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TONTOR ZONES MODEL FOR AUTOMATIVE OBJECT MONITORING

Gregory S. Tymchyk[1], Volodymyr I. Skytsiouk[1], Tatiana R. Klotchko[1], Roman B. Akselrod[2], Valerii Yo. Shenfeld[3], Aliya Kalizhanova[4], Didar Yedilkhan[5], Gaukhar Borankulova[6]

[1]National Technical University of Ukraine "Sikorsky Kyiv Polytechnic Institute", Department of Device Production, Kyiv, Ukraine, [2]Kyiv National University of Construction and Architecture, Kyiv, Ukraine, [3]Vinnytsia National Technical University, Vinnytsia, Ukraine, [4]Institute of Information and Computational Technologies CS MHES RK, Almaty, Kazakhstan, [5]Astana IT University, Astana, Kazakhstan, [6]Taraz Regional University M. Kh. Dulaty, Taraz, Kazakhstan

***Abstract.** The paper presents the results of analytical modeling of the case of the presence zone of an abstract object characterized by a solid mass. It has several zones of presence based on the foundations of the TONTOR theory. Research determined that the discrete solid-state zone of the presence characterizes the solid part of the AE itself or the particles that form the surrounding space near the abstract entity and is the most powerful zone among the existing zones. The proposed model for determining the parameters of TONTOR zones of an object provides the possibility of analyzing the state of this object during its movements in the working space and metrological measurements of coordinates. These metrological aspects in the automatic mode of operation of object state analysis system determine the properties that increase the accuracy and speed of operations for calculating object movement trajectories in various fields of research.*

Keywords: abstract entity, Pandan zone, automative monitoring

MODEL STREF TONTOR DO AUTOMATYCZNEGO MONITOROWANIA OBIEKTÓW

***Streszczenie.** W artykule przedstawiono wyniki modelowania analitycznego przypadku strefy obecności abstrakcyjnego obiektu charakteryzującego się masą stałą. Ma on kilka stref obecności opartych na podstawach teorii TONTOR. Badania wykazały, że dyskretna stała strefa obecności charakteryzuje stałą część samej AE lub cząstki, które tworzą otaczającą przestrzeń w pobliżu abstrakcyjnej jednostki i jest najsilniejszą strefą spośród istniejących stref. Zaproponowany model określania parametrów stref TONTOR obiektu zapewnia możliwość analizy stanu tego obiektu podczas jego ruchów w przestrzeni roboczej i metrologicznych pomiarów współrzędnych. Te aspekty metrologiczne w automatycznym trybie pracy systemu analizy stanu obiektu określają właściwości, które zwiększają dokładność i szybkość operacji obliczania trajektorii ruchu obiektu w różnych dziedzinach badań.*

Słowa kluczowe: abstrakcyjny obiekt, strefa Pandana, automatyczny monitoring

Introduction

An urgent problem in field of control and measuring devices manufacturing, industrial technologies of detail processing, ecology, research of astronomical objects is determination of object's presence, its coordinates of presence in research space. At same time, an important task is to monitor the current state of this object during its movement, which characterizes possible damage and violations of movement trajectory. Therefore, creation of a model for determining parameters by automated technical means provides opportunities to increase the accuracy of measurement, as well as to regulate the speed of these metrological actions.

In authors works [15, 16] main conception from presence zones of abstract entity (AE) are offered. Primary presence TONTOR zone (Pandan zone of AE) is zone, which characterize of mass presence in space. TONTOR Pandan zone as kind of mechanical and physical signal, within consider only power parameters of AE is offered [17].

Around AE, the gravitational zone of presence is performed as a zone in the form of a field structure that characterizes current state of the environment.

At the same time, this zone of presence characterizes the presence and parameters of a discrete solid body and its discrete elements, as well as the parameters of the location in space and the coordinates of the movement of these particles as elements.

So, in a similar way, the particles of the defined solid-state zone and the electric field of the field structure create a zone of presence around the AE and hold their field interactions. The forces of the presence of the zone of intermolecular and atomic interaction were partially considered in [16, 17], but they as the transition of the solid-state zone AE into the atomic-molecular zone are considered.

If we consider a property that can provide the effect of spreading force over a certain distance, then we define the zone of the presence of a solid body as the most powerful relative to other zones in accordance with the foundations of the TONTOR theory. At the same time, force transmission is not observed without a certain deformation of the field structure.

So, the goal of this work is the analytical modeling of basis of determining the parameters of discrete elements that form the zone of AE presence.

1. Proposed model of solid-state zone as AE presence zone

If we analyze the composition and nature of the existence of the AE presence zone, we can determine two phase states that have physical and mechanical properties as a solid discrete zone (SDZ) and a continuous solid zone (CSZ).

It is characteristic of CSZ that it exists inside a solid mass AE or a solid object AE. Such types of AE spaces are characterized by the ability to transmit physical regularities over a distance. SDZ consists of discrete mass, which united by a whole field structure as common block. Such an example can be the force of gravity during the interaction of individual masses of AE.

At same time, it is very important to determine and analyze properties of the constituent elements of AE presence zone, which has finite geometric, mechanical and physical properties.

Taking into account the peculiarities of such delimitation, it can be determined that the elements of zone have nature of existence of AE, which distinguishes finite physical and mechanical properties. Thus, sand located on the Earth's surface, compared to its geometric dimensions, is nothing more than dust, represents a whole structure of an orderly arrangement of discrete elements in space and can be considered as a basic abstract object.

In the case of CSZ, an unbounded solid object is characteristic. The middle of this AE characterizes the process in which the release of energy is observed. So, we have the nature of the field structure of central-metric geometry, for which the distribution patterns of temperature fields, normal, tangential energy loads are determined.

