RESONANCE
in Physics, Chemistry and Biology

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IZHEVSK

XX/XXI

In the book the resonant problems in different areas of physics, chemistry and biology from a uniform point of view - extremeness of resonant states of a motion in a nature are considered. The problems of dynamics of a motion and retention of atomic, macroscopic particles, microorganisms in inhomogeneous fields, beyond and inside of resonance conditions; problems of dynamic stability of unstable states, bifurcation, chaos, discreteness, evolution of nonlinear dynamic systems which are not containing in an explicit view a small parameter are analyzed. Fundamentals of the resonant theory of dynamic systems are state. The unsolved problems are marked and the trajectories of their solution, in particular: ball – lightning, activated water, resonant action of superweak fields at biological systems, including correlation between periods of solar Activity and processes happening at this time on the Earth are outlined.

Whom this book is for? On a wide circle of the readers wishing to see a wood from trees. The schoolchildren, students, experts with higher education and without it, who is not indifferent to riddles of a surprising Nature, environmental us, and who yet has not lost desire and patience to understand them.

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The foreword.

This book has arisen as result of numerous lectures and seminars, on which I have tried from identical position in accessible form to explain achievements of different researchers in the most different spheres of activity on uniform object of our examination her Majesty - Nature. The content of the book was finally formed after course of lectures for the students-biophysics of physical faculty of the Udmurt State University I had in a winter semester 1999/2000 to read.

The noticeable place in the book is occupied by a resonance phenomenon which permit to realize uniform connection of variant phenomena, environmental and piercing us. Moreover, my scientific workers and I had an opportunity to influence on « development of events » in this area

First of all, I am deeply grateful to the teacher and instructor Alexander Ivanovich Philatov, whose fruitful ideas and severe vision of fundamental principles of natural phenomena helped me in my examinations. The major influence to me was rendered by meetings and discussions at seminars with L.I. Sedob, A.G. Gurevich, V.I. Ozhogin, S.P. Kurduymov, V.L, Ginzburg, S.V. Vonsovskyi, V.G. Veselago. This book, is unconditional, would be never terminated without approval and support of my wife. Many friends and colleagues helped me in my work. I thank everyone, who helped me in this work. And certainly this book would not exist without support of my parents during all my life. Therefore I devote this book to light memory of my parents Georgyi, Mariya and Ivan.

Izhevsk, November 23, 2000.

Valentin Shironosov

The content

Introduction.

Resonance is usually said to be a phenomenon of an acute amplification of response of a dynamic system x to the external influence $f=f_0\cos\omega t$, when the frequency of the external influence ω is comparable to frequency ω_0 or with the sum of frequencies of system natural oscillations ($n\omega=\Sigma n_i\omega_{0i}$, where n, n_i are the whole numbers).

Thus the forced oscillations x arise and are maintained in the system owing to external additive or parametric effects (which are included in the motion equation additionally or change the system parameters). In this case oscillations stipulated by the external influence, are termed parametric.

The oscillations of a variable x are occurring with lagging: at small $\omega<<\omega_0$ ~ in phase with the oscillations of external influence f ($x\sim f_0\cos\omega t/\omega_0^2$); at large $\omega>>\omega_0$ –in antiphase (-π) with f ($x\sim -f_0\cos\omega t/\omega^2$); $\omega=\omega_0$ phase shift between oscillations x and external influence -π/2, and oscillation amplitude x has a maximum magnitude fQ/ω_0^2, where $Q=\omega_0/\varepsilon$– system quality-factor at resonance, and ε_r - its dissipation.

Let's note, that if the dynamic system is not independent one, i.e. the clear time dependence exists in the equations of motion, that this system can be considered as independent one, entering time as one of a coordinate of the phase space. At such method of approach it is possible to consider a system described by the differential equation of the second order with the external influence as a system with one and half degrees of freedom.

It is interesting to note that the history of physics development began as a matter of fact from a research of nonlinear equations – the famous Keppler's problem. The Keppler's problem contains typical attributes of nonlinear oscillation system with parametric_resonance: the dependence of period of planet revolution around the Sun on the orbit parameters, the large quality of harmonic components in time characteristics of current planet coordinates.

The consequent development of theoretical and experimental physics followed the way of designing the linear physical theories: the theory of elasticity, electromagnetism, problems of retention the bodies and particles beyond of the zones of parametrical resonance, quantum mechanics and quantum theory of a field. It took much time (from XVII to XX century) [1-146], to understand: the ideas of linearization [1, 2, 4, 6, 13] are not absolutely accepted for a solution of many problems, which physics used to face. And in this means return to the classics is observed nowadays.

Historically first of all the problems for linear dynamic systems where ω_0=const and $\omega_0=\omega_0\{\varepsilon_i(\omega t)\}$ type $\omega_0=(\varepsilon_0+\varepsilon_1\cos\omega t)$ were considered. The linearization of the problems resulted in <splashing the baby out with the water> - absence of the stable states of motion in the resonance zones [4-7, 21-27]. Later there were considered the problems of parametric resonance with $\omega_0=\omega_0 f\{\varepsilon_i(x_k, \theta_l, \omega t)\}$, where x_k, θ_l - the transmitting and rotational degrees of freedom, k, l = 1,2, 3N, N – the quantity of degrees of freedom [74-84, 95-97, 112-114, 122, 129,146].

The problems considering the motion and retention of different particles, cells, bodies with the dimensions from micro- up to macro- taking into account their characteristics (charges, mechanical, electrical, magnetic moments, mass) in nonuniform fields have a respectable history and are fall into typical problems of parametric resonance. It is stipulated by that the given problem periodically arose at solving the application problems in different fields of mechanics, physics, biology and medicine.

Let's note some of them:

a) robotizing – is the dimensional noncontact orientation, retention and control of microparts at assembling different units, articles and devices;

b) selective separation of different kinds of powders (magnetic, ferromagnetic etc., in particular for magnetic carriers of information – magnetic discs, tapes);

c) ultrasensitive transducer of fields (electromagnetic, acoustic, hydrodynamic, gravitation) on the base of suspensions;

d) weighting, retention and moving of different kinds of bodies (rotors of engines, gyroscopes, toys, transport on the magnetic suspension);

e) creation of traps for particles of different dimension types from elementary up to macro- and study of properties, dynamic of separate particles in such traps, including cells, electrons, ions, atoms, molecule (with the following package on the board– molecular technique), electrodynamic plasma retention.

f) Deriving of independent, stable, oscillating systems, in particular selfstable plasma, activated water.

The solution of a similar class of problems even as a first approximation encounters serious mathematical and physical problems.

The main physical problem was, that in the field of weighing particles at absence of a field source (electrical, magnetic, gravitational) the singular points – saddle ones can exist. Accordingly for saddles points in one direction the particle will be retracted in area of weighing, and in the other one to be pushed out. Still Hilbert (1600) and Irnshow (1842) considered the given problem. They fixed the fact of instability of equilibrium (static magnetic configuration). In statics the stable retention of a particle according to the Irnshow's theorem is impossible.

The deduction about stability of equilibrium has improved by Braunbek [2]. He has shown, that the unstable equilibrium in statics can become stable in dynamics at presence of a diamagnetic body in system. However due to weak symptom of diamagnetism at usual substances (except for superconductors) the Braunbek's results have not received wide practical diffusion.

But that is forbidden in statics, can be allowed in dynamics (in variable fields, or at a motion of particles in inhomogeneous fields).

In dynamics the solution of problems in turn encounters numerous mathematical problems. The basic problem consists in absence of a general vibration theory of strongly nonlinear systems at absence of small parameter and in occurrence of «strange» features even by considering of simple enough model systems, such as an attractor, chaos [3].

As a rule, as a “simple” model system of forced oscillations with additive and parametric action is considered a pendulum with a vibrant point of suspension. It is stipulated by that the relevant equation:

$$x'' + \varepsilon_r x' + (\varepsilon_0 + \varepsilon_1 \cos\tau) \sin x - \varepsilon_{-1} \cos(\tau + \varphi) \cos x = 0, \qquad (1)$$

is rather frequently met in different areas of physics: to a mechanics, electrodynamics, plasma physics etc. [318]. In particular, for a pendulum $\varepsilon_\beta=(\omega_\beta/\omega)^2$; $\omega_\beta=(a_\beta/l)^{1/2}$; β=0, ±1, where $a_0=g$ –acceleration of gravity, $a_{1,-1} = l_{1,-1}\omega$ – acceleration at longitudinal, transversal vibration, ω –frequency of vibration, l - length of a pendulum, $l_{1,-1}$ - vibration amplitudes of a suspension point of a pendulum (Fig. 1a). For a particle with a natural magnetic moment μ (fig. 1б), $\omega_\beta^2=\mu H_\beta/I$, where I – a moment of inertia, $\boldsymbol{H_0}$ - intensity of a constant magnetic field, $\boldsymbol{H_{1,-1}}$ - amplitudes of a variable magnetic field of longitudinal, transversal pumping, φ=const, $\tau=\omega t$, x'=dx/dτ.

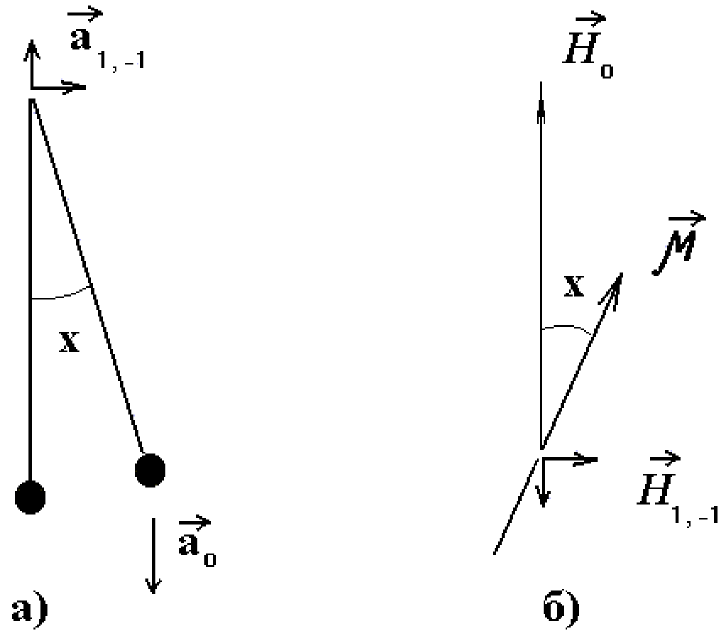


Fig. 1. a – a pendulum, b – a dipole in oscillating fields.

2. Resonance in linear systems. Traps for particles.

2.1. About dynamic stability of unstabilized states.

Perhaps, for the first time an opportunity of «atomic» traps making for holding particles could be seen in work of the Mathieu (1838), devoted to the problem of membrane vibration [4].

There was, that a relevant equation of the Mathieu:

$$x'' +(\varepsilon_0 + \varepsilon_1 \cos\ \tau)\, x=0, \qquad (2)$$

simultaneously describes and admits dynamic stability of unstable states beyond of parametric resonance zone in static ($\varepsilon_0 < 0$). An example is the stability of upturned pendulum (1) with vibrating point of hanging, described (2) at small angles of its diversion x from a vertical (a fig. 1a).

The simple reasonings display, that vibration of pendulum hanging point with a frequency $\omega > (2)^{1/2}\omega_0(l/l_1)$ ([18], p.122), is equivalent to occurrence of effective retracing force to a vertical. When the rod is speeded up downwards, the angle x is diminished on x_1, and deflecting moment of forces is diminished accordingly at a further motion of a rod upward. In result at motion upward the angle $(x-x_1)$ will increase only on $x_2 < x_1$. Thus, in spite of the fact that the vibrant force always changes the direction, in average it operates to a vertical, diminishing x. In summary the pendulum will take up position, diametrically opposite to normal.

In zones of parametric resonance for systems, describing by equation (2), stability is disturbed, and vibration amplitude grows without bounds (fig.2).

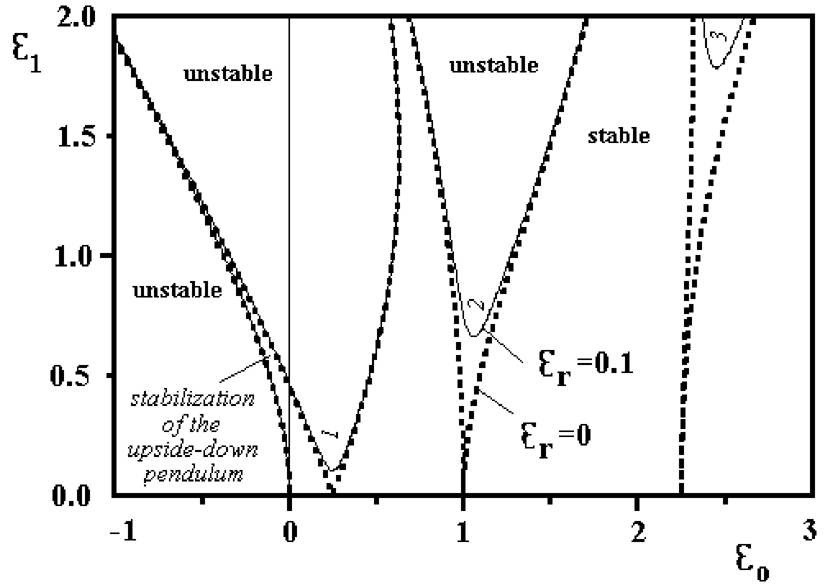


Fig.2. Zones of parametric resonance.

For the first time, apparently, B. Van der Pol in 1925 has specified that upturned pendulum has stability state. In 1950 P.L.Kapica, utilised a method of the approximate solution, has gracefully described and experimentally shown an effect of upturned pendulum (Kapica's pendulum). —« It is well known, - P.L.Kapica noticed [6], that for a body in a quiescence the most stable state is state, at which one its centre of gravity is in lowest point (relevant to a minimum of potential energy), and at dynamic balance the most stable state is state, at which one the centre of gravity is in the highest point (relevant to a maximum of potential energy) ». The most vivid example of this principle is the ordinary top. It is known, the force caused by friction of top seat about a surface, let top axis to be lifted and accept the most vertical position, the precession is quenched, and the top as though "die away". But except for classic cases of dynamic stability caused by gyro forces, a series others is known. For example, at a fast motion of the man on stilts, bicyclist, bus, locomotive etc the most stability state is state when the centre of gravity occupies, whenever possible, higher position

One of the most vivid examples of dynamic stability is pole with oscillating point of suspension. This phenomenon at demonstrating (century XIV, Bombay, fig. 3) is not less amazing, than top, and study it is instructively too.

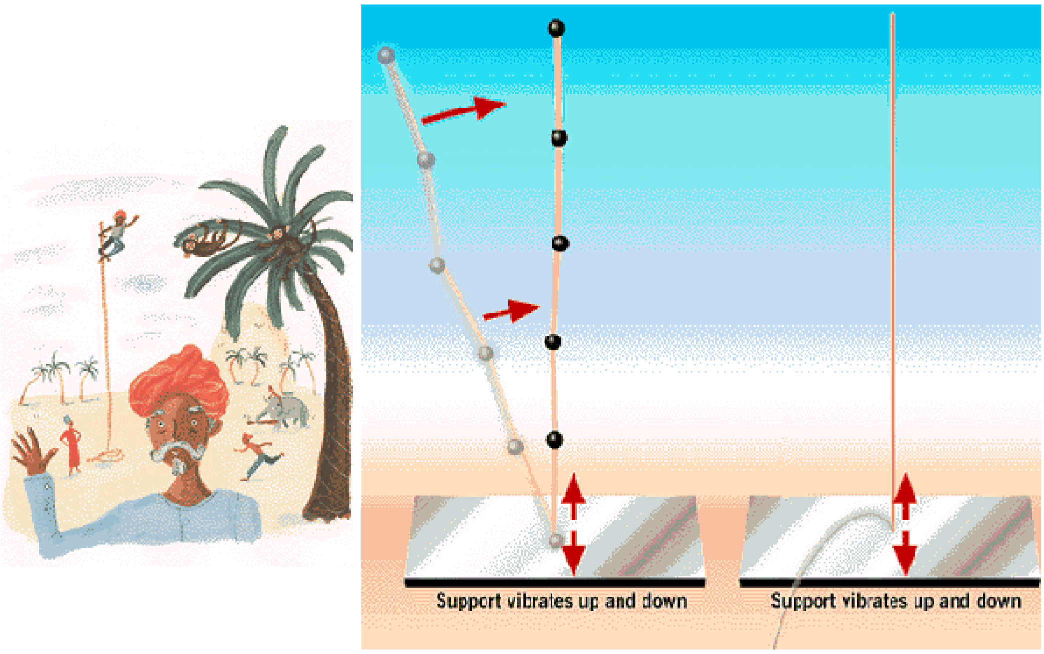


Fig. 3.

In 1908, mathematician Andrew Stephenson from university Manchester, using Newton's laws, has proved, that pole can be retained strengthly enough by vibrating of a support point along vertical, instead of translocating it from side to side, as ones usually do it, along horizontal [19].

P.L.Kapica has offered a simple and visual method [6] of dynamic stability analysis of a upturned pendulum with vibrant hanging point (fig. 1a, $x=\pi$) outside of parametric resonance zones and has described the device (fig. 4) for its demonstrating. . The vertical position of upturned pendulum is quite stable. In experiment this stability is well observed. For example, if a pendulum will be remove from a vertical position at some angle x, about a plumb position there will be oscillations, which one will damp due to friction, and a bit later the pendulum "die away" in a vertical position

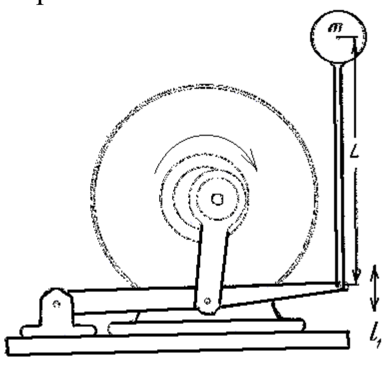


Fig. 4.

The Kapica’s method is usable for study of upturned pendulum motion with the quickly oscillating suspension outside of parametric resonance zones and based on two guesses. First - it is supposed, that the frequency of suspension vibration ω is so high, that for one period of complete oscillation of pendulum suspension under activity of exterior force f the angle x is a little deviated from some medial x_1; thus x may be represented as $x= x_1+x_2$, where x_2 is small fast - oscillating quantity. The second guess - a amplitude smallness of longitudinal vibration in comparison with length of pendulum l_1/l <<1 ($\alpha=l_1/l$ is a parameter of smallness). This solution method enables to compound a simple representation about physical substance of process. The fast oscillations of pendulum suspension leads to making an effective potential energy $U_{эфф} = U + \langle f^2 \rangle/(2m\omega^2)$ and moment of forces [18], which one exhibits itself, at the average, as the customary force, and it is similar with a gyro force:

$$\langle M \rangle = -(1/4)m\, l_1^2 \omega^2 \sin(2x), \quad (3)$$

Where m – is a mass of a pendulum.

The new paradoxical phenomena of a dynamic stability of unstable states in static were detected by V.N.Chelomey in experiments with vibrant fluids and solid bodies [13, 14].

1. **A stable position of system bundled «upturned» pendulums with pulsating point of suspension** (such as a fig. 1a, 3, 5.1).
2. **Heavy ball in a vibrant fluid.**

The cylindrical vessel (tube), produced from transparent material for observation convenience, is filled by a fluid, for example by water. Then the ball or cylindrical body from material, whose a specific gravity exceed a specific gravity of a fluid, is located in this vessel.

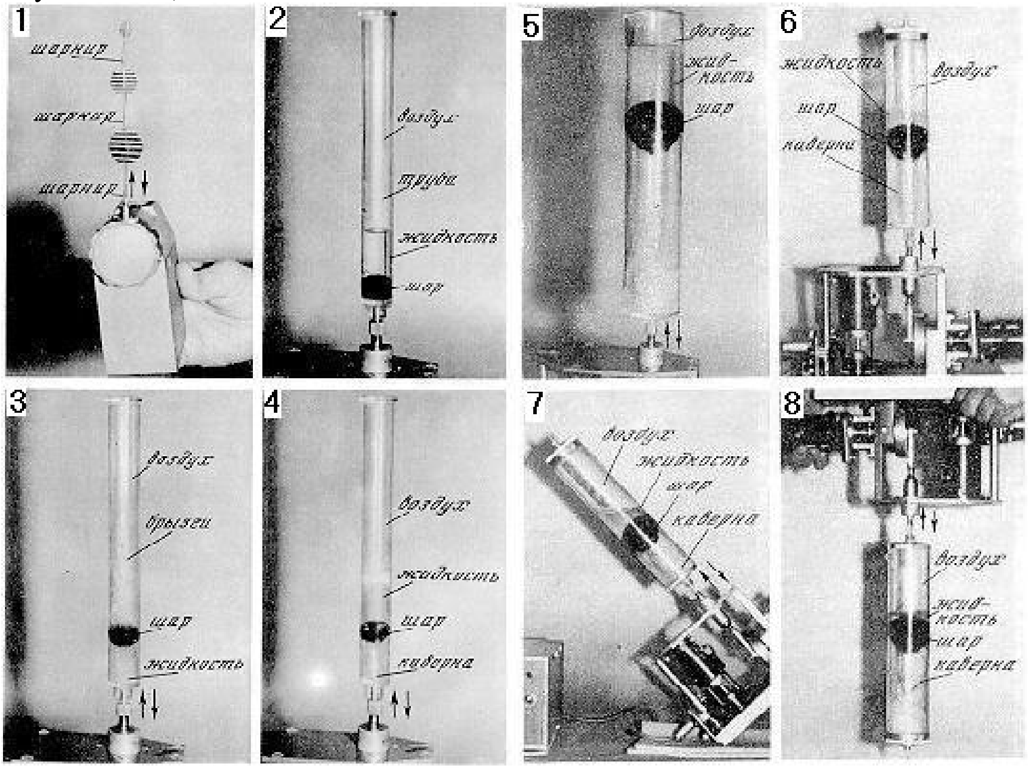


Fig. 5.1 - 5.8. Chelomey's «Pendulums».

The ball sinks and occupies the inferior position in a vessel (fig. 5.2). After that the vessel is placed on a shaker unit and exposed to vertical vibrations along its axis. At running into particular vibrations intensity the ball floats in a vessel (fig. 5.3). At increase of vibrations intensity the air space (cavern) with small quantity of fluid is formed under the ball, and the remaining fluid places above a ball (fig. 5.4). Thus the system is in a stable dynamic state. The small air pressure, framed under a ball, easily lifts it together a fluid up (fig. 5.5). Thus the system is stable in this new position. At inversion of vessel in a vertical plane on 180° the stable position of system is maintained (fig. 5.6 5.8). The similar experiment can be realised with a vessel, in which there are some balls (fig. 6.1, 6.2).

In this case similar appearances are observed too: the air caverns are formed almost under each ball with a fluid above them. It is possible to observe an inverse phenomenon: the cylindrical subject, light as contrasted to fluid, at vibrations can sink (fig. 6.3, 6.4). In all cases the system under vibrations activity tends to occupy the position, close to a state with a maximal potential energy.

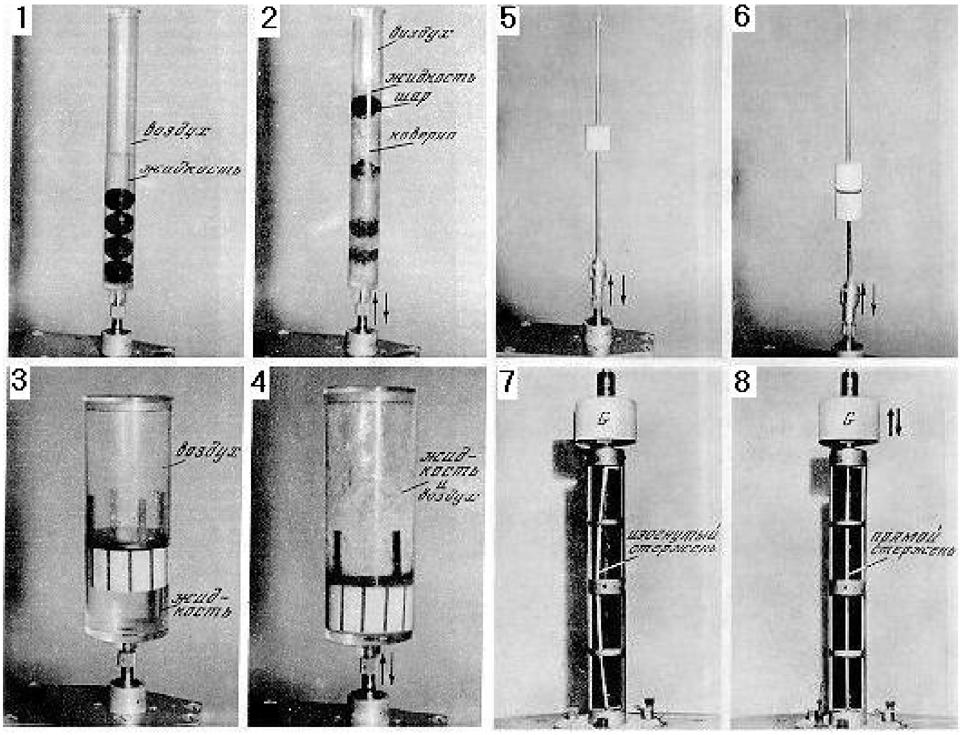


Fig. 6.1 - 6.8.Chelomey's «Pendulums».

