ON NONLINEAR DYNAMICS OF OSCILLATING KINKS IN MICROTUBULES

Batova A.S., Bugay A.N., Ustinov N.V.

Joint Institute for Nuclear Research, Russia, 141980, Dubna, Joliot-Curie St. 6,
phone 216-2119, E-mail: anna-sergeevna00@yandex.ru

Microtubules (MTs) are the key structural element of the cytoskeleton of cells involved in their division, intracellular transport and in a number of other processes. MTs consist of long chains of the tubulin dimers capable to the conformational changes that initiate the generation of nonlinear waves, including the solitons. It is believed that such waves can participate in the transmission of signals [1].

There are various models describing the dynamics of the dimers in MT. Here, we exploit the longitudinal model [2] to be considered within the frameworks of the continuous approximation. The resulting model equation of the dimer motion has the well-known solution in the form of the kink [3].

The purpose of this work is to investigate the nonlinear dynamics of MT in the case when dimer displacements include both the low-frequency and high-frequency components. To do this, a system of nonlinear partial differential equations for the low-frequency and high-frequency components of the dimer displacements is obtained by using the approximation of the slowly varying envelopes [4]. We find a solution containing arbitrary functions of this system, which, in turn, allows us to obtain an approximate solution of the equation of dimer motion in the longitudinal model. This approximate solution has the form of the oscillating kink, i.e. the kink with the high-frequency filling.

The evolution of the oscillating kinks is compared with the results of numerical integration of the initial equation of the model. Several types of dynamics are identified, which are determined by the parameters of the approximate solution we found.

This work was carried out within the framework of the Cooperation Agreement between JINR, Dubna, Russian Federation and the Ministry of Science, Technological Development and Innovation of the Republic of Serbia, project "Solitons and chaos in nonlinear dynamics of biomolecules".

References

1. *Zdravković S., Chevizovich D.* Nonlinear Dynamics of Nanobiophysics. – Springer, 2022. 368 pp.
2. *Zdravković S., Satarić M.V., Zeković S.* Nonlinear dynamics of microtubules – a longitudinal model // *Europhysics Letters* **102**, № 3, 2013. P. 38002.
3. *Satarić M.V., Tuszyński J.A., Žakula R.B.* Kinklike excitations as an energy-transfer mechanism in microtubules // *Physical Review E* **48**, №. 1, 1993. P. 589-597.
4. *Akhmanov S.A., Vysloukh V.A., Chirkin A.S.* Optics of femtosecond laser pulses. – AIP, 1992. 366 pp.