It is normal and tangential loads that can be determined [1, 18], based on relevant laws of theory of material resistance. Characteristic for this case are the analytical dependencies, which in rectangular coordinates determine the equilibrium of the element as

$$\begin{aligned} &\frac{\partial \sigma_x}{\partial x}+\frac{\partial \tau_{yx}}{\partial y}+\frac{\partial \tau_{zx}}{\partial z}+\rho X=0, \\ &\frac{\partial \tau_{xy}}{\partial x}+\frac{\partial \sigma_y}{\partial y}+\frac{\partial \tau_{zy}}{\partial z}+\rho Y=0, \\ &\frac{\partial \tau_{xz}}{\partial x}+\frac{\partial \tau_{yz}}{\partial y}+\frac{\partial \sigma_z}{\partial z}+\rho Z=0, \end{aligned} \tag{1}$$

where ρ is the specific mass of solid object (AE), X, Y, Z are mass of the force in corresponding coordinate, $\tau_{xy}, \tau_{yx}, \tau_{zx}, \tau_{xz}, \tau_{yz}, \tau_{zy}$ are tangential loads and σ_x, σ_y, σ_z are normal loads by space coordinates *x, y, z*.

These equations (1) characterize internal residual stresses that arise as a result of processes, dislocations in the internal environment of the object. Since we define a solid object as an AE with a large power, the internal stresses begin to weaken, but within a certain time the values level off and disappear at the end of the time interval.

We can determine the dislocation direction and its distance from the excitation coordinate using a strain gauge [2, 18].

Almost all AEs have SDZ, and CSZ compared to SDZ has a very limited application in practice. As a rule, SDZ has a joint movement with the AE surface and the captured part of the medium. Since the particles of SDZ have a finite mass, as a result, they have the shape of any configuration, and for artificial variants of SDZ, the varieties of forms can sometimes take on the appearance of geometric classical shapes, which greatly facilitates calculations and analytical studies of the nature of these elements.

When determining the spectrum of characteristics at a certain distance from the surface of the AE, we get other solutions, for example, the Solar System, where space objects are unevenly distributed at a distance from the Sun in space. Thus, according to Kepler's laws [5, 7], it is possible to determine the spectrum of volume and mass depending on the distance to surface of objects.

So, these are additional spectra in terms of density and the relationship between density and the shape of this object, which allows you to study the properties of surrounding space.

The interaction of SDZ's particles characterizes their mutual contact and its features, when the particles are under the influence of Brownian motion and Saint-Venant principle can be applied for boundary conditions of object's interaction [3, 6]. At the same time, the complex of forces during their action within the surface of the object with a zone can be modeled as a concentrated force.

Since the theory of resistance of materials doesn't study the spatial and temporal parameters of the movement of solid objects mass [9], the study of deformation requires additional informational data.

If the parameters of linear deformation are determined in the general case (Fig. 1), the same methods as [4, 10] are used. The deformation at point A, if we consider this case, will have a different value. As a result of this, it is advisable to specify direction of a single vector and to study the change in gap *AB = ds*, which is obtained as a result of the deformation, while the point *B* is selected on the given straight line.

According to the specified direction, it is appropriate to consider the linear deformation as

$$\varepsilon_s=\frac{A^*B^*-AB}{AB}=\frac{ds^*-ds}{ds} \tag{2}$$

where $A^*B^*=ds$ is length of the point *ds* after deformation according to TONTOR theory.

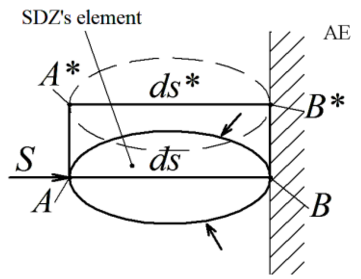


Fig. 1. General model of SDZ's element deformation, where dS is element of object's surface

Value of ε_p determines the true or real deformation as

$$\varepsilon_p \approx \frac{u}{l_0+\frac{1}{2}u} \approx \varepsilon-\frac{1}{2}\varepsilon^2 \tag{3}$$

where parameter u determined AA^* value.

Imagine that there is a coordinate system rigidly built up with the points of attachment of SDZ element (Fig. 2), with some free point having *x, y, z* coordinates. After the deformation, the point will move to the position, and point. In this case, vectors and, respectively, represent the displacement of points and.

If we consider coordinate system that determines the rigid connection of a discrete element of SDF (Fig. 2), in which there is a free point A with spatial coordinates *x, y, z,* then after the existing deformation, the point A will move to other coordinates A^*, and the point $B \to B^*$. So, in this case, the vectors AA^* and respectively represent the displacement of the points A and B^*.

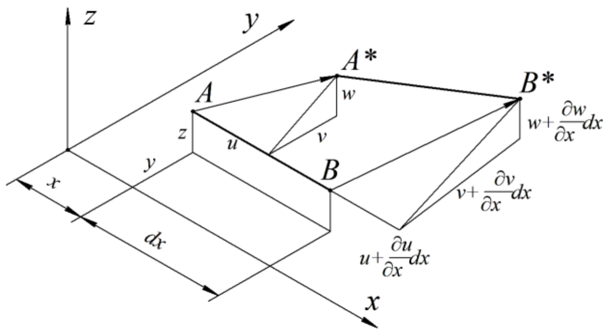


Fig. 2. Model of ε_x deformation value

The component movements of a point *A* along *x, y, z* axes are considered as *u, v, w*.

Then

$$u+\frac{du}{dx}dx,\ v+\frac{\partial v}{\partial x}dx,\ w+\frac{\partial w}{\partial x}dx \tag{4}$$

At same time, it is necessary to consider changing the volume of DSZ element. So, volume of discrete element will be

$$dV = dxdydz \tag{5}$$

After deformation we considered ε_x, ε_y, ε_z.