3. **Unattached washer on a vertical vibrant rod with the inferior hinge support.** On a direct vertical rod with one lower hinge support, the washer with a hole is dressed on, hole diameter is a bit more than a diameter of a rod. By gravity the washer drops. However, if to add the vertical oscillations to a hinge support of this rod, the washer does not drop, and remains almost in a fixed position on a rod, as though in a zero gravity state, the rod stands almost vertically (fig. 6.5). It is explained by activity of average vibrating forces and moments. The experiment is easily extended at a case of two or more washers (fig. 6.6), and also at a case of large clearances between rod and washer.

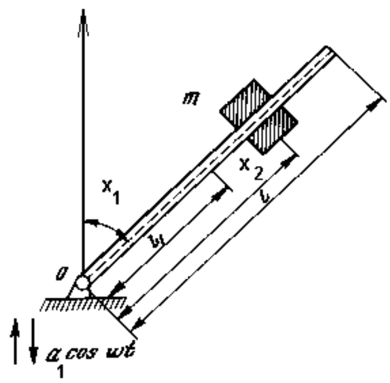


Fig 7.Chelomey's «Pendulum».

The differential equations of motion of "upturned" pendulum (rod) with unattached washer without clearances at vibrant inferior support point (fig. 7) looks like:

$$(I_0+I_1+mx_2^2)x''_1+2mx'_1x'_2+(k_1/\omega)x'_1-(M\ell_1+mx_2)(g/\omega^2-a\cos\tau)\sin x_1=0,$$

$$x''_2 + (k_2 /\omega)x'_2 - x_2 x'^2_1 + (g/\omega^2 - a\cos\tau)\cos x_1 = 0, \quad (4)$$

where I_0 - moment of a rod inertia (without a washer) relatively a spin axis; $I_1+mx_2^2$– moment of washer inertia; I_1 - natural moment of inertia of a washer; m - washer mass; x_2 - current coordinate of washer, counting off along a rod; x_1 - current angle of rod rotation at oscillations; ℓ - length of a rod; M - mass of a rod; ℓ_1 - distance from mass centre of a rod up to its spin axis; k_1x_1 - friction torque, framed by a motion of all system; k_2x_2 - frictional force of a washer about a rod referenced to a washer mass; ω- circular frequency of a hinge support vibration; a - amplitude of vibration. It is supposed, that $a/\ell \ll 1$.

This composite nonlinear system of equations, describing a motion of considered system, till now are not researched and contains the terms with a quickly varying phase. By a method of average the initial system of the differential equations is reduced to four nonlinear differential equations of the first order which ones do not contain a time in an explicit view. The functions, slowly varying in time, will be solutions of these equations. In this case a quasi-static solutions of these equations, giving values of equilibrium points of washer on a rod, are easily fond. The definition conditions of washer stability relatively a rod is not very difficult.

The check out of theoretical results was carried out computer-aided by a Kutt-Merson method with a self-acting select of an integration step. The obtained results give close coincidence to experience.

4. Stability improvement of elastic systems by means of vibrations. The rectilinear vertical rod is weighted with a load G, which weight exceeds the first Eulerian (critical) force. Under activity of this load the rod is bended (fig. 6.7). The load is provided with longitudinal vibrations by the vibration exciter, taking place on it. In this case the rod is straightened, and the load occupies a higher initial position (fig. 6.8).

Thus the rod exposed to periodic high-frequency longitudinal vibrations has critical force exceeding static critical Eulerian force. It can, in particular sense, be viewed as generalization of one of the most known Euler theorems of a stability of elastic systems at their static loading.

Explicitly the theory of an opportunity of stability improvement of elastic systems by the vibrations is expounded in a work [13].

2.2. Atomic traps.

In 1950 P.L. Kapica, considering a problem about upturned pendulum, has specified an opportunity of using of the orienting moment of forces, arising at oscillatory process, for colloids and molecules orientation [6]. Only in 1958 M.A. Gaponov, M.A. Miller theoretically have substantiated an arising opportunity of potential wells in nonuniform high-frequency electromagnetic fields for charged particles [20].

Practically simultaneously abroad several authors experimentally have shown retention of charged particles in nonuniform constant and variable electric fields outside of resonance zone [21, 22]. In 1989 the Nobel Prizes were awarded physicists: N.F. Remsy, V.Paul and H. Demelt for series of experimental works with isolated particles [23, 24, 27].

Idea of "atomic" traps has arisen in physics of molecular beams, mass spectrometries and physics of accelerating particles [21-27]. Those years (1950-1955) the experimenters have learned to focalize particles in two measurings with flat electrical and magnetic fields, operating at their magnetic or electrical dipole moments.

In a two-dimensional quadrupole the field configuration fig. 8a is generated by four electrodes of the hyperbolic shape, linearly extended along an axis Y, as shown at fig. 8б. If at electrodes to affix a constant voltage U plus a voltage V on a radio frequency:

$$\Phi_0 = U + V\cos\omega t, \quad (5)$$

that in a field with potential

$$\Phi = \Phi_0(x^2 - z^2)/(2r_o^2), \quad (6)$$

the equations of motion will look like:

$$\omega\omega x'' + (ax + 2qx \cos t)\, x=0,\ z'' + (az + 2qz \cos \omega t)\, z=0, \quad (7)$$

where $a_x = -\, a_z = a = 4eU/(m\, r_o^2 \omega^2)$, $q_x = -\, q_z = q = 2eV/(m\, r_o^2 \omega^2)$ or in variable (1)

$$x''_i + (\varepsilon_{0\,i} + \varepsilon_{1\,i} \cos\, \tau)\, x_i=0 \quad (8)$$

where $\varepsilon_{0x} = -\, \varepsilon_{0\,z}/2=a/4,\ -\, \varepsilon_{1x}=\varepsilon_{1\,z}/2=q/2,\ x''_i = dx/d\tau,\ \ \tau=\omega t.$

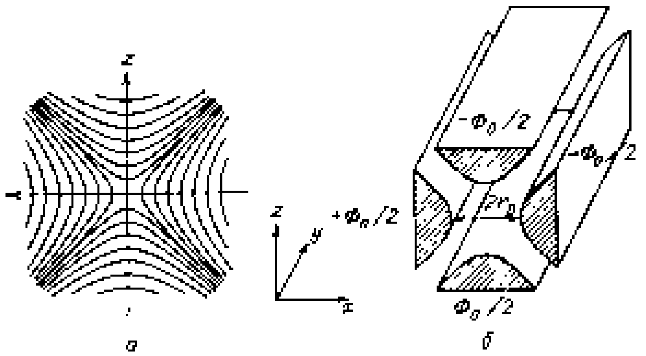


Fig. 8. A two dimensional quadrupole.

The Mathieu equations (7, 8) have two types of the solutions.

1. The stable motion: the particles oscillate in planes *x*, *z* with restricted amplitudes outside of resonance zones.

2. The unstable motion in resonance zones: the amplitudes on *x*, *z* exponentially accrue. The particles will be lost.

The existence of a stability depends only of parameters *a* and *q* and does not depend of initial parameters of ion motion, for example, of its velocity. Hence, on the diagram *a-q* there are areas of stability and instability (fig. 9).

For given problem only that part is interesting, where the stability areas on *x* and *z* are lapped over. The most essential area is area with $a > 0$, $q < 1$. The motion is stable on *x* and on *z* only inside of area.

Last decades the radio-frequency quadrupole, due to its universality and simplicity, has found wide application in many areas of science and technique – it is mass spectrometer and guiding system for beams. It became a variety of the standard measuring device.

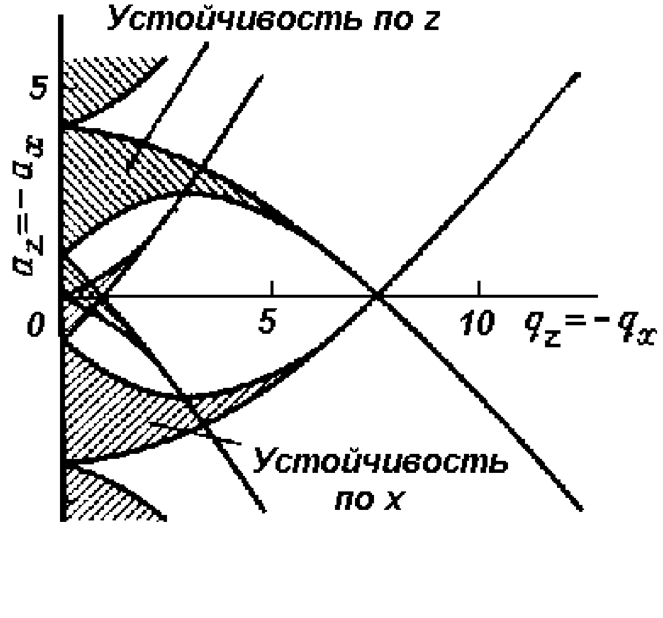


Fig. 9. The complete diagram of stability for a two-dimensional quadrupole field.

In a two-dimensional quadrupole (fig. 8) the dynamic stabilization of ions has directed the authors at idea of use its for entrapment of ions in a three-dimensional field [21, 24]. For the first time ion trap (fig. 10a) was created by them in 1954. Such traps allow exploring even single isolated particles during long time interval, and by that, according to Heisenberg's principle of indeterminacy, enabling to measure their properties with an extremely high accuracy.

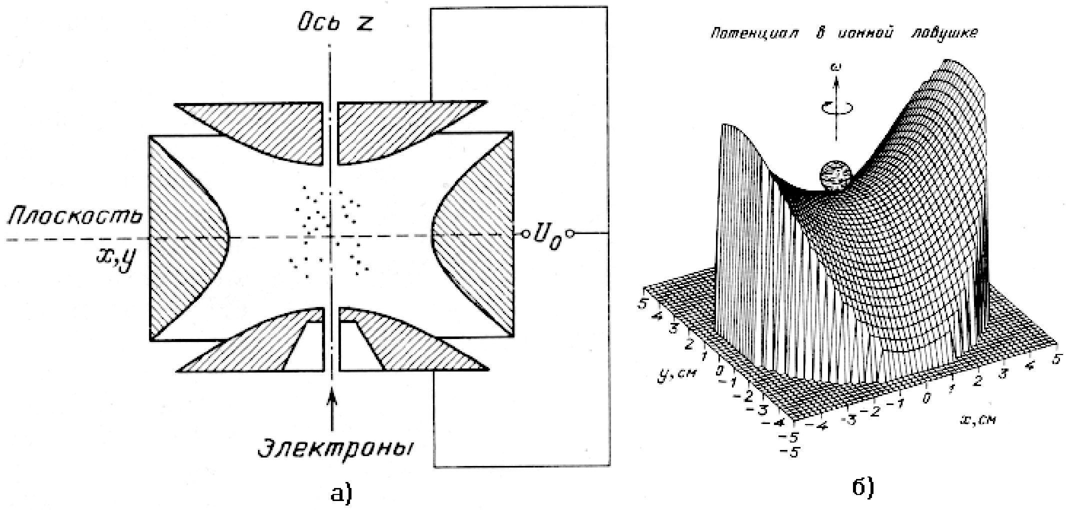


Fig. 10. An ion trap (a) and its mechanical analogue (б).

The potential configuration in an ion trap is determined by the formula:

$$\Phi=\Phi_0(r^2-z^2)/(r_o^2+2z_o^2), \qquad (9)$$

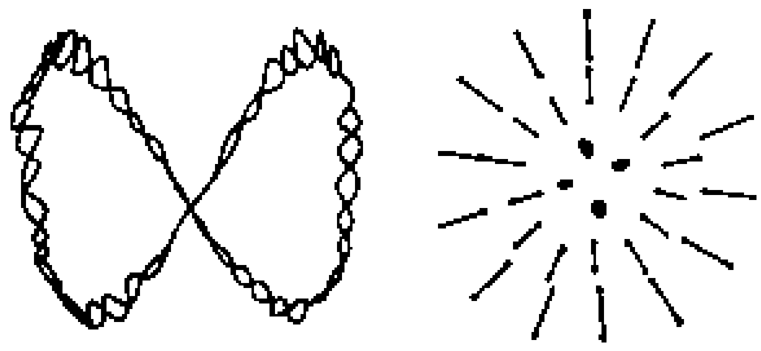
Where $2z_o^2= r_0^2$, $2r_o$ is an electrode calibre in a plane x, y.
Such configuration is generated by a ring of the rotation hyperboloid form and two caps with a hyperbolic surface possessing of rotary symmetry, as it is shown in a fig. 10a.

The relevant equations of motion in dimensionless variable look like [24]:

$$x''_i + (\varepsilon_{0\,i} + \varepsilon_{1\,i} \cos \tau)\, x_i=0, \qquad (10)$$

where $\varepsilon_{ox}=\varepsilon_{oy} = -\varepsilon_{oz} /2= a/4$, $-\varepsilon_{1x}= - \varepsilon_{1y}=\varepsilon_{1z} /2= q/2$. The own solutions of the Mathieu equations (10) are stable only in a particular range of parameters ε_{oi} and ε_{1i} (fig. 9).
It is easy to show a dynamic stabilization in a trap at mechanical analog (fig. 10б). Equipotential lines form a surface like a saddle in a trap. The authors [24] make such saddle from a Perspex on a disk. If we put a small steel ball on such surface - saddle, it will be roll downwards: its position is labile. However, if we make a disk to rotate with exact velocity, relevant to parameters of potential and ball mass (in this case it is some turns per second), the ball becomes stable, it makes small oscillations and can remain in such position for a long time. Even if we add the second or third ball, all of them will remain near to disk centre. An only condition is that relevant Mathieu parameter ε_{1i} has values within tolerance limits.

In 1959 Vurker with the scientific workers [22] have experimented on trapping of small (diameter ~mkm) charged aluminium particles in a quadrupole trap. Accordingly necessary forcing frequency was approximately 50 Hz. They have studied all natural frequencies and have received the particles orbits photos (fig. 11a). When the buffer gas stopped the motion of particles, they have detected that the incidentally moving particles were built in regular structure. They have formed a chip (fig. 11б).



а б

Fig.. 11 a – a photomicrograph of a Lissajous's orbit in a plane r, z of a separate charged particle of an aluminium dust. The micromotion is visible.

B - a "condensed" aluminium particles

Last years it was possible to observe separate entrapped ions by a laser resonant fluorescence [25]. Using the image amplifier of high resolution, Valter with the scientific workers observe a pseudo-crystallization of ions in a trap after their cooling by a laser light (fig. 12).

The ions are moved together in such positions, where focalizing forces in a trap compensate the Coulomb repulsion force, and the energy of all ensemble has a minimum. Distance between ions is of the order of several microns. These observations have unclosed a new research area [26].

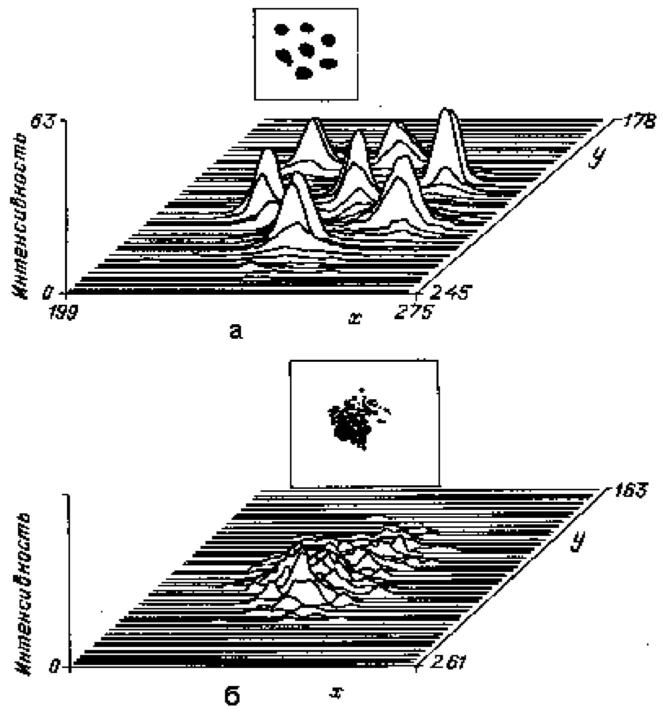


Fig. 12. a - pseudo-chip of seven magnesium ions. Distance between particles is 23 microns, b – the same particles at more «heat». A chip has melted.

An ion trap as a mass spectrometer. The ions oscillate in a trap with frequencies *r* and *z*, which are determined of ion mass at fixed parameters of a field. It gives an opportunity to carry out selective in masses the detection of the accumulated ions.

Traps for neutral particles. A base is a focusing of neutral atoms and molecules possessing dipole moment by the multipolar fields. The potential energy of a particle U with constant magnetic moment, locating in a magnetic field, is given by the formula: $U= -\mu \boldsymbol{B}$. If the field is nonhomogenous, there is a relevant force $\boldsymbol{F}= - \boldsymbol{grad}(U)$*).* For a neutron, possessing a spin $\hbar/2$*,* only two directions of a spin comparatively a field are allowed. Thus its magnet moment can be oriented either parallelly, or antiparallelly to a field $\boldsymbol{B}$. At a parallel orientation the particles are drawn in a field, and in an opposite case - are pushed out (analog of a classical problem of levitating top - "levitron", 2.3). It enables to realize their retention in volume with magnetic walls. A field of magnetic sextuple has a qualified configuration (fig. 13). Such field $\boldsymbol{B}$ increases at proportional of r^2, $B=(B_0/r_0^2)r^2$, and, correspondingly, its gradient $\partial B/\partial r$ is proportional to r.

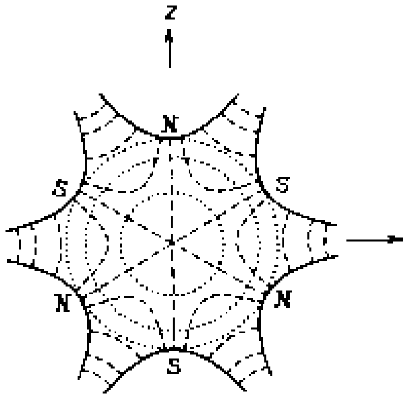


Fig. 13. Ideal sextuple field. The point lines - lines of magnetic field, dotted line - line of equal magnetic potential, B=const.

In a such field the neutrons with antiparallel orientation to the field, fulfil to a conditions of retention, i.e. their potential energy $U \sim r^2$, and resetting force $-cr$ always is guided to centre. They oscillate in a field with frequency $\omega=2\mu B_0/mr_0^2$. The particles with parallel orientation defocus itself and left a field. It is valid only so long as the orientation of a spin is maintained.

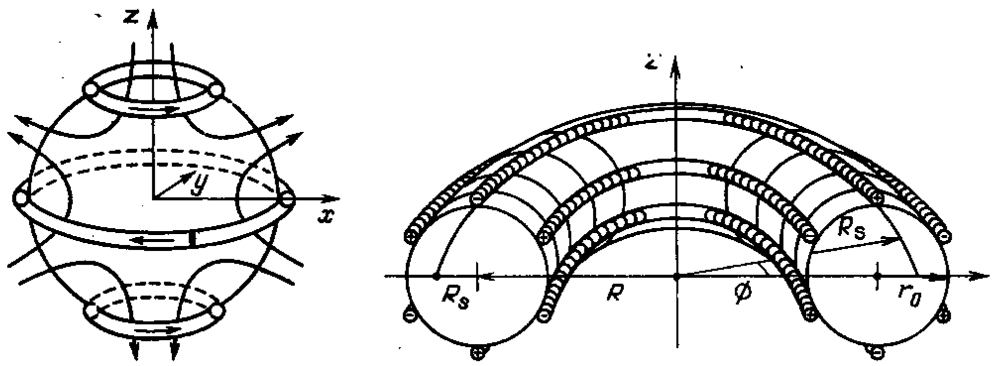


Fig. 14. a - sextuple sphere, b - sextuple torus.

In sextuple the direction of a magnetic field varies along azimuth, but while the motion of particles not too fast, spin adiabatically follows direction of a field, and the magnetic quantum number is maintained. Such behaviour allows using a fixed in time a magnetic field, as opposed to a case of charged particles in an ion trap. Sextuple sphere and sextuple torus allow receiving a closed volume of storage (fig. 14). The magnetic trap have allowed to construct "weights" for single neutrons and to measure gravitational mass of a neutron with sensibility ~ 10^{-25}g.

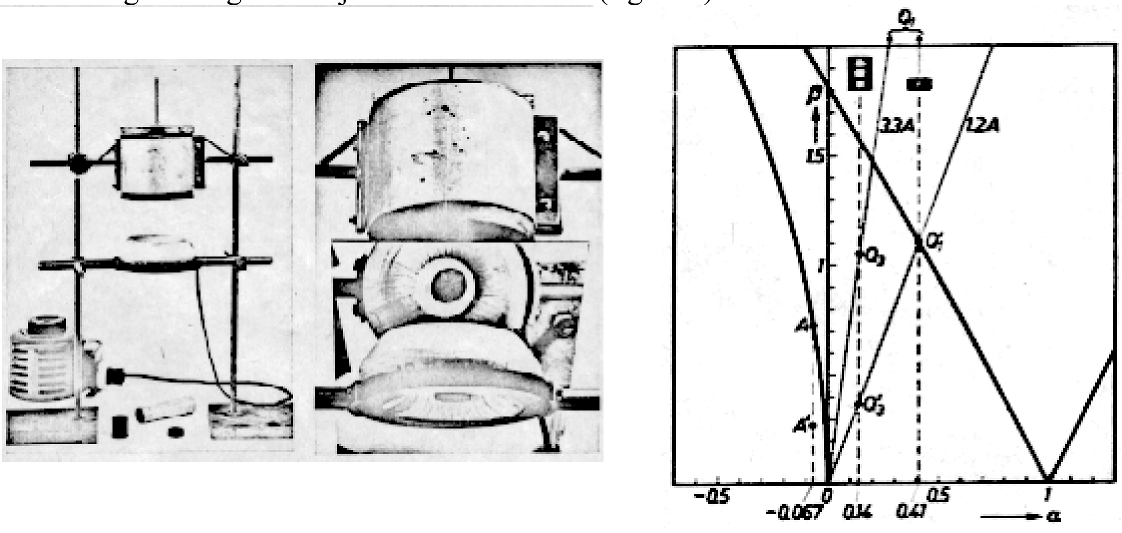
2.3. Problem of holding of undot magnetic particles

Historically " the first messages " about a levitation (hovering of subjects without a feedback) of extended objects (magnets) came from legends. Devout Mussulmans, in particular, were "... convinced, that a coffin with the late " prophet " is at rest in air, hanging without any support between floor and ceiling. They speak, - Euler wrote, - that Magomet coffin is held by the force of some magnet " ([28], p. 159). In later epoch (I-II century of new era.) the monks tried to make to hang in air a temple statue by the magnets.

As "...there is delighted of trick, which made in "a Temple of charm, or mechanical, optical and physical offices " by well-known Russian illusionist Gamuletskiy. His "office", existed till 1842, has become famous by that the visitors, rising upstairs, from afar could notice a gilded figure of the angel on the upper platform, at natural human height, soared at a horizontal position above the office door. That the figure has no any props, everyone could be convinced. When the visitors entered on a platform, the angel lifted arms, brought a horn to a mouth and played the it, moving fingers ".

" Ten years, - Gamuletskiy spoke, - I worked to find a point and weight of a magnet and iron to hold the angel in air. Besides work I used many funds for this miracle " ([29], p. 31).

In 70th in research laboratories of Phillips firm it was possible to observe curious effects - a levitating of constant magnets. Long before the “levitron” inventing [3035] H. van der Heide in 1974 theoretically and experimentally (fig. 15) on the basis of the Mathieu’s equations of a view (2, 8) investigated the effects of dynamic weighing of constant magnets outside of resonance zones (in a combined magnetic field - constant and variable ones) [36]. The constant field is formed by ring magnets, variable – by inductor connected to line-operated voltage through the adjustable transformer (fig. 15a).



а) б)

F*ig. 15: a - magnetic trap [36], b - zones of stable weighing.*

H. van der Heide [36] also has analyzed opportunities of containing and practical use of a propelling constant magnet in a field of a fixed constant magnet, in particular for making a carrier on magnetic suspension (fig. 16).

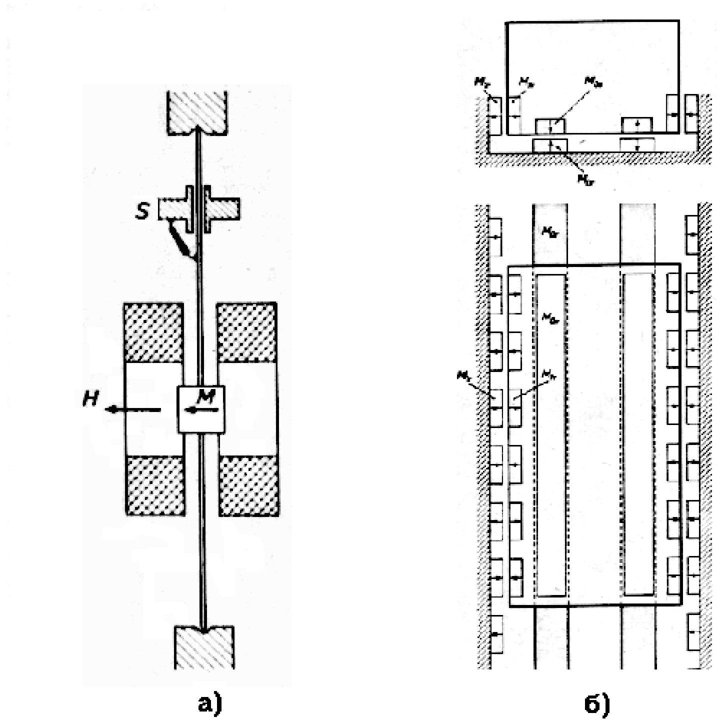


Fig. 16. Retention of a propellenting constant magnet in a field of fixed constant magnet (a - principle, b - realization).

