

**SELF-ORGANIZING, SYNCHRONIZATION AND SELF-ALIGNMENT IN THE LIVING AND INANIMATE OBJECTS**

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**Abstract**

The establishment of the dynamic equilibrium of different objects with the medium is examined. Examples of the dynamic behavior of living and inanimate objects are given. It is concluded that the chaotic behavior is the necessary condition for the presence of this equilibrium.

**Key words**

Dynamic equilibrium, Synchronous dynamics, Nonequilibrium.

**1. Introduction**

The establishment of dynamic equilibrium with the medium plays a paramount role for the existence of living and inanimate objects. Its purpose is the minimization of energy consumption with interaction of object and medium. Depending on ambient conditions and internal state of object, the region of achieving the equilibrium can have different configuration, position and sizes. Paramount role in reaching of equilibrium is played by chaotic fluctuations, which have wide spectrum and several oscillating models as a result. In an object, there is always the possibility to tune for changes in the environment when the width of the zone of its natural fluctuations intersects the strip of the fluctuations of the conditions of environment. Then there are conditions for the appearance of resonance and the object finds the region of dynamic equilibrium with the medium (Fig. 1).

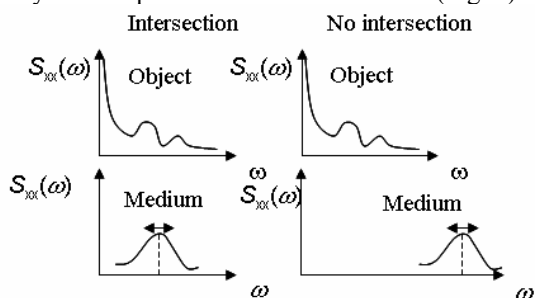


Fig. 1 Natural fluctuations of object (upper figures) and fluctuations of the conditions of medium (lower figures). In the left figures there is the intersection, in the right figures there are no intersections.

A study of the dynamics of chaotic fluctuations and their connection with the state of environment were investigated on the following objects:

- Men, the dynamics of his respiration and its connection with the state of man [Lukyanov, Usachev, 2003] and [Lukyanov, Rassadina 2005];
- Flow of liquid in the pipes, a change in the nature of fluctuations with a change in the flow conditions;
- Nonequilibrium metallic (copper) film with the fractal structure of surface and connection of its relief with the conditions of production and with the state of environment [Anisimov., Lukyanov, Serov etc., 2005].

**2.1. Synchronous dynamics of breathing and heartbeat**

Respiratory system is one of the important for the human organism and its state and connection with other physiological systems has a great influence on the general state of man [Lukyanov, Rassadina 2005]. There is special interest in its connection with the heart activity. The conducted investigations showed that the heart and respiratory system are found in the close phasing and the synchronization. Between the rhythm of the heart contractions and the rhythm of respiration there is a rigid interrelation, where the respiratory system assigns the rhythm in the mutual work (Fig. 2, 3).

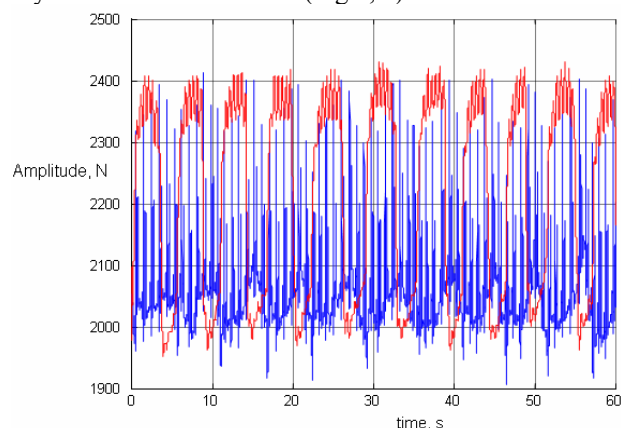


Fig. 2. Synchronous dynamics of breathing (red curve) and heartbeat (blue curve)

