an example of a prototypical quantum algorithm. It was shown that, the choice of a generic $H_b$ could lead to an abundance of level crossings in the energy spectrum for the $|00\rangle \rightarrow |00\rangle$ operation of the CNOT gate. The influence of these level-crossings on the performance of the adiabatic quantum algorithm was not considered there. However, the effects of level crossings in the spectrum were discussed in [1] and it was noted that the addition of an appropriate sort of perturbation to the system will break the symmetries and therefore split any level crossings. The question of how to provide an appropriate perturbation still remains open.

In this paper, we propose that noise will inherently fulfil the role of the crucial symmetry breaking perturbation in physical implementations of an AQC system and as a result of this, the condition that $H_0$ and $H_b$ do not commute is no longer required. The CNOT gate algorithm is again used as an example of a prototypical quantum algorithm and we show that the performance of this generic algorithm is relatively resistant to the effects of noise, in agreement with [2–4]. As reported in [2], we find that in some situations the presence of noise increases the success probability, we then go on to explore the relationship between this increase in success probability and the fidelity of the final state. We also discuss the idea of using a tailored artificial noise signal to try and enhance the performance of the adiabatic quantum computation process. To do this, we derive and utilise a generalised stochastic version of the Pechukas-Yukawa equations [12, 13]; where the dynamics of the energy eigenvalues are mapped exactly on to the classical dynamics of a 1D gas of Brownian particles with a mutual repulsive force.

## II. GENERALISED PECHUKAS-YUKAWA MODEL

The standard Pechukas-Yukawa model is derived from a Hamiltonian of the form (1). However, to incorporate a source of noise in to the model we start with the following Hamiltonian;

$$\mathcal{H}(\lambda(t)) = \mathcal{H}_0 + \lambda(t) Z H_b + \delta h(\lambda(t)), \tag{2}$$

where the perturbation strength $\lambda(t)$ plays the role of 'time' and the new stochastic term $\delta h(\lambda)$ describes random fluctuations in the Hamiltonian due to an external noise source. The instantaneous eigenvalues and eigenfunctions of (2) are denoted $x_n(\lambda)$ and $|n(\lambda)\rangle$ respectively; $\mathcal{H}(\lambda)\,|n(\lambda)\rangle = x_n(\lambda)\,|n(\lambda)\rangle$. By following the same procedure as the derivation of the