Later, in 1983 this idea was licensed by an inventor Roy Harrigan [33] and was implemented (1983 - 1995, fig. 17) as levitron - levitating magnetic toy – top [30-35].

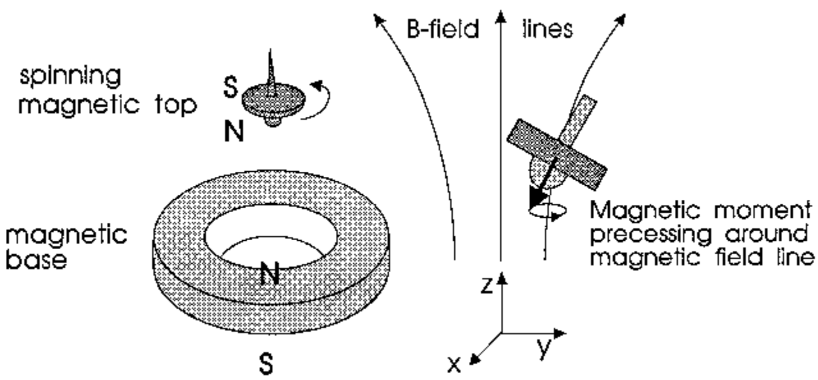


Fig. 17. Levitron.

2.3. A "$1/R^3$ problem " in system of two dipoles.

It is necessary to note that to find the solution of nonlinear set of equations, describing a dynamics of bodies and particles with account of transmitting and rotary degrees of freedom in general is impossible practically. Therefore majority of the authors, as a rule, at the analysis of dynamics of particles in traps confined themselves to the solution of the equations such as the Mathieu's equation (2, 8) outside of a resonance zone. More composite nonlinear dynamic systems were considered in V.V. Kozorez's works [37].

To a problem of a stability of magnetic systems the results on study of particles behavior possessing of magnetic moment are refered. These result in that time played the important role in the theory of a meson and nuclear forces (Tamm, 1940). Its were, that the free magnetic particle, at its motion, does not remain on a stationary trajectory, and drop on the magnetic - attractive center (a"$1/R^3$ problem ").

The representations about stable system of free magnet-interactioning bodies reduce, as a rule, to the following: instability of equilibrium (Irnshow's theorem), instability of planetary system (a "$1/R^3$ problem"), effect of stabilization by sign-variable force.

One of the ideas of the " $1/R^3$ problems " solution is the Gynsburg's idea about necessity of the account of space extent of a magnetic particle, or, " the account of response of an natural field of a particle " [38,39]. Gynsburg noticed that the account of response of a natural field also could eliminate the drop on the magnetic - attractive center. The qualitative reasons, marked in [39], are reduced to that at convergence of magnetic moments the kinetic energy of a precession will increase. However in detail this problem is not considered ([39], p. 262-263): " it is necessary to note, and it is strict, that the absence of drop at the account of an natural field yet is not shown by us, if the magnetic moments are parallel each other and to line, connecting them, then $U \sim 1/R^3$ as usual, the precession of the moments is absent and drop have to take place ".

On the basis of V.V. Kozorez's works [37] the trajectory can not much more excess the sizes of a magnetic body in stable planetary magnetic system, and the translational and rotary magnets motions are strongly correlated. Kozorez has considered different models of magnetic interaction (fig. 18):

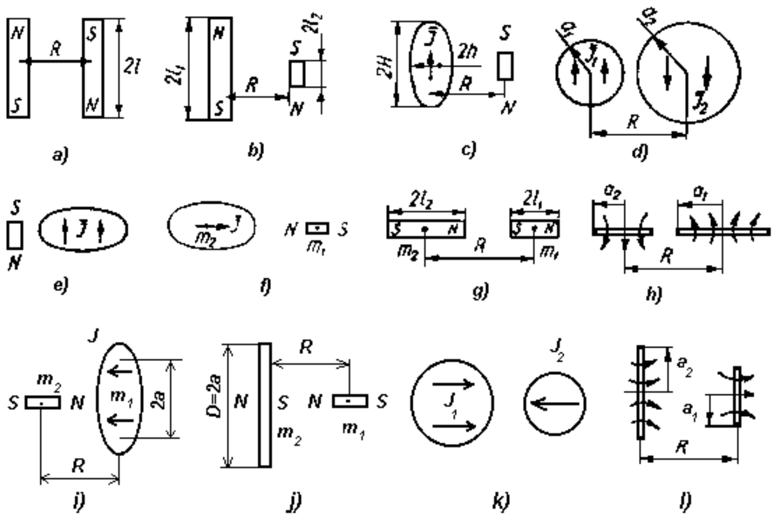


Fig. 18. To a «1/R³ problem».

In case of two lengthy identical magnets the area of stable orbital trajectories of motions arises in the field of parameters $2lR^{-1}$>0,425 (fig. 19).

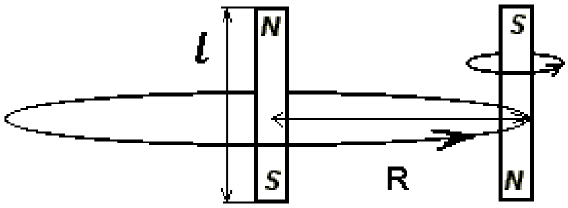


Fig. 19. An orbital stability in system of two magnets.

In a general view, the results for systems (fig. 18) of stabilities areas are shown in the table 1.

The table 1

fig.18	Type of magnetic system	Area of stable trajectories
a	Two identical lengthy magnets	$2lR^{-1}>0,425$
b	System of lengthy and small magnets ($l_1>>l_2$)	$2l_1R^{-1}>0,5$
c	Oblong spheroid-dipole	$(R\sigma_0)^{-1}H>(0,5)$^1/2, $(Hh^{-1})_{min}$~1,23, $\sigma_0^2(\sigma_0^2-1)=H^2h^{-2}$
d	Two magnetic balls	There is no stability at anyone R independently of $a_1a_2^{-1}$
e	Oblate spheroid-dipole	The system is unstable
f	Oblong spheroid-dipole	The system is unstable
g	Two lengthy cylindrical magnets	There is no stability independently of l_1/l_2
h	Two ideally conductive current rings Ψ_1, Ψ_2=const	$\Psi_1\Psi_2^{-1}\neq 1$, a_1/R, $a_2/R\leq 1/2$
i	Oblate spheroid-dipole	$Ra^{-1}<(3)$^1/2
j	Disk - dipole	$Ra^{-1}<(3)$^1/2
k	Two magnetic balls	The system is unstable
l	Two ideally conductive current rings	$\Psi_1\Psi_2^{-1}\neq 1$ a_1/R, $a_2/R\leq 1/2$

Experiment of orbital flight of a free magnet. Along with the theoretical proof of a stability of planetary magnetic systems the experimental substantiation of orbital motion stability is interesting. Let's consider plan of experiment in more detail (fig. 20) [37].

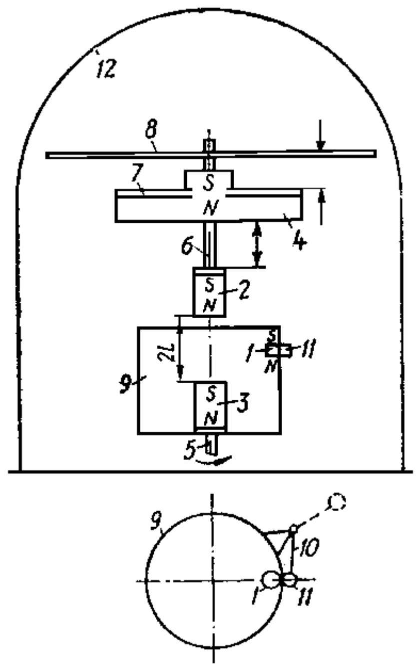


Fig. 20. Experiment of free magnet orbital flight.

The magnetic system consists of a disk magnet 1 (diameter 7 mm), intended for free orbital flight, fixed cylindrical magnets 2,3 (diameter 15 mm, height 50 mm), rods 5,6, disk 7 and cover 8. For tuning magnetic system in installation it was possible to change the sizes marked by arrowed lines. The magnets are magnetized in a direction marked by the letters N and S.

The rods 5, 6, disk 7 and cover 8 manufactured from usual magnet-soft steel, and magnets 1-3 - of anisotropic oxide-barium ferrite 2БА with preferred magnetic properties at a direction to an installation axis.

For starting on an orbit the thin dielectric glass 9 (diameter 60 mm) with copper level 10 and steel bob 11 was used. The bob with level could turn in a horizontal plane. The glass 9 was set in gyration by the electromotor. Under a demountable glass cap 12 a vacuum could be created.

Before start the magnet 1 was manually placed on an interior cylindrical surface of a glass 9 in a contact zone of a bob 11 with an outside surface of a glass. The attraction between a bob 11 and magnet 1 was stronger than an attraction of a magnet to fixed magnets 2, 3 owing to the greater removal from an installation axis. Therefore magnet 1 at a fixing and slowly rotating glass 9 was contained on its interior surface.

At untwisting of a glassful up to $n \geq 300$ rev/min the bob 11 broken away outside surface of a glass and occupied a position shown by a dotted line. The magnet 1 at this velocity was retained by centrifugal forces on an interior surface of a glassful. In accordance with diminution of velocity up to $n \sim 220$ rev/min the centrifugal force of a magnet diminished so, that the attraction of fixed magnets "drew out" it on an orbit without contact to a glass 9, then a glass was stopped.

At first the experiments were carried out without vacuum. The free flights began from several coils - spiral trajectories finishing by drop or on magnets 2,3,6, or on the base of installation. After tuning magnetic system the time of free flight was increased to several seconds. In separate experiments the magnet, at first, moved on a twisting spiral, then the size of an orbit was increased and orbit again was transmuted into a spiral with the end on fixed magnets. The flights along a spiral with simultaneous vertical oscillations were observed too, and their amplitude on initial coils was usually more, than on next.

After achievement the some seconds of flight without vacuum, the experiments have begun to carry out in vacuum. It has appeared that the degree of air rarefaction under a cap significantly influences time of free flight. It began to increase, and, at last, at vacuum of 10^{-3} mm of mercury column the three experiments of free flight time 5 mines. 58 sec., 6 mines. 2 sec. and 6 mines. 35 sec. was possible to realize.

The free flight in these experiments exemplified the following. During 0,5-1,0 min. the flat circular trajectory of a magnet placed nearly below than middle of distance between magnets 2, 3 and practically did not vary. Then radius R of a trajectory began gradually to diminish from 30 up to 25 mm, and the velocity of gyration was gradually incremented from n~230 up to n~250 rev/min.

The diminution of trajectory radius from 25 up to 10 mm was lasting 4-4,5 min and was accompanying by gradual climb of a flight plane and increase of gyration velocity up to n~300-350 rev/min. Besides the angle between magnetic axes of a free magnet 1 and magnets 2, 3 varied. In the beginning of free flight it was about 10^o, at R~10 mm the axis were practically parallel.

In accordance with diminution of a trajectory radius, since *R~10* mm, in flight there were oscillations of a free magnet in a vertical direction with frequency of the same order, as velocity of orbital gyration. Their amplitude was gradually incremented, and, at last, at *R~5* mm the magnet 1 dropped on a magnet pole 2 or 3.

2.4. The cells in "atomic" traps..

Alive cells are very difficult objects for researches. Many procedures, widely applicable for fixed sections, are completely inapplicable for alive objects, as can destroy a cell or change its metabolism (for example, electron microscopy). By operation with biological molecules an electrophoresis is widely apply. The electrophoresis was discovered by the Russian scientist F.F. Reis in 1807 [40].

Recently [41-49], in terms of electrophoresis phenomenon, the traps for cells (effect of a cells levitation in electromagnetic fields) are developed and intensively use. This method is a basis of a recent trend - intravital research of cells.

Alive cells, like high-molecular organism substances, at physiological value pH have on their surface a redundant negative charge, which is formed owing to a dissociation of ionogenic groups of a cell membrane, mainly acid groups. The electric cell charge plays the important role in a gas exchange, adsorption of substances from exterior medium, formation of structure of cell aggregations and in all physiological life phenomena.

In a general view the theory of a cell dynamic in electromagnetic fields in polar fluids - electrolytes is extreme difficult, and its solution is not easier than the solution of problems of "traps of atomic and elementary particles ".

Now, as a rule, three basic mechanisms of retention and control of separate cells are take into account.

1. Induced electrical dipole moment. When the electric field influences at a polarized particle, the charge inside and outside of this particle is polarized, inducing the artificial electrical dipole moment. Absolute value of a dipole vector $\boldsymbol{p}$ depends from:

- Size of a particle;
- Absolute value of the appreciated electric fields;
- Differences between a particle and medium in ability to be polarized.

The resulting electrical dipole moment $\boldsymbol{p}$ of a homogeneous dielectric sphere in dielectric medium can be noted as:

$$\boldsymbol{p} = 4\pi\xi_2 f(\xi_1,\xi_2) r^3 \boldsymbol{E}, \tag{11}$$

where $f(\xi_1,\xi_2)=[(\xi_1-\xi_2)/(\xi_1+2\xi_2)]$ - so-called factor of Clausius Mosotti, ξ_1 and ξ_2 - complex dielectric constants of medium and particle with radius r accordingly, and E - electric intensity. Usually the complex dielectric constant is assumed $\xi=\varepsilon - i(\sigma/\omega)$, where ε - real inductivity, σ - specific conductivity, ω - angular frequency.

If $\xi_1>\xi_2$, that $f(\xi_1,\xi_2) > 0$ and the resulting electrical dipole moment is guided along a vector of an electric field E. Otherwise, if $\xi_1<\xi_2$ that $f(\xi_1,\xi_2) <0$ and the resulting electrical dipole moment is guided against a vector of applicated electric field. It is necessary to note, that for a sphere the Clausius Mosotti's factor is limited by $1 \geq f(\xi_1,\xi_2) \geq 1/2$, thus absolute value of electrical dipole moment is limited.

2. Forces, influencing at a particle (dielectrophoresis). The force, influencing at a dipole at a dielectrophoresis ***F*** (fig. 21), is computed by the following basic equation:

$$\boldsymbol{F}=\mathrm{Re}\{(\boldsymbol{p}\nabla)\boldsymbol{E}\}, \qquad (12)$$

where ***p*** - artificial electrical dipole moment of a particle, ***E*** - electric intensity.

For a particle with a volume *V* this formula can also be take down by the computed effective polarizing ability:

$$F(t)=\mathrm{Re}\{Vu(\boldsymbol{E}\nabla)\boldsymbol{E}\}=\mathrm{Re}\{Vu\nabla E^2\}/2. \qquad (13)$$

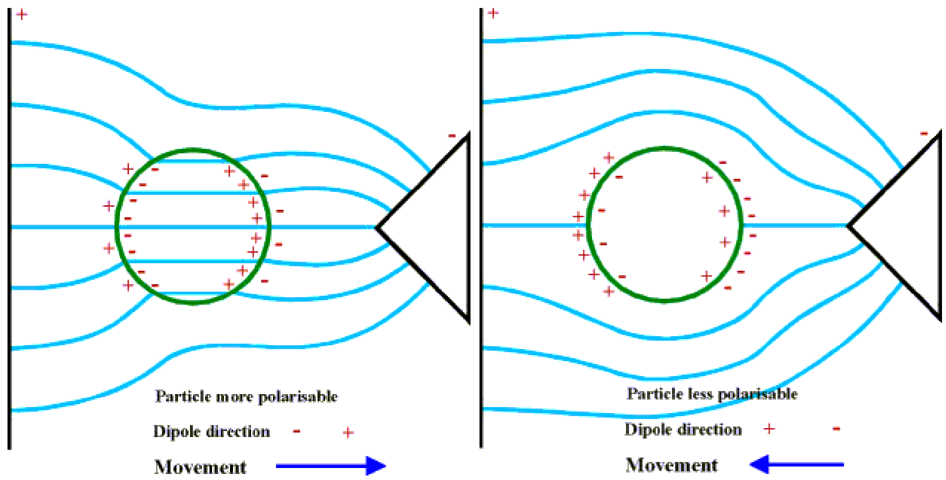


Fig. 21. A cell in a heterogeneous electric field.

For a homogeneous uncharged sphere the effective polarizing ability is computed by formula:

$$u=\xi_2 f(\xi_1,\xi_2). \qquad (14)$$

The integrating of the formulas (12) and (13) gives well-known expression for force acting on a sphere at a dielectrophoresis:

$$F=2\pi r^3 \xi_2 \mathrm{Re}\{[(\xi_1-\xi_2)/(\xi_1+2\xi_2)]\nabla E^2\}. \qquad (15)$$

For illustrating of all, that was mentioned above, it is necessary to note, that the Clausius Mosotti's factor can be both positive, and negative (or to have a zero value), hence, force, influencing on a particle can be guided along or against a gradient of an electric intensity.

3. Rotatory moment of a particle. Electrorotation. The rotatory moment, influencing at a dipole, is described by the following equation:

$$\boldsymbol{N}=[\boldsymbol{p}\cdot\boldsymbol{E}]. \qquad (16)$$

The formula reads that the rotatory moment depends only of an electric field vector and does not depend of a gradient of intensity. The absolute value of a difference of phases between artificial dipole ***p*** and vector of an electric intensity ***E*** determines an absolute value of a rotatory moment, achieving a maximum at difference of phases in 90° and minimum at 0°. Thus, the particle in a rotation electric field will be turn in an antiphase with a field (fig. 22). It is possible to show that the rotatory moment depends only of imaginary components of electrical dipole moment and for particle with radius ***r*** is:

$$N(\omega)=-4\pi\xi_2 r^3 \mathrm{Im}\{f(\xi_1,\xi_2)\}E^2. \qquad (17)$$

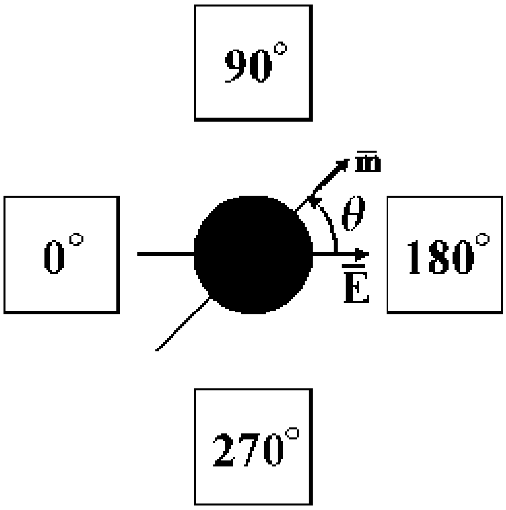


Fig. 22. A cell in a rotation electric field.

Dielectrophoresis - traveling wave. Definition of the induced electrical dipole moment:

$$\boldsymbol{p}(t)=p_x(t)\boldsymbol{a}_x+p_y(t)\boldsymbol{a}_y+p_z(t)\boldsymbol{a}_z, \tag{18}$$

where $\boldsymbol{a}_x$, $\boldsymbol{a}_y$, $\boldsymbol{a}_z$ - unit vectors of axes ***x, y*** and ***z*** accordingly and p_x, p_y, and p_z - absolute values of the induced electrical dipole moment.

At dielectrophoresis a force of electric field effect in a traveling wave (the fig. 23) is computed by the following formula:

.

$$F(t)=-4\pi^2\xi_2 r^3 \mathrm{Im}\{f(\xi_1,\xi_2)\}E^2/\lambda, \tag{19}$$

where λ - wave length of a traveling field and $\mathrm{Im}\{f(\xi_1,\xi_2)\}$- imaginary number of the Clausius Mosotti's factor. The real and imaginary parts of the Clausius Mosotti's factor give the components, coinciding and not coinciding on a phase of a dipole $p(t)$, which by the gyration determines a behavior of particles at a dielectrophoresis and electrorotation in a traveling wave (fig. 23).

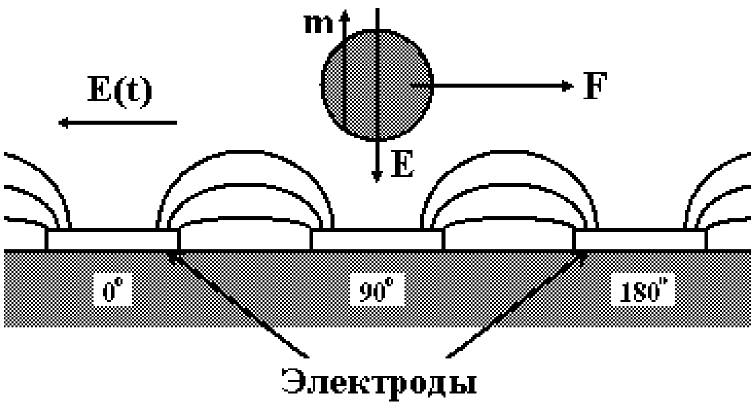


Fig. 23. A dielectrophoresis - «traveling on waves ».

The forces, arising at a linear dielectrophoresis, are placed in equilibrium by viscous drag (are evaluated by the Stoks' formula). Thus, dielectrophoresis in medium with viscosity η, velocity x of a particle, moving along an electrode net, is evaluated by the formula:

$$\upsilon = -2\pi\xi_2 r^2 \mathrm{Im}\{f(\xi_1,\xi_2)\} E^2/(3\lambda\eta). \quad (20)$$

The velocity is proportional to a quadrate of a particle radius, quadrate of an electric intensity, path length, viscosity of medium and imaginary part of the Clausius Mosotti's factor.

The application of electrodes of the different shapes is effective at particles separation. In a fig. 24 the electrodes for a dielectrophoresis are shown which are applied at researches and separation of different particles and cells at Glasgow University [49].

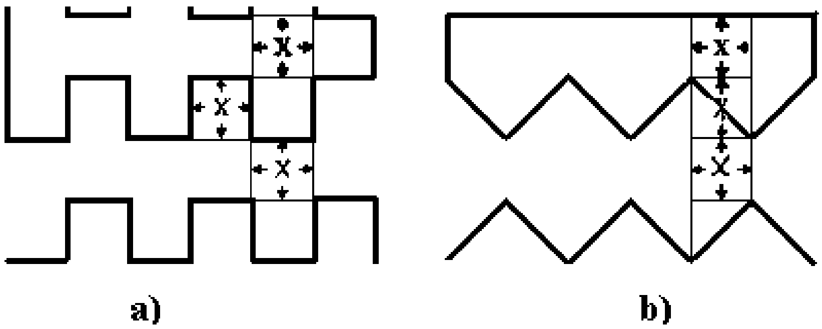


Fig. 24 a - toothed, b - sawed electrode net
The electrodes are made with step 1-100 microns.

Production of microelectrodes for electrokinetic researches is fulfilled with assistance of department of electronics and micro- and nano- production electronic engineering of a world class [48, 49]. The combined application of a photoengraving and electron-beam printing has allowed making a special electrode nets by the sizes from 500 nanometers up to 500 microns. The area of electrodes can achieve several square centimeters.

2.5. Ponderomotive influence of waves at "resonators".

A problem of resonances and small denominators in a celestial mechanics [50-52], radiation belts of planets and dynamics of charged particles in electromagnetic fields [20-27], a problem of intermolecular forces [53-55] are refered to traditional ponderomotive resonant problems,

Apparently, for the first time ponderomotive resonant activity attracted attention in XVIII century in connection with a problem of resonances and small denominators in a celestial mechanics [51]. The set of commensurable "resonant" relations between orbital periods of planets and satellites of solar system, between their rotary (around of the axes) and orbital motions was noted. [51, 52].

The origin of resonances practically reduces to impossibility of prediction of solar system evolution [52]. A selection of an initial physical model for its solution is not still clearly. In opinion of some authors the essential role in stabilization of resonant structure of solar system the moments of interreacting bodies momentum are played [52]. A.K.Gulak partially have could to simplify the solution of this problem on the basis of the equation of a dynamic balance [50, 56-58]. He gets the equation [58] from specific integral of a motion for a centrally symmetric field ([18], p. 53).

Ovenden's guess about extremeness of resonant states of a motion in a nature for an explanation of resonances in a celestial mechanics has played an important role. [59].

Recently the new «resonant» points in physics have appeared. They have emerged on joints of optics and physics of magnetic phenomena with a mechanics. Emergence one of this (focusing and self-focusing of nuclear and light beams, resonant light pressure [60-63]) is stipulated by laser making and application. The origin of another (series of separate works on ponderomotive influence of an electromagnetic field in a magnetic resonance [64-79] and retention of particles with a magnet moment [36, 37, 80-84]) is stipulated by development of magnetic resonance detection methods and series of the technical appendixes.

