vertical mass current J_z generates annular gravity-magnetic field H_φ and radial gravity-magnetic field H_r - see (6).

4. Gravity-magnetic field H_φ deflects by GL-forces vertical mass flow in the radial direction, creating a radial mass flow - radial mass current J_r.

5. Gravity-magnetic field H_φ deflects by GL-forces radial mass flow perpendicular to the radius, creating a vertical mass current J_z.

6. Gravity-magnetic field H_r deflects by GL-forces vertical mass flow perpendicular to the radius, creating a annular mass current J_φ.

7. Gravity-magnetic field H_r deflects the GL-forces annular mass flow is perpendicular to the radius, creating a vertical mass current J_z.

8. The mass current J_r generates a vertical gravity-magnetic field H_z and annular gravity-magnetic field H_φ - see (4).

9. The mass current J_φ generates a vertical gravity-magnetic field H_z and radial gravity-magnetic field H_r - see (5)

10. The mass current J_z generates a annular gravity-magnetic field H_φ and radial gravity-magnetic field H_r - see (6).

GL-forces can be found as follows. Let us transform (1.3):

$$F_L=G\cdot\xi\cdot S_o. \quad (9)$$

where

$$S_o=\left(J\times H\right). \quad (10)$$

This vector product in cylindrical coordinates looks as [5]:

$$S_o = \begin{bmatrix} S_{or} \\ S_{o\varphi} \\ S_{oz} \end{bmatrix} = \begin{bmatrix} J_\varphi H_z - J_z H_\varphi \\ J_z H_r - J_r H_z \\ J_r H_\varphi - J_\varphi H_r \end{bmatrix} \tag{11}$$

So, for a known solution of equations system (3-6, 8) the GL-forces can be found by (9-11).

3. The Equations of Hydrodynamics for a Whirlpool

Whirlpool, as the movement of water, also satisfies the Navier-Stokes equations for a viscous incompressible fluid. For stationary flow this equation has the following form (see, for instance, [6]):

$$\mathrm{div}(v) = 0, \tag{16}$$

$$\nabla p - \mu \cdot \Delta v + \rho (v \cdot \nabla) v - \rho F_m = 0, \tag{17}$$

where

ρ - permanent water density,

μ - coefficient of internal friction,

p - pressure,

v - the rate of flow in the given point, a vector

F_m - mass force, a vector.

The mass current and the rate of flow are connected by an obvious relation

$$J = \rho \cdot v, \tag{18}$$

Therefore, the equations (7) and (16) are identical, and the equation (17) can be rewritten as

$$\nabla p - \frac{\mu}{\rho} \cdot \Delta J + \frac{1}{\rho} (J \cdot \nabla) J - \rho \cdot F = 0. \tag{19}$$

The mass forces here are GL-forces F_L and gravity forces P, or taking into account (2.9),

$$F = G \cdot \xi \cdot S_o + P. \tag{20}$$

For known currents and forces the pressure can be found from (19). So, the equations system

(2.3-2.6, 2.8-2.11, 19, 20) (21)

is the equation system of whirlpool, permitting to find the distribution of speeds and pressures in the body of the whirlpool.

4. The Computational Algorithm

The solution of the system (3-6, 8) as functions separable relative to coordinates has the following form: (which can be checked by direct substitution):

$$H_r. = \eta \cdot f_8(r) \cdot \exp(\eta \cdot z) \quad (1)$$

$$H_\varphi. = \eta \cdot f_2(r) \cdot \exp(\eta \cdot z) \quad (2)$$

$$H_z. = f_3(r) \cdot \exp(\eta \cdot z) \quad (3)$$

$$J_r. = -\eta^2 f_2(r) \cdot \exp(\eta \cdot z), \quad (4)$$

$$J_\varphi. = \eta^2 f_7(r) \cdot \exp(\eta \cdot z), \quad (5)$$

$$J_z = \eta \cdot f_{10}(r) \cdot \exp(\eta \cdot z), \quad (6)$$

where

$$f_2(r) = -q \cdot e^{br^m} \quad (7)$$

$$f_8(r) = -h \cdot e^{br^n} \quad (8)$$

$$f_{10}(r) = \left(\frac{f_2(r)}{r} + f_2'(r) \right), \quad (9)$$

$$f_3(r) = -\left(\frac{f_8(r)}{r} + f_8'(r) \right), \quad (10)$$

$$f_7(r) = f_8(r) - \frac{1}{\eta^2} f_3'(r), \quad (11)$$

$h,\ q,\ b,\ m,\ n,\ \eta$ – certain constants

Algorithm of the system (3.21) solution can be, for instance, as follows:

1. determine the tensions and currents from (1-6),
2. determine GL-forces from (2.9-2.11),
3. determine mass forces from по (3.20),
4. determine the pressures from (3.19).

5. The Analysis of the Whirlpool Equations

Now we shall analyses the solution (4.1-4.6).

The origin will be located on the ocean surface, and the axis will direct straight up. Then for $z < 0$ and $\eta > 0$ the value and direction of the current J_z is determined by its sign, and the current is directed up or down if $\text{sign}(J_z) > 0$ or $\text{sign}(J_z) < 0$ accordingly. There exists a certain radius $r = R_b$, for which $J_z = 0$. Let us call R_b the radius of "vertical calm".

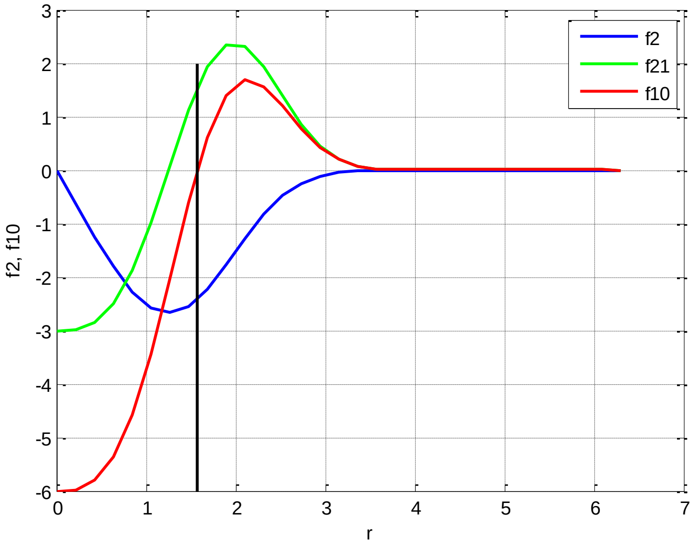

Fig. 1.

Fig. 1 shows the functions $f_2(r),\ f_2'(r),\ f_{10}(r)$ for $q = 3,\ h = 6,\ \beta = -0.17,\ m = 3,\ n = 4$. The upper window show these functions, and the lower windows show their logarithms. The figure shows also the vertical for that value of $R_b = 1.6$.

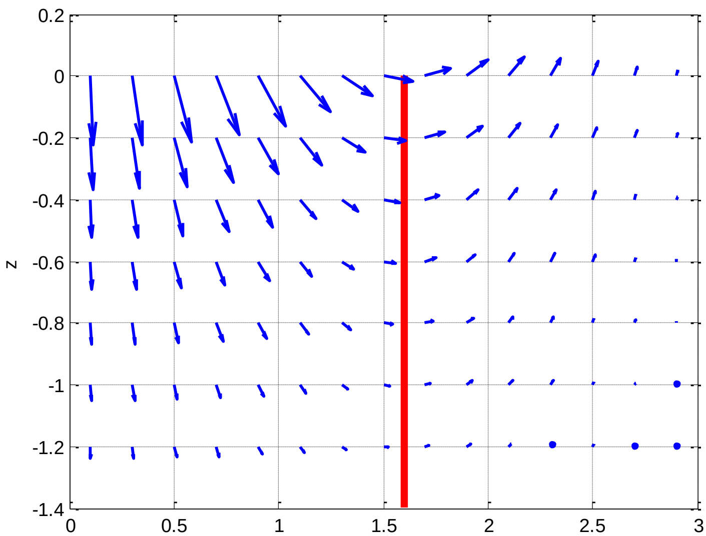

Fig. 2.

