

EDUCATION AND DEBATE

Patient–practitioner–remedy (PPR) entanglement. Part 2: extending the metaphor for homeopathy using molecular quantum theory

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A quantum metaphor developed previously for homeopathy, involving triadic patient–practitioner–remedy (PPR) entanglement, is extended by importing concepts used in chemistry to describe the electronic structures of molecules. In particular, the electronic energy states of triangular tri-atomic molecules are used metaphorically to predict that (a) the more a homeopathic medicine is potentised, the deeper the level of cure is likely to be, and (b) the practitioner can be included as a beneficiary of the therapeutic process. The model also predicts that remedy attenuation and degree of PPR interaction could (in the quantum theoretical sense) represent a pair of complementary conjugate variables. *Homeopathy* (2003) 92, 35–43.

Keywords: molecular orbital theory; tri-atomic molecules; quantum mechanics; PPR entanglement; remedy potency

Introduction

In the first part of this paper¹ a metaphor for homeopathy was developed in which the potentised medicine, the patient, and the practitioner were seen in terms of a non-local therapeutically ‘entangled’ triad, described qualitatively in terms of the transactional interpretation of quantum mechanics.² The term patient–practitioner–remedy (PPR) entanglement was used to denote this situation, by analogy with EPR entanglement, that describes the non-local interaction between correlated particles in a quantum system.³

If homeopathy (or indeed any therapeutic situation) could be described metaphorically in quantum theoretical terms, then the possibility should exist for developing a non-commuting algebra of PPR entan-

glement to formally describe the process. Such an endeavour could ultimately lead to new ways of experimentally testing and verifying homeopathy. The question then arises as to what form such a non-commuting algebra might take. One possibility is for the patient (Px), the practitioner (Pr) and the remedy (Rx) to each be represented by a wave function, Ψ (without necessarily ascribing meaning to it at this moment), such that their interaction and superposition generates a new wave function, as follows:

$$\Psi_{\text{PPR}} = \alpha\Psi_{\text{Px}} + \beta\Psi_{\text{Pr}} + \gamma\Psi_{\text{Rx}}, \quad (1)$$

where the coefficients α , β and γ represent complex numbers. PPR entanglement may then be envisaged as a state, Ψ_{PPR} , arising out of the superposition of these individual wave functions, describing the non-local interaction between the patient, the practitioner, and the medicine such that no single one of these components can be factored out.

Equation (1) above is reminiscent of the way electronic wave functions for molecules (called molecular orbitals or MOs) are constructed from individual

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electronic atomic wave functions (i.e. atomic orbitals, AOs), in chemistry.^{4,5} This suggests that a non-commuting algebra of the homeopathic process might be developed to metaphorically describe the Px–Pr–Rx interaction leading to a PPR entangled state. This paper begins to explore further the quantum metaphor for homeopathy by examining how the quantum theory of molecular systems could be used to qualitatively model the consequences of triadic Px–Pr–Rx interaction that could lead to PPR entanglement. First though, it will be necessary to explain a little about how quantum mechanics is used in chemistry.

Quantum mechanics in chemistry

Introduction and disclaimer

Chemists visualise molecular aggregates of atoms in terms of polygonal and polyhedral shapes, eg triangles, hexagons, tetrahedra, octahedra, etc. Molecules are essentially collections of quantum entangled sub-atomic particles. In addition, unless the molecules are isolated (as can happen in the gas phase) they can be quantum entangled with each other. However, in order for quantum theoretical calculations on molecules to be performed, it is first necessary to make a series of simplifying approximations to the theory whose effect is to ignore the entangled status of molecules and their sub-atomic constituents. That these calculations can produce results in close agreement to those found experimentally tends to justify these approximations. Because of this agreement between theory and experiment, it is possible that the electronic structures generated by molecular quantum mechanics calculations can approximate to molecules in their pristine entangled states, even though these structures are derived via a mathematical process that effectively ignores their entanglement.

The hydrogen atom

The simplest atom is hydrogen, which consists of a single positively charged proton as its nucleus, surrounded by a single negatively charged electron. The way this electron behaves as a wave under the influence of the positive nucleus is described by the Schrödinger equation, which in its simplest form is

$$H\Psi = E\Psi, \quad (2)$$

where H is a mathematical operator called the Hamiltonian. This expresses the total energy of a system in terms of momentum and position, and it can be simply the sum of its kinetic and potential energies, or in more complex systems, a set of differential equations.⁶ An operator is a mathematical instruction to carry out an operation on whatever quantity comes after it. Ψ is the wave function of the electron, and E is the energy of the electron. Equation (2) simply says 'An operation – performed on the wave function Ψ of

a quantum system equals the energy of the quantum system, E times the wave function, Ψ .' Solutions to this equation ultimately generate states of increasing energy called orbitals. Rather like the different harmonics exhibited by a stretched string when it vibrates, the different orbitals may be viewed as the shape the electron wave function adopts at different energies (Figure 1). To quote John Gribbin, 'an orbital can be considered as a region (of space) in which the (negative) electric charge of the electron is distributed, as if the electron were smeared out over the entire orbital.'⁶ The square of Ψ , Ψ^2 , represents the probability of finding the electron somewhere within the orbital.

