A Quantum Extension of Action Potential Coupling in 3D Tracts

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Abstract

In this note the authors consider ions in nodes on different axons in a 3D axon bundle. The ions are proposed to be studied quantum mechanically, with their evolution under gravitational waves and a bath, being coupled via their field to distant ions in nodes on other axons within the same tract. The setup is closely linked with the quantum perceptron proposed earlier by the authors. The expected novel result is a 3D formulation of the 1D Schrodinger Equation in the coupled setting.

We start with N ions in the cat state. Next we apply the gates corresponding to U_{grav} as given by the Solovay-Kitaev theorem. We calculate the state after M time steps or applications of the unitary. Suppose the ions are dispersed into a circle with a larger radius than the initial bounding circle. Once across the boundary, they interact with the bath of K ions, possibly different and more numerous. Suppose the charge on a system ion is q and a bath ion is q'. So there is a potential

$$V = E_{\vec{qq'}} |r_q - r_{q'}| = \frac{k_{Coulomb} q'}{|r_q - r_{q'}|}. \tag{1}$$

Let V' be the net bath-generated potential (due to all the q') that the system experiences after crossing the bounding circle of radius R. So the new net V becomes,

$$V_{net} = V_{grav} + V'. \tag{2}$$

This corresponds to perturbing the initial Hamiltonian H by a small increase H_0. Thus the new unitary to be used with the Solovay-Kitaev theorem becomes

$$U'(t) = U(t) + e^{-itH_0/\hbar}, \tag{3}$$

corresponding to a new sequence of quantum computing gates. See Figure 1.

All of the above has occurred at a single node of an axon. Consider a single ion at this node. Let $\psi(s)$ be its wavefunction where s is the co-ordinate along the axon. Let θ be the angle that this axon subtends with the xz plane and ϕ with the yz plane. In future work, we will be interested in the wavefunction of

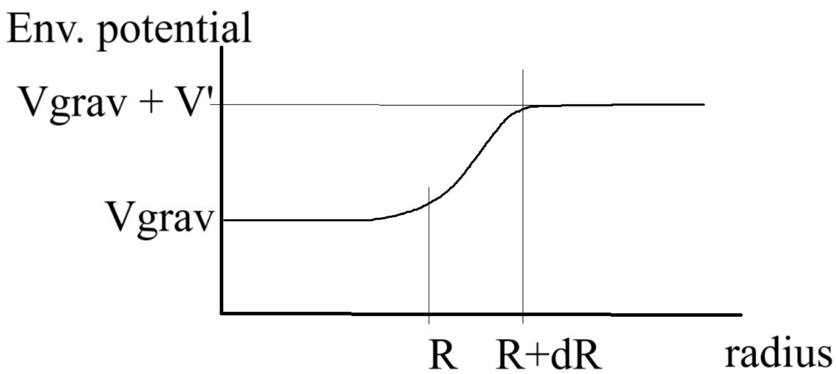

Figure 1: Environment of the ions around their starting location within a node of axon A, say.

this ion at the node of axon A as seen at axon B. It is this latter wavefunction which will determine the coupling between axons. We will also be interested in simulating both the single node in detail and the entire tract in suitably pared down details.