So, there exists a certain radius of "vertical calm" for which the vertical flow of water is not present $(J_z = 0)$, and more close to the center of whirlpool the water flow is directed down $(J_z < 0)$, but with increasing distance from this radius the water begins to rise $(J_z > 0)$. And so the water of surrounding ocean pours into the funnel with this radius of "vertical calm".

Let us look now on the vector field of the currents J_r, J_z in the vertical plane of the whirlpool section. The Fig 2 shows fragment of this field for the part of the plane $r = \overline{0,\ 3}$ and $z = \overline{0,\ -1.4}$ for the same value of the constants. It shows also "the vertical of calm". One can see that the mass currents (equivalent to the speeds) decrease drastically when the distance to the whirlpool center increases.

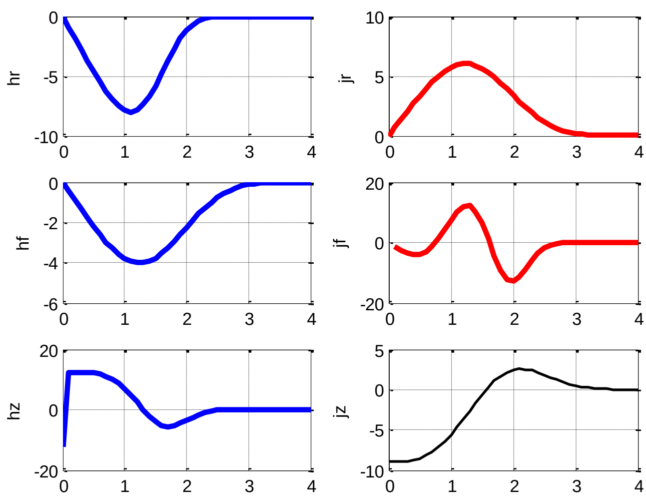

Fig. 3.

So we see that the mass currents in the whirlpool circulate vertically. Wherein in a small central area the mass of water moves down with great speed, and in the distant, but large area the water rises up with low speed. On the free surface of the ocean along the axis a recess is formed and along the borders the elevation is formed - this can be seen in Fig. 2, if you mentally unite the ends of the arrows in the upper horizontal. The water rushes from the elevation to the recess. The kinetic energy of such circulation is expended only on the losses of internal friction. The potential energy does not change. It means that in this case there is no transformation of potential energy into kinetic energy and vice versa. However (as we already indicated) the gravitating body expends its energy for creating and maintaining the mass currents – see Appendix.

Let us consider now those parts of separable (1-6), which depend on the coordinate r. Fig. 3 shows the graphs of these parts $h_r,\ h_\varphi,\ h_z,\ j_r,\ j_\varphi,\ j_z$ for the same value of the constants..

Now let us consider the vector field of currents $J_r,\ J_\varphi$ on the circle in horizontal plane of whirlpool for the same values of constants – see Fig. 4. There the analyzed points located on the "dotted" radii are designated by circles. "Green (light)" short segments show the vectors of currents proportional to the speeds, and the "blue (dark)" segments combine the ends of these vectors. Evidently, the distribution of vectors recalls Fig. 0. One can see that on small radii the speeds are directed tangentially to the circle, and with increase of the radius the radial components of the overall speed also are increasing, but the overall speed is decreasing.