Molecular "resonators". For the first time an uniform approach to a problem of waves ponderomotive influence to the resonators was offered by P.N.Lebedev in his doctoral thesis at the end of the last century ([53], p. 84-150). " Despite of all difference, - Lebedev wrote, - which, at the physical nature, the oscillations electromagnetic, magnetohydrodynamic, ultrasonic represent, the laws of their ponderomotive influence to the relevant resonators are identical, it shows a probability, that the laws, fond by us, are general for all possible (and yet not examined by us) oscillations, and their substantiation it is necessary to find in the reasons which are not depending of distinctions of functioning oscillation and the resonator, established by it " ([53], p. 89-90).

A lot of time passed since. January 4, 2001 there will be 110 years from the date of writing by P.N.Lebedev the program of works about essence of molecular forces ([53], p. 19). At center of the program there was a problem on mechanical influence of waves at resonators. " We have to affirm, - he wrote, - that between two emission molecules, as between two vibrators, in which the electromagnetic oscillations are exited, there are ponderomotive forces " ([53], p. 85). " Two ways were represented to the further researches: the first way, remaining on base of the electromagnetic light theory, using for experiments the electromagnetic waves to examine the laws of joint oscillations of two, and then several conjugate systems with natural frequency periods, - the problem, which is detailed attacked now in articles of prince B. Golitsin, Oberbek and Vin, ... The other way, when the all research, how it was made for electromagnetic oscillations, gain ground to different modes of oscillations... We thus dilate an applicability of the found laws and on those cases, in which both mechanism of the oscillations, and the mechanism of the resonator, receiving it, can remain unknown " ([53], p. 88).

Lebedev has gone on the second way. In this work the development of both directions is traced, and the unsolved problems on the present moment are planned.

Historically there was, that the problems with fixed resonators and with resonators with invariable frequency were considered in first [4, 53]. A series of problems with mobile resonators, which frequency varied at their travels and turns were considered later [74-84].

In principal in surveyed works the cases were analyzed, when the resonator sizes are much less than a wavelength and only sometimes [53, 85, 86] with the comparable sizes.

The works by P.N. Lebedev on ponderomotive influence of waves on resonators. The laws of ponderomotive forces are described by P.N. Lebedev in his doctoral thesis "Experimental research of ponderomotive influence of waves on resonators " ([53], p. 84-150). As electromagnetic resonators Lebedev has used the contours hanged on torsion scales (fig. 25).

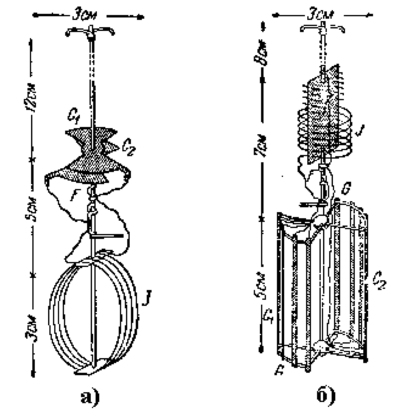


Fig. 25. a) the magnetic resonator, б) the electrical resonator.

A Hertz’s radiator was the source of electromagnetic waves. Transferring the researchs on oscillations, different at their physical nature (electrodynamic, magnetohydrodynamic, acoustic), Lebedev has found complete identity of their influence to the relevant resonators. " The main interest of research, - he noted, - lays in a principle opportunity to spread the found laws... to intermolecular forces " ([53], p. 150).

His researches have given a deduction, that generally the two types of forces independent from each other acts to the resonator. On the one hand they are rotary forces, and with another – the forces of pressures aiming to translocate the resonator in a direction of wave propagation.

From results of observations and calculations on gyration it was followed " ... 1) The plane wave rotates the resonator so that it hole has coincided with a wave plane and, hence, it's excitation has increased, if the resonator is adjusted above, and rotates it in the opposite direction, if it is adjusted below. 2) The maximums of these opposite activities lay near to a resonance ". Further on the basis of calculations, Lebedev has received the formula for the moment of forces act on the resonator with natural frequency 0 and with attenuation ω_r:

$$N = -(\omega/\omega_r) W \omega_r(\omega-\omega_0)/[\omega_r^2+(\omega-\omega_0)^2],\ N_{max} = -(\omega/2\omega_r)W, \qquad (21)$$

where ω - frequency of a wave, W - energy accumulated by the resonator ([53], p. 110, 131).

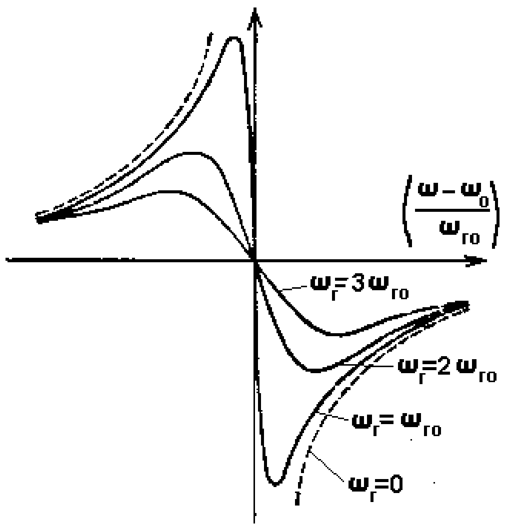


Fig. 26. Frequency dependence of « rotary forces » for resonators with different time of attenuation 1/ω_r.

The observations on repulsion have given a deduction, that "... 1) The plane wave incident on the resonator, tend to take away it in a direction of a motion, i.e. the sound source makes a repulsion of the resonator. 2) This pressure of a plane wave on the resonator achieves a maximum at a complete resonance and at transition through it does not change a sign ". Calculated by Lebedev the force of pressure, acting on the resonator, is:

$$F_{\text{д}} = N' = -(\omega/\omega_r) W' \omega^2 \omega_r^2/[(\omega_0^2+\omega_r^2-\omega^2)^2+4\omega_r^2\omega^2],\ F_{\text{д}max}=(\omega/4\omega_r)W', \qquad (22)$$

where W' is proportional to energy, incident on the resonator in unit of time (fig. 27).

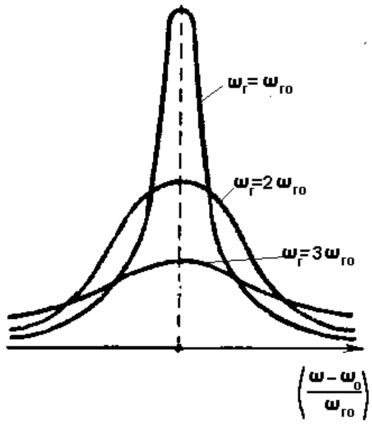


Fig. 27. The dependence diagrams of forces of pressure from a frequency detuning
at different times of attenuation $1/\omega_r$.

In summary Lebedev noticed, that "... The forces of pressure can be removed from examination of spatial distribution of forces around of the resonator and from relevant excitation of the resonator for each specific moment, and the forces of rotation submit to identical laws both in near by oscillations source, and at a great distance " ([53], p. 147).

The further Lebedev's experiments on light pressure on solid bodies and the gases, magnetometric researches of the reasons of magnetic fields formation around of rotaried bodies brought to solution of intermolecular forces nature [53].

Resonant light pressure. Lebedev,s works again have attracted the attention in connection with lasers emergence and study of resonant light pressure [61]. The resonant light pressure is stipulated by acting of monochromatic laser radiation on the uncharged gas of resonant atoms. In a field of a standing wave, the force influencing on resonant atom, about 10^3 eV/sm, in a travelling wave field 10^{-3} eV/sm.

Usually at calculation of forces of light pressure a change of induced dipole moment of atom **P**, at its travels in a field, is neglected, and consequently the quantity of force is defined under the formula [61]:

$$F_i \cong P_k \partial E_i \partial x_k, \qquad (23)$$

In a travelling wave field [61]:

$$F \cong 2(\omega/\omega_r)\,(\nabla \omega_r^2/c)\omega_1^2/[(\omega_0-\omega-\omega\upsilon/c)^2+\omega_r^2+2\omega_1^2], \qquad (24)$$

where $\omega_1=PE/\hbar$ - frequency of stimulated transitions, r - natural linewidth, - velocity of atom. In a field of a standing wave the force is gradient:

$$F_i \cong -\,\partial U/\partial x_i, \qquad (25)$$

depends of a wave phase and oscillates with a period $\lambda/2$ [61].

For the first time an opportunity of a focusing (draft) of an atomic beam with a traversal - nonuniform resonant light field, coaxial with a beam of a laser beam, Askarian theoretically has substantiated [60]. Experimentally it was observed by the authors [87]. The relevant formulas for force, acting on atoms, after establishment of equilibrium state of system: field - atoms during a relaxation $\sim 1/\omega_r$, look like [60, 62]:

$$\boldsymbol{F}=\boldsymbol{F}_1+\boldsymbol{F}_2, \qquad (26)$$

where

$$\boldsymbol{F}_1 \cong -\,(\omega/\omega_r)\,(D_0P^2E^2/\,\hbar c)\{\omega_r^2\boldsymbol{n}/[(\omega_0-\omega+k\upsilon)^2+\omega_r^2+\alpha E^2\omega_r^2]\},$$

$$\boldsymbol{F}_2 \cong -\,(\omega/\omega_r)\,[D_0\underline{P}_2\mathrm{grad}_R E^2/(2\hbar\omega)]\{/[(\omega_0-\omega+k\upsilon)/(\omega_0-\omega+k\upsilon)^2+\omega_r^2+\alpha E^2\omega_r^2]\},$$

and n=1, $\boldsymbol{n} \uparrow\uparrow \boldsymbol{k}$, $\boldsymbol{k}$ – the wave vector, D_0 - population difference in a zero field, α - parameter of saturation (is comparable with the formulas [53]). Later Klimontovich and Luzgin [62] have shown an opportunity of joint self-focusing of atomic and light beams.

The resonant light pressure has found a wide practical application for cooling and acceleration of atoms, isotope separation, of separate particles retention etc. [61, 7].

Ponderomotive influence of waves on patterns in a magnetic resonance. A lot of separate works on untraditional methods of a magnetic resonance - direct ones was emerged [64-69]. In usual methods the spectrums detection is conducted on change of parameters of electromagnetic field acting on a pattern at a resonance. In direct methods - pattern is used as the detector, and consequently they are not exposed to those restrictions in sensitivity, which are proper to usual methods. As a rule, the direct methods are based on detection of energy, impulse and angular moment transmitted to a pattern from electromagnetic field. The change of pattern energy as a result of a dissipation of spin energy gives the increase of its temperature [88-90]. Transmission of an impulse and angular moment to substance from the field at a resonance, and also dependence of pattern energy on spatial coordinates in inhomogeneous fields, or its dependence on pattern orientation, give the origin of ponderomotive forces [64, 70-72] and moments of forces [65-69, 76-78].

For the first time the origin of force in nuclear magnetic resonance specification (n.m.r.). was taken into account by Ya.G. Dorfman in 1947 [64]. He has offered a new original method of magnetic resonance detection. The essence of a method consists in the following. The investigated substance placed on torsion balance pan being in identical nonuniform magnetic field $\boldsymbol{H}_0$ ($H_{oz}>>H_{ox,oy}$). By virtue of symmetry of a field the balance will be in equilibrium. If on one end of balance to create the resonant conditions, the nuclear moments will begin to precess around $\boldsymbol{Ho}$ and will drop out of an aggregate magnetization $\boldsymbol{M}$. In result the force acting at the balance is:

$$\Delta F_i^{Д} \cong (M_{оя} - M_{яz}) V dH_o/dx_i, \qquad (27)$$

where V - volume of substance which is placed in resonance conditions, $M_{оя}$ - saturation magnetization. Its maximal value is $\Delta F_i^{Д}{}_{max} \cong M_{оя} V dH_o/dx_i$. The Dorfman's method allows measuring gyromagnetic ratio γ, linewidth $2\Delta H$, but also absolute value of a magnet moment μ. The experimentally a Dorfman's method was not tested due to smallness of quantity $M_{оя}$ at n.m.r.

In a ferromagnetic resonance conditions (f.m.r.). the acting of a ponderomotive force on a sample ~ (27) for the first time, apparently, was taken into account by V.E. Shapiro [71, 72]. Its quantity in f.m.r. conditions excesses $\Delta F_i^{Д}$ by some orders at the expense of the greater quantity M for ferromagnetics.

Later F.r.Morgentaller on the basis of an energy-momentum tensor [73], has predicted an existence of a ponderomotive force new components acting on a ferromagnetic at a resonance:

$$\Delta F_i^{M} \cong K_1(\delta\Pi\gamma H_0 \Delta H) dH_0/dx_i, \qquad (28)$$

where $K_1=K_1(H_0,\Delta H,V,dH_0/dx_i)$~1 - some coefficient, ($\delta\Pi$ - power absorbing by spin - system. It is easy to show, that $\delta\Pi \sim (M_o - M_z) V\gamma H_0 \Delta H$ and, hence $\Delta F_i^{M} \cong \Delta F_i^{Д}$

The exchange of the angular moment in the processes of interaction of a resonant electromagnetic field and substance gives the origin of the moment of forces acting on a pattern. For the first time the ponderomotive moment of forces in electronic paramagnetic resonance conditions was observed by Alzetta and Gosini [65, 66].

A sensitivity of registration method on the angular moment at S.C. (standard conditions) does not yield to usual, and in the area of low frequencies ($\omega < 2\pi 10^6$ Hz), essentially excesses.

The opportunity of a magnetic resonance registration on the moment of forces, in principle, follows from experiment of the Einstein – de Gaas (gyromagnetic effect) and is its analog [68]. The essence of effect is following: a ferromagnetic [91] or paramagnet [92-94] is hanged by a quartz fiber and placed in a constant magnetic field, parallel to fiber After quick turning off of a field there are pattern rotation. The spin system in a constant magnetic field gains a macroscopic magnetic moment. By means of processes of a spin relaxation during a relaxation T_1 the opposite mechanical moment is gained by a grate:

.

$$L=(M_0V/\gamma), \tag{29}$$

where V - volume of a sample. The moment of forces acting for this time

$$N=(M_0V/\gamma T_1), \tag{30}$$

makes an angular deviation

$$\theta=2\pi\theta_0\,(T_1/T_0), \tag{31}$$

where T_0 - period of a torsion pendulum, θ_0 - angular deviation at continuous acting of N.

The quantity of the moment of forces in a continuous mode of pump is defined under the formula [69]:

$$N=\delta\Pi/\omega=(M_0V/\gamma T_1)(\gamma^2T_1T_2H_2^2)/(1+\gamma^2T_1T_2H_1^2+(\Delta\omega T_2)^2)^2, \tag{32}$$

where $T_{1,2}$ - time of a cross and longitudinal relaxation, H_1 - amplitude of a field of pump. The field of pump acts on a pattern constantly, therefore rotation yielded by paramagnetic absorption, in $T_0/(2\omega T_1)$ times more (10^6 [68]), than in case of gyromagnetic effect. The different modifications of a registration method on the moment of forces with use of torsion balances on a quartz fiber were offered. As has appeared, the registration of a magnetic resonance on the moment of forces for polycrystals ДФПГ at room temperatures [58] on the sensitivity does not yield to the widely spread spectrometers e.p.r.. (electronic paramagnetic resonance) in a super high frequencies band. However relation signal / noise in a method of registration on the moment of forces linearly depends from ω, whereas in e.p.r.- spectrometers ω^2. Therefore mechanical method is more convenient for low frequencies. Already at 10 MHz its sensitivity is higher, than at usual spectrometers.

The registration method on the moment of forces has proved more convenient and at researching of nonlinear effects in the area of small fields H_0, of major levels of pump power and in case of considerable dielectric losses [68, 69]. The modification of this method taking account of nonlinear effects, such as emergence a cross components of a static magnetization at a resonance, dilates its opportunities for a case of large relaxation times, as $N{\sim}M_0H_0(T_1/T_2)$ [69].

There are different modifications of this method on a basis of torsion balance [69, 70]. In one case (static) the angle of pattern rotation as whole is measured at adiabatic passage of a magnetic resonance line on a field,

$$\theta=N/A, \tag{33}$$

here A - constant of a torsion of a suspension line.

In the second case the modulation H_1 by rectangular pulses with frequency equal to frequency of a rotating pendulum for making a regime of forced oscillations is added, at which:

$$\theta=-(4Q_cN/A\pi)\cos(\Omega_0t),\ Q_c=(AI/\omega_{rc})^{1/2}, \tag{34}$$

where I - moment of inertia, Q_c - mechanical quality factor of system, ω_{rc} - attenuation of a pendulum.

In the third case to linear sweep on a field H_0 the small amplitude modulation δH_0 with frequency Ω_0, $\gamma\delta H_0<<(T_1T_2)^{-1/2}$ is added. Accordingly:

$$\theta=-(Q_c/A)[dN(H_0)/dH_0]\cos(\Omega_0t). \tag{35}$$

The relation the signal / noise at use of a phase detector with breadth $\Delta\Omega_0$ on frequency of a rotating pendulum Ω_0 for the second and third cases is [69]:

$$R=4N(Q_c\Omega_0/KTA2\pi\Delta\Omega_0)^{1/2}. \tag{36}$$

The relation the signal / noise for the first case can be improved up to quantity:

$$R=4N(\pi Q_c\Omega_0/2KTA\Delta\Omega)^{1/2}, \qquad (37)$$

where $\Delta\Omega$ - bandwidth of a low-frequency filter of a constant voltage transformer into variable and then - in constant again.

3. Parametric resonance in nonlinear systems.

3.1. Simple computational method for nonlinear dynamic systems.

The works on making traps for macro- and microparticles of a different type (including cells, electrons, ions, atoms and molecules) even as a first approximation encounter serious mathematical and physical difficulties. The initial model equation (1) for a similar class of problems is solved only for separate special cases.

At small angles of deviation x and $\varepsilon_1=0$ the equation (1) is reduced in the well known Mathieu equation, which supposes a stable state of upturned pendulum and making of traps ($\varepsilon_0<0$, $\varepsilon_1\neq0$) outside of a parametric resonance zone [21-27].

In 1982 the authors [5] on the basis of a numerical modeling have detected a stable parametrically excited oscillations of a upturned pendulum in a resonance zone. Later [5, 11] relevant dependences of oscillation amplitudes from ε_0, ε_1 were obtained. Besides of this a lot of other nontrivial solutions were considered: oscillatory, oscillatory -rotation [5, 6, 11, 16, 17]; a chaos origin [5, 12, 15] etc. The searching of the solutions (1), as a rule, for different cases was conducted with use of different methods (by Chezary [8, 9], Krilov-Bogoluybov [5, 16], through a variable an activity - angle [12] etc [3, 109, 110]) with expansion sin x, cos x in terms on degrees of a smallness x. Such variety of methods impeded a joint of particular solutions, interpretation of the obtained results and comprehension of the reasons of chaos origin, bifurcations in systems describing by the equations such as (1).

Therefore, taking into account two Poincare's postulates [111, p. 75] that:

(I) "the periodic solutions are an unique gap, through which we could try to penetrate in area considered inaccessible ";

(II) " the periodic solution can disappear, only merged with other periodic solution (the periodic solutions disappear by pairs similarly to real roots of the algebraic equations) ";

let's use a generalization [112-114] of the relevant methods for a finding and examination on a stability of the periodic solutions (1) on critical points of function of activity [59, 111, 115-117, 120].

For this purpose we shall copy the equation (1) in the Lagrange,s form:

$$d(\partial L/\partial x')/dt-\partial L/\partial x=-\partial F/\partial x', \qquad (38)$$

where

$$L=T-U,\ T=x'^2/2,\ F=\varepsilon_r x'^2/2, \qquad (39)$$

$$U=-(\varepsilon_0+\varepsilon_1\cos\tau)\cos x-\varepsilon_1\cos(\tau+\varphi)\sin x. \qquad (40)$$

Generally x can be a vector and $U=U(\boldsymbol{x},\tau)$. Let's search the solution (38) near to the periodic solution on frequency as a series:

$$x=x_0+\sum_{n=1}^{\infty}[x_n\cos(n\alpha\tau)+(y_n/n)\sin(n\alpha\tau)], \qquad (41)$$

where x_0, x_n, y_n generally $f(\tau)$.

Taking into account dependence x, $x' = f(x_k, y_k, x_k', y_k')$, it is possible to receive in approach of slowly varying amplitudes for a period $2\pi/\alpha$ the following short equations:

$$x_k' \cong -\partial S/\partial y_k - \partial R/\partial x_k,\ y_k' \cong \partial S/\partial x_k - \partial R/\partial y_k, \tag{42}$$

where $y_k = x_0'$, $k=1, 2, \ldots, \infty$ and

$$S = s - y_0^2, \qquad s = \langle L\rangle = (\alpha/2\pi)\int_0^{2\pi/\alpha} L\,\mathrm{d}\tau, \tag{43}$$

$$R = (\varepsilon_r/2)\,[\,y_0^2 + (1/2)\sum_{n=1}^{\infty}[x_n^2 + y_n^2]. \tag{44}$$

At a derivation (42) the formulas were taken into account

$$\langle\partial L/\partial x_n\rangle \cong \langle[(\partial L/\partial x)\cos(n\alpha\tau) + (\partial L/\partial x')(\mathrm{d}\,(\cos(n\alpha\tau))/\mathrm{d}\tau)]\rangle, \tag{45}$$

$$\langle\partial L/\partial y_n\rangle \cong \langle[(1/n\alpha)(\partial L/\partial x)\sin(n\alpha\tau) + (\partial L/\partial x')(\mathrm{d}(\sin(n\alpha\tau))/\mathrm{d}\tau)]\rangle, \tag{46}$$

$$\langle\partial L/\partial x_0\rangle \cong \langle\partial L/\partial x\rangle, \quad \langle\partial L/\partial y_0\rangle \cong \langle\partial L/\partial x'\rangle, \tag{47}$$

$$x'' \cong x_0'' + \sum_{n=1}^{\infty}[(2y_n' - n^2\alpha^2 x_n)\cos(n\alpha\tau) - n\alpha(2x_n' + y_n)\sin(n\alpha\tau)], \tag{48}$$

and extremeness conditions of action function (38). In variable amplitude - phase the equations (42) will accept a view:

$$\psi_n' \cong (1/n\alpha r_n)\,\partial S/\partial r_n, \quad r_n' \cong -(1/n\alpha r_n)\,\partial S/\partial\psi_n - (\varepsilon_r/2) r_n, \tag{49}$$

where

$$x_n \cong r_n\cos\psi_n, \quad y_n/n\alpha \cong r_n\sin\psi_n, \tag{50}$$

$$x = x_0 + \sum_{n=1}^{\infty}[\,r_n\cos(n\alpha\tau - \psi_n). \tag{51}$$

In a variable action - angle:

$$\psi_n' \cong \partial S/\partial\chi_n, \quad \chi_n' \cong -\partial S/\partial\psi_n - \varepsilon_r\chi_n, \tag{52}$$

where

$$x = x_0 + \sum_{n=1}^{\infty}[\,(2\chi_n/n\alpha)^{1/2}\cos(n\alpha\tau - \psi_n). \tag{53}$$

It is easy to show, that as a first approximation the Krilov-Bogoluybov's method ([16], § 14) and method *of S-function* at $n=1$ result to the identical short equations for r_1 and ψ_1. For this purpose it is enough to substitute (42) in (51) and to take into account equalities $\langle\partial U/\partial r_n\rangle \cong \langle(\partial U/\partial x_1)\cos(\alpha\tau - \psi_1)\rangle$, $\langle\partial U/\partial\psi_1\rangle \cong \langle(\partial U/\partial x_1)\sin(\alpha\tau - \psi_1)\rangle$. The relative detuning on frequency will be a relevant parameter of smallness in both cases ([16], p. 170).

The improved first approach similar [16], it is possible to receive from an equilibrium condition $\partial S/\partial x_n = \partial S/\partial y_n = 0$ at $\varepsilon_r \cong 0$:

$$\partial S/\partial x_n, \partial y_n = \partial\langle T\rangle/\partial x_n,\partial y_n - \partial\langle U\rangle/\partial x_n,\partial y_n = 0. \tag{54}$$

Substituting (39), (41) in (54), we shall receive:

$$x_n = 1/(\pi n^2\alpha) \int_0^{2\pi\alpha} \partial U/\partial x \cos(n\alpha\tau)\, d\tau,$$

$$y_n = 1/(\pi n^2\alpha) \int_0^{2\pi\alpha} \partial U/\partial x \sin(n\alpha\tau)\, d\tau, \tag{55}$$

where as a first approximation $x \cong x_0 + x_1 \cos(\alpha\tau) + (y_1/\alpha)\sin(\alpha\tau)$.

