NEW QUALITATIVE PHENOMENA IN INTRAMOLECULAR DYNAMICS AND THEIR QUANTUM ANALOGS

B. ZHILINSKII, G. DHONT, D. SADOVSKII, *Université du Littoral, UMR 8101 du CNRS, 59140 Dunkerque, France*.

Qualitative theory of general dynamical systems began with the work by Poincaré on classical mechanics and made subsequently considerable progress. General questions of the construction of classical integrable models and of their generic modifications under the variation of physical control parameters form the basis of modern qualitative theory of dynamical systems. Via the classical-quantum correspondence principle, this theory was extended, in particular, to quantum finite particle systems. During the last 20 years such qualitative phenomena as quantum bifurcations, quantum phase transitions, rearrangement of bands, and more recently—quantum monodromy were found to be present typically in a number of simple and very well known quantum atomic and molecular systems. Moreover, the collaboration between molecular physicists and mathematicians has led to the introduction of new formal mathematical concepts which are necessary to describe previously unnoticed qualitative features of both classical and quantum dynamical systems. These new concepts, namely, fractional monodromy[a] and bidromy[b] will be introduced briefly on the basis of more standard concepts of classical mechanics such as integrable approximation, energy-momentum map, regular and singular fibrations; their relevance to the problem of the qualitative description of molecular spectra and dynamics will be demonstrated[c]. On the one hand, simple atomic/molecular systems can be used as an excellent test ground for the new theory. At the same time, our qualitative approach opens the way to the analysis of highly excited systems with such high density of states that makes the traditional state-by-state description of quantum systems impossible.

[a] N.N. Nekhoroshev, D.A. Sadovskii, B.I. Zhilinskii. Fractional Hamiltonian monodromy. Annales Henri Poincaré, (2006) **7** 1099–1211.
[b] D.Sadovskii, B. Zhilinskii. Hamiltonian systems with detuned 1:1:2 resonance. Manifestation of bidromy. Ann. Phys. (N.Y.) 2007, **322** 164–200.
[c] D.A. Sadovskii, B.I. Zhilinskii. Quantum monodromy, its generalizations and molecular manifestations. Mol. Phys. (2006) **104** 2595–2615.