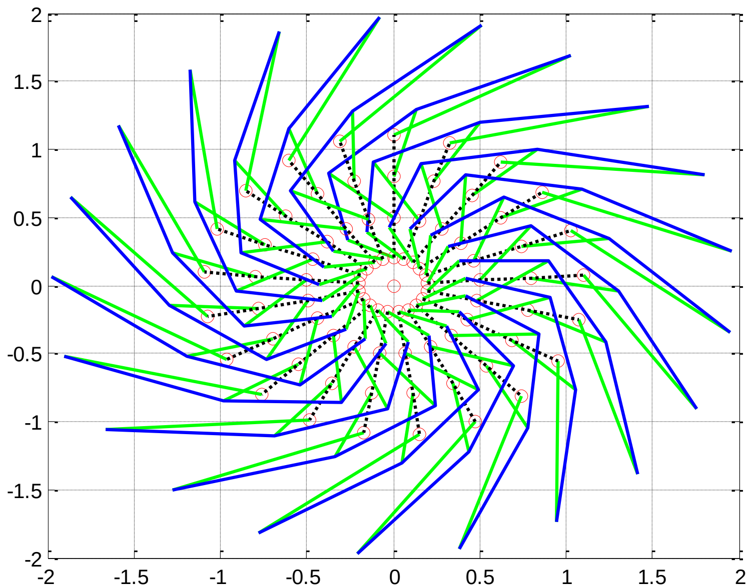

FIG. 4.

Fig. 5 shows also the graphs of currents $j_r,\ j_\varphi,\ j_z$ depending on z for several values of r and for the previous values of the constants.

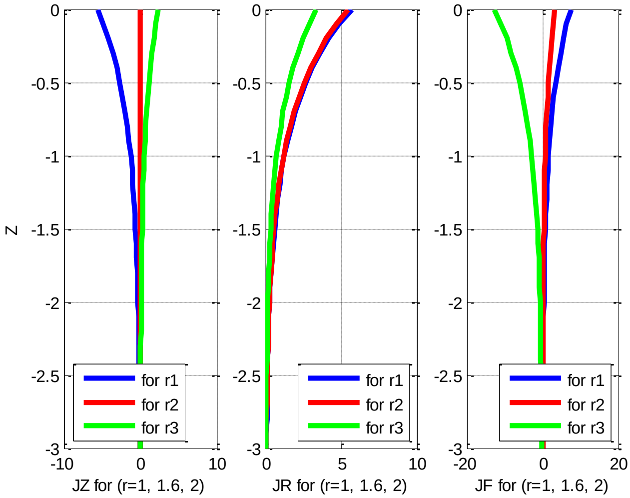

Fig. 5.

6. Energy Flows

The projections of **fluence** vector of gravito-magnetic energy $S_{or}, S_{o\varphi}, S_{oz}$ are determined from (2.11). The fluence vector on the circumference of section on the of the horizontal plane is determined as

$$\left(S_r, S_\varphi, S_z\right) = 2\pi \cdot r \cdot \left(S_{or}, S_{o\varphi}, S_{oz}\right). \quad (1)$$

Also, we shall determine the summary energy flow as

$$S = \sqrt{\left(S^2{}_r + S^2{}_\varphi + S^2{}_z\right)}. \quad (2)$$

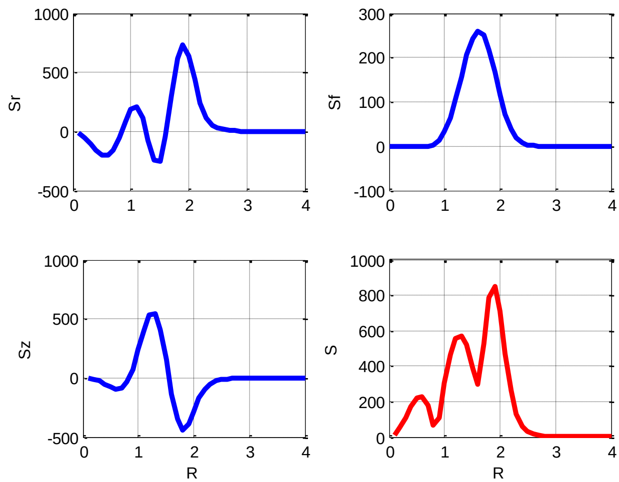

Fig. 6.

Fig. 6 shows the projections of vectors (1, 2) depending on z for several values of r and for the previous values of the constants.

Fig. 7 shows the projection of vectors (1, 2) on the plane of vertical section of the whirlpool in dependence of z for several values of r and for previous values of the constants. Evidently, the energy flow decreases from the center of the jet down and sideways.

