

Physical Review B - Condensed Matter and Materials Physics 2003 vol.67 N16, pages 1613021-1613024

---

## **Nonideality of quantum operations with the electron spin of a $^{31}\text{P}$ donor in a Si crystal due to interaction with a nuclear spin system**

Saikin S., Fedichkin L.

*Kazan Federal University, 420008, Kremlevskaya 18, Kazan, Russia*

---

### **Abstract**

We examine a  $^{31}\text{P}$  donor electron spin in a Si crystal to be used for the purpose of quantum computation. The interaction with an uncontrolled system of  $^{29}\text{Si}$  nuclear spins influences the electron-spin dynamics appreciably. The hyperfine field at the  $^{29}\text{Si}$  nuclei positions is noncollinear with the external magnetic field. Quantum operations with the electron wave function, i.e., using magnetic-field pulses or electrical gates, change the orientation of hyperfine field and disturb the nuclear-spin system. This disturbance produces a deviation of the electron spin qubit from an ideal state, at a short-time scale in comparison with the nuclear-spin diffusion time. For  $H_{\text{ext}} \approx 9$  T the estimated error rate is comparable to the threshold value required by the quantum error correction algorithms. The rate is lower at higher external magnetic fields.

---