The negative charge on the electron is not to be confused with the sign of the amplitude of the wave function. As with any wave, there are peaks and troughs, ie the amplitude can be positive or negative. This is important when it comes to adding wave functions together. Where the amplitudes are of the same sign (eg all peaks or all troughs), the waves reinforce one another (ie both amplitudes are positive or negative): where the amplitudes are of opposite sign, they cancel each other out (ie peaks cancel out troughs). Throughout this paper, orbitals will be represented by filled (ie positive amplitude) or empty circles (ie negative amplitude).

For the hydrogen atom, the lowest energy solution (called the electronic ground state) is the spherically shaped 1s orbital. Going up in energy, the solutions to the Schrödinger equation produce more possibilities for orbital shape. Thus at the next level, there is the spherically shaped 2s orbital, and three perpendicular dumb-bell-shaped 2p orbitals (Figure 1).

Atoms more complex than hydrogen have more than one electron, and each atomic orbital can contain up to two electrons of opposite spin. Thus, the atom of helium has a nucleus consisting of two protons and two neutrons surrounded by two electrons. In the electronic ground state of helium, the two electrons exist in the 1s orbital and have opposing spins. In this electronic ground state, these two electrons are entangled with each other,⁷ if the spin state of one of these electrons were to change, it would instantaneously affect the spin state of the other.

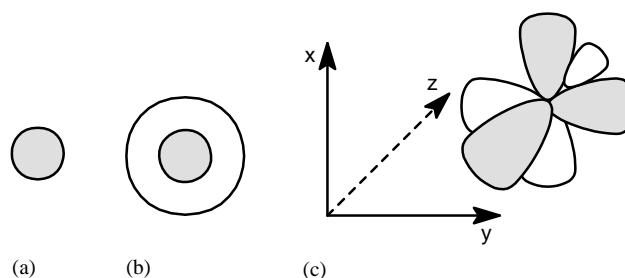


Figure 1 Atomic orbitals of hydrogen: (a) 1s orbital, (b) a 2s orbital, and (c) three 2p orbitals at right angles to each other.

Approximating for molecules

The quantum mechanical description of molecules used by chemists views them as combinations of electronic wave functions provided by their constituent atoms, ie (MOs) φ , formed by combinations of individual atomic (AOs) x .⁵ In order to derive MOs from AOs, chemists adopt a series of simplifying approximations. This is because difficulties arise from the fact that molecules consist of more than one atom and can contain many interacting electrons. Solving the Schrödinger equation for such complex systems is a difficult task, hence the approximations. The first of these is the Born–Oppenheimer approximation, which states that, as the nuclei of a molecule are much heavier than the electrons, the latter can be considered to move or undergo transitions instantaneously against a field of essentially ‘frozen’ nuclei. Thus it is possible to write the total wave function or Schrodinger equation of the molecule $\Psi(r, R)$ as a product of two parts, one which describes the nuclei, $\Xi(R)$ and one which describes the electrons $\Phi_{el}(r)$ such that:

$$\Psi(r, R) = \Phi_{el}(r)\Xi(R), \quad (3)$$

where R represents the coordinates of the nuclei and r the coordinates of the electrons. Now because the nuclear part of (3), $\Xi(R)$ evolves in time much more slowly than the electronic part $\Phi_{el}(r)$, the Schrödinger equation for the molecule thus reduces to one in which only the electronic coordinates r are variables. So, the problem of solving $\Psi(r, R)$ reduces to one of solving $\Phi_{el}(r)$ for a given nuclear geometry. However, by making this approximation the electrons of a molecule are effectively disentangled from the nucleus.

A molecule contains many electrons so $\Phi_{el}(r)$ represents a many-electron wave function. This, too, is difficult to solve exactly so that a further approximation is adopted. This is called the orbital approximation and it consists in expressing a many-electron wave function in terms of a product of one-electron wave functions, Φ , that are MOs of the system, eg

$$\Phi_{el}(e_1, e_2, \dots, e_n) = \varphi_1(e_1), (e_2), \dots \varphi_n(e_n) \quad (4)$$

effectively disentangling the electrons from each other. The problem then is how to choose the form of the MOs, $\varphi_1, \varphi_2, \dots, \varphi_n$. These MOs are constructed from the individual AOs, x of the atoms making up the molecule. The approximation most often used is called the linear combination of atomic orbitals (LCAO). This allows an MO φ_i to be written as a linear sum of contributions from the AOs, x_j of the molecule such that

$$\varphi_i = \sum c_{ij}\chi_i, \quad (5)$$

where c_{ij} are the coefficients or weighting of the contributions of each AO x_j to the MO φ_i .

