THE TITIUS LAW AND ITS PHYSICAL FUNDAMENTALS

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A cosmic planetary system (PS) having a sufficient enough number of the satellites moving eccentrically and interacting one with another within a $R-r$ layer (R – outer and r – inner boundaries) is the spatially limited oscillating system with many degrees of freedom. There is a set of the remotest apocentres of PS satellites (at the first approximation it is a sphere of R radius) at outer boundary of such a system. An inner boundary of PS is a set of the pericentres of the satellites, which are the nearest from the gravitating centre (GC). They are moving eccentrically as if they are reflected from these boundaries. In such a system: 1) the virial theorem works, *i.e.*, there is the relationship between the time averaged potential (gravitational) U and kinetic E energy: $-\langle U\rangle = 2\langle E\rangle$; 2) the radial standing waves are formed; 3) the initial gravitational energy decreases during the relaxation of PS to its stable state. So, if the outer satellites' layer R loses the equilibrium as result of some perturbation only a half of its gravitational energy, *i.e.*, $-GM/(R/2) = -2GM/R$, remains in PS according to the virial theorem. The another half of energy either runs away from PS by the energy-bearing satellites or transforms into positive kinetic energy of a new satellite belt at the $R/2$ vicinity from GC. If this new state of PS is to be broken by an outer or inner reason, then a part of the $R/2$-layer satellites migrates toward GC and their specific energy will be equal to $-2^2GM/R$ at the $R/2^2$ distance. When such events are repeated by n times the distance of the middle of an n-th layer from GC will be equal to $R_n = R/2^n$ with the energy of $U_n = -2^nGM/R$. By using the inverse geometric ratio and denoting $R_n = 2^na$ we have $U_n = -GM/(2^na)$, which reminds a quantum energy level of the Bohr atom model. If the distance of the lowest layer is b (this retreats from the symmetry could be explained by some GC influence such as tides or/and the magnetic moment) we obtain the known formula:

$$a_n = 2^na + b. \tag{1}$$

In the Titius Law $a = 0.3$ AU and $b = 0.4$ AU. Distances of the giant satellites of Jupiter, Saturn and Uranus can be described approximately by the (1) formula [1]. Inexact fitting of planetary and satellites distances to the Titius Law is explained by the influence of another mechanisms (*e.g.*, radial standing waves [2], tides, resonances, *etc.*), which takes place in the process of a PS formation and its relaxation to the stable state. Therefore, radial standing wave structures [2] (the Titius structures) must prevail in the rings and near stellar nebulae at the some stages as well as in the systems of the giant satellites formed by accreting mechanism.

REFERENCES

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