So, we have to get a new volume, neglecting movement deformations

$$dV = (1+\varepsilon_x)\ (1+\varepsilon_y)\ (1+\varepsilon_z)dxdydz \tag{6}$$

In this case, volume deformation will be

$$\varepsilon_V=\frac{dV-dV_0}{dV_0}=(1+\varepsilon_x)(1+\varepsilon_y)(1+\varepsilon_z)-1 \tag{7}$$

or within limits of small deformations

$$\varepsilon_V=\varepsilon_x+\varepsilon_y+\varepsilon_z \tag{8}$$

The presented analytical model determines the patterns of change in the deformation process of a separate element of SDZ, while the modelling concerns only one element of AE zone.

2. Structure of DSZ macro element's placement in space AE

From the preliminary examination it is very well seen that the AE surface is always under pressure, which leads to its certain destruction. As a result, a layer of solid elements is formed around AE. These only partial elements are in a state of relative calm, and therefore gradually form certain layers. Currently, it is possible to isolate three layers around AE. The first layering is a dense layer on the object surface. In this case, being in close contact with the surface and with each other, they do not have intermolecular adhesion, although they are under pressure. In this case, above physical and mathematical description is quite suitable for a single element, but not for the entire layer as a whole.

The second layer is characterized by fact that DSZ elements are in such close proximity to each other that any outside force can lead to a chain reaction of pushing elements. In this case, the external force that acts on discrete element leads to its movement. As a result, this element does a blow to the neighboring one, which in turn is also neighboring and so on.

The third layer is characterized by the fact that a single element can move to infinity around AE without ever encountering other elements.

All of the foregoing proves that there is a problem of the location of discrete sized elements in different layers of zone. In study of literary sources, it turned out that the spectrum in size is result of the solution of second-order differential equation in aperiodic form [11]. The maximum value of such an aperiodic function is number of elements of a definite size obtained as a result of a certain technological process. In general, the distribution function *n(d),* depending of the granule *d* diameter, in its construction is very similar to the entire function of solving differential equation, as

$$n(d) = E(A_1 e^{k,d} - A_2 e^{-k_2 d}) \tag{9}$$

where A_1, A_2, k_1, k_2 are amplitudes of quantity and capacity in technological and natural processes.

This equation becomes more understandable if its result is presented as a result of the interaction of two phantoms, namely phantom of the formation of granules and phantom scrap. The general situation with shape of granules (SDZ particles) is currently purely subjective description. It is believed that longer the external forces act on the object, more it approaches the spherical shape, that is, even the diameter d in equation (9) should be taken as the average.

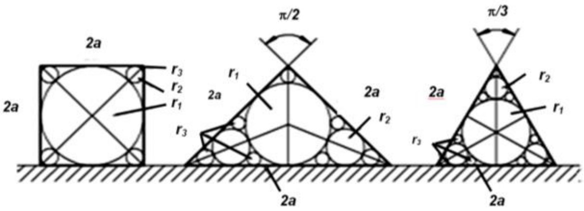
A classic example is a form of sand granules, pebbles, and the like that have been formed for millions of years. Such layers of objects of sphere form a zone of presence of the globe, etc. And if the spectrum of diameters can somehow be guided by the principles of expression (9), then the spectrum of distribution in size, depending on the distance to the surface in general, is extremely difficult to determine. If the planar version of the projections of this zone can still be modeled, then with a 3D solution to this problem, the situation is extremely difficult.

So, let's try to simulate a variant of the flat task simulating SDZ, based of this simulation is following conditions.

First, it is possible to simulate on SDZ plane only in situation when the basic elements are quite easily formed into some definite form of the finite element. At present, we can consider such elements a square, equilateral and equilateral triangle.

Boundary of any AE Pandan zone is a sphere, and projection of a sphere is a circle. Consequently, in each elementary SDZ there is a finite number of projection sphere (Fig. 3).

Our task is to determine the zone that is not involved in the DSZ. This problem has two solutions, namely direct and inverse. For a direct task, we focus on shapes with sides 2a and the angles between the sides of which we have, or. At the same time, these figures should be the simplest, so that they could be composed of layers of DSZ (Fig. 3).



a) b) c)

Fig. 3. Simulation of SDZ plane task: a) a square with a side 2a, b) a rectangular equilateral triangle with a side 2a, c) an equilateral triangle with a side 2a

Since boundary of the Pandan zone is a sphere, and its projection onto the circle plane, a definite number of round objects may be located within the limits of the completed geometric figure. In addition, they should occupy the maximum zone. Thus, the inverse problem can be considered determination of the number and size of round objects, which maximally fill a certain zone of the surface. This task is very complicated, because it requires solving equation (9), which has many unknowns. Therefore, we confine ourselves to considering a direct problem based on (Fig. 3a). So, we need to find out the principle of filling the plane of an elementary figure. At present, the following formula can be used to determine such percentage dependence

$$S_e(\%) = \frac{\Delta S}{S_e} 100\% = \frac{S_e - S_0}{S_e} 100\%$$

where S_e is DSZ of elemental particle, S_0 - zone by circle is covered.

Thus, if the elementary particle has the shape of a square (Fig. 3a), then we obtain the following result. Square $S_k = 4a^2$; square of circle radius r_1: $S_{01} = \pi r_1^2 = \pi a^2$; square of circle radius r_2: $S_{02} = \pi r_2^2 = \pi r_1^2 \left(\frac{1 - \sin\frac{\pi}{4}}{1 + \sin\frac{\pi}{4}} \right)^2 = \pi a^2 \left(\frac{1 - \sin\frac{\pi}{4}}{1 + \sin\frac{\pi}{4}} \right)^2$.

