Studies of Spin-1 Tunneling on IBM's Quantum Computer

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We present quantum protocols of the explicit observation of spin-1 tunneling and splitting of energy levels as a result of tunneling on a quantum device [1]. Spin-1 can be realized with two spins-1/2. Namely, spin-1 operators can be represented with two 1/2 spin operators. We use this representation to model the operator of evolution with Hamiltonian which describes single-spin tunneling on a quantum computer. The energy level splitting is observed on the basis of the detection of energy levels of the Hamiltonian on IBM's quantum computer, ibmq-bogota [3]. For this purpose, an algorithm for the detection of the spectrum of spin systems proposed in [2] is used. We also study the evolution of the mean value of the z-component of spin-1 on the quantum computer to detect oscillations of spin-1 between the states $|1\rangle$, $|-1\rangle$. The results of quantum calculations are in agreement with the theoretical ones. We observe explicitly spin-1 tunneling on ibmq-bogota [1].

References

[1]   Gnatenko Kh. P., Tkachuk V. M., Eur. Phys. J. Plus 138, 346 (2023).

[2]   Gnatenko Kh. P., Laba H. P., Tkachuk V. M., Eur. Phys. J. Plus 137, 522 (2022).

[3]   IBM Q experience, https://quantum-computing.ibm.com/