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J Phys Chem Biophys 2018, Volume 8
DOI: 10.4172/2161-0398-C1-029

5th International Conference on

Theoretical and Applied Physics

July 02-03, 2018 | Vienna, Austria

Complex quantum world on the tower of scales

Michael G Zeitlin and **Antonina N Fedorova**
University of La Laguna, Spain

We present some new approaches for the description of a set of quantum phenomena. Our set-up is based on consideration of hidden properties of the underlying functional space, i.e. the Hilbert space of states. Instead of structureless "kinematical space" of states we consider dynamical ones. Its main attributes are as follows: underlying hidden symmetry, filtration generated by action of this hidden structure. As a result we can decompose our generic functional space of states into orbits generated by proper actions.In the most simple case such a framework, it corresponds to well-known multiresolution decomposition. In this example, the corresponding hidden symmetry is a noncommutative affine group. But our machinery works in a more general situation too (i.e. in case of solvable Lie groups). As a result, we obtain the full set of internal scales, starting from the coarse one which provides full multiscale decomposition. It means that starting from the most localized state with best possible localization properties, we can generate a full zoo of all possible quantum states, including chaotic, entangled, decoherent and so forth. Numerical experiments based on our numerical-analytic approach, demonstrate different types of proper quantum patterns. It should be noted that in such a way, we include in a set of states non-Gaussian states too. It allows us to extend a variety of possible states which will be useful in the prototypes of the future quantum devices. Our analytical consideration is based on the study of Wigner dynamics in the framefork of Wigner-Moyal-von Neumann set-up.

zeitlin@math.ipme.ru