Thus, the percentage of uncovered zones will be

$$S_k(\%) = \frac{S_k - S_{01} - 4S_{02}}{S_k} 100\% = \left[1 - \frac{\pi}{4} - \pi \left(\frac{1 - \sin\frac{\pi}{4}}{1 + \sin\frac{\pi}{4}} \right)^2 \right] 100\% = 12.2\% \tag{10}$$

If we have square of an equilateral rectangular triangle $S_{\Delta 1} = 2a^2$, square of circle radius r_1: $S_{01} = \pi r_1^2 = \pi a^2 \left(\frac{4 - \sqrt{2}}{4} \right)^2$; square of circle radius r_2: $S_{02} = \pi r_2^2 = \pi a^2 \left(\frac{4 - \sqrt{2}}{4} \right)^2 \left(\frac{1 - \sin\frac{\pi}{8}}{1 + \sin\frac{\pi}{8}} \right)^2$; square of circle radius r_3: $S_{03} = \pi a^2 \left(\frac{4 - \sqrt{2}}{4} \right)^2 \left(\frac{1 - \sin\frac{\pi}{4}}{1 + \sin\frac{\pi}{4}} \right)^2$.

Thus, the percentage of uncovered zones will be

$$S_{\Delta 1}(\%) = \frac{S_{\Delta 1} - S_{01} - 2S_{02} - S_{03}}{S_{\Delta 1}} 100\% = \left\{ 1 - \frac{\pi}{2} \left(\frac{4 - \sqrt{2}}{4} \right)^2 \left[1 + \left(\frac{1 - \sin\frac{\pi}{8}}{1 + \sin\frac{\pi}{8}} \right)^2 + \left(\frac{1 - \sin\frac{\pi}{4}}{1 + \sin\frac{\pi}{4}} \right)^2 \right] \right\} 100\% = 25.9\% \tag{11}$$

In addition to dependencies (10) and (11), where there is a fairly good relationship between the square and the rectangular triangle, there is another one. This dependence shows the relationship between the radiuses of inserted objects at the right angles of a square or a rectangle. Currently, this is a series of circles, whose centers are located on bisector of the corner and which have four tangents. Of these, two touch the sides of the right corner, and two other previous and next circles.

The radius of this circle will be

$$r_n = a\left(\frac{\sqrt{2}-1}{\sqrt{2}+1}\right)^n \tag{12}$$

where $n = 0, 1, 2, 3 \ldots \infty$ and is the serial number of circle from center.

At the same time for zero reference first circle is taken.

In this case, the circle's zone will be:

$$S_{0n} = \pi\left[a\left(\frac{\sqrt{2}-1}{\sqrt{2}+1}\right)^n\right]^2 \tag{13}$$

If we have square of an equilateral triangle as $S_{\Delta 2} = a^2\sqrt{3}$; square of circle radius r_1: $S_{01} = \frac{1}{3}\pi a^2$; square of circle radius r_2: $S_{02} = \pi\frac{a^2}{3}\left(\frac{1-\sin\frac{\pi}{6}}{1+\sin\frac{\pi}{6}}\right)^2$, percentage of uncovered zones will be

$$S_{\Delta 2}(\%) = \frac{S_{\Delta 2} - S_{01} - 3S_{02}}{S_{\Delta 2}}100\% = \left\{1 - \frac{\pi}{\sqrt{3}}\left[\frac{1}{3} + \left(\frac{1-\sin\frac{\pi}{6}}{1+\sin\frac{\pi}{6}}\right)^2\right]\right\}100\% = 19.4\% \tag{14}$$

Consequently, among all these figures, square and least efficient rectangular triangle are most effectively used, although it would seem that density of use of the square in it should have been greater.

Take one more step. That is, we introduce additional circles in all figures in Fig. 3. They may now have following dimensions.

For a square this can be circles of radius r_3 located at its angles (4 pieces) (Fig. 3a), for a rectangular equilateral triangle it is possible to add circles of radius r_3 in the amount of six pieces (Fig. 3b), for an equilateral triangle we have the ability to add nine circles of radius r_3. In this way, we will have a general covering of zone in the following form:

$$S_k(\%) = \frac{S_k - S_{01} - 4S_{02} - 4S_{03}}{S_k}100\% = 11.9\%$$

$$S_{\Delta 1}(\%) = \frac{S_{\Delta 1} - S_{01} - 2S_{02} - 7S_{03}}{S_{\Delta 1}}100\% = 7.7\%$$

$$S_{\Delta 2}(\%) = \frac{S_{\Delta 2} - S_{01} - 3S_{02} - 9S_{03}}{S_{\Delta 2}}100\% = 12.67\%$$

As can be seen from preliminary consideration of the possibility of covering square, the best square and its halves. It should be noted that the percentage of non-covering of square is maintained regardless of number of SDZ selected elements. From the preceding equations (10), (11), (13) and (14) it is possible to imagine a series of dependencies that give the percentage of uncovered zone as equations (15) gives only an idea of the possible number of circles on SDZ elemental zone:

$$S\% = \left\{1 - \pi k^2\left[\begin{array}{l} a^2 + b^2\left(\frac{1-\sin\frac{\pi}{n}}{1+\sin\frac{\pi}{n}}\right)^2 + \\ +c^2\left(\frac{1-\sin\frac{\pi}{2n}}{1+\sin\frac{\pi}{2n}}\right)^2 + \\ +d^2\left(\frac{1-\sin\frac{\pi}{4n}}{1+\sin\frac{\pi}{4n}}\right)^4 + \ldots + \\ +m^2\left(\frac{1-\sin\frac{\pi}{mn}}{1+\sin\frac{\pi}{mn}}\right)^{2m} \end{array}\right]\right\}100\% \tag{15}$$

Currently, the last member of this series is uniquely relying on value. Again, we remind that all elementary particles of SDZ are in close contact, such as sand or pebbles on the shore of the reservoir. In the case of a violation of this state, this layer is transferred to a new state.

This new layer, as we have already mentioned above, in general classification resembles a well-known suspension of colloidal chemistry [12–14].

At moment it is understood (suspenzo – latching hanging) a certain amount of solid particles of a certain size that move at the same speed in a definite direction. At the same time, all particles do not comply with laws of Brownian motion [9, 16].