The AOs contribute electrons to the MOs, which determine how the molecule is bound together from its

constituent atoms. The MOs are strictly ordered in terms of energy and symmetry; the least energetic MOs (called bonding MOs) having the highest symmetry, while the higher energy MOs (called anti-bonding MOs) have the lowest symmetry. These disentangling approximations produce data in line with the experiment, so quantum mechanics reproduces the expectations of an older science.⁸ The point is, entanglement is a fundamental property of molecular systems so that where such agreement between experiment and theory exists, the results obtained can sometimes be approximated to entangled systems.

The simplest example of molecular quantum mechanics to consider is the formation of a molecule of hydrogen, H_2 , from two hydrogen atoms.

The hydrogen molecule, H_2

A hydrogen molecule H_2 , is considered to be formed by the overlap of two atomic orbitals from each of the hydrogen atoms. Following equation (5), this is accomplished mathematically by taking a linear combination of the two atomic wave functions, thus

$$\varphi = c_1\chi_1 + c_2\chi_2, \quad (6)$$

where χ_1 and χ_2 are the two atomic orbitals being combined and c_1 and c_2 are two coefficients which determine the relative mix of χ_1 and χ_2 in φ .

We can see how restrictions on the relative values of c_1 and c_2 arise by examining the probability density for an electron located in an MO φ . Probability density for an electron is given as the square of the wave function, so that

$$\varphi^2 = (c_1\chi_1 + c_2\chi_2)^2 = c_1^2\chi_1^2 + c_2^2\chi_2^2 + 2c_1c_2\chi_1\chi_2 \quad (7)$$

This expression shows how the electron density is distributed over the molecule. Thus, $c_1^2\chi_1^2$ relates to the electron probability density over atom 1, $c_2^2\chi_2^2$ over atom 2, and $2c_1c_2\chi_1\chi_2$ represents the electron density between the two atoms. As the AOs χ_1 and χ_2 are normalised, each of the integrals of $c_1^2\chi_1^2$ and $c_2^2\chi_2^2$ is equal to 1. Therefore

$$c_1^2 = c_2^2 \text{ so that } c_1 = \pm c_2 \quad (8)$$

This leads to the important conclusion that this linear combination of two atomic orbitals χ_1 and χ_2 generates two solutions for φ , ie two new MOs, φ_1 and φ_2 . Another way of considering this is that there are two ways that the two AO wave functions represented by x_1 and x_2 can interfere with each other: constructively and destructively. The constructive solution generates an MO of lower energy than the individual AOs x_1 and x_2 , and is called a bonding MO φ_1 (represented as two adjacent filled circles in Figure 2): the destructive solution generates an MO of higher energy than x_1 and x_2 and is called an anti-bonding MO φ_2 (represented by adjacent filled and empty circles in

Figure 2), ie

$$\varphi_1 = c_1\chi_1 + c_2\chi_2, \quad (9)$$

$$\varphi_2 = c_1\chi_1 - c_2\chi_2, \quad (10)$$

The energy difference between the bonding and anti-bonding MOs φ_1 and φ_2 is directly dependent on the degree of overlap between their constituent AOs, χ_1 and χ_2 . Thus, when the overlap is strong, the energy difference between bonding and anti-bonding MOs is large; conversely, when the overlap between χ_1 and χ_2 is weak, the energy difference between φ_1 and φ_2 is small.

As with AOs, MOs can contain up to two electrons of opposing spin, and the lowest energy solution gives the ground state of the hydrogen molecule, which is represented in Figure 2.

The two electrons in the ground-state MO of the hydrogen molecule are in an entangled state. In the bonding MO of the hydrogen molecule, there is a strong probability (represented by $1 > [\varphi]^2 > 0$) of the two electrons being found in the space between the two protons. Thus, the repulsive electrostatic forces existing between electrons themselves and the protons themselves are more than compensated by the overall attractive electrostatic forces between protons and the electrons. This represents an overall stabilisation of the molecule compared to the individual atomic orbitals of two separate hydrogen atoms. However, in the anti-bonding MO, the probability of finding the electrons in the space between the two protons is zero, ie $[\varphi]^2 = 0$. This is represented as a node of zero electron density in the middle of the molecule. Thus, if for whatever

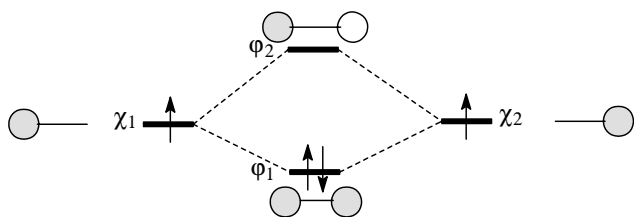


Figure 2 Formation of bonding and anti-bonding MOs from interaction between two identical AOs in a homonuclear diatomic molecule, e g. H_2 (electrons are represented by the vertical arrows).

