R4-O-002101

FORMATION PROCESSES OF DISK-SHAPED CLUSTERS IN CHAOTIC SYSTEMS

G.A. MELNIKOV, N.M. IGNATENKO, A.S. GROMKOV

Southwest State University (SWSU), Kursk, Russia

The process of self-organization of particles with chaotic motion into a cluster system begins with a situation that randomly arises as a result of fluctuations, when two particles are at a distance equal to the distance of the minimum potential energy of interaction between two particles, but the binding energy is not enough to form their bound state [1, 2]. In this case, the appearance of the third particle at a distance exceeding the distance between the close pair leads to the appearance of the Efimov effect (Fig. 1).

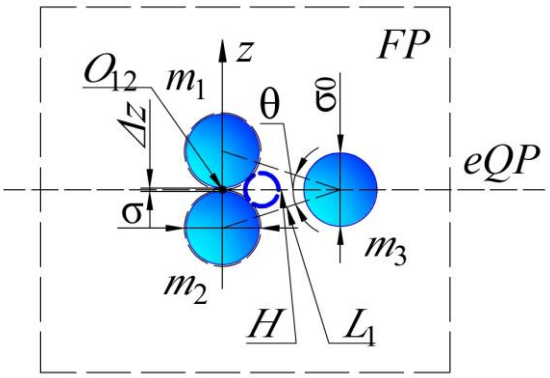

Fig.1. The Efimov effect in a three-particle cluster with the arrangement of particles according to the rule of the "golden" triangle in the model of absolutely hard spheres.

The diameter of one of the two interacting particles σ (in the dimer) and the distance to the third disturbing particle L_1 will be determined based on the properties of the "golden" triangle [3, 4]:

$$L_1 = \frac{\sigma}{2\sin\frac{\theta}{2}} = \Phi \cdot \sigma\,, \qquad (1)$$

where θ is the "golden" angle, Φ = 1.6180339… is the value of the "golden" proportion ("golden" ratio).

In the equatorial plane of the disk-shaped cluster, a centrally symmetric system is formed with the center at the center of mass of the dimer and circular formations of densely packed absolutely hard spheres. Such formations in the equatorial plane are characteristic of the structure of planar clusters (2D clusters), which have recently been actively studied [5].

In the structure of a disk-shaped cluster as an independent physical object, the formation of a nano-sized potential region in the form of a toroid is possible. When such clusters are irradiated with proton-ion beams, a toroidal quantum dot is formed into their structure [6].

REFERENCES

[1] V. Efimov, “Energy levels of three resonantly interacting particles,” Nucl. Phys. A, vol. 210, pp. 157–188, 1973.

[2] P. Naidon, S. Endo, “Efimov Physics: a review,” arXiv:1610.09805v2 [quant], 7 Apr 2017.

[3] The Fibonacci Association:http://www.mscs.dal.ca/Fibonacci/.

[4] The Fibonacci Quarterly: http://www.fq.math.ca/.

[5] G.A. Melnikov, “Clusters of Fibonacci in the structure of condensed medium,” Izv. Vyssh. Uchebn. Zaved. Fiz., vol. 61, no. 9-2 (729), pp. 207–210, June 2018.

[6] Y. Chiu, Li-Wei Huang, Ching-Ming Wei, Chia-Seng Chang, T. Tsong, “Magic numbers of atoms in surface-supported planar clusters,” Phys. Rev. Lett., vol. 97, p. 165504, 2006.

[7] G.A. Melnikov, N.M. Ignatenko, A.S. Gromkov, "Quantum dots in structure of quasicrystalline systems," Journal of Physics: Conference Series, vol. 1347, pp. 012031(6pp), 2019.