The third layer of SDZ is a series of discrete objects that move around AE in some closed orbits. Such objects, as a rule, move in one direction and eventually go to the plane (disk). A good example of this stratum is astronomical phenomena such as, for example, galaxies or solar planetary system. In addition, one can consider such a phenomenon as an electron shell of an atom. Such a shell has a rather specific character [5] because it has a duality of behavior as a layer of SDZ.

Consequently, the atom has a kernel and an electric shell. The core consists of electrically neutral neutrons and positively charged protons. Both protons and neutrons move in middle of the nucleus under influence of nuclear forces. The electron shell consists of electrons moving along the "orbitals" rather than orbits. This phenomenon gives a description of the quantum-mechanical theory of atom construction. According to quantum mechanical theory of atom construction, the electron has a dual nature, that is, on the one hand, it behaves like a solid particle, and on the other, like a wave. At present, mechanical properties of an electron are due to the presence of a mass of rest and associated properties. Nevertheless, during the movement of electron behaves like a wave, that is, it has amplitude, wavelength, frequency of oscillations, etc. But it is not clear why the wave has no mass? Therefore, the quantum-mechanical theory believes that it is impossible to speak of an orbit with some parameter, but only about the probability of finding an electron in one or another point in space. Consequently, under this thesis, under the electron orbit, one should understand not a specific trajectory of motion, but some stratum around the nucleus, where the probability of an electron at a certain moment is greatest.

Thus, the electronic orbit does not characterize the moving of an electron from point to point, but only characterizes the parameters of layer, which determines the distance of its location from nucleus. Therefore, electron does not represent in the form of a material point, but if the electric cloud covering nucleus of an atom, which has its condensation and thawing of the charge. However, it should be borne in mind that this cloud does not have sharply defined contours, and therefore, at great distances from nucleus, there is a probability of finding an electron. The electronic cloud has no clearly defined boundaries. Explanation at the level of hydrogen atom, which represents failure of a regular sphere. In this ball there is ability to determine the equipotential surfaces on which electron density will have same value.

In the case of hydrogen atom, it is concentric spheres. In the atom of hydrogen on the electron, only the force of attraction of a positively charged nucleus is valid. In the multielectron atom only the force of a positive charged nucleus acts. In addition, in a multi-electron atom, the interaction forces of discrete electrons are interconnected [16], that is, we have one example of the law of aggression [15, 17, 19] in the study of various types of applications. At the same time, a very important aspect is the application of the active surface sensor, which is used in automatic systems for metrological measurements of parameters and monitoring of the coordinates object during its movement in space.

As a result, we have certain stratification, namely, internal layers weaken the action of the field of nucleus most distant layers. In addition, this shielding does not have an isotropic state when interacting with each electric cloud. Therefore, in many-electron atoms, the electron energy depends not only on the principal quantum number, but also on the size of orbital quantum number, which determines the shape of electron cloud.

Unlike the microcosm, we have some other physical phenomena in the macro world. Consequently, starting with a certain particle size that is much larger than an atom, we have the opportunity to explain all the processes of motion in the SDZ on the basis of aero and hydrodynamics and astronomical phenomena. It was mentioned above that all particles of SDZ move around the AE for approximately a circular orbit. In addition, this situation is typical for almost all AE regardless of scaling. For this purpose we turn to theoretical astronomy as a means of explaining such a movement in space. Consequently, the principles of the description of such an orbital motion are based on Kepler's laws [5]. At the moment, most important for us is first law, that is: orbit of the planet in essence of ellipse in one of tricks of which is sun. Thus, if we discard all secondary signs (astronomical), then we must assume that any SDZ moving around the AE has a description for the canonical equation of the ellipse, that is:

$$\frac{x^2}{a^2}+\frac{y^2}{b^2}=1 \tag{16}$$

where *a* and *b* are large and small semi-ellipse.

Thus, eccentricity of ellipse

$$e=\frac{c}{a} \tag{17}$$

where *c* is the distance of ellipse tricks from its center.

On the other

$$c=\sqrt{a^2-b^2} \tag{18}$$

or after transformations

$$b=a\sqrt{1-e^2} \tag{19}$$

Quite often, instead of eccentricity *e*, angle φ is introduced by

$$\sin\varphi=e \tag{20}$$

As a consequence, the previous equations (17), (18), (19) and (20) have an opportunity to rewrite as

$$\left.\begin{aligned} e&=a\sin\varphi\\ b&=a\cos\varphi\\ \cos\varphi&=\sqrt{1-e^2}\end{aligned}\right\} \tag{21}$$

Quite often the focal equation of an ellipse is used

$$r=\frac{P}{1+e\cos V} \tag{22}$$

where *r* is the focal radius of vector of ellipse point, *P* is the ellipse parameter or focal coordinate, *V* is polar angle of ellipse point.

In addition to Kepler's laws, there are problems in astronomy about two, three and *n* bodies that interact with each other due to force of gravity [20]. If we discard secondary astronomical signs, then we will have a number of *n* interacting AE's. Currently, the section devoted to gravity zone of presence, shows most generalized cases of interaction.

Consequently, if we have an AE with mass m moving in orbit in accordance with (21), (22) then on section of size *dl* on it the force *F* of gravity, i.e.

$$m\frac{d^2\overline{l}}{dt^2}=F \tag{23}$$

If we take into account that vector of force *F* has projections on the coordinate axis, then equation (23) can be rewritten in following form:

$$\left.\begin{aligned} m\frac{d^2x}{dt^2}&=\mathbf{F}\cos\alpha\\ m\frac{d^2y}{dt^2}&=\mathbf{F}\cos\beta\\ m\frac{d^2z}{dt^2}&=\mathbf{F}\cos\varphi\end{aligned}\right\} \tag{24}$$

On other, if we have two AE with masses m and m_1 at a distance ρ from each other, then, according to Newton's law, they interact with force

$$F=\gamma\frac{mm_1}{\rho^2}$$

where γ – constant of gravity.