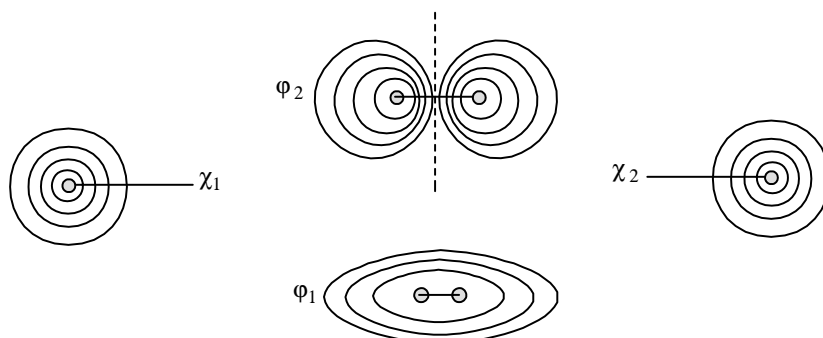


Figure 3 Electron density distributions in bonding φ_1 and antibonding φ_2 MOs.

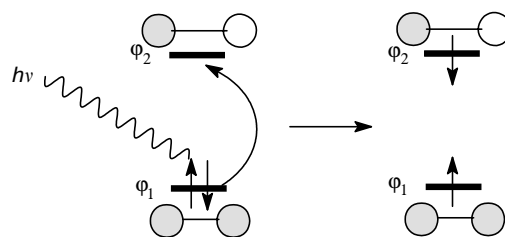


Figure 4 Excitation by irradiation of an electron from a bonding into an anti-bonding orbital.

reason, any electrons appear in the anti-bonding MO, they will destabilise the hydrogen molecule (Figure 3).

That the combination of AOs forms the same number of new MOs is a general result. Thus, combining n atomic orbitals from n atoms will generate n molecular orbitals. When n is an even number, then $\frac{1}{2}n$ will be bonding and $\frac{1}{2}n$ anti-bonding. When n is an odd number, the split of bonding and anti-bonding molecular orbitals is more complex, as we shall see later.

The energy gap between φ_1 and φ_2 is important because it predicts the energy required to electronically excite a hydrogen molecule. Thus, when a hydrogen molecule absorbs radiation of the right frequency, an electron is promoted into the anti-bonding MO φ_2 (Figure 4).

The overall effect is to destabilise the molecule as an electron in an anti-bonding MO increases the net repulsive forces in the molecule. This causes the distance between the two protons of the hydrogen molecule to increase. However, promotion of one of the electrons into the anti-bonding φ_2 orbital effectively disentangles them because any change in spin state of one does not necessarily affect the spin state of its partner.

The tri-atomic hydrogen molecule, H_3

Most molecules are more complex than diatomic hydrogen, H_2 , which means that in attempting to unravel their electronic structures, more orbital interactions have to be taken into account. This is a difficult problem mathematically, so that simpler methods are often sought that allow more qualitative approaches to the understanding of the form and relative energies of the MOs.

One such approach is called the fragment orbital method,⁵ which consists in treating a complex molecule of unknown electronic structure as if it were split into two smaller units whose MOs are known. It is then possible to derive the MOs of the complete molecule via the interaction of the orbitals of the two sub-systems, in the same way the MOs of the hydrogen molecule are derived from the individual AOs.

Thus, the triangular tri-atomic H₃ molecule made up of three hydrogen atoms, H_a, H_b, and H_c, can be divided conceptually into two fragments consisting of a hydrogen molecule, H_a-H_c, and an atom of hydrogen, H_b (Figure 5).

The orbitals of the H_a-H_c fragment are none other than the bonding and anti-bonding MOs of H₂, (relabelled σ_1 and σ_2 to avoid confusion with the MOs of triangular H₃) while the orbital of the H_b fragment is simply the AO of a hydrogen atom. Consequently, the relative energy of the H_b AO will be higher than the bonding MO of the H_a-H_c fragment. The combination of the orbitals from the two fragments is shown in Figure 6.

The sizes of the circles represent the electron density on each atom, and whether they are filled or empty represents the sign of the electron wave function on these atoms. Thus, the bonding MO from the H_a-H_c fragment σ_1 is combined with the AO of the H_b fragment to form a new bonding MO φ_1 that extends over all three H atoms of the triad, and an MO φ_3 that is weakly bonding between H_a and H_c but anti-bonding between H_b and H_c and H_b and H_a. The overall effect is to make this φ_3 orbital anti-bonding.

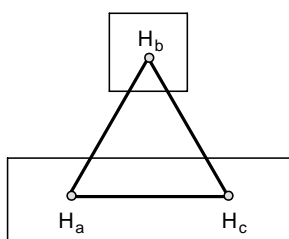


Figure 5 Fragment-orbital approach to the triangular H₃ molecule.

The anti-bonding MO σ_2 from the H_a-H_c fragment remains as it was, ie anti bonding between H_a and H_c but is now also non-bonding between H_b and H_c and H_b and H_a. This MO is now designated φ_2 .

Calculations show energetic ordering of these MOs as shown in Figure 6. It turns out that the two anti-bonding MOs φ_2 and φ_3 have the same energy and symmetry (ie they each have one node of zero electron density), and are said to be degenerate.