3.2. About a Kapica pendulum beyond and within of a parametric resonance zone.

Let's return to the equation (1), we shall search the solution as (49), using the representation $\cos x = \mathrm{Re}\,[\exp(ix)]$ and formula (39) and [121]:

$$\exp[ir_n \cos(n\alpha\tau - \psi_n)] = \sum_{K=-\infty}^{+\infty} Jk_n(r_n) \exp[ik_n(n\alpha\tau + \pi/2 - \psi_n)], \tag{56}$$

is received:

$$S = \sum_{n=1}^{\infty} n^2\alpha^2 r_n^2/4 - y_0^2/2 + (1/2) \sum_{k_1,k_2,..=-\infty}^{+\infty} \prod_{n=1}^{+\infty} Jk_n(r_n) \sum_{\beta=-1}^{+1} \varepsilon_\beta \delta^{\pm\beta}_{\sum_{N=1}^{\infty} k_n n\alpha} (1+\delta^0_\beta)\cos[x_0 +$$

$$+ \sum_{n=1}^{\infty} k_n(\pi/2 - \delta^{\pm 1}_\beta \psi_n) - \delta^{-1}_\beta (\pi/2 \pm \varphi)], \tag{57}$$

where $Jk_n(r_n)$ – Bessel,s function, $\delta^n{}_\beta$ - Kronecker,s symbol.

Frequently, as the experience displays, it is enough to be restricted of the contribution in S (57) from several summands, in particular from $n=1$. It is quite enough for practical calculations without essential losses of accuracy [83], as a series (57) rapidly converges because of known property of Bessel,s functions rapidly to diminish with index growth at a fixed value of argument r_n. Generally $U=U(x, \tau)$ and the convergence of a series (41) will be defined by boundedness of functions being under integrals (55).

A searching of the periodic solutions of the equations such as (1), as it follows from (42, 49, 52), at $\varepsilon_r=0$ is reduced to searching and examination on a stability of critical points (57) on r_n, ψ_n, or χ_n, ψ_n, x_n, y_n, and x_0, y_0.

Let's consider the different cases of the solutions (1). In the most prime case of a mathematical pendulum without the account of friction and vibrations the results of calculations (49) on S (57) with $n=1$

$$S \cong [\alpha^2 r_1^2/4 - y_0^2/2 + \varepsilon_0 J_0(r_1)\cos x_0], \tag{58}$$

testifies about quite satisfactory accuracy. The relative error of approach on r_1 even at angles of deflection of a pendulum $x \sim 160^0$ does not exceed 5,5 % (p. 55, [16]).

Introduction of longitudinal vibration, as it follows from

$$S \cong [\alpha^2 r_1^2/4 - y_0^2/2 + \varepsilon_0 J_0(r_1)\cos x_0 + \varepsilon_1 J_{1/\alpha}(r_1)\cos(x_0 + \pi/2\alpha)\cos(\psi_1/\alpha)], \tag{59}$$

and (49), gives the occurrence of two types of critical points. The position of equilibrium $x_0 = \pm n\pi$, $\psi_1 = 0$, $\pm\pi/2$, $1/\alpha$ (even) corresponds to first ones, $x_0 \neq \pm n\pi$, $\psi_1 = 0$, $\pm\pi/2$ ($1/\alpha$ odd), $n = 0, 1, 2$ – to second ones … (in particular, $x_0 = \pm(2n+1)\pi/2$ at $\varepsilon_0 = 0$). Therefore, taking into account the "mergence" of two periodic solutions on Poincare (II) owing to presence of the second type of critical points $x_0\neq\pm n\pi$ (bifurcation of a period $1/\alpha=2\leftrightarrow 1/\alpha=1$), we shall search a solution of a problem about Kapica,s pendulum beyond and inside of a parametric resonance zone as:

$$x=x_0+r_1\cos(\tau/2-\psi_1)+r_2\cos(\tau/2-\psi_2). \qquad (60)$$

Such representation (52) gives expression *S* (57) up to *n=2*

$$S\cong[r_1^2/16+r_2^2/4-y_0^2/2+\varepsilon_0[J_0(r_1)J_0(r_2)\cos x_0+2\sum_{n=1}^{\infty}J_{2n}(r_1)J_n(r_2)\cos(x_0-n\pi/2)$$

$$\cos n(2\psi_1-2\psi_2)]-\varepsilon_1[J_2(r_1)J_0(r_2)\cos(2\psi_1)+\sum_{n=1}^{\infty}J_{2n\pm2}(r_1)J_n(r_2)\cos(x_0-n\pi/2)-$$

$$-\quad \cos n(2\psi_1-\psi_2)\pm2\psi_1]\}. \qquad (61)$$

Being restricted the terms about r_k^4 at decomposition $J_n(r_k)$in *S* (61) and using variable x_k, y_k (50), we shall receive:

$$S\cong[x_1^2/16+y_1^2/4+x_2^2/4+y_2^2/4-y_0^2/2+(\varepsilon_0 f_0-\varepsilon_1 f_1)\cos x_0+(\varepsilon_0F_0-\varepsilon_1F_1)\sin x_0], \qquad (62)$$

where

$$f_0=\{1-(x_1^2+4y_1^2+x_2^2+y_2^2)/4+[(x_1^2+4y_1^2)^2+(x_2^2+y_2^2)^2]/64+(x_1^2+4y_1^2)(x_2^2+y_2^2)/16\}, \qquad (63)$$

$$\mathrm{f}_1=\{(x_1^2-4y_1^2)[8(x_1^2+4y_1^2)/3-(x_2^2+3y_2^2)]/64-x_1y_1x_2y_2/8\}, \qquad (64)$$

$$F_0=[4x_1y_1y_2+x_2(x_1^2-4y_1^2)]/8,\ \mathrm{F}_1=x_2[1/2-(x_1^2+4y_1^2)/8-(x_1^2+y_1^2)/16], \qquad (65)$$

Substituting *S* (62) into (42), at $\varepsilon_r\cong0$, $\sin x_0=x_2=y_2=x_1=y_1=y_0=0$ we shall receive the relevant equations for a finding of equilibrium points and characteristic roots λ_0:

$$\partial S/\partial x_2\cong\partial S/\partial y_2\cong\partial S/\partial x_0\cong\partial S/\partial y_0\cong0, \qquad (66)$$

$$\partial S/\partial x_1=x_1[1-4\varepsilon_0^{\pm}(1-x_1^2/8-y_1^2/2)-2\varepsilon_1^{\pm}(1-x_1^2/6)]\cong0, \qquad (67)$$

$$\partial S/\partial y_1=y_1[1-4\varepsilon_0^{\pm}(1-x_1^2/8-y_1^2/2)+2\varepsilon_1^{\pm}(1-2y_1^2/3)]\cong0, \qquad (68)$$

$$(\lambda^2+S''x_1x_1)[(\lambda^2+S''x_2x_2S''y_2y_2)(\lambda^2+S''x_0x_0S''y_0y_0)-S''y_2y_2\,S''y_0y_0\,S''x_0x_2], \qquad (69)$$

where

$$\lambda=\lambda_0+\varepsilon_r,\ \varepsilon_{0,1}^{\pm}=\varepsilon_{0,1}\cos x_0\ \text{ и } S''_{i,j}=f(x_1,y_1,\varepsilon_{0,1}^{\pm}). \qquad (70)$$

In a case $x_1=y_1=0$ the expressions (67, 68) are identically equal to zero and

$$\{\lambda^2+[(1-4\varepsilon_0^{\pm})^2-4(\varepsilon_1^{\pm})^2]\}\{\lambda^4+\lambda^2(1+\varepsilon_0^{\pm})^2/4+(1-4\varepsilon_0^{\pm})[(\varepsilon_1^{\pm})^2+2\varepsilon_0^{\pm}(1-\varepsilon_0^{\pm})]\}. \qquad (71)$$

From the first bracket (71) we get an estimation of a upper bound of the stable solution $4(\varepsilon_1^{\pm})^2<(1-4\varepsilon_0^{\pm})^2$, from second one - inferior $(\varepsilon_1^{\pm})^2>2|\varepsilon_0^{\pm}(1-\varepsilon_0^{\pm})|$, that is in the consent with results obtained earlier by other methods for the Kapica,s pendulum ($\varepsilon_1^{\pm}<0$) beyond of a parametric resonance zone [6, 110].

In a case $x_1\neq0$, $y_1=0$ ($x_1=0$, $y_1\neq0$) from conditions $\partial S/\partial x_1=0$ ($\partial S/\partial y_1=0$) (66-70) it is possible to receive:

$$x_1^2=6[(4\varepsilon_0^{\pm}+2\varepsilon_1^{\pm}-1)/(2\varepsilon_1^{\pm}+3\varepsilon_0^{\pm})],\ (y_1^2=(3/2)(4\varepsilon_0^{\pm}-2\varepsilon_1^{\pm}-1)/(3\varepsilon_0^{\pm}-2\varepsilon_1^{\pm})]\ ), \qquad (72)$$

$$[\lambda^2+(x_1^2/24)[2\varepsilon_0^{\pm}+\varepsilon_1^{\pm}+1)]f_x(\lambda)=0,\ ([\lambda^2-\varepsilon_1^{\pm}\,y_1^2(2\varepsilon_0^{\pm}-2\varepsilon_1^{\pm}-1)/6]f_y(\lambda)=0\ ), \qquad (73)$$

where $f_y(\lambda)$– expression in a square brackets (69).

From (73) the existence of two stable states of a motion of the Kapica,s pendulum ($\varepsilon_0^{\pm}<0$) in a parametric resonance zone $2\varepsilon_1^{\pm}>4|\varepsilon_0^{\pm}|+1$, $(2|\varepsilon_1^{\pm}|>4|\varepsilon_0^{\pm}|+1)$ follows. These states differ from each other only by change of a sign $\varepsilon_1^{\pm}$. The result with $y_1\neq0$, (72) and $\varepsilon_0=0$ was earlier obtained by the Krilov-Bogolyubov's method ([16], with 281) without the account x_0, x_2, y_2, y_0 and relevant analysis on a stability. Such approach is not correct, as the deletion of the terms with x_2, y_2, in (62) on frequency of perturbing force gives, as it follows from (69, 70) to the wrong inference about instability of excited oscillations of the Kapica,s pendulum in a resonance zone on x_0, y_0,, that contradicts to carried out experiment and results of a numerical modeling [17].

3.3. Dynamic stability of saddles point in autonomic systems.

The finding of the dynamic systems periodic solutions and examination them on a stability in a series of problems (such as "levitron", "atomic" traps etc.) can be carried out by a finding of critical points and determination of matrix signdefiniteness of second derivatives *of S-function* ([114], 4.1). Let's consider an opportunity of making of an atomic trap on a saddle point in a nonuniform static field without covering of additional variable and static fields:

$$T=[(\mathrm{d}x_1/\mathrm{d}t)^2+(\mathrm{d}x_2/\mathrm{d}t)^2]/2, \quad (74)$$

$$U=c_{20}x_1^2+c_{02}x_2^2+c_{40}x_1^4+c_{22}x_1^2x_2^2+c_{04}x_2^4, \quad (75)$$

where T, U - kinetic, potential energy.

S-function of a considered problem in approach

$$x_1\cong x_{10}+x_{11}\cos(\tau)+y_{11}\sin(\tau)+x_{12}\cos(2\tau)+(y_{12}/2)\sin(2\tau), \quad (76)$$

$$x_2\cong x_{20}+x_{21}\cos(\tau)+y_{21}\sin(\tau)+x_{22}\cos(2\tau)+(y_{22}/2)\sin(2\tau), \quad (77)$$

looks like [114, 122]:

$$S=[-3c_{04}y_{21}^4+(-6c_{04}x_{21}^2-24c_{04}x_{20}^2-3c_{22}y_{11}^2-c_{22}x_{11}^2-4c_{22}x_{10}^2-4c_{02}+2)y_{21}^2+$$
$$+(-4c_{22}x_{11}y_{11}x_{21}-16c_{22}x_{10}y_{11}x_{20})y_{21}-3c_{04}x_{21}^4+(-24c_{04}x_{20}^2-c_{22}y_{11}^2-3c_{22}x_{11}^2-4c_{22}x_{10}^2-4c_{02}+2)x_{21}^2-$$
$$-16c_{22}x_{10}x_{11}x_{20}x_{21}-4y_{20}^2-8c_{04}x_{20}^4+(-4c_{22}y_{11}^2-4c_{22}x_{11}^2-8c_{22}x_{10}^2-8c_{02})x_{20}^2-3c_{40}y_{11}^4+(-6c_{40}x_{11}^2-$$
$$-24c_{40}x_{10}^2-4c_{20}+2)y_{11}^2-3c_{40}x_{11}^4+(-24c_{40}x_{10}^2-4c_{20}+2)x_{11}^2-4y_{10}^2-8c_{40}x_{10}^4-8c_{20}x_{10}^2]/(8). \quad (78)$$

Let's consider a special case: $x_{n,m}$, $y_{n,m}=0$, $(n, m\neq1)$. From conditions of an extreme $S_i'=0$ we have two cases 1) $x_{11}^2=(-2c_{20}+1)/(3c_{40})$, 2) $x_{11}=0$. Accordingly from a matrix of second derivatives *of S-function* $\{S_{ij}''\}$ we shall receive characteristic roots L_i:

$$\begin{aligned}
&L_1=-2(-c_{20}+1);\\
&L_2=-1;\\
&L_3=2c_{20}-1;\\
&L_4=0;\\
&L_5=(2c_{20}c_{22}-6c_{40}c_{02}-c_{22})/(3c_{40}); \qquad (79)\\
&L_6=-1;\\
&L_7=(2c_{20}c_{22}-4c_{40}c_{02}+2c_{40}-c_{22})/(4c_{40});\\
&L_8=(2c_{20}c_{22}-12c_{40}c_{02}+6c_{40}-c_{22})/(12c_{40});
\end{aligned}$$

System (74-75) has stable solutions (L_i< 0) at: c_{20}<1/2 и а) c_{02}<1/2; c_{22}>6abs(c_{40})($-2c_{02}$+1)/($-2c_{20}$+1); б) c_{02}>1/2; c_{22}>2abs(c_{40})($-2c_{02}$+1)/($-2c_{20}$+1) (fig.28).

Hence, the stable solutions exist not only for U with c_{20}, c_{02}>0 (valley point of a potential energy), but also with c_{20}>0, c_{02}<0 (saddle).

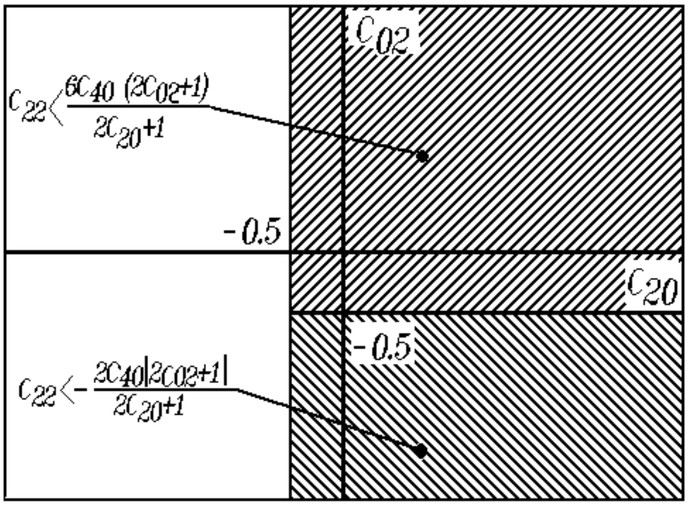


Fig. 28. Stability zones for a saddle point.

The calculation results were tested by numerical and analogue simulation on a hybrid complex.

In trivial case, when all $x_{n,m}$, $y_{n,m}$=0, from view {S_{ij}''} follows, that for stability of the obtained solutions the requirement c_{20}, c_{02}>0, i.e. presence of a valley point U at $x_1=x_2=0$ is necessary.

3.4. About a stability of unstable states, bifurcation, chaos of nonlinear dynamic states.

In the most simple case for a pendulum with $\varepsilon_0=\varepsilon_{-1}=0$, $\varepsilon_1\neq 0$ a point of a bifurcation $1/\alpha=2\leftrightarrow 1/\alpha=1$ is fond from joint consideration of two periodic solutions on **(II)**. Carrying out the calculations similar (66-73), near to a point of equilibrium $x_0=\pm(2n+1)\pi/2$, $x_1=y_1=y_0=0$ we shall receive:

$$\prod_{k=0}^{2} (\lambda^2+S''x_kx_kS''y_ky_k-\delta_k^2 S''x_ky_kS''x_ky_k)=0, \quad (80)$$

$$S''x_0x_0S''y_0y_0=-(\varepsilon_1^*x_2)(1-x_1^2/8)/2,\ S''x_1x_1S''y_1y_1=(1+2\varepsilon_1^*x_2)^2, \quad (81)$$

$$S''x_2x_2S''y_2y_2-S''x_2y_2S''x_2y_2=(1+3\varepsilon_1^*x_2/4), \quad (82)$$

$$x_2\cong[4/(3\varepsilon_1^*)][1-(1+3\varepsilon_1^*/2)^{1/2}],\ \varepsilon_1^*=\varepsilon_1\sin x_0,\ y_2=0. \quad (83)$$

The periodic solutions with $\alpha^{-1}=1$ at $|x2\,|<$/2 are unstable on x_0, y_0 (exp$|\lambda|\tau$), as $S''x_0x_0S''y_0y_0<0$. Solving simultaneously (72), (83), it is possible to define the relevant point of a bifurcation from a requirement (fig. 29):

$$|x_1^*(\varepsilon_1')|+|x_2^*(\varepsilon_1')|=\pi/2, \quad (84)$$

where $x_1^*\cong 59^o$, $x_2^*\cong 31^o$, $\varepsilon_1'\cong 0.61$.

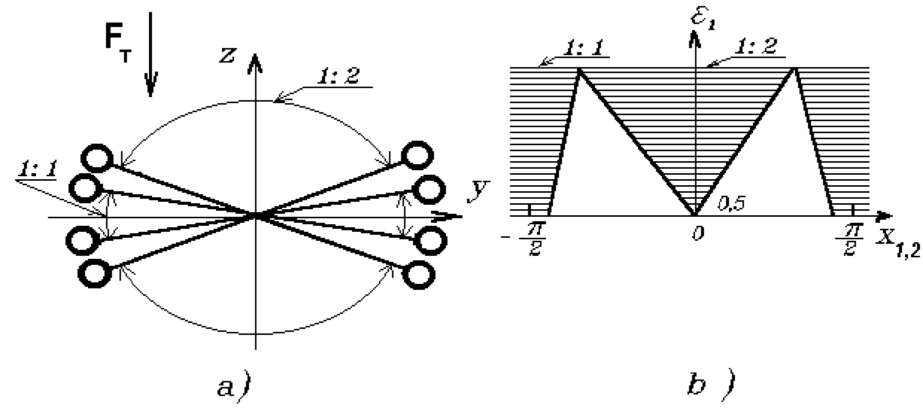


Fig. 29. The script of bifurcation emergence for a upturned pendulum on the Poincare at ε_0=0. a) $0{,}5<\varepsilon_1<0{,}61$; б) the diagrams of dependence $x_{1,2}(\varepsilon_1)$.

In this case (with ε_0=0) the occurrence of a bifurcation can simultaneously set to origin of chaos in system (1) (fig. 29). The fluctuations, errors from the macrosystem used at physical, analogue or a numerical modeling of determined system, described by the equation (1) can be the reason. In result the cascades of transitions between different types of periodic motions at $\varepsilon_1=\varepsilon_1'$ (oscillatory 1:2, 1:1; rotary 1:1 etc.), perceived as chaos, will be observed.

Computerized simulation of the equation (1) on digital analogue computer «Rusalka» and natural modelling on a compass magnetic needle placed in a magnetic field have confirmed the correctness of obtained results in limits of modelling errors.

3.5. Discreteness, chaos and evolution in nonlinear dynamic systems.

If to reduce in the table the orbital periods and periods of rotation of all bodies of Solar system, there will be a commensurability of many periods [52]. It specifies the existence of a series of resonant phenomena between interdependent resonators. There are resonances between orbital periods of the terms of the same system, and also resonances between orbital and axial periods of rotating bodies.

Apparently, the resonances are the extremely important distinctions of Solar system. The bodies, once have hit in a resonance, under certain conditions, can remain there unrestrictedly long; hence, the resonant structure stabilizes the Solar system for a long time and the evolution of Solar system in the greater measure is determined by resonant dynamics [52].

Problem of resonances and small denominators in a celestial mechanics refer to traditional ponderomotive resonant problems [50-52]. An important role the Oveden's assumption about extremeness of motion resonant states in a nature has played for an explanation of resonances in a celestial mechanics [59].

The origin of resonances practically results to the prediction impossibility of Solar system evolution because of hardness of resonant problems [52]. A choice of an initial physical model for its solution is not still clearly too. In opinion of some authors the intrinsic angular momentum of interacting bodies plays the essential role in stabilization of resonant structure of Solar system [52]. A.K. Gulak [50, 56-58] partially have could to simplify the solution of this problem on the basis of the equation of a polydynamic balance, obtained by him:

$$\Delta F+(8m/K^2)(E-P)F=0, \quad (85)$$

where F - dynamic strength function, which extreme values determine the states of a dynamic balance of system; m, E and K - accordingly mass, total energy and angular momentum of a particle; P - potential energy, assigned in each point of a field by a static strength function. He in fact obtains equation (85) [58] from specific integral of a motion for a centrally symmetric field ([18], p. 53).

" Every time, when we approach to an explanation of those or other natural phenomena by classical mechanics techniques, we should not forget, that actually any phenomenon is not submitted in the pure state. However precisely the forces, acting to material system, were defined, some insignificant perturbations always will stay unaccounted. These last ones however they are small were, influence at a motion of material system, in particular, if a motion is unstable. Thus, only stable motions maintain the general character, and therefore, only they more or less correctly describe the real motions " ([123], p. 243, 1929). This clear principle of a stability of real motions, excellent recommending itself in many basic problems of a celestial mechanics, unexpectedly has allowed to N.G. Chetaev [123] to receive a pattern of almost quantum phenomena for mechanical dynamic systems.

After the simple calculations, on the basis of two postulates that:

(1) Some motions in a nature are most chosen by a point of view of stability;

(2) There are insignificant perturbations in a reality;

Chetaev has received [123] basic equation of " permissible orbits " as:

$$\Delta\Psi+2(U-h)\Psi+(\Delta A/A)\Psi=0, \qquad (86)$$

where $H=T-U$ - Hamiltonian function responding to material system, and $A^2=\Psi\Psi^*$ density of trajectories in an arbitrary point of a phase space.

" If? $\Delta A=0$, the basic equation " (86) " takes the form of the differential equation which Shredinger put in a basis of his so-called wave mechanic " [123].

The solution of the differential equation (86) can exist only at some defined values h. Assemblage of values h, for which it is possible, is termed as a spectrum [123].

" We think to ourselves a material system, moving under activity of some forces in an insignificant field of perturbation. This field destroys any motion, if only it is not stable and permissible. Thus, stable, permissible motions are maintained. Always there are insignificant deviations, by virtue of which the real motions of material system happen in quite small area, enveloping the stable trajectory " [123].

The simple method of the solution 3.1 is based on extremeness *of S-function* (42) for resonant states of motions. From it follows, that from all variety of motions, observed in a nature, - the resonant states of a motion are most stable. In result, because of presence of a random background of perturbation fields, there is a natural selection of most stable - discrete resonant states of a motion. In due course at a motion of material systems in a phase space under action of perturbation fields there will be bifurcations under the script 3.4, that will carry to the chaos and further to transition to new stable resonant states of a motion.

4. Resonant traps.

4.1. Ponderomotive waves influence at patterns in conditions of magnetic resonance.

The phenomenon of a magnetic resonance imports the principally new moment to consideration of a problem of ponderomotive activity of waves on resonators. It consists of change of a natural frequency $\omega=\omega(\mathbf{r}, \theta_i)$ of pattern - resonator at its travels and rotation as whole [74-79] in a nonuniform magnetic field $\mathbf{H}(\mathbf{r}, t)$. A corollary of this is the occurrence in space of the chosen areas - " of resonant zones " - with a resonant field action. The first attempts of resonant retention of a particle (of a sphere - anisotropic monocrystal Ferro-yttrium garnet in conditions of a ferromagnetic resonance) were carried out in 1974-1976 [74, 79].

Conditions of experiment (fig. 30). The monocrystal $Y_3Fe_5O_{12}$ as sphere with parameters: *d=0,97-0,41* mm, line width $2\Delta H$=0,49–0,56 e, a field of an anisotropia H_a= – 40 e, saturation magnetization $4\pi M_o$=1750 Gs, density =5,17 g/cm^3, patterns in a regimen of a continuous transverse pumping $\boldsymbol{H_1}$. The patters were placed in center of the resonator H_{101}, with a quality factor $Q=10^3$. Power of S.H.F.- oscillations of a magnetron working on frequency 9,42 Ghz, was controlled by a polarization attenuator in limits *P=0-0,5*

W. The gradient of a field in central area between pole ends of a permanent magnet with *Ho=3280* e did not exceed 2 e/cm

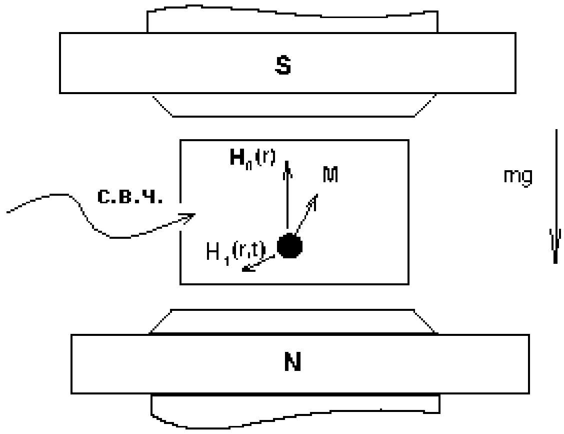


Fig. 30. The plan of experiment on a levitation in f.m.r. conditions.