So, if we choose a fixed coordinate system, then coordinates for masses of AE will be: m - x, y, z; m_1 - x_1, y_1, z_1. Using these coordinates, we have the opportunity to write down

$$\left.\begin{aligned} r^2&=x^2+y^2+z^2\\ r_1^2&=x_1^2+y_1^2+z_1^2\\ \rho^2&=(x_1-x)^2+(y_1-y)^2+(z_1-z)^2\end{aligned}\right\} \tag{25}$$

where γ, γ_1 – radius-vectors m_1, m_2.

Similarly, from (25) we obtain

$$\left.\begin{aligned} \cos\alpha&=\frac{x_1-x}{\rho}\\ \cos\beta&=\frac{y_1-y}{\rho}\\ \cos\varphi&=\frac{z_1-z}{\rho}\end{aligned}\right\} \tag{26}$$

If we obtain equations (25) and (26) in (24), we obtain equation of motion for the masses m and m_1.

Consequently, the equation for the motion of AE with a mass *m* will be

$$\left.\begin{aligned} m\frac{d^2x}{dt^2}&=\gamma mm_1\frac{x_1-x}{\rho^3}\\ m\frac{d^2y}{dt^2}&=\gamma mm_1\frac{y_1-y}{\rho^3}\\ m\frac{d^2z}{dt^2}&=\gamma mm_1\frac{z_1-z}{\rho^3}\end{aligned}\right\} \tag{27}$$

The equations of motion for AE with the mass m_1 will look

$$\left.\begin{aligned} m\frac{d^2x}{dt^2} &= -\gamma m m_1 \frac{x_1-x}{\rho^3} \\ m\frac{d^2y}{dt^2} &= -\gamma m m_1 \frac{y_1-y}{\rho^3} \\ m\frac{d^2z}{dt^2} &= -\gamma m m_1 \frac{z_1-z}{\rho^3} \end{aligned}\right\} \tag{28}$$

If we integrate equations (27) and (28), then we will have a solution to the problem of motion of two AE under the action of mutual attraction.

In order to solve this problem we make a number of assumptions, the main of which is the placement of the mass m_1 at the origin, that is $x_1 = y_1 = z_1 = 0$. As a consequence, we obtain

$$\left.\begin{aligned} \frac{d^2x}{dt^2} &= -\gamma(m_1+m)\frac{x}{r^3} \\ \frac{d^2y}{dt^2} &= -\gamma(m_1+m)\frac{y}{r^3} \\ \frac{d^2z}{dt^2} &= -\gamma(m_1+m)\frac{z}{r^3} \end{aligned}\right\} \tag{29}$$

In astronomy [5, 7], equation (29) is called the differential equations of a material point with a mass m around a material point with a mass m_1 (the typical nonsense mass has a size, hence it is a point).

Equations (29) have a special case of solution. The essence of this solution is that if we take the mass of one point in M and position it at the origin, then motion of a point with mass μ around it can be rewritten by equation (29) in following form:

$$\left.\begin{aligned} \mu\frac{d^2x}{dt^2} &= -\gamma\mu M\frac{x}{r^3} \\ \mu\frac{d^2y}{dt^2} &= -\gamma\mu M\frac{y}{r^3} \\ \mu\frac{d^2z}{dt^2} &= -\gamma\mu M\frac{z}{r^3} \end{aligned}\right\} \tag{30}$$

If (30) is reduced to μ, then we obtain

$$\left.\begin{aligned} \frac{d^2x}{dt^2} &= -\gamma M\frac{x}{r^3} \\ \frac{d^2y}{dt^2} &= -\gamma M\frac{y}{r^3} \\ \frac{d^2z}{dt^2} &= -\gamma M\frac{z}{r^3} \end{aligned}\right\} \tag{31}$$

In the case of solving problem of three bodies we accept following input data:

- mass of the AE: m, m_1, m_2;
- coordinates of the masses: x, y, z; x_1, y_1, z_1; x_2, y_2, z_2;
- mutual distances: ρ_{01}, ρ_{12}, ρ_{02}.

By analogy with previous case, we have the following dependencies:

$$\left.\begin{aligned} \rho_{01}^2 &= (x_1-x)^2+(y_1-y)^2+(z_1-z)^2 \\ \rho_{02}^2 &= (x_2-x)^2+(y_2-y)^2+(z_2-z)^2 \\ \rho_{12}^2 &= (x_2-x_1)^2+(y_2-y_1)^2+(z_2-z_1)^2 \end{aligned}\right\} \tag{32}$$

If we solve this problem in a similar way to previous one, we obtain a series of equations for masses m, m_1 and m_2

$$\left.\begin{aligned} m\frac{d^2x}{dt^2} &= k^2mm_1\frac{x_1-x}{\rho_{01}^3}+k^2mm_2\frac{x_2-x}{\rho_{02}^3} \\ m\frac{d^2y}{dt^2} &= k^2mm_1\frac{y_1-y}{\rho_{01}^3}+k^2mm_2\frac{y_2-y}{\rho_{02}^3} \\ m\frac{d^2z}{dt^2} &= k^2mm_1\frac{z_1-z}{\rho_{01}^3}+k^2mm_2\frac{z_2-z}{\rho_{02}^3} \end{aligned}\right\}$$

$$\left.\begin{aligned} m_1\frac{d^2x_1}{dt^2} &= -k^2mm_1\frac{x_1-x}{\rho_{01}^3}+k^2m_1m_2\frac{x_2-x_1}{\rho_{12}^3} \\ m_1\frac{d^2y_1}{dt^2} &= -k^2mm_1\frac{y_1-y}{\rho_{01}^3}+k^2m_1m_2\frac{y_2-y_1}{\rho_{12}^3} \\ m_1\frac{d^2z_1}{dt^2} &= -k^2mm_1\frac{z_1-z}{\rho_{01}^3}+k^2m_1m_2\frac{z_2-z_1}{\rho_{12}^3} \end{aligned}\right\} \tag{33}$$

$$\left.\begin{aligned} m_2\frac{d^2x_2}{dt^2} &= -k^2mm_2\frac{x_2-x}{\rho_{02}^3}-k^2m_1m_2\frac{x_2-x_1}{\rho_{12}^3} \\ m_2\frac{d^2y_2}{dt^2} &= -k^2mm_2\frac{y_2-y}{\rho_{02}^3}-k^2m_1m_2\frac{y_2-y_1}{\rho_{12}^3} \\ m_2\frac{d^2z_2}{dt^2} &= -k^2mm_2\frac{z_2-z}{\rho_{02}^3}-k^2m_1m_2\frac{z_2-z_1}{\rho_{12}^3} \end{aligned}\right\}$$

where k_2 – gravity constant of astronomical signs.