Having derived the three MOs of H₃, it is now possible to place the three electrons that each individual hydrogen atom has brought to the molecule. Thus, two electrons with opposing spins will occupy the bonding MO φ_1 , and one will occupy either of the two anti-bonding MOs, φ_2 and φ_3 (it does not matter which as they both are of the same energy). This makes the molecule unstable compared to H₂, and unlikely to exist, but when it is ionised, the H₃⁺ cation is created and has been observed to exist with the predicted geometry of an equilateral triangle. Removal of the electron in an anti-bonding MO leaves only two electrons but in the bonding MO φ_1 and so stabilises H₃⁺ compared to H₃. As with the helium atom and the H₂ molecule mentioned earlier, the paired electrons in the φ_1 orbital are entangled.

Such so-called electron-deficient bonding, where two electrons bind three nuclei together, is quite common in chemistry.⁹ This is important as it suggests that taking something material away from the molecule (an electron) increases its stability and leaves behind a quantum entangled system. We shall see later what bearing this result, derived as it is from molecular quantum mechanics, has on the nature of Px-Pr-Rx interaction.

The pattern of energy levels found in the MOs of the H₃ molecule (ie one bonding and two anti-bonding) are actually generalisable to other tri-atomic molecular systems.⁵ Thus, it is possible to consider what happens to the ordering of the three MOs of H₃ if one of the atoms (say, H_b) is replaced by a different atom. In terms of their ability to attract electron density in chemical bonds towards themselves, atoms can be more or less active (electronegative) than hydrogen. The effect of replacing H_b with atoms of different

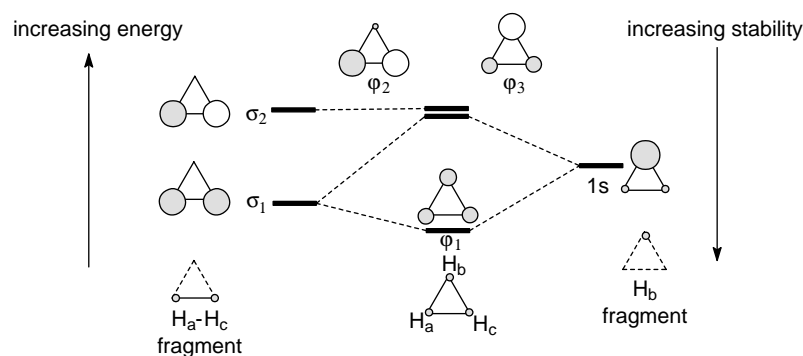


Figure 6 Construction of MOs for triangular H₃ by the fragment-orbital approach from the bonding and anti-bonding orbitals of H₂ and a 1s AO from a hydrogen atom. The H₂ MOs have been relabelled to show their difference from H₃ MOs.

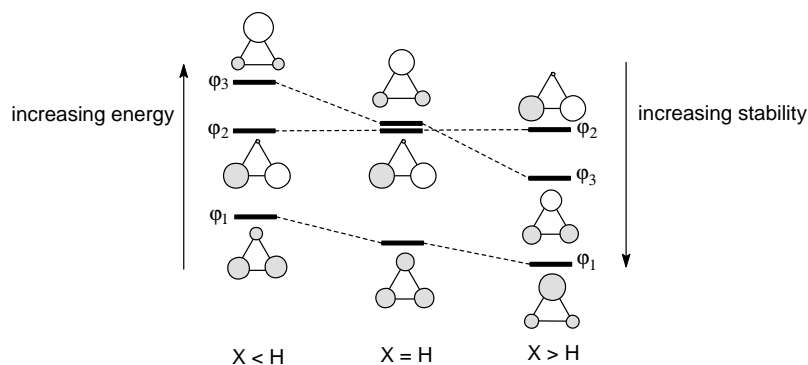


Figure 7 Variation in energy and form of the MOs of a triangular triatomic molecule H_2X as a function of the changing electronegativity of X .

electronegativity on the relative energies of a triangular tri-atomic molecule, is shown in Figure 7.

Thus, a more electronegative atom (right column) causes the bonding MO φ_1 to be of lower energy and removes the degeneracy of the φ_2 and φ_3 anti-bonding MOs, with φ_3 now being of lower energy than φ_2 . It also causes more electron density to reside on the replacement atom. This is shown by an increase in the size of the filled circle over that atom. A less electronegative replacement (left column) for H_b causes the MO φ_1 to be of higher energy than when $X = H$. Also, more of the electron density resides over H_a and H_c and less on H_b . In addition, the anti-bonding MO φ_2 is now of lower energy than φ_3 . The MO φ_2 is actually unaffected by the replacement of H_b because there is no electron density over the replacement atom, ie the orbital coefficient over this atom is zero and there is no filled circle over it. The H_3^+ cation may be thought of as having its H_b atom replaced by the more electronegative and electron-deficient H^+ ion. Thus, the bonding between the three H nuclei of H_3^+ is of the three centre, two electron variety mentioned above. Again, this will be seen to be a significant result when considering the role of potency.