**2. Subjects of the study and experiments**

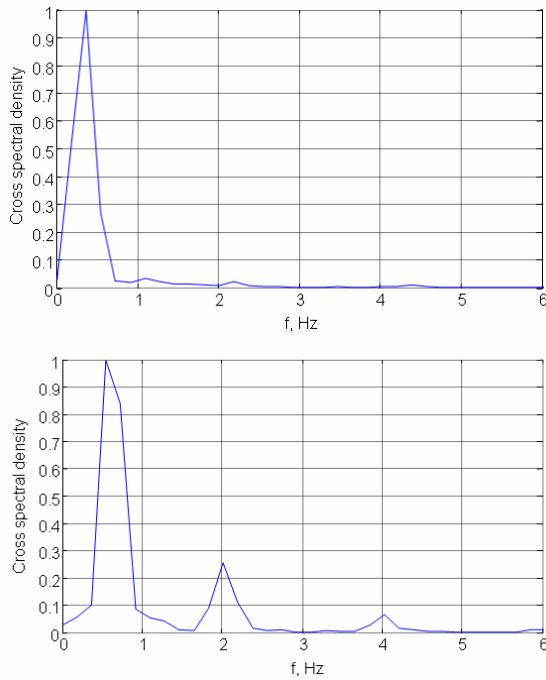


Fig. 3. Cross spectral power density for the systems of respiration and heart activity of a sick person (above) and the healthy person (below)

The 3-Dimensional space plot for the respiration of a sick person and the healthy person are given in the following figure 4 (It is reconstructed according to the results of measuring the air velocity in to the nose of the man).

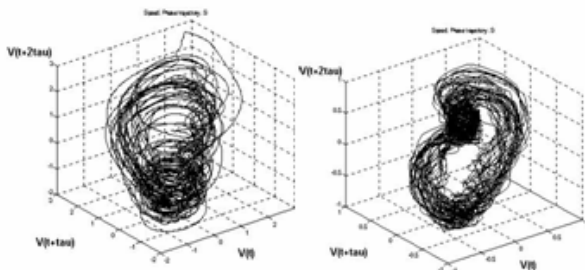


Fig. 4. Space-plot of respiration of a sick person (left) and the healthy person (right)

The frequency of the envelope of heart activity coincides with the respiratory rate. This means that the activity of heart is synchronized with the activity of respiratory system.

In the phase space for the sick person the phase trajectory looks like the skein of wire with disordered winding. The trajectory of the healthy person has himself two areas of attraction. These are the area of inhalation and the area of expiration, in which occurs the synchronization testily (Fig. 3, right). In man of patient such zones are absent (Fig. 3, left).

## 2.2. Study of the nature of the fluctuating motions of liquid in the pipe

During the motion of liquid in the pipe the fluctuating motions also appear. The spectrum of these of fluctuations affect the dimensions of pipe, rate of flow, type of liquid, the temperature of medium and so forth

are given below the graphs, on which is shown a change in the nature of the pulsations of the temperature in the dependence on the rate of flow of water in the pipe. The fluctuations of temperature in different points of pipe with one expenditure are shown for Fig. 5. The spread of pulsations has a value of 0.08 K.

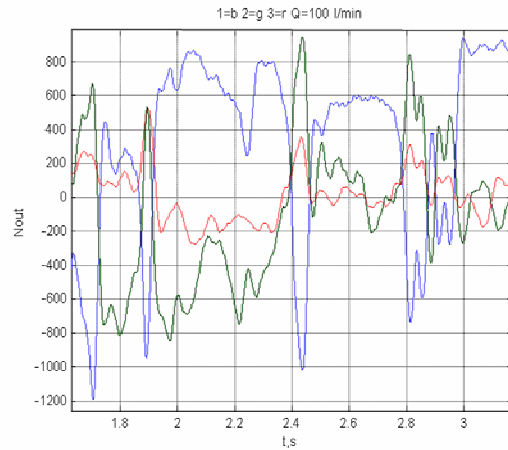


Fig. 5. Fluctuations of temperature in different points of pipe

The spectral power density for various volume flowrate is showed on Fig. 6. The diameter of the pipe  $d = 50$  mm