Among ponderomotive effects detected in experiments on a levitation [74, 79], it is necessary to note: spatial travel of spheres and their low-frequency pulsations; a breaking off of two spheres from each other at a resonance; stable orbital motions and short-term hoverings (levitation ~ 1-3 sec) of sphere inside the S.H.F.- resonator.

Ponderomotive effects detected in experiments [74, 79], have allowed to explain the results of the numerous experimental examinations which have been carried out in the area of a nonlinear ferromagnetic resonance on a magnetoacoustic resonance on not anchored patterns [74, 77, 79, 95-96]. In particular, such its features, as low-frequency pulsations of a magnetoacoustic resonance with frequency 3 Hz and less, hysteresis of excitation on a field etc. [95].

The relevant formulas for forces and moments of forces acting on anisotropic patterns at f.m.r., look like [77]:

$$F_{i0,1}=k_{0,1}M_0\nabla_i H_{0,1}, \tag{87}$$

$$N_{и,a(\theta,\varphi)}= k_{и,a(\theta,\varphi)}M_0H_{a,1}, \tag{88}$$

where $k_0 = -\,\omega_0\omega_1^2\Delta\omega/(\omega_1^2+\omega_r^2+\Delta\omega^2)^2$, $k_1= \omega_0\omega_1^2(\omega_r^2+\Delta\omega^2)/(\omega_1^2+\omega_r^2+\Delta\omega^2)^2$,

$k_и =\omega_1\omega_r/(\omega_1^2+\omega_r^2+\Delta\omega^2)$, $k_{a,\theta} = -\,[10\omega_0\omega_1^2\Delta\omega/(\omega_1^2+\omega_r^2+\Delta\omega^2)^2][\sin 2\theta(2\cos 2\theta+$

$+\sin^2\theta\sin^2 2\varphi)]$, $k_{a,\varphi}= -\,[10\omega_0\omega_1^2\Delta\omega/(\omega_1^2+\omega_r^2+\Delta\omega^2)^2](\sin^4\theta\sin 4\varphi)$, $\omega_{0,1}=\gamma H_{0,1}$, $\Delta\omega=\omega-\omega_0$, γ - gyromagnetic ratio.

At a resonance $F_{i0,1}>>mg$, however a quantity of working on travel or rotation of patterns as whole does not exceed a quantity ~ M_0H_0, owing to insignificance of the sizes of a resonance region on $r\sim 2\Delta H/(\nabla H)$.

4.2. Resonant holding of bodies and particles with natural magnetic moment.

The experiments on particles levitation at f.m.r. [74, 79, 95] initiated a lot of experimental and theoretical works on resonant traps [80-84, 97, 112-114, 122, 127].

A problem of a resonance capture of a spin particle in a nonuniform variable magnetic field $\boldsymbol{H}\cong\{H_1\cos\omega t,\ H_1\sin\omega t,\ \mu_{20}r^{-3}\}$ was considered one of first [81]. It was solved on the basis of simultaneous consideration of the equations: spin $d\boldsymbol{S}/dt=\gamma[\boldsymbol{S}*\boldsymbol{H}]$ and force $\boldsymbol{F}= -\,\mu\nabla(\boldsymbol{SH})$, influencing on a particle with natural magnetic moment $\mu = \mu S$. As a result of a separation of quick and slow ones the problem about a dipole motion was reduced to a problem about a particle motion in a field with an effective potential energy $U_\Sigma = U_п + U_ц$, where $U_п = (\mu_{10}\mu_{20}/r^3)\{1-\gamma^2 H_1^2/[(\Delta\omega(r))^2+\omega_r^2+\gamma^2 H_1^2]\}$, $\Delta\omega(r) = (\omega - \gamma\mu_{20} r^{-3})$ and $U_ц$- the centrifugal contribution [81].

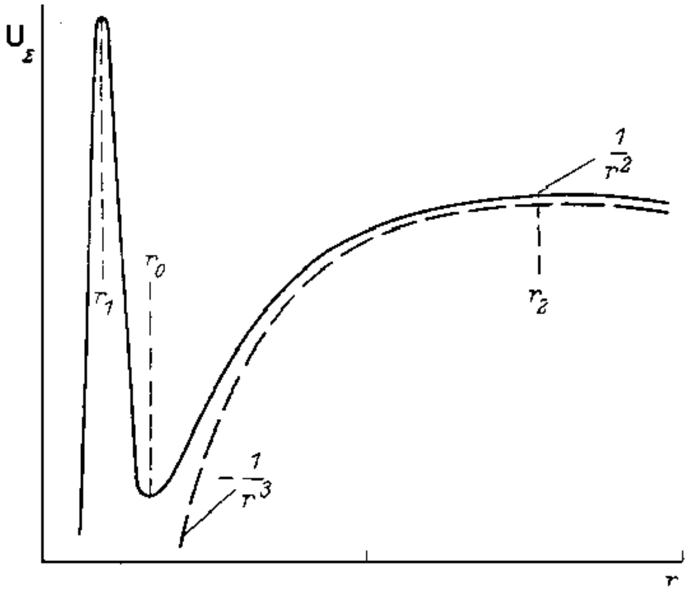


Fig. 31. An average effective potential energy of macroscopic spin particle in a nonuniform magnetic field (~μ_2/r^3) and HF-resonant field with $\omega = \gamma\mu_2/r^3$.

Thus, the instability such as ~$1/r^{-n}$ with n > 2 is possible to stabilize by magnetic resonant interaction (fig. 31). The account of the nonlinear terms of interaction gives the origin of a lot of discrete orbits on r (fig. 32) at the expense of a resonance capture on harmonicses $(n/m)\omega$ [81].

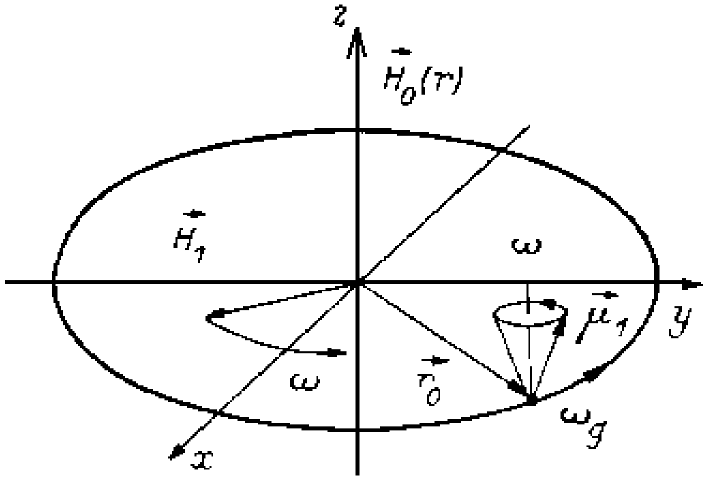


Fig. 32. Stable motion in a point r_0 at a resonance capture.

The similar resonance capture will be observed for any particles possessing electrical dipole moment and a spin, for example - electrical, nuclear pseudomagnetic dipoles, as equations of motion [81] by classical consideration will be similar.

In work [97] at consideration the elementary classical problem of a magnetic needle on a rod in a nonuniform magnetic field of a view $\boldsymbol{H}=[H_1\cos\omega t,\ 0,\ H_z(x)]$ the "unusual" resonant effects were detected. In initial model the kinetic, potential energies and dissipative function and equation of motion are noted as:

$$T=I(\mathrm{d}\theta/\mathrm{d}t)^2/2+m(\mathrm{d}x/\mathrm{d}t)^2/2,\ U=-H_0\cos(\theta)-H_1\sin(\theta)\cos(\omega t),$$

$$F=a_1(\mathrm{d}\theta/\mathrm{d}t)^2/2+a_2(\mathrm{d}x/\mathrm{d}t)^2/2, \qquad (89)$$

$$x_1''+2\beta_1 x_1'+\omega_1^2 x_1=\omega_3^2\cos\omega t,\ x_2''+2\beta_2 x_2'+\omega_2^2 x_2=0, \qquad (90)$$

where

$$\omega_1^2=\omega_S^2 h(x_2)\sin(x_1)/x_1,\ \omega_2^2=-\,\omega_L^2(1/x_2)(\mathrm{d}h(x_2)/\mathrm{d}x_2)\cos(x_1),\ \omega_3^2=\omega_b^2\cos x_1,$$

$$x_1=\theta,\ x_2=x/x_{\max},\ \beta_1=a_1/(2I),\ \beta_2=a_2/(2m),\ \omega_L^2=\mu H_0/(m x_{\max}^2),\ \omega_S^2=\mu H_0/I,\ \omega_b^2=\mu H_1/I,$$

$$H_z=H_0(1-kx_2^n)=H_0 h(x_2) \qquad (91)$$

As a result of simulation by the digital analogue computer "Rusalka" the stable resonant states of a motion were found. For example, at $\omega_S^2=0,3$, $\omega_L^2=0,5$, $\beta_1=\beta_2=\omega_b=0$, x_1 and x_2 make oscillating motions around of center (0, 0) with a frequencies relation 1:1, 2:3, 4:7 and others. At increase of action amplitude H_1, the stable trajectories of a motion about points ($\pm\pi/2$, 0) (fig. 33) were detected.

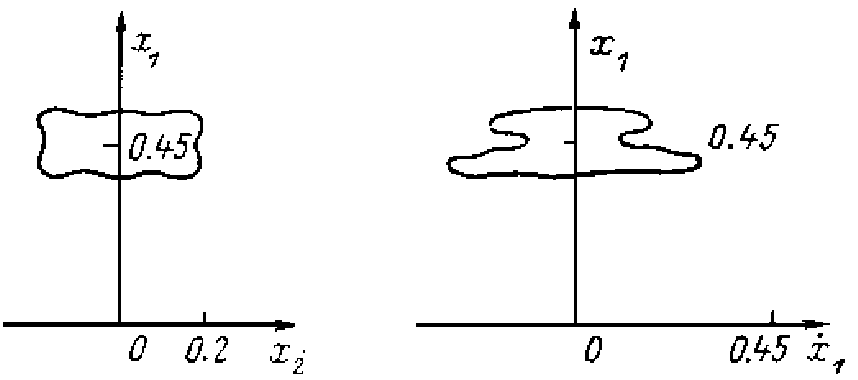


Fig. 33. Stable trajectories at $\omega = 0.1\omega_1$, $x_{10}'=-0,07$, $x_{10}=0,2$, $x_{20}'=-0,07$, $x_{20}=0,11$.

The occurrence of the stable solutions near by ($\pm\pi/2$) is extremely important for problems of particles motion in fields with n < -2 (such as dipole). At angulars $\theta\approx\pi/2$ there is a change of character of attraction interaction ($\theta<\pi/2$) on a repulsion ($\theta>\pi/2$). There is an energy pumping-over of a translational motion to rotary motion, and on the contrary. The origin of stable states of a motion and absence of a collapse in a dipole case will be in result.

In case of a motion of a magnetic top (fig. 34) in a constant, nonuniform, axially symmetric magnetic field ***H (r)*** the Hamiltonian function will accept a view:

$$H=m/2(r'^2+r^2\varphi'^2)+\mathrm{I}/2(\chi'^2\sin 2\theta+\theta^2)-I_0/2(\psi'+\chi'\cos\theta)^2-\mu H(r)\cos\theta, \qquad (92)$$

And resonance capture will take place [82] at $(\omega_1^2\omega_2^2-\omega_L^2\omega_l^2)[\omega_L^4-\omega_1^4]^{1/2}=0$, where $\omega_1=\varphi'$, $\omega_2=\chi'$, $\omega_L^2=-\mu(\partial H/\partial r)(1/r)$, $\omega_l^2=-\mu H/I$, $\cos\theta=(\omega_1/\omega_L)^2$.

At $\omega_L\neq\omega_l$ (accordingly $\theta\neq 0,\ \pi$) $\omega_1\omega_2=\omega_L\omega_l$, that is similar to conditions of synchronization of objects with close frequencies [98].

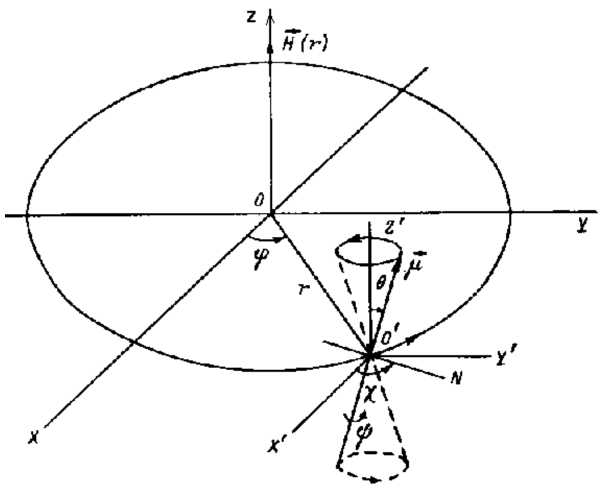


Fig. 34. A magnetic gyroscope.

The considered examples have allowed assuming the existence of stable states of motions in a parametric resonance zones, as was shown in work [84]. As model the motion of a magnetic dipole in a gravity field and variable magnetic field framed by the solenoid was considered.

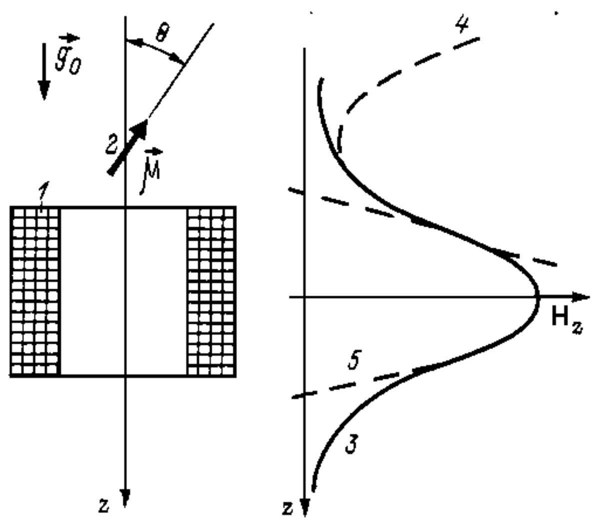


Fig. 35: 1 - solenoid, 2 - dipole, 3 - real dependence $H_z(z)$,
4, 5 - approximation $H_z(z)$.

The distribution of a field ***H*** of the solenoid (in a cylindrical coordinate system) was approximated by the following view:

$$H_z=H_0(s+z^2-0.5\rho^2)\cos(\omega t), \quad H_\rho=-H_0\rho z\cos(\omega t), \quad H_\varphi=0, \qquad (93)$$

where s=const, $s>0$ ($s<0$) for a dipole hanged up above (inside) solenoid. Thus the components of a field vector-potential will satisfy Laplace,s equation. Lagrangian for case of a dipole - rotator with $s > 0$ is possible to note as:

$$L=\rho'^2+z'^2+k\theta'^2+\xi[(s+z^2-0.5\rho^2)\cos\theta-\rho z\sin\theta]\cos(2\tau)+gz, \qquad (95)$$

where $k=I/m$, $\xi=8\mu H_0/(m\omega^2)$, $g=8g_0/\omega^2$, $\tau=\omega t/2$, m – mass, I - moment of inertia, - μ magnetic moment. A Lagrangian for a case $s < 0$ notes similarly. Further the solution is searched as: $z\cong a_{10}+a_{11}\cos\tau+b_{11}\sin\tau+a_{12}\cos2\tau+b_{12}\sin2\tau$, $\rho=a_{21}\cos\tau+b_{21}\sin\tau$, $\theta=a_{31}\cos\tau+b_{31}\sin\tau$, where a_{ij}, b_{ij} <<1 – slowly varying functions of time. The stationary points are gained by the solution of system of the equation a_{ij}', $b_{ij}'=0$

with their later on examination on a stability in variations. The a_{10}, $\theta=(a_{31}{}^2+b_{31}{}^2)^{1/2}$ from *k*, obtained as a result of calculations for $|s| = 1$, have a composite view (fig. 36) [84].

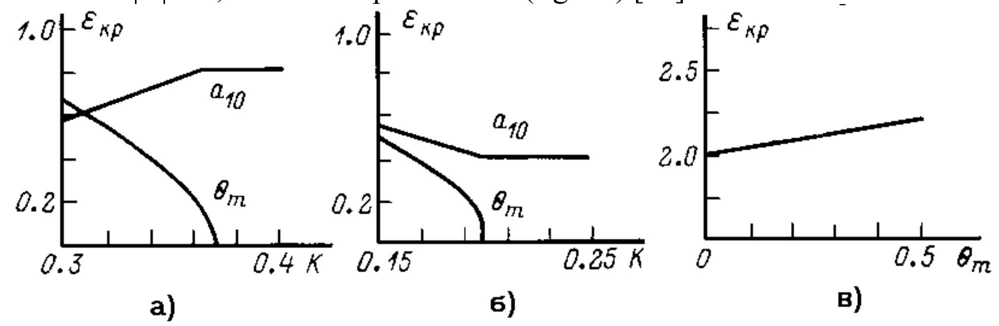


Fig. 36: a) s=1, g=0,2, ξ=1; в) s= –1, g=0,1, ξ=1; c) s= –1, g=0,1.

The opportunity of spatial particle sorting on quantity *k* follows from the diagrams (fig. 36) and experiments [84]. The solution becomes unstable at $\xi>\xi_{кр}$, and for $s>0$ $\xi_{кр}=2$ and does not depend from θ_m, and for $s < 0$ such dependence exists. In particular, there is such combination *k* and *g*, that at magnification ξ the stable solution transfers in unstable and then again becomes stable after origin of dipole oscillations on θ.

For checkout of numerically - analytical calculations the modelling of motion equations by means of the analogue computer "Rusalka" and nature (physical) modelling was carried out. Thus the ferrite of barium magnet was hanged above an electromagnet face. With the purpose of expansion of starting conditions area in a resonance region resulting in to magnet retention, the hanging was carried out in Glycerinum. Thus the magnet behavior was qualitatively described by the solutions obtained as a result of calculations. In a fig. 38 there is the photograph of retention of a samaric - cobaltic magnet grain in constant and variable magnetic fields.

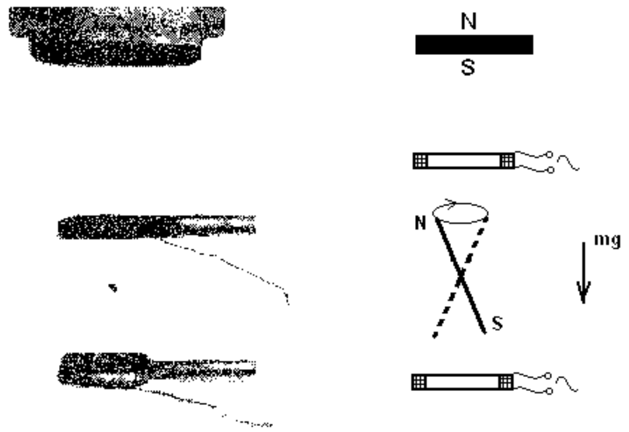


Fig. 37. Resonant retention of a samaric - cobaltic magnet particle in constant and variable nonuniform magnetic fields (1987).

4.3. Problem of two magnetic dipoles taking into account equations of their spins motions.

Examining a problem of two magnetic dipoles, the authors, as a rule, consider their as dot. It automatically results in a deletion of the terms in a Lagrangian which responsible for occurrence of the spin equation, magnetic dipoles, and to their collapse. Generally for a quickly rotary top the solution of a problem can be obtained from set of equations - spin equation:

$$d\boldsymbol{S}/dt=(\mu/\hbar)[\boldsymbol{S}*\boldsymbol{H}], \quad (96)$$

and equation of force acting on a particle with a natural magnetic moment $\boldsymbol{\mu}=\mu\boldsymbol{S}$ [99–102]:

$$\boldsymbol{F}= - \mu\nabla(\boldsymbol{S}*\boldsymbol{H}), \tag{97}$$

or on the basis of dipole concrete model and relevant Lagrangian [37, 103-106].

It was shown earlier [37], that the account of magnetic moments above dipole one reduces to a stability of an orbital motion of one particle around of another on distances comparable to their sizes (2.4 and fig. 19). In case of one dipole, which is in a nonuniform resonant magnetic field, with a potential energy such as *1/r3*, the account of the spin equation reduces to origin of stable states of a motion [74, 81, 95]. For system of two magnetic dipoles possessing an natural moment of momentum - a spin, the occurrence of a similar resonant stability is expected without an external field too, as the character of their interaction at a resonance essentially depends on a detuning on frequency [74, 95]. Such opportunity is analyzed in work [80].

By analogy with Kozorez's works [37], we shall consider the simplified problem of a dipole motion $\boldsymbol{\mu}_1$ in a field of a dipole $\boldsymbol{\mu}_2$ [80]. The equations of motion in this simplified case ($m=m_1<<m_2$) look like:

$$d\boldsymbol{\mu}_1/dt= \gamma_1[\mu_1*\boldsymbol{H}_{12}], \tag{98}$$

$$d\boldsymbol{\mu}_2/dt= \gamma_2[\mu_2*\boldsymbol{H}_{21}], \tag{99}$$

$$d^2(m\boldsymbol{r}_{12})/dt^2=\nabla(\boldsymbol{\mu}\boldsymbol{H}_{12}), \tag{100}$$

where $\boldsymbol{H}_{12}=(3\boldsymbol{n}_i(\boldsymbol{\mu}_j\boldsymbol{n}_i) -\boldsymbol{\mu}_j)/r^3$ – field of a dipole $\boldsymbol{\mu}_j$ in the location of a dipole $\boldsymbol{\mu}_i$; $i,j=1,2$; $\boldsymbol{n}_i=\boldsymbol{r}_{ij}/r$, $r=|\boldsymbol{r}_{ij}|$.

We shall confine of case of the periodic solution - orbital motion of a dipole μ_1 with frequency $\boldsymbol{\omega}\uparrow\uparrow\boldsymbol{oz}$. Transferring in a rotating coordinate system, for (98-99) we shall receive:

$$d\boldsymbol{\mu}_{Bi}/dt= \gamma_i[\mu_{Bi}*\boldsymbol{H}_{Bij}] +[\mu_{Bi}*\omega]. \tag{101}$$

Guessing a mode of fixed oscillations and condition $d\boldsymbol{\mu}_{Bi}/dt=\boldsymbol{0}$ from (101), we have:

$$A_{ij}\mu_{Bij}=0, \tag{102}$$

where $\{\mu_{Bij}\}=\{\mu_{B1x}, \mu_{B1y}, \mu_{B2x}, \mu_{B2y}\}$, $A_{1j}=\{0,\alpha_1,0,1\}$, $A_{2j}=\{-\alpha_1,0,2,0\}$, $A_{3j}=\{0,1,0,\alpha_2\}$, $A_{4j}=\{2,0,0,-\alpha_2\}$, where $\alpha_i=[(\omega-\omega_{ij})/\omega_{ij}](\gamma_i/\gamma_j)=4;1$, $\omega_{ij}=\gamma_i\mu_{Bjz}/r^3$ – frequencies of a Larmor's precess of *i'th* dipole in a field of *j'th* one. Equation (102) have solution at

$$\alpha_1\alpha_2=(\omega-\omega_{12})(\omega-\omega_{21})=4;\ 1; \tag{103}$$

$$\mu_{Biy}=\alpha_i^{-1}\mu_{Bjy}= - \alpha_j\ \mu_{Bjy}; \tag{104}$$

$$\mu_{Bix}=2\alpha_i^{-1}\mu_{Bjx}= - (\alpha_j/2)\mu_{Bjx}; \tag{105}$$

$$\mu_{Biz}=\mu_{iz}. \tag{106}$$

The results of the solution (103-106) for special cases of particles with identical spins and identical values of gyromagnetic numbers ($|\gamma_1|=|\gamma_2|$, $\mu_1= \mu_2$) are submitted in tab. 2. It follows from it, that the resonance capture basically is possible without the account of a dissipation only on harmonicses of Larmor's precess frequency of the first dipole in a field of second one. The occurrence of the solution $\omega=-\omega_{12}$ is stipulated by absence of a dissipation (at the expense of spin flipping and its precession in an opposite direction). Such situation is typical at consideration of a magnetization vector motion in conditions of a magnetic resonance without a dissipation [107].

The table 2

Problem of two interacting dipoles taking into account their spins.