The important conclusions from this quantum mechanical analysis of the interaction of three atoms to form a triangular tri-atomic molecule are as follows:

- A set of one bonding and two anti-bonding MOs of defined relative energies are created.
- The relative energies of the bonding and anti-bonding MOs are directly dependent on the degree of overlap between the constituent AOs; the greater the overlap, the bigger the energy difference between bonding and anti-bonding MOs.
- These relative energies change on replacing an the atom with one of different electron-attracting power.
- The stability of the molecule as a whole is dependent on the number and distribution of electrons in bonding and anti-bonding MOs. Thus, H_3^+ is more stable than H_3 because compared with the

former, the latter has one electron in an anti-bonding MO.

This quantum theoretical analysis of the triangular tri-atomic molecules H_3 and H_3^+ is the basis of the molecular quantum metaphor for homeopathy.

Extending the quantum metaphor for homeopathy

I noted above how it might be possible to describe the patient, the practitioner and the remedy each in terms of a wave function, and that their non-factorisable superposition could produce a new wave function as a descriptor of the PPR entangled state (see equation (1)). Of course, the meaning ascribed to the notion of ‘wave function’ for a patient, practitioner, or medicine cannot be the same as for an electron. The latter is a fundamental particle of matter whose wave function, via the Schrödinger equation, describes its motion in terms of its mass and energy, both potential and kinetic. Patients, practitioners, and even remedies are clearly far more complex entities than electrons! Although Hawkin and others have proposed that even the whole universe might be describable in terms of a wave function,¹⁰ providing an answer to the question of what a wave function could mean in the context of homeopathy is a daunting task. I will therefore confine myself to attempting to demonstrate how the implicit non-locality and formalisms of quantum mechanics could help understand and give voice to the intrinsic non-locality of the therapeutic process in general and homeopathy in particular.¹¹

Comprehending the meaning of ‘the wave function’ in the therapeutic PPR-entangled context used here, would in my view, have to include elements of something best described as ‘intentionality’ on both the parts of the patient (to be healed) and the practitioner (to heal). How such intentionality could be mathematised into a ‘calculus of cure’ (so that a wave function for a patient or a practitioner could be

properly defined) is something that is beyond the scope of this paper and, at the moment, the wit of its author.

Molecular quantum mechanics and triadic PPR entanglement

PPR entanglement can be represented in the form of an equilateral triangle (Figure 8), with the Px, Pr, and Rx ‘occupying’ its corners.¹¹

Equating this with triangular molecules, such as H₃ and H₃⁺ means considering the Px, Pr, and Rx, as ‘atoms’ each donating something describable as a ‘wave -function’ (but see the disclaimer above) to the Px–Pr–Rx ‘molecule’. In that context, the energy levels and relative stabilities of triangular molecules shown in Figure 7 could be used to predict certain outcomes of the interaction between patient, practitioner and remedy. Figure 9 is essentially Figure 7 redrawn to illustrate this.

Thus, as ‘atoms’, both Px and Pr may be considered to be roughly similar. Rx, on the other hand, is an altogether different type of entity to Px and Pr, such that the left and right columns of Figure 7 (where one atom is regarded as being less or more electronegative than the other two) are more relevant to the Px–Pr–Rx interaction, becoming columns A and B in Figure 9, than the centre diagram (where all the atoms are equivalent).

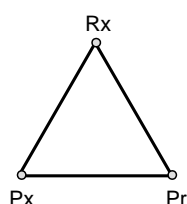


Figure 8 Diagram representing triadic PPR entanglement: Px = the patient, Pr = the practitioner, and Rx = the remedy.

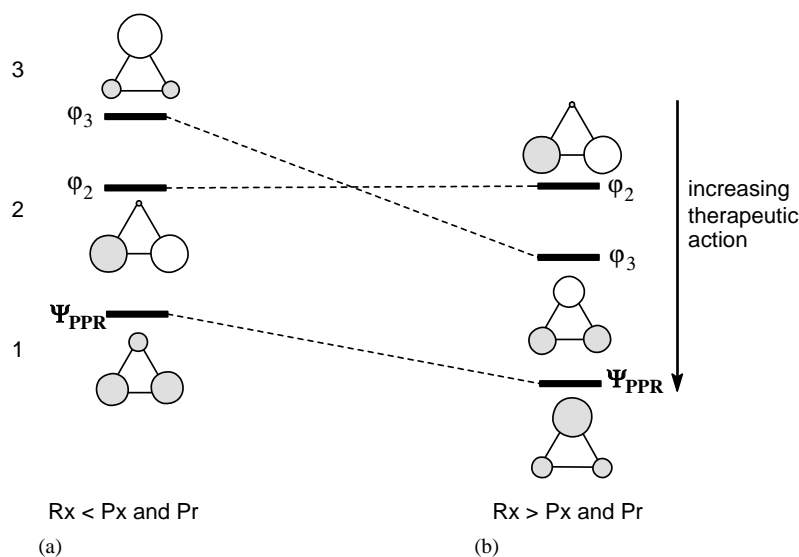


Figure 9 Variation in triadic Px–Pr–Rx interaction with increasing therapeutic action: only the state Ψ_{PPR} in each case is PPR entangled.

