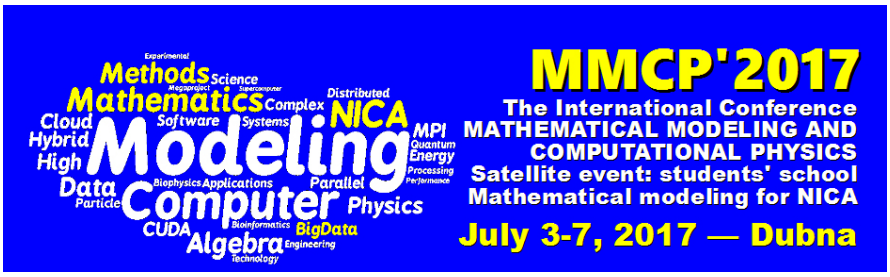


Contribution ID: **66** Type: **not specified**

# Hidden attractors in bubble contrast agent model

*Thursday, 6 July 2017 14:45 (15 minutes)*

In this work we studied a model, describing dynamics of a spherical gas bubble in a fluid. The bubble is oscillating close to the wall of finite thickness under the influence of external field pressure. This model is a generalization of the well-known Rayleigh-Plesset equation describing dynamics of gas filled bubble in an incompressible fluid. In the model considered in this work, the fact that gas bubble is close to an elastic wall of finite thickness is taken into account. Thus, the model depicts a bubble contrast agent, oscillating in a neighborhood of a blood vessel wall. Besides, in the model being studied, compressibility and viscosity of the fluid are taken into consideration. In earlier works, dedicated to the dynamics of gas bubbles in a fluid, the possibility of existence of hidden attractors was not taken into account. In this work we investigated different motion modes of the bubble oscillations. We used perpetual points method to seek for hidden attractors. We have shown that in the system under investigation there are hidden chaotic attractors and co-existing periodic attractors. Also, we have given an example of existence of hidden chaotic attractor, when the parameters of the system are physically realistic. As well, it was shown that in the range of parameters where this attractor exists, if we vary frequency of the external force, system can unexpectedly switch from periodic motion to chaotic and vice versa. The example mentioned above shows importance of finding of hidden attractors for applications. If chaotic behavior is undesirable, parameters should be choosen in a way avoiding ranges where hidden attractors exist.

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**Session Classification:** Mathematical methods and application software for modeling complex systems and engineering (III)