№	$\gamma_{12}\mu_{1,2z}$	ω/ω_{12}	$\mu^{B}_{1,2x}$	$\mu^{B}_{1.2y}$	α_1	α_2	$V_{д.д.}=<\mu_1H_{12}>\|_{t=2\pi\omega}$
1		3	↑↑	0	2	2	$(2\mu_z^2-\mu_0^2)/r^3$

2	$\gamma_1=\gamma_2$, ↑↓	2	0	↑↓	1	1	$(3\mu_z^2-\mu_0^2)/2r^3$
3		0	–	–	–1	–1	
4		–1	↑↓	↑↓	–2	–2	μ_0^2/r^3
5		3	↑↓	0	–2	–2	$-(2\mu_z^2-\mu_0^2)/r^3$
6	$\gamma_1=-\gamma_2$, ↑↑	2	0	↑↑	–1	–1	$-(3\mu_z^2-\mu_0^2)/2r^3$
7		0	–	–	1	1	
8		–1	↑↑	0	2	2	$-\mu_0^2/r^3$
9		0	–	–	1	1	
10	$\gamma_1=\gamma_2$, ↑↓	i	–	–	Im	Im*	imaginary solution
11		i	–		Im	Im*	imaginary solution
12		0	–	–	–1	–1	
13	$\gamma_1=-\gamma_2$, ↑↑	i	–	–	Im	Im*	imaginary solution
14		i	–	–	Im	Im*	imaginary solution

In system of three spin particles, two of which are identical, on the basis of tab. 2 (№ 1, 5; 2, 6; 4, 8) it is possible to make a deduction about presence no more two allowed states with opposite orientation of spins (↑–↑↓– 1–8) at each level – ω_{12}, $2\omega_{12}$, $3\omega_{12}$.

The concrete dependence of an effective interaction energy $U_{д.д.}$ from r can be found from a conservation law of angular momentum of closet system (field + dipoles),

$$\boldsymbol{S}_п+\boldsymbol{S}_1+\boldsymbol{S}_2+[\boldsymbol{r}_{12}*m\boldsymbol{\upsilon}]=\boldsymbol{L}=\mathbf{const}, \tag{107}$$

where $\boldsymbol{S}_i = \mu_i/\gamma_i$ – generally mechanical moment of dipoles (spin - for elementary particles, torque - for magnetized gyroscopes). Approximately it is possible to consider, neglecting losses and radiation, for a case (103-106):

$$\mu_{1z}/\gamma_1+\mu_{2z}/\gamma_2+mr^2\omega\cong L_z. \tag{108}$$

The results following from the equation (108), are shown in tab. 3 (for estimates the value L_z about $2\mu_0/3^{1/2}|\gamma|$ is accepted and the symbol $r_0=\gamma^2 m$, accordingly $\omega_0=|\gamma|\mu_0/(r_0r^2)$, $|\omega|=|\gamma|\mu_0/r^3$) is introduced. The occurrence of "singularity" in a point $r\sim r_0$ ($|\omega|\sim\omega_0$) was expected at the solution of a resonant problem, as the terms such as $\boldsymbol{S}_п$ (57), responsible for a dissipation in system were rejected. The usually dissipative terms restrict a variations of a precession angular θ ($\mu_z=\mu_o\cos\theta$) up to quantity $\theta_m\cong(\pi-\omega_r/\omega_1)/2$ [81].

The table 3

Parameters values of interacting dipoles system without the account of a dissipation.

№	$\gamma_{12}\mu_{1,2z}$	ω/ω_{12}	$\sim\mu_z/\mu_o$	$V_{д.д}$
1	$\gamma_1=\gamma_2$, ↑↓	3	$\omega_0(\omega_0+\omega)$	$(2\mu_0^2/3r^3)[(1+3r_0/2r)^{-2}-3/2]$
2		2	$\omega_0(\omega_0+\omega)$	$(\mu_0^2/2r^3)[(1+r_0/2r)^{-2}-1]$
3		–1	$\omega_0(\omega_0-\omega)$	(μ_0^2/r^3)
4	$\gamma_1=-\gamma_2$, ↑↑	3	$\omega_0(\omega_0-\omega)$	$-(2\mu_0^2/3r^3)[(1-3r_0/2r)^{-2}-3/2]$
5		2	$\omega_0(\omega_0-\omega)$	$-(\mu_0^2/r^3)[(1-r_0/r)^{-2}-1]$
6		–1	$\omega_0(\omega_0+\omega)$	$-(\mu_0^2/r^3)$

The relevant diagram of dependence and diagrammatical drawing of possible stable motions are given in a fig. 38.

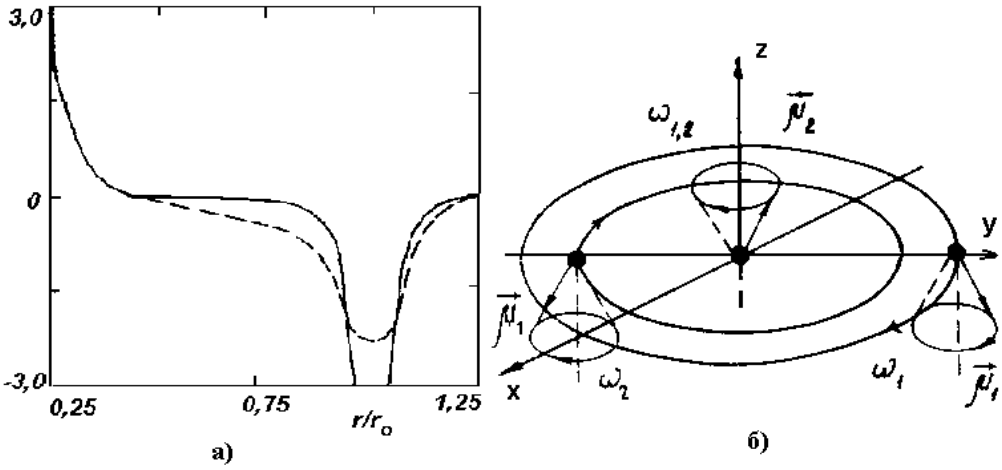


Fig. 38: a - diagrams of an average potential energy of two spin particles μ_1 and μ_2, full line - without a dissipation, dotted line – taking into account a dissipation (tab. 2, №6);
b - possible stable motions of spin particles, $\omega_2=2\omega_{12}$ (tab. 2, №5).

At convergence of dipoles the angular of a precession θ is incremented, as it was expected at the expense of magnification of a field of "pump" $H_1=H_{x,y}^{д.д}$, and in a point r_0 it diminishes as a result of two frequencies synchronization - "mechanical" $\omega_0^0(m)=|\gamma|\mu_0/r_0^3$ and "magnetic"$|\omega|=|\gamma|\mu_0/r^3$.

The resonance capture in system of one or two magnetic dipoles (fig. 19) concerns to problems of objects synchronization with close frequencies [98].

The rest cases of a resonance capture (1-3, tab. 3) can result to a stability and essential influence to character of a motion of spin particles too, if take into account additional components from (97) such as Coulomb or gravitational $1/r^2$.

Let's carry out the estimates of dipoles motion parameters for systems [4, 5] tab. 3 (fig. 38): orbit radius r_0, rotation frequency and dipole precession μ_1, time of "life" - dissipation τ_r. As the macrodipoles we shall take two spherical patterns with parameters: $4\pi M_0$=1750 Gs, ρ=5 г/см^3, $d/2$=0,1 sm. and frequency of natural rotation $\omega_c=2\pi 10$ Hz, where M_0 - magnetization, ρ - density, d - the pattern diameter. Accordingly we shall receive:

$$r_0/(d/2)\cong(4\pi M_0)^2/(3\pi\rho d^2\omega_c^2)\cong 10^3, \tag{109}$$

$$\omega\cong 2\pi 10^{-5}\ \text{Hz},\ |\gamma|=(r_0/m)^{1/2}\cong 2\pi 10\ \text{Hz/e}, \tag{110}$$

$$\tau_r^{(4)}\cong(c/r_0\omega)^3(1/\omega)\cong 10^{45}\ \text{sec}, \tag{111}$$

$$\tau_r^{(5)}\cong(c/r_0\omega)^2\tau_r^{(4)}\cong 10^{71}\ \text{sec}, \tag{112}$$

where $\tau_r^{(4)}$ and $\tau_r^{(5)}$ - times of a dissipation [108] in a radiating dipoles system (fig. 38). In case of microdipoles, for example - electron-positron, an orbit radius in precision is equal to an electron classical radius and the further consideration on the basis of this approximate model demands a refinement.

5. Instead of the inference - unsolved problems
5.1. About a nature of a ball – lightning.

The nature of a ball - lightning remains a mystery so far [136, 137]. P.L. Kapica more than 40 years ago [138] has offered a resonant model of a ball - lightning. In this model for the first time an origin and stability of a ball - lightning is explained by action of short-wave resonant electromagnetic oscillations during a thunderstorm at ions motion.

Resonant model of Kapica, explained much, has not explained main - the reasons of origin and existence of intensive short-wave electromagnetic oscillations during a thunderstorm.

In work [129], on the basis of a series of propositions [53, 80, 81, 113, 114, 138, 139], that:
1) Inside a ball - lightning there is a resonant short-wave electromagnetic radiation (wave length λ is commensurable with its geometrical sizes $\boldsymbol{d}$ [138]);
2) The most stable states of a motion in a nature are resonant states [114], which character is uniform and does not depend of a nature of interacting bodies ([53], p. 89);
3) The unstable states in a statics can become stable in dynamics (trap for charged particles, upturned pendulum of Kapica beyond and inside of a parametric resonance zones, system from one, two and more magnetized gyroscopes at a resonance) [80, 81, 113, 114];
the self-agreed resonant model of a ball - lightning is offered.

Let's assume that at a thunderstorm there is a powerful discharge. The "linear" lightning (one, in particular two) will result to inducing of cross, short-term magnetic and electromagnetic fields (Hertz radiator [53]). In result the motion of the formed ions will happen in composite combined electromagnetic ("stationary" and variable) fields. Induced "stationary" magnetic fields will cause occurrence short-term, polar-different of current coils with a composite configuration - μ^+ and μ^-. As a first approximation we shall be consider a system from two current coils μ^+, μ^- as magnetized and is opposite charged gyroscopes. Under certain conditions in such system the origin magnetoresonance stable dynamic states on distances $r \sim r_0 = \gamma^2 m$ is possible, where γ - gyromagnetic ratio, m - mass [80]. Thus, the lightning discharge, at particular circumstances can result to occurrence of a self-stable plasmoid.

Mechanism of origin of stable states of a motion at a resonance is easy enough [80, 81, 114]. At the expense of a precession of magnetized charged gyroscopes μ^+, μ^-, one in a field of another, on particular distances r_0 at a resonance there can be a repulsion of dipoles instead of an attraction, and the system becomes stable [80, 114].

Let's estimate parameters of such system. " It is known, that the effective absorption from the outside of intensive radiowaves of electromagnetic oscillations of the ionized gas cloud - plasma can happen only at a resonance, when the natural period of plasma electromagnetic oscillations will coincide with a period of absorbing radiation... If to consider, that the immersed frequency corresponds to natural oscillations of sphere, it is necessary, that length of an immersed wave was approximately equal to four diameters of a ball - lightning (more precisely $\lambda = 3{,}65\, d$)" [138].

Most frequently the balls - lightning have a diameter from 10 up to 20 cm to which the lengths of waves from 35 up to 70 cm will correspond. At $d \sim 10$ cm, taking into account the known formulas: $\gamma = e/(2mc)$, $\lambda = 3{,}65 d$, $d = 2r_0$, $d = v/(\gamma H)$, $\omega = \gamma H$, $N_0/V_0 = 4mc^2/(e^2 d^2)$, $E = mv^2/2 = (mc^2/2)(d/\lambda)^2$; received: $E = (0{,}2–16)$ Mg, $N_0/V_0 = m/m_1 = (3–96)\cdot 10^{16}$ particles/cm^3, $H = (17–400)$ Me; for $m_1 = (1–32)\cdot m_p$ (proton).

Thus, inside a ball - lightning, besides of short-wave electromagnetic oscillations guessed by Kapica, there are additionally considerable magnetic field ~Me. As a first approximation the ball - lightning can be considered as self-stable plasma "confining" itself in natural resonant variable and stationary magnetic fields. The resonant model of a ball - lightning at it more rigorous consideration, probably, will allow to explain its many features not only qualitatively, but also quantitatively, in particular, experimentally to receive the self-stable plasma resonant formations controllable by electromagnetic fields. It is iteresting to note, that temperature of such self-confining plasma in comprehension of a random motion "will be close" to zero, as we deal with a strictly ordered synchronous motion of charged particles. Accordingly lifetime t_0 of a ball - lightning (resonant system) is great ~ Q (quality factor). Taking into account the formula for a total power of radiation of travelling charged particles on a circle in a constant magnetic field:

$$P = 2N_0 e^4 H^2 v^2 / (3m^2 c^5 (1 - v^2/c^2)),$$

we receive an estimate $P \sim 25\text{-}500$ W, at $d \sim 10$ cm, accordingly $t_0 \sim E/P \sim 4*10^3$ sec.

The table of parameters values obtained from self-consistent resonant model of a ball - lightning and data of observations is submitted below [136, 137].

The table 4

Parameters of a ball - lightning (for d ~ 10 cm)

Data of	*E*, Mg	N_0/V_0, part./cm^3	*H*, e	t_0, c	*T*, ^{0}K	*P*, W
calculations	(0,2–16)	(3–96)*10^{16}	(17–400)	4*10^3	~ 0	25–500
[136, 137]	(0,85–9,5)	5,8*10^{16}	170	1–10^3	4000	10–500
[]/p.	[136]/71	[141]/80	[136]/80	[136]/66,46	[136]/76	[137]/25
The note: H - field apart ~1 m from a lightning (unfortunately a distance in a case [136] up to bells it is not known precisely).						

5.2. Abnormal properties of activated water.

The phenomenon of noncontact electrochemical activation of fluids (NAF) was theoretically predicted by I.L. Gerlovin in 1982 on the basis of attacked by him of the physical theory of a fundamental field [124]. The experimental data on noncontact electrochemical activation (ECA) for the first time were published by V.M. Bahir in 1992 [125].

Hermetically thin-walled enclosed vessels (ampoules or the capsules), or tube from polyvinilchloride (PVC, diameter of 3 mm, wall thickness of 1 mm) with a physiologic solution were positioned in work (anode or cathode) chambers electrochemical diaphragm activator. The activation of ampoules, as a rule, was conducted for 30 min at the turned on of current, or at a current turned off just before of dip of vessels with a physiological solution in an ECA - mediums.

In the table 5 the exponents for solutions in ampoules after noncontact activation during 30 minutes are submitted [126].

The table 5:

Parameters	Initial physiological solution	Acolyte	Katolyte	ΔЛА0 / ΔЛАР	ΔСА0 / ΔСАР	ΔФА0 / ΔФАР	ΔЛК0 / ΔЛКР	ΔСК0 / ΔСКР	ΔФК0 / ΔФКР
pH	6,7±0.2	1,1	11,5	–0,8±0,1 –1,3±0,1	–0,2±0,1 –0,5±0,1	0,1±0,2 0,2±0,15	0,5±0,2 0,8±0,2	0,2±0,15 0,4±0,2	–0,4±0,1 –0,2±0,1
ОВП, mV	260±5	1135±15	–845±5	110±10 150±7	31±8 30±5	–80±5 –130±4	–490±7 –560±10	–280±5 –370±6	23±7 30±10

where ΔLA0 = pH (ORP)lao–pH (ORP) initial physiological solution; L,G, F - material of an ampoule (lavsan, glass, fluoroplastic); A - activation in an anolyte, C - in a catholyte P (O) - activation at a turned on (off) current just before of vessels dip with a physiological solution in an ECA - medium.

Thus, after an exposure of hermetic ampoules with a physiological solution in an anolyte or in a catholyte the pH and ORP of a physiological solution essentially varied, that can be considered as a phenomenon of a noncontact ECA. This effect is qualitatively identical in a turned on electrolyzer and in a turned off one. Anolyte and catholyte influence at a physiological solution through glass, lavsan and fluoroplastic. Thus for a glass and lavsan the directivity of pH and ORP changes corresponds to a sign of electrochemical machining (anode or cathode), and the inverse of a sign of electrochemical machining is characteristic for fluoroplastic. In 2 hours the exponents pH and ORP, changed as a result of a noncontact ECA, are relax, that testifies of absence of electrolysis stable products penetration inside of enclosed ampoules. Hence, noncontact ECA is carried out on an energy level without an attendant transport (mass transfer) of ions through an ampoules wall [126].

For clearing up of a nature of a noncontact activation phenomenon we have carried out additional experiments [127].

Experiment 1. Hermetically thin-walled polyethylene packages (film thickness ~ 0,1 mm) with distilled water were placed in the working cathode chamber of the electrochemical activator "Espero -1". The activation was conducted for a 30 minutes at the turning on current with a diaphragm and without it. The results are given in the table 6.

The table 6:

Parameters	Initial distilled water	Medium of catholyte with a diaphragm.	Medium of catholyte without a diaphragm..	Δpack. with a diaphragm.	Δ pack. without a diaphragm.
pH	7,2±0,2	10,7	7,6	–0.4±0,2	–0,4±0,2
ORP, mV	264±5	–873±5	-460±5	–364±20	–384±20

where Δpack. with a diaphragm = pH (ORP)pack. without a diaphragm. – pH (ORP)initial distilled water.

Experiment 2. Hermetically thin-walled polyethylene packages (film thickness ~ 0,1 mm) with distilled water were placed in cylindrical tanks from alimentary aluminum and plastic (d_{al}=14 cm, d_{pl}=14 cm), filled with a catholyte. A catholyte (pH=13,5, ORP = - 950 mV) gained with installation "Emerald - SI". The activation was conducted for a 30 minutes in quick-prepared solutions. The results are given in the table 7.

The table 7

Parameters	Initial distilled water	Δal	Δal+pep	Δal+tf	Δal+pl	Δpl	Δpl+f
pH	7,5±0,2	–0,3±0,2	0±0,2	–0,8±0,3	–0,4±0,3	–0,4±0,3	0,3±0,3
ORP, mV	289±3	–749±10	–245±10	–301±10	–175±10	–165±15	–280±15

where Δx =pH (ORP)x – pH(ORP) initial distilled water, al+pep - the catholyte is poured is in a thin polyethylene package (~ 0,1 mm), skintight to aluminium tank walls, al+tf – aluminium tank with a thin-walled teflon coat al+pl - catholyte is poured is in platinum tank (with walls thickness ~ 2 mm) and located in aluminium tank. pl+f - thin aluminium foil densely adjoins to walls of platinum tank.

Experiment 3. Dielectric vessels with an anolyte and catholyte (V = 100 mls.), prepared with installation «Emerald - SI» at Va=Vk =5 l/hours, were placed in a microwaves -field (P = 1 KW, =2.4 GHz) for 1 minute, then their parameters were measured. Parallelly we heated an anolyte and catholyte for 1-2 minutes in a water bath and measured their parameters. The results are given in the table 8.

The table 8.

Parameters	Initial solutions		Microwaves		Heating	
	anolyte	catholyte	anolyte	catholyte	anolyte	catholyte
pH	3,9	12,4	3,0	13,1	2,7	13,0
ORP, mV	1108±10	–960±10	1093±10	–253±10	1085±10	–928±5
T, C	22±0.1	22±0.1	50±2	50±2	50±2	50±2

From this experiments it follows:

1) The noncontact electrochemical activation of water is observed at small thickness of a dielectric partition (mm and less) and depends on its material. For a partition from identical material, NAF in anode and cathode chambers has a different ΔROP sign (tab. 5);

2) NAF happens both for an ECA of water with a diaphragm, and without diaphragm (tab. 6);

3) ΔROP is incremented at activation in metal tank, or in metal tank with a thin nonconducting dielectric coat (tab. 7);

4) There is an effect of not thermal action of a microwaves-field on a catholyte (sharp diminution ROP, tab. 8).

Abnormal properties 1-4 phenomena of noncontact electrochemical activation can be sufficiently simply explained by origin near to the anode and cathode of stable high-energy resonant systems, consist of oscillating dipoles (two and more) - water, OH^- [80, 114, 127-129]. In a statics such dipoles systems are unstable (effect of a collapse), but in dynamics at a resonance there is the effect of dynamic stabilization of unstable states (fig. 38б) [80, 114, 129].

Variable electromagnetic field from resonant system of two synchronous - oscillating dipole (SOD) [80] has a narrow frequency spectrum (resonant effect) and quickly decreases ~ $1/r^n$ (where n>3).

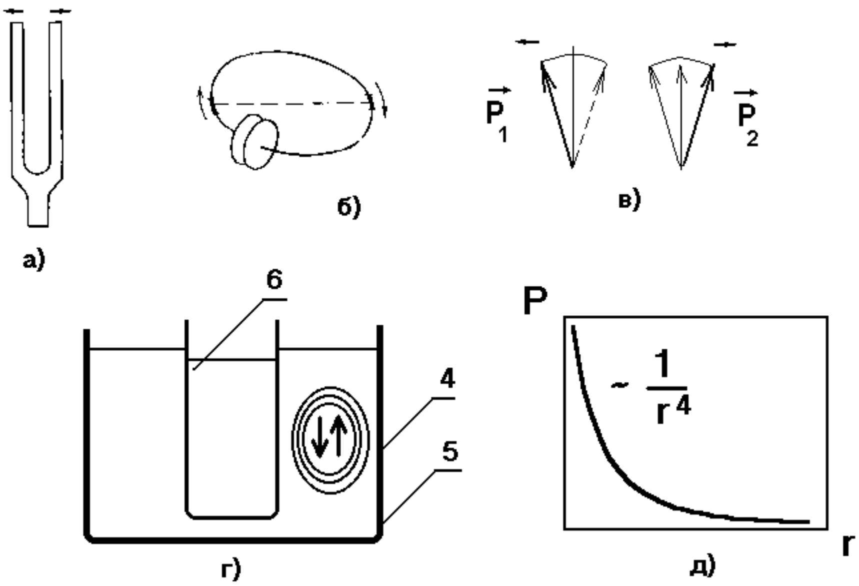


Fig. 39. To interpretation of a phenomenon of noncontact activation in a fluid.

As well as in a case ([130], p. 118) of tonometer (fig. 39а), or oscillatory circuit (fig. 39б) the oscillations of constituents SOD (fig. 39в) - dipoles $\mathbf{P}_1$, $\mathbf{P}_2$ at a resonance, and in cases а) and б), happen in an antiphase. In result, the radiation from SOD quickly decreases with distance (fig. 39 г, д) and the system has a major quality factor (lifetime).

The maximum of a radiations spectrum from SOD probably is on a microwaves frequency band, as for OH^- the characteristic frequencies of rotary transitions are ~ 2 GHz (wave length about =18 cm). Therefore the noncontact activation can happen only through thin walls, at close distances from SOD, and it will be essential to depend on spectral properties of a partition material. The NAF amplification in metal tanks of the cylindrical shape can be explain (tab. 7) by amplification of an effective microwaves-field at the expense of reflection from conductive surfaces (effect of microwaves-resonator). It is necessary to expect amplification NAF at the sizes of tanks ~λ_o, $\lambda_o/2$.

At the same time it is well known [126], that redox potential (ROP) - the most important exponent for interior medium of a human organism - has negative values, which usually there are in limits from -100 up to - 200 millivolts (mV). ROP of potable water practically always there is above zero and usually is in limits from +100 up to +400 mV. It is valid practically for all types of potable water – running water, bottle water and gained after clearing in installations of an inverse osmosis and majority of manifold large and small water-purifying systems.

When the usual potable water penetrate in a tissue of a human organism, it takes away the electrons from cells and tissues, which consist of water on 80 -90 %. As a result the biological structures of an organism (cell's membranes, cell's organoids, nucleic acids and others) expose to oxidizing fracture. So the organism is outworn, ages, the vital organs lose their function. But these negative processes can be retarded, if in an organism with a drink and nutrition receive the water possessing properties of interior medium of an organism, i.e. activated and with negative value ROP water. If the potable water has more negative ROP, than ROP of interior medium of an organism, it replenish him by this energy, which will be used by cells as an energy reserve of antioxidant protection of an organism against unfavorable influence of environment. For example, that at giving a drink of mice by water with ROP = - 450 mV irradiated with a lethal X-ray dose, the mortality has decreased from 96 up to 10 % in comparison with control group, which received a usual (not activated) water with positive ROP [126].

On the other hand there is a well-known method of B.I. Kiselyov of noncontact activation of solutions by a magnetic field, UVR, laser with additional action by the generator of acoustic oscillations changing a structure of water microclusters from ~ 20 dipoles up to ~2-3 [144, 145]. The method has found wide application for treatment of many diseases and hardening of immunity. On the basis of an e.p.r.-method the author has detected a microclusters subdivision in water up to 2-3 ("chaotically" oscillating dipoles with frequencies 10-20 Hz [144]).

On the basis of detected NAF effects [127] the different devices for noncontact undiaphragm activation of physiological solutions in particular of dropping bottles were designed [146]. The experiments have shown an opportunity of noncontact activation in the created droppers:

a) blood, with ROP change from initial +290 mV up to -270 mV;

б) physiological solutions, from +270 mV up to -140 mV.

The ROP relaxation time of noncontact -activated fluids in experiments was ~2 hours.

5.3. Resonant action of fields at biological systems.

Perhaps no modern methods of noncontact diagnostics and therapy do cause so many of inconsistent controversies, as a phenomenon of resonant millimeter therapy (EHF-therapies) and electric-puncture testing of medicines [131-135]. As in this, and other cases there is a low-energy noncontact action at biological systems.

At EHF-therapies the action by mm - radiation of particular frequencies, with power P=20-0,001 mW/cm^2 and less on the man (the heating of tissues 0,1^{o}C and less) results to a high-effective (~95-98 %) treatment of many diseases.

The phenomenon of electric-puncture testing of medicines (PETM) was discovered by R. Foll in 1954 at share examinations with M. Glazer-Tyurk. Unexpectedly it was disclosed that the different medicines, taking place near to man's acupuncture points, could essentially change their electrical parameters up to the best or worse [132].