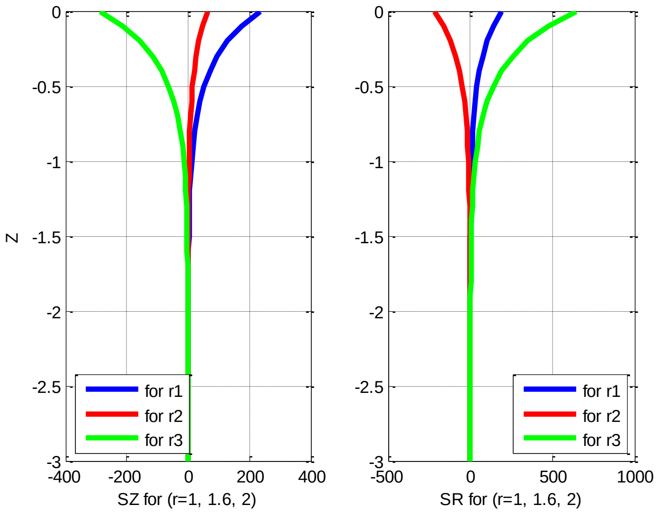

Fig. 7.

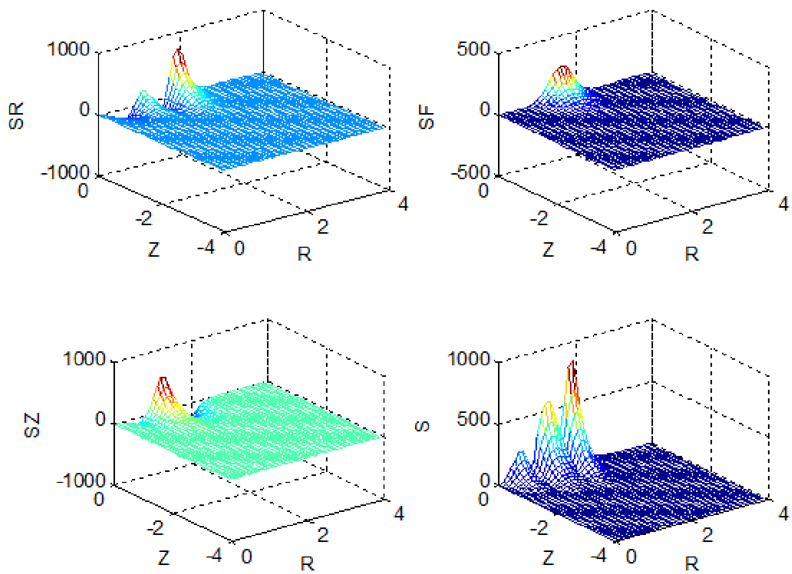

Fig. 8.

Fig. 8 shows the projection of vectors (1, 2) on the plane of vertical section for the previous values of constants. Evidently, the vertical energy flow changes its sign depending on r. There exist such values of the constants (they are used in our case), for which the total energy flow in every horizontal section is equal to zero.

Thus, in a swirlpool the flow of energy circulates vertically. Consequently, the energy of vertical circulation remains constant. The potential energy of the whirlpool also remains constant. Thus, in this case, there is no conversion of potential energy into kinetic energy and vice versa. The energy flux circulates also along the rim. Radial flow of energy is spent on compensation for the losses from internal friction. This energy can come only from the outside - from a gravitating body (as already pointed out - see. Appendix).

Let us consider also the kinetic energy of mass currents on the circumference of the horizontal plane section. This energy is proportional to the values

$$\left(W_r, W_\varphi, W_z\right) = 2\pi \cdot r \cdot \left(J_r^2, J_\varphi^2, J_z^2\right) \tag{3}$$