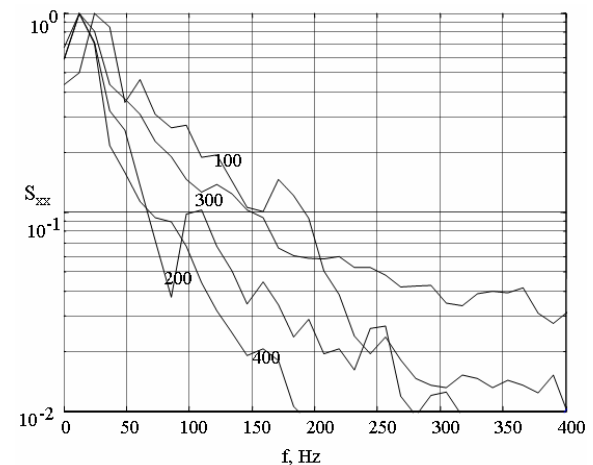


Fig. 6. Spectral power density for fluctuations of the velocity by various volume flowrate of the water in the pipe of 50 mm diameter.

## 2.3. Study of metallic films with the fractal structure

The processes, similar examined above, with the resonance phenomena in the space, occur also during the magnetron spraying of thin metallic films [Anisimov., Lukyanov, Serov etc., 2005]. It was shown that such films form three-dimensional fractal structures on the surface of the base layer [Anisimov., Lukyanov, Serov etc., 2005]. This occurs because of the redistribution of energy in the spectrum of the pulsations of potential in the installation for the magnetron spraying under the action of the resonator, which plays the role of space-filter (Fig. 7).

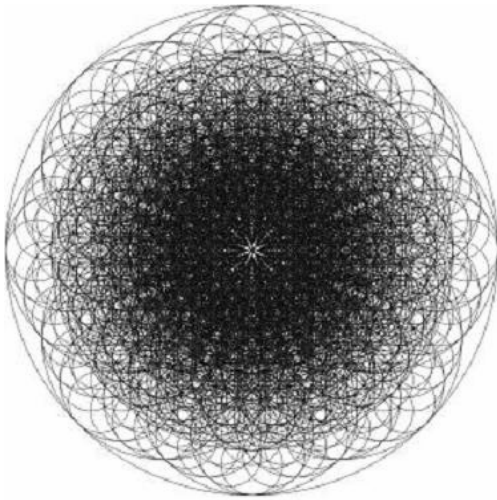


Fig. 7. Resonator

These processes are accompanied by the resonance phenomena, with which the regulated fluctuations are developed under the action of the external periodic forces, which introduce into the system ordering (Fig. 8, 9).

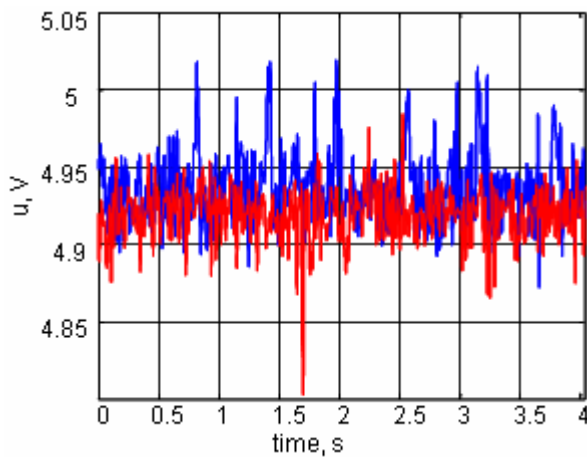


Fig. 8. Pulsations of electric potential with the production of the copper film. Red curve with resonator, and blue curve without resonator.