If in the system of equations, to formulate the equations containing x, then three, which contain y, and three z, which containing z.

Then integrate of result twice, then we obtain following system of equations

$$\left.\begin{aligned} m\frac{dx}{dt}+m_1\frac{dx_1}{dt}+m_2\frac{dx_2}{dt} &= \alpha \\ m\frac{dy}{dt}+m_1\frac{dy_1}{dt}+m_2\frac{dy_2}{dt} &= \alpha' \\ m\frac{dz}{dt}+m_1\frac{dz_1}{dt}+m_2\frac{dz_2}{dt} &= \alpha'' \end{aligned}\right\} \tag{34}$$

The following transformations give

$$\left.\begin{aligned} mx+m_1x_1+m_2x_2 &= \alpha t+\beta \\ my+m_1y_1+m_2y_2 &= \alpha' t+\beta' \\ mz+m_1z_1+m_2z_2 &= \alpha'' t+\beta'' \end{aligned}\right\} \tag{35}$$

where $\alpha,\alpha',\alpha'',\beta,\beta',\beta''$ are constant of integration.

Quite often, equation (35) is called integrals of motion of the center of mass.

In this mode of movement, the integral of zone, which is obtained in a similar way, as well as previous equations, is very important

$$\left.\begin{aligned} \sum m\left(y\frac{dz}{dt}-z\frac{dy}{dt}\right) &= c_1 \\ \sum m\left(z\frac{dx}{dt}-x\frac{dz}{dt}\right) &= c_2 \\ \sum m\left(x\frac{dy}{dt}-y\frac{dx}{dt}\right) &= c_3 \end{aligned}\right\} \tag{36}$$

For solve the problem of the interaction of n bodies, the so-called potential function is introduced, which is determined by the equation

$$E_{\Pi} = k^2\left(\frac{mm_1}{\rho_{01}}+\frac{mm_2}{\rho_{02}}+\frac{m_1m_2}{\rho_{12}}\right) \tag{37}$$

In the general case, that is, the problem with n objects in brackets must be members, that is, the number of combinations for two of the all mutually attracted objects. For example, for four objects, the number of members will be, for five objects, for six, and so on. In the future, expressions of derivatives in the function E_Π for each coordinate are obtained.

In the final case, we obtain the equation

$$\frac{d}{dt}\sum m\left[\left(\frac{dx}{dt}\right)^2+\left(\frac{dy}{dt}\right)^2+\left(\frac{dz}{dt}\right)^2\right]=2\frac{dE_\Pi}{dt} \tag{38}$$

This equation can be integrated and obtained

$$\sum m\left[\left(\frac{dx}{dt}\right)^2+\left(\frac{dy}{dt}\right)^2+\left(\frac{dz}{dt}\right)^2\right]=2E_\Pi+h \tag{39}$$

where h – constant of integration.

Since the linear velocity V is defined as

$$\left(\frac{dx}{dt}\right)^2+\left(\frac{dy}{dt}\right)^2+\left(\frac{dz}{dt}\right)^2=V^2 \tag{40}$$

then equation (39) can be rewritten in the form

$$\sum mV^2=2E_\Pi+h \tag{41}$$

Equations (39) and (41) are called integrals of a living force or energy integrals. It should be emphasized that exploring the form of orbits in the problem of three bodies is strictly analytically feasible only in some particular cases. Therefore, in all other cases, methods of partial integration are applied.

From the above description of the motion in distant layer of SDZ zone, it can be seen that macro processes have a significant difference from the micro processes. Thus, at the level of construction, SDZ's atom, which is an electronic cloud, has a dual nature of the wave and the corpuscles. At the macro level of SDZ, wave properties are completely left. Objects, that rotate around their centers of mass, move along ellipsoidal orbits. Moreover, in the course of the movement all free-moving elements of SDZ are tuned into one plane with the subsequent process of creating larger objects. The most successful example [8, 20] here is Saturn with its rings (Fig. 4). There is another rather significant difference, namely, that atom's Pandan zone has a spherical shape, and the Pandan zone of the macro object is a mix of sphere and disk.

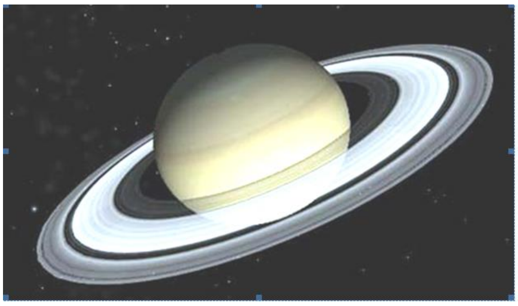


Fig. 4. Rings of Saturn

The approximate mathematical dependence has form:

$$\left.\begin{aligned} y&=\frac{1}{ax+bx+c}\\ y&=\frac{1}{-ax-bx-c}\end{aligned}\right\} \tag{42}$$

which represents two curves that rotate relative to the vertical axis of symmetry with a coordinate at the point and have a maximum in size.

3. Conclusions

Thus, on the basis of the conducted research, it was determined that any abstract object that is in a suitable environment, near its main mass, has its own surrounding space filled by individual solid particles. For the most part, particles comply with physical laws in view of their interaction with the main mass of AE and the surrounding space.