From this admittedly crude standpoint, it can be seen that the use of molecular quantum theory to metaphorically describe the homeopathic process in Figure 9 initially predicts three possible outcomes for the Px–Pr–Rx interaction.

- A fully PPR-entangled state, Ψ_{PPR} , (1 in Figure 9) which corresponds to the ground-state bonding MO φ_1 in Figure 7. This could imply a therapeutically curative outcome or ‘solution’.
- A state (3 in Figure 9) corresponding to the anti-bonding MO φ_3 . Note that although the patient Px and the practitioner Pr are involved in a ‘bonding interaction’ (ie their ‘orbital coefficients’ or filled circles are overlapping; possibly implying a positive interaction between Px and Pr), the medicine Rx is not. Its ‘orbital coefficient’ is an open circle indicating non-overlap or ‘anti-bonding’ with Px and Pr. This could imply only a partial or non-curative therapeutic outcome; perhaps, because of an incorrect prescription, possibly involving aggravation (as this ‘solution’ is of higher ‘energy’ ie has less depth of therapeutic activity than either Ψ_{PPR} or the original unentangled states of the patient and the practitioner).
- A state (2 in Fig 9) corresponding to the anti-bonding MO φ_2 . Here, the interaction between Pr and Px is ‘anti-bonding’ (ie their ‘orbital coefficients’ or circles are of the opposite type, filled and empty; possibly implying a negative interaction between Px and Pr) and there is no involvement of the remedy as it has no ‘orbital coefficient’ or circle. This ‘solution’ is even less curative than that represented by φ_3 and could involve aggravation as again, this ‘solution’ is of higher ‘energy’, ie has less depth of therapeutic activity than either Ψ_{PPR} or the original unentangled states of the patient and the practitioner.

The term ‘energy’ here should not be taken in the homeopathic sense. Greater energy in a patient, and the physical and psychological benefits this endows, are usually sort-after therapeutic outcomes. This is not the way the term ‘energy’ is used here. Looking at the various states depicted in Figure 7 and 9, we can see that an increase in energy from point of view of the molecular quantum theory, translates into a decrease in depth of therapeutic activity of the Px–Pr–Rx interaction. Thus, a molecule with electrons in higher energy states is more likely to be unstable. Conversely, an improvement in a patient’s energy in the homeopathic sense actually refers to their moving down the page in Figure 9. Thus, ‘increase in energy’ in a quantum theoretical sense has the opposite meaning to the way the term is used in homeopathy.

From Figure 9, it is possible to make some general predictions about the nature of the Px–Pr–Rx interaction using the quantum metaphor. Thus, Ψ_{PPR} has a greater depth of therapeutic activity, in column B relative to its counterpart in column A. The orbital coefficients of Ψ_{PPR} (the size of the circles over both Px and Pr) in column B, shows that they are smaller than that over Rx. In column A, the Px and Pr circles are larger than Rx. Thus, in column B, the relative sizes of the orbital coefficients of Ψ_{PPR} emphasise the medicine more than the patient or the practitioner as the important factor. In column A, the relative sizes of the orbital coefficients on Ψ_{PPR} emphasise the patient and the practitioner more than the medicine. Overall, Ψ_{PPR} is lower (i.e., has increased depth of therapeutic action) in column B than column A, which could suggest that depth of cure is greater when the emphasis is on the remedy during PPR entanglement.

The energy-level diagram on the right-hand side of Figure 7 is derived from the molecular quantum theoretical solution for a triangular molecule where one of the atoms has more electron-attracting power than the other two. An example of this is the electron-deficient molecule H_3^+ , derived by combining a hydrogen molecule, H_2 , with a hydrogen ion, H^+ . This means that in terms of electrons, the H^+ fragment contributes nothing to the bonding: only the H_2 fragment contributes electrons. Thus although in H_3^+ the electron density is greatest over the electron deficient fragment in δ_1 , it has contributed far less in terms of electrons to the overall bonding in the molecule. What are the ramifications of this for Px–Pr–Rx interaction.

In order to achieve the greatest Px–Pr–Rx interaction, that which is contributed by the remedy Rx to Ψ_{PPR} should be minimal, while that contributed by Px and Pr should be maximal, ie $Rx < Px$ and Pr in column B of Figure 9. In other words, the more attenuated the medicine, i e the higher the potency of Rx, the greater the Px–Pr–Rx interaction (leading to increased depth of therapeutic action of Ψ_{PPR}) and the deeper the level of cure. Conversely, in column A where $Rx > Px$ and Pr , the degree of interaction

between Px and Pr is less, Rx is also less attenuated and so the depth of therapeutic action of Ψ_{PPR} is less. This conclusion, derived directly from the molecular quantum mechanical metaphor, seems to bear out classical homeopathy¹² and is certainly along the lines of the model proposed by Vithoulkas.¹³ It also suggests a complementary relationship between remedy attenuation and degree of Px–Pr–Rx interaction in that the stronger the interaction of Px and Pr, the higher the potency of Rx needed for depth of cure.

