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Interplay of symmetry and topology in science

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Qualitative methods in natural science are based mainly on simultaneous use of symmetry and topology arguments. The idea of the present talk is to demonstrate how the corresponding mathematical tools (based on symmetry and topology arguments) initially applied to describe classification of different phases of matter and transitions between them are extended to construct qualitative theory of finite particle systems and more general dynamical systems. I start with reminding basic notions and tools associated with application of group action ideas to physics as initiated and developed by Louis Michel (1923-1999) [1,2]. Then geometric combinatorial and topological ideas are used to give qualitative description of singularities of dynamical integrable classical system and their quantum analogs. Quantum monodromy and its various generalizations as well as description of energy bands of isolated finite particle quantum systems in terms of topological invariant, Chern number [3], will be discussed on concrete molecular and atomic examples.

[1] *Symmetries in nature. Scientific heritage of Louis Michel. Ed.: T. Damour, I. Todorov, B. Zhilinskii, WS, Singapore, 2014,* ***[2]*** *L. Michel, B. Zhilinskii, Phys. Rep. 2001, 341, 11-336,* ***[3]*** *T. Iwai, B. Zhilinskii, Ann. Phys. (N.Y.) 2011, 326, 3013-3066*

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