The examinations, carried out by F. Morrel, have shown, that the medicines improving the electrical parameters of biologically active points (BAP), at their subsequent introduction in an patient organism already in 15-20 minutes are able to diminish a blood sedimentation rate, for example from 40 up to 20 mm/hour [132].

It is interesting, that the effect of electric-puncture testing of medicines was reproduced even if the tested medicine was in a glass ampoule, sequentially «was included» in a measuring circuit of the electrodiagnostic device, was positioned on a skin of the patient or inside of a passive cylindrical (negative) electrode.

The further examinations, carried out by R. Foll and Ф. F. Cramer, have shown, that the reproducibility of a phenomenon of electric-puncture testing of medicines (PETM) does not depend on shape or sort of the testing medicinal preparation, for example as a solution, tablets, dusts, globule, whether they are in glass ampoules, aluminum foil or white paper.

The results obtained by R. Foll and his colleagues, not only have put a basis in development of new methods of therapy based on individual selection of pharmaceuticals, definition of their optimum dosages and compatibility without introduction in a man's organism, i.e. distantly, but also have served as stimulus to examination of biophysical mechanisms and substance of this phenomenon.

One of the first hypotheses, explaining PETM, was a hypothesis about an electromagnetic nature of radiations interaction of alive and lifeless (medicines) objects of a nature. Thus it was guessed, that the different pharmaceuticals have natural spectrums of characteristic electromagnetic oscillations, inducing the resonant response at coincidence to frequency of electromagnetic oscillations of biological object (of organs, tissues, cells, protein etc.), expressing in change of electrical parameters of biologically active points.

For affirming this hypothesis F. Verner undertook the attempt of the proof that the different medicines (being a lifeless nature objects) have unequal spectrums of characteristic electromagnetic oscillations (fig. 40).

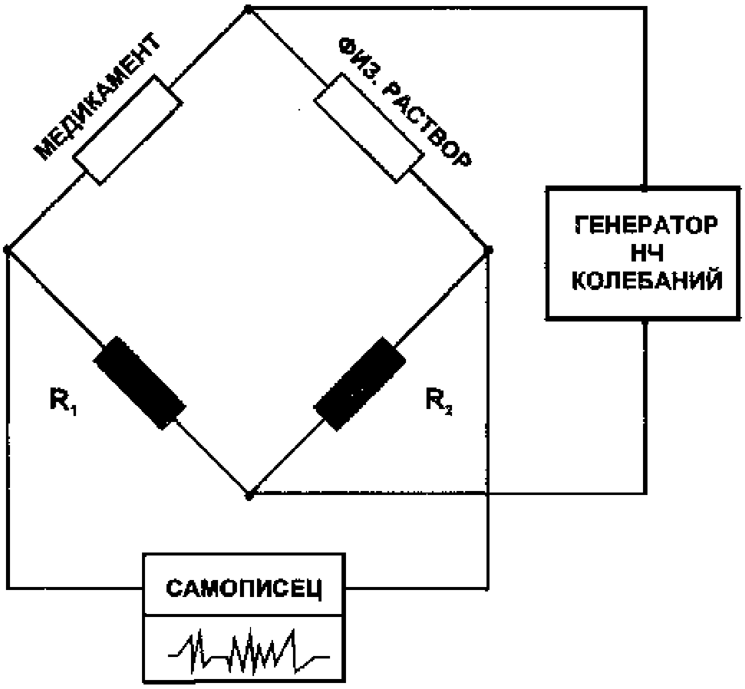


Fig. 40. Model of examination of electromagnetic oscillation spectrums of homeopathic medicines (F. Verner, 1966).

As objects of examination F. Verner took the solutions of homeopathic agents in different potencies. The homeopathic agents were added into a syringe. The metal piston and needle of a syringe served as electrodes for connection to the device representing itself as high-ohmic Uinston's bridge and the generator of electrical oscillations with frequency of impulses running from 0,9 up to 10,0 Hz. These experiments have shown that different homeopathic agents, as well as their separate potencies, have the unequal resonant responses to electromagnetic oscillations of different frequency. In particular, it has appeared, that the basic resonant frequency of a homeopathic agents Aurum metallicum (gold), constitutes 6 Hz, and a drug Belladonna - 9,2 Hz.

From other examinations of PETM the Cramers's works deserve of the special attention. They devote to study of radiations range of electromagnetic oscillations of medicines and their screening off by different materials.

For an estimate of radiations range of electromagnetic waves by medicines the simple plan of experiment was used. It include a gradual removal of a medicine from metal rings of a different diameter, i.e. testing of medicines through an air gap formed by a metal conductor — a ring and a wall of an ampoule, containing a medicinal preparation (fig. 41).

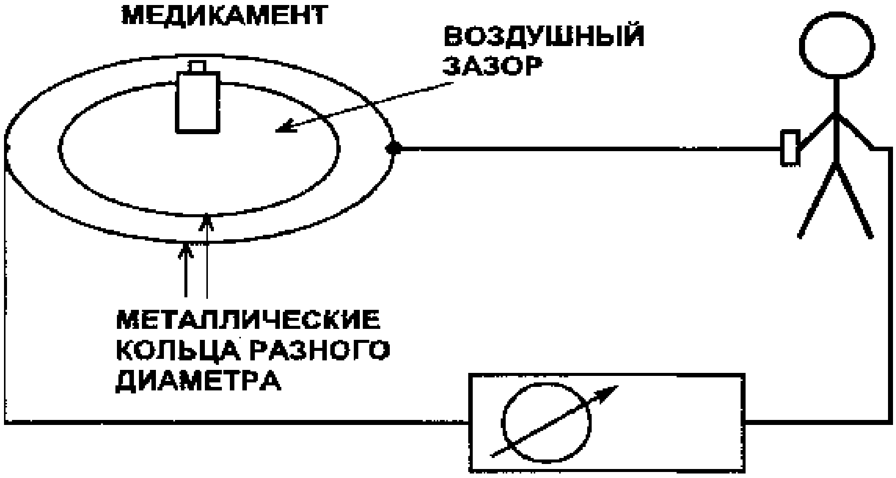


Fig. 41. The plan of examination of an influence range of electromagnetic radiations of medicines (Cramer F., 1972).

Now it is difficult to judge what purpose have been achieving by author at carrying out of this experiment and whether he guessed, that the range, set by him, of electromagnetic waves radiation of medicines, varying depend on a potency and properties of testing drugs from 7 up to 21 mm, corresponds to waves lengths about GHz.. The series of experiments on screening off electromagnetic radiations of medicines by different materials were carried out by F. Cramer at the personal request of R. Foll [132]. During these experiments the following facts were set:

• PETM is not reproduced, if the tested ampoule containing a medicine, is wrapped up in materials which are not passing a infra-red radiation, for example, black paper, wood, board, masking tarpaulin etc.;

• PETM is not reproduced, if the tested ampoule containing a medicine, is screened of the leave of green plants or is located in a solution of chlorophyll, hemoglobin and other biological mediums (saliva, urine etc.); is attenuated at using of leave or red lobes, and do not change at use of white lobes;

• PETM is not reproduced, if the testing medicinal agent is placed in glass dark vessel **with wall thickness more than 5 mm.**

Summarizing this data, it is pertinent to make a deduction, that the spectrums of electromagnetic oscillations of medicinal preparations also can lay in an infrared wave rang and absorb by biological mediums.

The V.P. Kravkov's experiments are phenomenologically close to effect of testing of medicine [132]. This experiments not only convincingly have proved the efficiency of high potencies activity of homeopathic drugs (dilution more than 10^{-23}), but also have anticipated the PETM discovery.

The essence of the experiments, which have been carried out by V.P. Kravkov, was reduced to the following. Through arterial and venous vessels of an anatomic section of the deblooded rabbit's ear, a physiological solution was infused, which streamed by drops from tank, inserted into a terminating part of vena. The amount of a fluid, flowing in a vascular channel, during a particular time period defines with the precise balance, on cup of which the drops of a physiological solution fell (fig. 42).

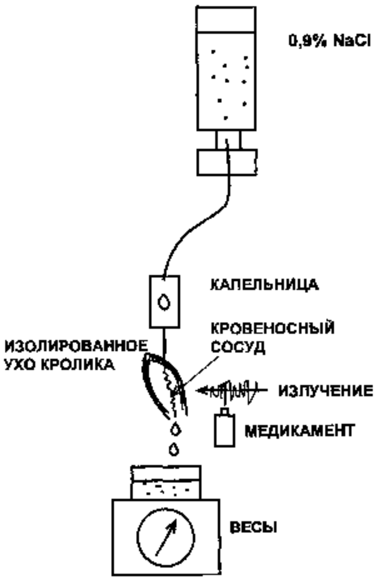


Fig. 42. The plan of examination of distant acting of medicines at biological objects (Kravkov V.P., 1924).

During the carried out experiments the author establishes, that a location of different metals (the copper, lead etc.), and also solutions of an epinephrine and other medicinal preparations near to rabbit ear vessels can change amount of a fluid, flowing in a vascular channel, (in relation to the control). Thus, for the first time the distant effect of interaction of alive and lifeless nature objects, i.e. transmission of information or characteristic electromagnetic properties of medicines was ascertained.

In general it is possible to explain a physics of EHF-therapy and PETM processes on the basis of the offered hypothesis about origin of high-quality SOD ($\sim10^{18}$) of a synchronous - oscillating dipoles (5.2 [, 127, 128]) in water. The main component of biological systems is water (> 70 %). The noncontactly activated water by this or that expedient (of an ECA, EHF, PETM,…), gains properties of "maser" - system of highly active ions, molecules of "microgenerators". In particular, the water, activated by resonant EHF - electromagnetic radiation, gains properties, congenerous to ECA - activation [127, 128]. The molecules of activated water, as has shown at their clinical testing in Medical center SRC "IKAR" [135], are original miniature «EHF» generators (" the Kremlin tablets "), which, passing through an organism, carry out its «restoration» - treatment by a resonant field. And consequently even the small quantity of substances dissolved in such water, cause the essential effects (effect, congenerous to homeopathies).

Many such separate SOD, possessing a major potential internal energy, at their synchronization can conform for biosystems immunity, their energetic, response on exterior "energy-information" action.

Probably, the many incomprehensible "abnormal" effects in future will be explained on the basis of the resonant theory of nonlinear dynamic systems.

5.4. Sun, radiation and life.

At times on the Sun there are the periods of high activity – there are forming of «stains» and huge explosions, on power similar to nuclear explosions with ejection of substance, plasma and radiation (fig. 43, 44). The incandescent plasma cloud - "solar wind" - pulls out in outer space and in two - three days reaches our planet.

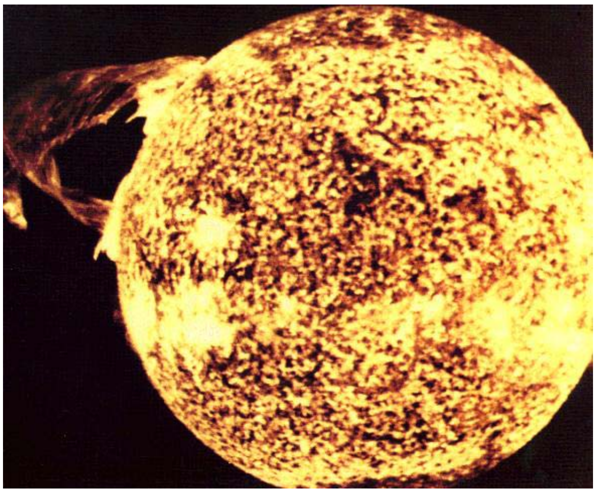


Fig. 43. The sun in the active phase.

The well-known Russian biologist Alexander Leonidovich Chigevskyi one of first has supposed that the solar activity essentially acts all alive. " It would seem, death and Sun can not steadfastly look each other. However there are days, when for the patient man the Sun is a source of death. In this days from life-giver it converts to an enemy, from which the man has no place to disappear and to escape. The mortal Sun influence overtakes the man, where he was », wrote Chigevskyi in the book " An Earth echo of solar storms " [140].

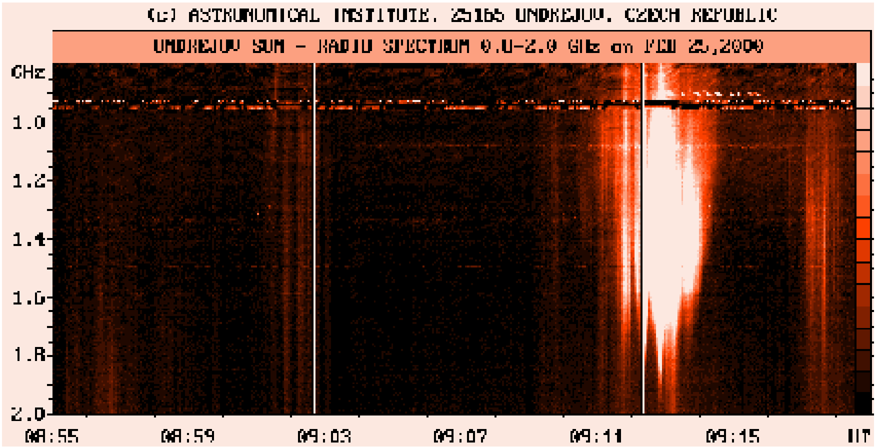
The periods of high Sun activity, which happen one time per 11 years, cause the social and natural catastrophes - wars, revolutions, a mutation of microorganisms [141], epidemics, large mortality. The periods of grandiose historical events: 1848, 1906, 1917, 1928, 1937, 1947, 1958, 1968, 1979, 1991 falls at the years of solar activity. In a phase of wane, on the contrary, the wars stopped, the peace was concluded, epidemics calmed down.

In the beginning of XX century the doctors For and Sardu have carried out a statistic account of the patients of all clinics in France and have suspected, that "peak" of malaises depends on any natural phenomena. It has appeared that for two - three days before the marked dates the astronomers observed explosions on the Sun. To explain this dependence they were not able.

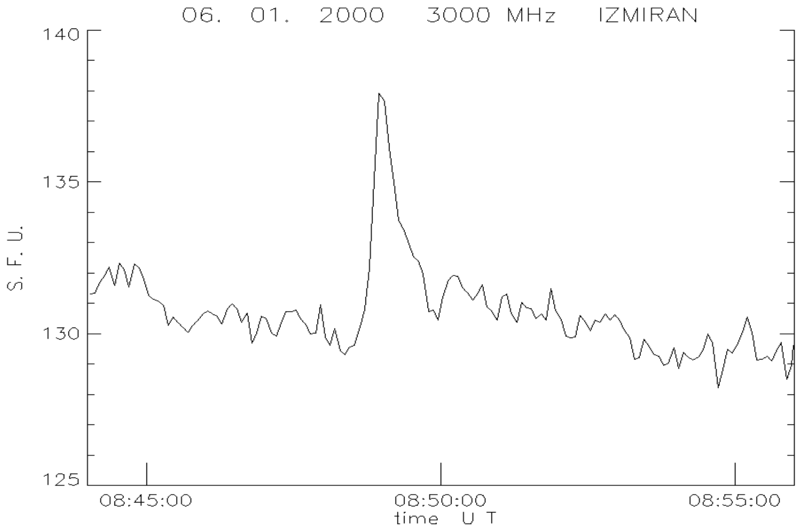
Some experts consider that the Sun somehow acts nervous system, causing a mass psychosis. The opponents objects: it is impossible, as the human organism is resistant enough, and the influence of solar fields is too weak. In life there are more potent social factors causing the historical catastrophes.

For a long time the many scientists skeptically concerned into to the Chigevskyi's assertion, that the Sun caused mass epidemics. However recently it is already detected, that the heightened solar activity reduces the human immunity [142], results to a microbe's mutation [141], causes a sharp change of dynamic characteristics of blood sedimentation of the patients by ischemic illness of heart [143]. But what is a mechanism of action?

The scientists of many countries have noted « at a heightened level of solar radiation in a blood a number of lymphocytes responsible for immunity is enlarged very quickly. That is the organism struggles with harmful exterior action. Why frequently it is so inefficient? Using a principally new procedure and microfluorimeter "Radical DIF-2, created in institute, it was possible to fix that solar radiation almost twice reduces ability of lymphocytes to synthesize a protein - a building material of the future antibodies, which kill an infection. Therefore, the protective forces of an organism are attenuated. Probably, it also is one of the reasons of epidemics origin during the restless Sun. The scientists can not say yet, what concrete component of solar radiation "is guilty", but they guess, that though it is rather weak on intensity, nevertheless, at the expense of resonant effects, results to a serious consequences. It is known that the marching soldiers have destroyed the bridge. The similar things can happen and in our organism, when the "weak" solar fields begin to resonate with oscillations occurring in cells » [142].



a)



б)

Fig. 44. Spectral components of solar activities.

A present influenza epidemic is caused by heightened solar radiation, the higher scientific worker of cell Biophysics institute of RAS N. Karnauhova [142]. The next 22 cycle of activity due has begun in 1999 and would be prolonged till 2002 (fig. 44a, б).

It is possible to put forward enough simple hypothesis explaining the influence of solar radiation at biosystems. As the initial moment for a hypothesis we shall accept the following chain of the facts obtained by the different authors in different time on nonlinear resonant dynamic systems:

1) Phenomenon of noncontact activation of fluids (by electrolysis, fields magnetic, microwaves. UVR, laser) [124, 125, 127, 133, 144, 145, 146];
2) Resonant action of electromagnetic fields at biological systems (EHF -, bioresonant therapy) [131, 132];
3) Reaction of acceleration of erythrocytes sedimentation in days of solar activity [143];
4) Correlation of solar activity with periods of social and natural catastrophes - wars, revolutions, mutations of microorganisms, epidemics, heightened mortality [140-142];
5) Effect of origin of stable resonant structures of oscillating dipoles (SOD) [80];
6) Resonant structure of a ball - lightning [138, 129];
7) Occurrence of «maculae», ejections of plasma, radiations in solar activity days (fig. 43, 44);

8) Influence of noncontact activated fluid at biosystems [144, 145].

During solar activity the origin on the Sun of resonant turbulent formations - «maculae» (such as a ball - lightning) results to occurrence in radiation spectrums of the Sun (fig. 43) of potent eruptions on particular resonant frequencies. This frequencies in turn causes a change of resonant microcluster structure of SOD dynamic [80,127,128] and water dynamic being a basis for all biological systems.

Proceeding from this it is possible easy to explain a phenomenon of effective treatment of the diversified diseases, including a hypertonia of 1-3 stages, sepsis, herpes, infectious hepatitis, AIDS (2-3 stages), with use NAF. Cells in an organism are original, small-type reactors for an ECA and accordingly NAF in an organism. Incipient thus high -energetic systems of oscillating dipoles SOD form a synchronous skeleton, which ensures the basic energetics and immune status of an organism. Accordingly a treatment by means of mm- or bioresonant therapy, water -, aeroionotherapy promotes restoration of SOD energetic on particular frequencies [128, 131-135, 144-146].

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The appendix - some accents of the problem history:

? century before N.E. (" the first reports " about a levitation from legends, " informs, - Euler wrote - as if Magomet's coffin is held by the force of some magnet ").
I-II century of N.E. (the monks with the help of magnets tried to make to hang in air a temples statues).
XIV century. ***Bombay*** (trick with pole, with an oscillating hanging point).
XVI century. ***Kepler*** (problem about a motion of celestial bodies).
1600. ***Hilbert*** (it is fixed the fact of instability of equilibrium in a static configuration of interreacting bodies).
XVIII century. (problem of resonances and small denominators in a celestial mechanics).
1802. ***V.V. Petrov*** (for the first time has made a diaphragm electrolyzer - device for «alive» and «dead» water).
1807. ***F.F.Reis*** (has discovered an electrophoresis).
XIX century. ***Gamuletskyi*** (levitation of the angel figure of a magnet in air, his "office", had been existing till 1842).
1838. ***Mathieu*** (problem of a membrane vibration).
1842. ***Irnshow*** (theorem of equilibrium instability in a static magnetic configuration of interreacting bodies and particles).
1891. ***P.N. Lebedev*** (the fundamentals of the uniform theory of a resonant ponderomotive interaction of acustic, magnetohydrodynamic, electromagnetic resonators are designed).
1908. ***Andrew Stephenson*** (problem of a vertical pole, multilink pendulum with a oscillating hanging point).
1923. ***N.G. Chetaev*** (the basic equation " of permissible orbits " for a classical discrete mechanics is obtained).
1925. ***B. Van der Pol*** (has specified stability of a upturned pendulum state).
1939. ***Braunbeck*** (has shown, that the unstable equilibrium in statics can become stable in dynamics, at presence of a diamagnetic body in system).
1940. ***I.E. Tamm*** (" a $1/R^3$ problem ").
1941. ***V.L. Ginsburg*** (the idea about the account of an internal field reaction - can eliminate a fall on magnetic - attractive center. The qualitative reasons are reduced that at convergence of magnetic moments the kinetic energy of a precession increases).
1947. ***Ya.G. Dorfman*** (has offered a n.m.r. registration method on the basis of origin of a ponderomotive force in conditions of a nuclear magnetic resonance).
1950. ***P.L. Kapica*** (has considered a problem about a upturned pendulum with vibration, has specified an opportunity of use of the forces orienting moment incipient at oscillatory process, for orientation of colloids, molecules).
1956. ***V.N/ Chelomey*** (has carried out the unusual experiments with upturned vibrant fluids and solid bodies).
1954-1959. ***N.F. Remsi, V. Paul and H. Demelt*** (the atomic traps are created, in 1989 they are awarded of Nobel Prizes for series of experimental works with isolated particles)
1958. ***M.A.Gaponov, M.A. Miller*** (theoretically have substantiated an opportunity of origin of potential pits in nonuniform high-frequency electromagnetic fields for charged particles).
1960. ***I.I. Blehman*** (has substantiated an integrated indication of motion stability).
1962. ***G.A. Askarian*** (for the first time theoretically has substantiated an opportunity of a focusing (draft) of atomic beam by a traversal - nonuniform resonant light field, coaxial with a bundle of laser rays).
1964. ***Alzetta G., Gozzini A.*** (observed the ponderomotive moment of forces in conditions of an electron paramagnetic resonance).
1968. ***V.E. Shapiro*** (has taken into account the origin of forces at f.m.r.).
1973. ***Morgenthaler F R*** (on the basis of energy tensor - impulse, has predicted the existence of a ponderomotive force, acting on a ferromagnetic at a resonance).

1974. ***Ovenden M. W.*** (for an explanation of resonances in a celestial mechanics the hypothesis of extremeness of resonant states of a motion in a nature is proposed).

1974. ***V.V. Kozorez*** (levitation in system of two undot magnets, current rings).

1974. ***H. van der Heide*** (has shown an opportunity of a levitation of permanent magnets beyond of resonance zones in a combined magnetic field - constant and variable, in particular in a field of permanent magnets).

1977. ***A.I.Filatov, V.G.Shironosov*** (have considered the effects of resonance levitation of particles at f.m.r..).

1978. ***Bjorkholm J. E., Freeman R. R., Ashkin A., Pearson D.*** (experimental observed a focusing - draft of an atomic beam by a traversal - nonuniform resonant light field, coaxial with a bundle of laser rays)

1979. ***Yu.L.Klimontovich, S.N. Luzgin*** (have shown an opportunity of a joint self-focusing of nuclear and light beams).

1980. ***A.K. Gulak*** (has set the equation of a dynamic balance on the basis of the account of momentum moments of interreacting bodies in solar system for a prediction of its evolution and discrete structure).

1982. ***Yu.I. Neimark, P.S. Landa*** (on the basis of a numerical modeling, have detected stable parametrically excited oscillations of a upturned pendulum in a resonance zone).

1982. ***I.L Gerlovin*** (on the basis of the vacuum theory theoretically has predicted a phenomenon of noncontact electrochemical activation of fluids in diaphragm electrolyzers).

1983. ***Roy Harrigan*** (has devised a levitron - levitating magnetic top).

1983. ***V.G. Shironosov*** (has considered a problem of a resonance entrapment of a spin particle in a variable and nonuniform constant magnetic field).

1985. ***V.G. Shironosov*** (has shown an opportunity of origin of stable systems of oscillating dipoles at a resonance)

1987. ***Dietrich F, Chen E, Quint J W, Walter*** (observed a pseudo-crystallization of ions in a trap after their cooling by a laser light).

1988. ***V.G. Shironosov*** (has offered an S-function method for the analysis of nonlinear dynamic systems beyond and inside a resonance zones on the basis of property of extremeness of resonant states of a motion in a nature).

1989. ***A.V. Bonshtedt, V.G. Shironosov*** (have shown the effect of a magnetic dipole levitation in a field of gravity and variable resonant and unresonant magnetic field).

1989. ***B.I. Kiselev*** (has detected effect of noncontact activation (structurization) of physiological solutions and the high-effective methods of treatment designed on its basis).

1992. ***V.M. Bahir*** (experimentally has detected the effect of noncontact activation in diaphragm electrolyzers).

1997. ***Green N.G., Hughes M.P., Monaghan W., Morgan H.*** (effect of cell levitation in electromagnetic fields).

1997. ***V.G. Shironosov, E.V. Shironosov*** (the effect of noncontact activation of fluids in undiaphragm electrolyzers is detected).