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ORIGINAL PAPER

Quasi-quantum phenomena: the key to understanding homeopathy

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On the basis of the first- and second-order Gompertzian kinetics it has been proved that the crystallization and its reciprocal process of dissolution belong to the class of quasi-quantum non-local coherent phenomena. Hence, there exists a direct link to homeopathy: molecules of the remedy prepared in the process of dilution of the active substance are non-locally interconnected at-a-distance. The results obtained provide strong arguments justifying formulated *ad hoc* macroscopic versions of quantum non-locality, entanglement and coherence employed in interpretation of the homeopathic remedies activity and effectiveness. In particular they are consistent with the predictions of the weak quantum theory developed by Atmanspacher and coworkers. *Homeopathy* (2010) **99**, 104–112.

Keywords: Gompertzian systems; Zwietering–Gompertz function; Quantum coherence; Non-locality; Entanglement; Crystallization and dissolution; Homeopathy

Introduction

In order to explain theoretically the enigma of homeopathy, researchers employ either well established physical concepts like thermodynamics,[1] chaos,[2] field,[3] quantum theory[4,5] or generalize existing models to obtain e.g. *weak* version of the quantum mechanics[6] or macroscopic version of quantum entanglement[7–9] and non-locality.[10] The second approach seems to be more prosperous, although controversial (mainly due to the decoherence problem), as the orthodox quantum theory is difficult to apply on the macroscopic scale, which is a genuine scene for homeopathic processes, i.e. remedy preparation and therapy. It is generally assumed that typical microscopic effects as quantization, superposition, correlation or uncertainty do not appear in macroscopic word. There exist, however, the macroscopic quantum phenomena of the first kind (superconductivity, superfluidity) and the second kind (macroscopic quantum tunnelling *via* Josephson junction), but they play significant role at low temperatures when there is little thermal motion present to mask the quantum nature of a substance.[11,12] Hence, the macroscopic quantum phenomena of the first and second kind cannot be employed in investigation of homeopathic remedies activity and their effectiveness. On the other hand, researchers discovered that some microscopic concepts as non-locality or entanglement can be applied in formulating quantum *metaphors* for homeopathy,[13–17] which are very useful in description[18] of its frontier problems.

The main objective of the present work is introducing, on the basis of the previously obtained results,[19,20] a new class of quasi-quantum phenomena responsible – among others – for biological growth (regression) and crystallization (dissolution) processes. The proposed model is introduced in the framework of the generalized quantum theory including space-like (non-local) fields. Quasi-quantum phenomena seem to be a missing link between micro- and macro-levels of the matter organization, which provide strong arguments for justifying *ad hoc* formulated macroscopic versions of quantum entanglement[6–9] and non-locality[10] employed in construction of quantum *metaphors* for homeopathy.[13–18] In particular the quasi-quantum phenomena are consistent with the weak quantum theory[6] predicting existence of quantum formalism without Planck's constant and probabilistic interpretation, which can be applied in the macroscopic areas, for instance, in philosophy, psychology and medicine.

The paper is organized as follows. The basic concepts of the growth (decay) according to the first- and second-order Gompertzian kinetics, non-locality and entanglement as

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well as the minimum-uncertainty space-like coherent states of the Morse oscillator are presented in Appendix. They are employed to define the quasi-quantum phenomena in the main part of the article, in which some possible applications of the results obtained in interpretation of the homeopathic remedies activity are proposed and connections with existing theories and discoveries in the field are discussed.

Quasi-quantum phenomena

It is generally assumed that micro- and macro-worlds are characterized by the two classes of phenomena: quantum and classical. The quantum properties of micro-objects (particle, atom, molecule) are coded in the wave equations (11) and (12), whose eigenfunctions define the state of the object, whereas eigenvalues represent so-called observables, for example energy or momentum. The quantum world is characterized, among other, by the following phenomena: quantization of observables – they can take discrete values; superposition and coherence of quantum states; position–momentum and time–energy uncertainty described by the Heisenberg's relations; non-local long-range correlations characterized by the Bell's inequality and entanglement of distinct quantum states and objects *via* e.g. Einstein–Podolski–Rosen channel. On the other hand, the classical level of the matter organization is described by the Hamilton and Lagrange equations of motion for objects moving on the well defined time- and space-trajectories. Their observation does not change the state of the object hence, both time and energy, position and momentum are determinable at the level of experimental accuracy. The macro-observables are not quantized, so the energy and momentum of macro-object can take arbitrary real values and the state of the system is unequivocally determined by the Hamilton or Lagrange functions and the initial conditions.