Figure 9 also predicts that there are three possible outcomes of Px–Pr–Rx interaction, only one of which, (1), involves curative PPR entanglement. What about the other two outcomes, represented by φ_2 and φ_3 ? In column B, we see that outcome 3 (where Px and Pr are involved in a ‘bonding’ interaction with each other but an ‘antibonding’ interaction with Rx), has a greater depth of therapeutic activity than 2 (where Px and Pr have an ‘antibonding’ interaction with each other and no interaction at all with Rx). In other words, when for whatever reason, the greatest degree of Px–Pr–Rx interaction is possible, giving an unentangled Rx (which could mean ‘a non-similar medicine’) results in a better outcome than giving no remedy. That φ_3 in column B is represented as having only slightly less depth of therapeutic action than the PPR entangled state Ψ_{PPR} in column A, would tend to support this.

Lastly, it is worth mentioning an inescapable conclusion that arises from the energy-level diagrams illustrated in this paper. Figure 10 is a digest of Figs. 2,7 and 9. It shows diagrammatically how (as with the formation of a hydrogen molecule from two hydrogen atoms providing bonding and anti-bonding solutions), interaction between the patient and the practitioner yields two states represented as $Px + Pr$ and $Px - Pr$; the former being therapeutically more favourable than the latter. Then, the $Px + Pr$ state interacts with the potentised medicine Rx to form two new states, $Px + Pr + Rx$ and $Px + Pr - Rx$; the former again being more therapeutically favourable than the latter (note: the pluses and minuses here do not mean addition and subtraction but denote a positive interaction or no interaction, respectively, between Px, Pr and Rx).

Note how the ‘driving force’ for this process is the impulse to greater depth of therapeutic action *but* that it also includes the practitioner. In other words, the possibility arises that by being entangled in the curative process, the practitioner can be in some way a receiver

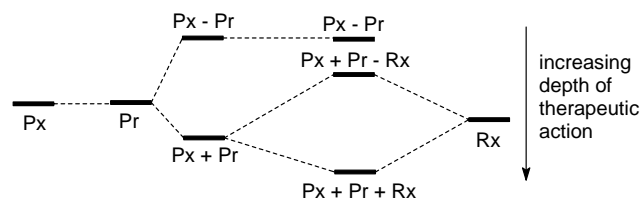


Figure 10 Schematic showing how triadic Px–Pr–Rx interaction leads to an increased depth of therapeutic action on the patient and the practitioner.

of its benefits. This is certainly in line with modern views of the healing process, both in homeopathy (see for example reference¹⁴) and in other healing professions.¹⁵

Conclusions

In this paper, I have tried to extend the previously developed quantum metaphor for homeopathy,¹ and its notion of patient–practitioner–remedy or PPR entanglement, by importing concepts derived from molecular quantum mechanics as used by chemists.^{4,5} At this stage, such an exploration is necessarily qualitative, crude, and highly speculative. Nevertheless, by likening the triadic Px–Pr–Rx interaction to the molecular quantum mechanical formalism that describes the electronic structures of triangular tri-atomic molecules, such as H₃ and its stable cation H₃⁺, it is possible to make the following predictions concerning homeopathy.

1. That Px–Pr–Rx interaction generates three possible outcomes, only one of which is a possible PPR entangled therapeutically curative ‘solution’, Ψ_{PPR} .
2. That the relative depth of therapeutic action of a curative PPR entangled state Ψ_{PPR} , depends on whether the remedy or the patient–practitioner relationship is emphasised.
3. That the greatest depth of therapeutic action can occur when the remedy is emphasised during PPR entanglement.
4. That the two other outcomes mentioned above are to not prescribe a medicine, or to prescribe an unentangled remedy, and that which is the least unfavourable outcome of the two depends on the initial degree of Px–Pr–Rx interaction.
5. That a possible consequence of a therapeutically curative Px–Pr–Rx interaction leading to PPR entanglement, is benefit for the practitioner as well; a conclusion in line with more modern views of the healing process.

It is worth noting that the highly diluted medicine behaves as a curative agent directly in proportion to the degree of Px–Pr–Rx interaction. Thus, the quantum theoretical metaphor developed here predicts a degree of complementarity (in the Heisenberg sense)⁶ between medicine attenuation and Px–Pr–Rx interaction.

Finally, it should be said that the molecular quantum theoretical metaphor developed here is necessarily crude, for the simple reason that in order to solve Schrödinger’s equation for molecules,

approximations have to be made that effectively ignore entanglement. This might be thought to contradict the very basis of the metaphor but some useful conclusions are possible probably because paired electrons in ground-state orbitals remain entangled. However, this does mean that the search for better physical models on which to base PPR entanglement should continue. Such a model might be the Greenberger–Horne–Zeilinger quantum entangled state¹⁶ between three particles, in which each particle is entangled with the rest of the system, but no two particles are entangled with each other. I hope to be able to report on the development of this model at a later date.

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