$$W = \left(W_r + W_\varphi + W_z\right). \tag{4}$$

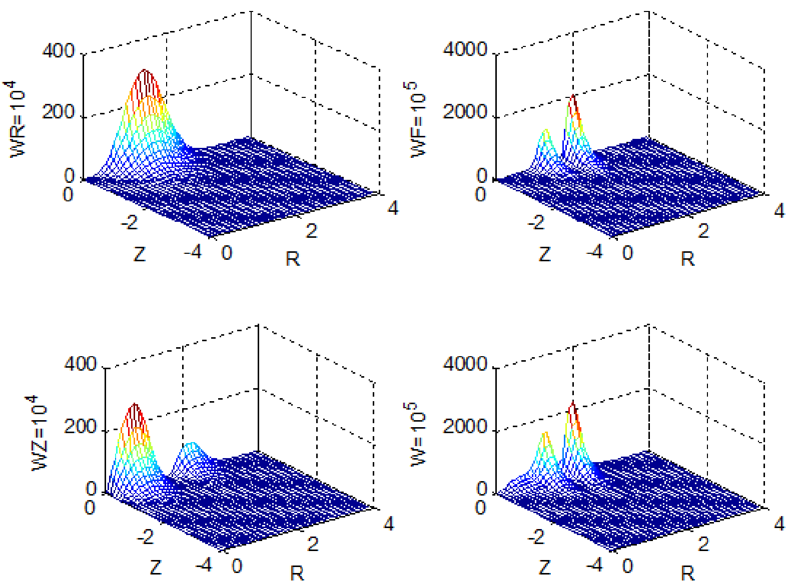

Fig. 9.

Fig. 9 shows diagrams of energy (3, 4) in the plane of the vertical cross section of the whirlpool at the previous values of the constants.

Shown also are the total value of each type of energy. It is seen that the highest value has the energy of the circular currents and this energy is concentrated in a narrow central tube.

7. Pressure

In conclusion let us consider the calculation of pressure in the whirlpool with the help of the algorithm described in Section 4. The pressure will be determined by formula (3.19), and the mass forces – by formula (3.20).

Thus,

$$\nabla p = \frac{\mu}{\rho} \cdot \Delta J - \frac{1}{\rho}(J \cdot \nabla)J + \rho \cdot G \cdot \xi \cdot S_o + \rho \cdot P . \qquad (1)$$

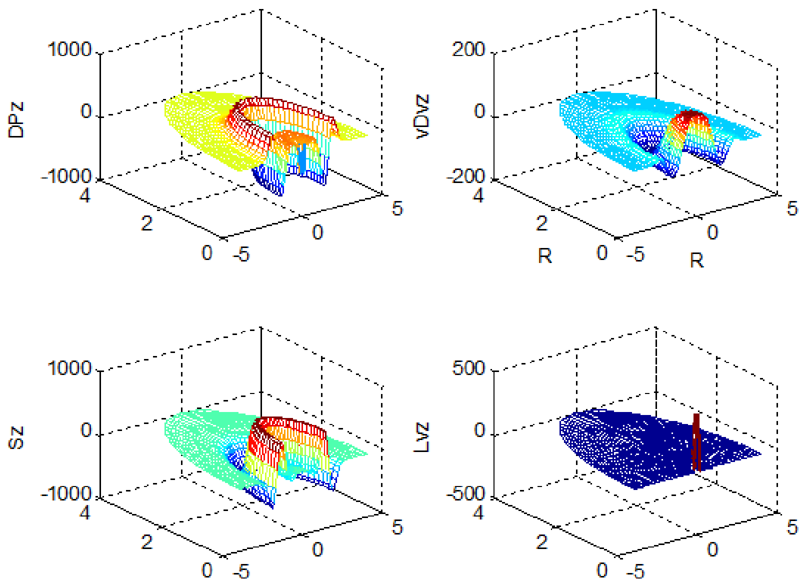

Fig. 10 shows the values from (1) and calculated for the surface of whirlpool for $z = 0$. In the calculation we have used the previous values of the constants and the following values of constants from (1):

$$\frac{\mu}{\rho} = 10^{-8}, \ \frac{1}{\rho} = 1, \ \rho \cdot G \cdot \xi, \ \rho \cdot P = 1. \qquad (2)$$

The windows in Fig. 10 show projections on the axis z for $z = 0$ of the following values:

$$DPz = \nabla p, \ Lvz = \frac{\mu}{\rho} \Delta J, \ vDvz = (J \cdot \nabla)J, \ Sz = S_o . \qquad (3)$$

The pressures on the free surface reflect the form of whirlpool's surface.