On the border line between micro- and macro-levels of matter organization, there are the macroscopic quantum phenomena of the first and second kind.[11,12] Additionally, the results presented in the Appendix admit existence of the macroscopic quantum phenomena of the third kind appearing in the Gompertzian systems. The notion *Gompertzian system* denotes, for example, living systems (organ, tissue, organism, population of organisms, bacterial colony, tumour) as well as crystals composed of atoms, molecules or ions, whose growth (decay) is described by the Gompertz function (1). The Gompertz growth function belongs to the wide class of sigmoidal (S-shaped) functions and describes exponential growth, which then is exponentially retarded and saturated as time continues. The Gompertzian growth is a result of two classes of competitive processes: the first process stimulates growth and the second constrains growth at the saturation stage. The modified Gompertz function (3) has also been applied to describe the crystallization (dissolution) process. The process of crystallization consists of two stages: (i) nucleation in which molecules come into contact and interact to form spatially ordered structures, and (ii) crystal growth which is the enlargement of the interacting nuclei. Since there are several analogies between crystallization and bacterial growth (growth of bacteria resembles nucleation and crystal's enlargement, whereas bacterial consumption of nutrients resembles a decrease in supersaturation), this process can be described by the modified Gompertz function (3). It can be proved that this function satisfies the second-order differential equation (8), representing the so-called second-order Gompertzian kinetics. It is interesting to note, that equation (8) is a special case of the more general quantum space-like Horodecki–Feinberg equation (17) for the time-dependent Morse potential (16). In particular, a comparison of the macroscopic equation (8) for the Zwietering–Gompertz function (7) with the quantum equation (17) and its ground state solution (19) for the time-dependent Morse oscillator, leads to the following conclusions:

1. The second-order macroscopic equation governing the Gompertzian growth is a special case of the quantum Horodecki–Feinberg equation for the time-dependent Morse oscillator.
2. The quantum wave function for the ground state of the Morse oscillator for $x_e = 1$ is reduced to the macroscopic Zwietering–Gompertz function.
3. The transition from the micro- to macro-domain can be done by substitution $x_e = 1$ and $v = 0$ in the quantum formulae.
4. The macroscopic second-order Gompertzian kinetics is described by the quasi-quantum equation whose eigenvalue is quantized and takes only one value $\frac{1}{4}$.
5. The Gompertzian systems are characterized by only one eigenfunction representing the fundamental mode of growth.
6. The eigenvalue $\frac{1}{4}$ is equal to the dimensionless dissociation energy of the Morse oscillator, hence the latter is in the dissociation state – there is no oscillation in time and the evolution of the system is consistent with the arrow of time.

The presented above conclusions are revolutionary as they reveal existence of a new, so far unknown, class of the macroscopic quantum (quasi-quantum) phenomena appearing in the Gompertzian systems. The notion *quasi-quantum* refers to the possibility of application of the quantum language and formalism in description of macroscopic phenomena like biological growth or crystallization process. In particular the second-order Gompertzian kinetic equation (8) takes identical form as the microscopic eigenvalue equation for the quantized state of growth. Since the second-order growth equation (8) is a special case of the non-local Horodecki–Feinberg equation (17), the Gompertzian growth belongs to the class of macroscopic non-local phenomena. The nature of this non-locality can be explained having introduced another quasi-quantum phenomenon – macroscopic coherence. If we put $x_e = 1$ into quantum annihilation and creation equations (25) and (26), the former reduces to the equation describing growth whereas the latter – regression (decay) of a macroscopic Gompertzian system. The results obtained indicate that the quantum equations describing non-local coherent states of time-dependent Morse oscillator with anharmonic constant equal to one have identical form as the