Thus, these particles create a solid-state zone of the presence of an abstract entity, have a different geometric shape, density. The physical essence of the existence of particles around an abstract entity is characterized by the parameters of common electric, magnetic fields, gravity and acoustic fields.

Volume of the abstract entity is determined by the force field of the space close to the surface of the main mass, this space is filled by particles that can enter the near zone from the surrounding space of the environment with force fields or their components, that is, electrostatic, gravitational, acoustic fields of the main abstract object. In other cases, the particles are the products of the decay of the abstract entity itself, which occurs either with time of existence or as a result of violations of the normal modes of its action.

Thus, surface particles located in dense interaction with an abstract object do not have gravity with the main mass due to molecular force fields, but they move along the surface with a certain trajectory.

Therefore, it can be determined that the particles located in the AE space are subject to fields of various origins, for example, electric, magnetic, gravitational fields, when interacting with the aerohydrodynamic environment, which is characteristic of bodies, which located in outer space.

Therefore, the presence of a deterministic zone of the presence of a multidisperse solid body is characteristic of all objects. Similar zones of presence can be considered in a wide range of objects of different sizes and basic masses, that is, they can be used in the study of both galactic bodies and atomic masses using methods similar to analytical results.

Therefore, proposed model for determining the parameters of TONTOR zones of object provides the possibility of analyzing the state of this object during its movements in the working space, metrological measurements of coordinates.

These metrological aspects in the automatic mode of operation of object state analysis system determine the properties that increase the accuracy and speed of operations for calculating object movement trajectories in various fields of research

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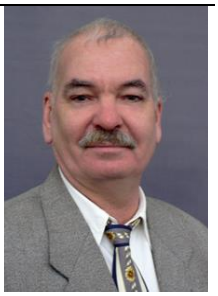
D. Sc. Eng. Gregory S. Tymchyk
e-mail: deanpb@kpi.ua

Professor, dean of Instrument Making Faculty, National Technical University of Ukraine "Sikorsky Kyiv Polytechnic Institute". Created a new class of laser spectral-correlation systems based on passive Fabry-Pierre resonators for operational control of quality parameters of parts and the condition of technological equipment in precision instrument manufacturing.

http://orcid.org/0000-0003-1079-998X

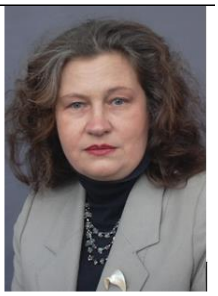
Ph.D. Volodymyr I. Skytsiouk
e-mail: max_sk@bigmir.net



Senior Researcher, Instrument Making Faculty, National Technical University of Ukraine "Sikorsky Kyiv Polytechnic Institute". Scientific directions: These metrological aspects in the automatic mode of operation of object state analysis system determine the properties that increase the accuracy and speed of operations for calculating object movement trajectories in various fields of research.

http://orcid.org/0000-0003-1783-3124

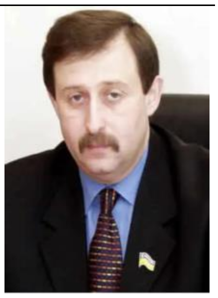
Ph.D. Tatiana R. Klotchko
e-mail: t.klochko@kpi.ua



Senior Researcher, Instrument Making Faculty, National Technical University of Ukraine "Sikorsky Kyiv Polytechnic Institute". Scientific directions: These metrological aspects in the automatic mode of operation of object state analysis system determine the properties that increase the accuracy and speed of operations for calculating object movement trajectories in various fields of research.

http://orcid.org/0000-0003-3911-5369

D.Sc. Roman B. Akselrod
e-mail: akselrod.knuba@ukr.net



Doctor of Science, Vice-rector for academic work and regional development, Kyiv National University of Construction and Architecture, Kyiv, Ukraine.
Scientific directions are evaluation and forecasting of the efficiency of investments in entrepreneurial projects, in logistics and economic systems of various levels, in human capital. Deals with Financial instruments of international scientific and technical cooperation, modeling of the marketing business-processes under the industrial enterprise's competitiveness reflexive control, and modeling of the dialogue "human-computer" for ergonomic support of e-learning.

http://orcid.org/0000-0001-7643-7194

Ph.D. Valerii Yo. Shenfeld
e-mail: leravntu@gmail.com

Ph.D., Associate Professor, Associate Professor of department of Industrial Engineering of Vinnytsia National Technical University. Research Interests: development and research of new technology samples, in particular for vibration cutting and surface deformation strengthening of machine parts.

http://orcid.org/0000-0002-5548-6971

Ph.D. Aliya Kalizhanova
e-mail: kalizhanova_aliya@mail.ru

Candidate of physical and mathematical sciences, professor, Institute of Information and Computational Technologies CS MHES RK, Almaty, Kazakhstan, the chief researcher of the Institute of Information and Computational Technologies of the Ministry of Education and Science CS of the Republic of Kazakhstan. Scientific interests of the leader: mathematical modeling of systems, models of transport systems network analysis, optimization methods, technologies for developing sensor systems for signals receive - transmit, mathematical modeling of Bragg fiber gratings.

http://orcid.org/0000-0002-5979-9756

Ph.D. Didar Yedilkhan
e-mail: yedilkhan@gmail.com

Ph.D, associate professor at Astana IT University, Department of Computer Engineering. Research interests: Data science, Machine learning, Deep learning, Intelligent systems, optimization.

http://orcid.org/0000-0002-6343-5277

Ph.D. Gaukhar Borankulova
e-mail: b.gau@mail.ru

Candidate of Technical Sciences, Associate Professor, head of Chair department of "Information systems", Taraz Regional University M. Kh. Dulaty. Research area: Information systems, Big data.

http://orcid.org/0000-0001-5701-8074