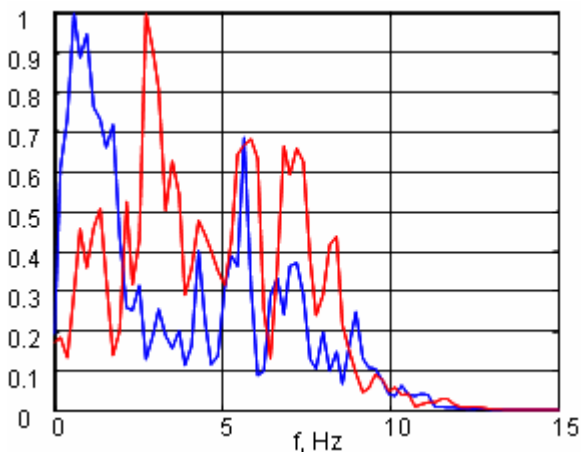


Fig. 9. Power spectral density with resonator (red curve) and without resonator (blue curve)

This resonance is a special case of the general class of the processes of self-organizing in the dissipative structures, distinctive special feature of which is the quasi-periodic nature of a change in some parameters of system. Thus the density gradient, which is the reason for nuclei forming, is created, appear the mechanical fluctuations of the medium. The combined action of external forces and fluctuations of medium leads to the fact that under specific conditions in the system can begin the formation of the regulated structures, fluctuation of the centers of nuclei forming they are synchronized with the redistribution of energy of oscillating process and the appearance of resonance phenomena.

It's occurs the evolution, result of which is metallic film on the surface of the base layer and entire "history" of the production of this film "is preserved" in its structure. This means that if we examine copper film (Fig. 10, lower picture) as the result of this evolution, then it is

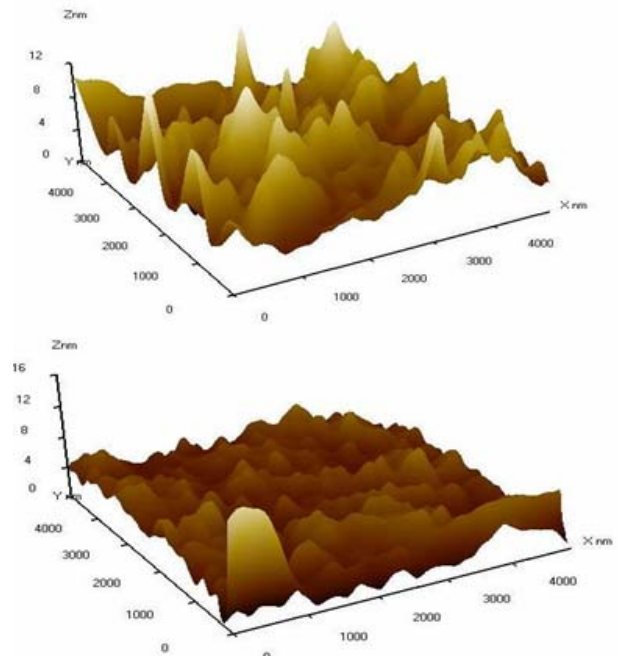


Fig. 10. Relief of the surface of the copper films. Maximum altitude in the upper picture is 16 nm, on the lower is 16 nm, the area of the pictures is 4000 of 4000 nm.

possible to attempt to restore some properties of the reference system, because of which it was obtained, or which "gave birth to" this film.

### 3. Conclusions

Chaotic behavior allows the possibility to enter into the resonance with the medium. This occurs due to the energy distribution of fluctuations along the spectrum. Then the probability of finding the resonance is substantially higher than in system with the fluctuations near what that of the specific frequency. When system is found in the resonance with the medium, energy consumption in it is minimal. It is possible to give several examples. If in the turbulent flow the size of some vortex began arbitrarily to change, then because of

the viscosity adjacent vortices, after spending some energy they would not give to it this to make.

The sounding of the music on the concert is not such, as on the studio records (especially for the rock- music and for jazz): it more strongly differs from ideal. This occurs because the musicians search for resonance with the spectators, they subconsciously produce deviations.

In the following picture (Fig. 11) participants in the group the Rolling Stones, on concert of which in St. Petersburg was the author. On this concert these thoughts arrived him into the head.



Fig. 11. The Rolling Stones (from [http://en.wikipedia.org/wiki/The\\_Rolling\\_Stones](http://en.wikipedia.org/wiki/The_Rolling_Stones))

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