8. Conclusions

Based on the determined assumptions a system of whirlpool equations was built and one of the possible solutions was found. This solution explains the observed phenomena, namely

- vertical circulation of water: the active fall of water in the center of whirlpool and the rising of water from the depths with low speed, but on a great space.,
- horizontal rotation of water around the circumference with forming linear waves, at an angle to the tangent of the circle,
- form of whirlpool's surface,
- <u>the existence of energy source of whirlpool energy in a calm ocean</u>.

Appendix

Conservative forces (by definition) do not perform work on a closed trajectory. The force of gravity is a conservative force (which is proved mathematically). Hence the conclusion is reached that

> 1) there does not exist a motor using only conservative forces (specifically, the force of gravity) to perform work.

Next *an unproven* conclusion is made that

> 2) there **does not exist** a motor using **the energy** of conservative forces source (including the gravity forces), for performing the work.

Coulomb forces are also conservative. From this by analogy one can make the conclusion 1). However, the conclusion 2) is easily refuted: there exists, for example, a DC motor with self-excitation. Its energy source is a constant voltage source, i.e., a source of Coulomb forces. Therefore, in the general case, the assertion 2) is incorrect, and the true statement is as follows:

> 3) **There can exist** a motor using **the energy** of conservative forces source for performing work.

Nevertheless, the existence of the motor that uses energy of the **electrical** <u>conservative</u> forces source (SECF) does not mean that there is a motor that uses the energy source of the **gravitational** <u>conservative</u> forces (SGCF).

Electrical forces create the charges motion along a closed trajectory – *electric current* which forms a magnetic field. Due to this the energy of SECF turns into magnetic energy. It occurs even if the energy is not expended <u>for the motion</u> of the charges on the closed path. Thus, the energy of SECF exceeds the energy of the mechanical motion of the charges. This is the reason for the existence of a motor using the energy SECF.

Gravity forces also can create a mass motion on a closed trajectory – *mass current*. Let us assume that mass current also forms a *gravity magnetic* field (it is shown in [6]). Then by analogy with the previous we may assume that

> 4) **there can** exist a motor using the **energy** of the source of **gravity** conservative forces for performing work.

This does not contradict the law of conservation of energy: it is the energy of SGCF that is converted into work, and SGCF power source loses some of its energy (it cannot be said that the energy of SGCF may be used only for the movement of the masses).

References

1. Francisco J. Beron-Vera, Yan Wang, María J. Olascoaga, Gustavo J. Goni, George Haller, Objective Detection of Oceanic Eddies and the Agulhas Leakage. J. Phys. Oceanogr., 43, 1426–1438, 2013.
2. Khizirow U.S. The ebb and flow - the result of the precession of the whirlpools. «The Papers of Independent Authors», Publisher «DNA», Russia-Israel, Printed in USA, Lulu Inc., catalogue 16537771, vol. 33, 2015, ISBN 978-1-329-02052-8 (in Russian).
3. Khmelnik S.I. Mathematical Model of Dust Whirl, http://vixra.org/pdf/1505.0087v2.pdf
4. Khmelnik S.I. Structure of Constant Current, http://vixra.org/pdf/1504.0170v2.pdf
5. Khmelnik S.I. The Flow Structure of the Electromagnetic Energy in the Wire with Constant Current (in Russian) http://vixra.org/pdf/1504.0061v1.pdf
6. Khmelnik S.I. Experimental Clarification of Maxwell-Similar Gravitation Equations, http://vixra.org/pdf/1311.0023v2.pdf
7. Khmelnik S.I. Navier-Stokes equations. On the existence and the search method for global solutions. Second edition. Published by "MiC" - Mathematics in Computer Comp., printed in USA, printed in USA, Lulu Inc., ID 9976854, Israel, 2011, ISBN 978-1-4583-2400-9