論文 / 著書情報
Article / Book Information

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Category(English)	Doctoral Thesis
種別(和文)	論文要旨
Type(English)	Summary

（博士課程）
Doctoral Program

論 文 要 旨

THESIS SUMMARY

系・コース： Department of, Graduate major in	電気電子 エネルギー 系 コース	申請学位（専攻分野）： Academic Degree Requested	博士 (学 術) Doctor of Philosophy
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要旨（英文 800 語程度）
Thesis Summary（approx.800 English Words ）

This thesis focuses on both the theory and experimental sides of quantum computing via silicon quantum dots (QDs).

In a theoretical study, I used Pauli spin blockade (PSB) phenomena to create a large quantum network using QDs. Before this study, the community had focused on using photon (quantum optics) to create photonic networks. Considering developed CMOS technology, as semiconductors are one of the most promising candidates for quantum computers in the future, using the PSB to create multipartite entanglement states is unprecedented. A few hybrid schemes are using photons (in the cavity system) and semiconductors, but they cannot be experimentally realized with current technology.

The rise of quantum technology challenges the debate on quantum supremacy, usually focusing on the algorithms' theoretical feasibility. These algorithms are generally lacking environmental noise which makes physical realization far tricky. Recently, with the claim of Google, quantum supremacy has become very popular. There are several ways of showing suppression of barriers in the classical environment by harnessing quantum resources. A Pseudo-telepathy game, magic square game (MSG), which is played against a referee, is an inspiring example. To show the quantum supremacy, the advantage of quantum physics over classical physics, I have proposed an experimental and timely setup that uses distant QDs coupled to an optical cavity to surpass the classical limit in the MSG. By using the quantum resources (power of sharing entanglement states), in the MSG, I have shown that the players can have a unit success probability (Ps = 1) against the referee while they could have a maximum probability of 8/9 with classical resources. I have also shown that by having the information about the players' setup and strategy, the referee can bias the game, which is a kind of tunnelling between classical and quantum worlds.

In the experimental part of this thesis, I prepared setup to readout of charge state and detect PSB in QDs by using the radio frequency single electron transistor (RF-SET) technique.

First of all, I detected the RC leakage problem in the MOS device and investigated the optimal working frequency range to overcome that problem. I used an SET, silicon single QD, to readout charge state, which opened the way for checking the existence of the PSB in double QD.

Secondly, in order to have higher sensitivity in RF readout, I used microelectronics to optimize setup and increase the sensitivity by having good impedance matching. When top gate (TG) voltage changes, the device's capacitance changes, and parameters set to a certain value for the matching become useless. To suppress this, I used GaAs-based double varactors to tune impedance matching up to best matching to increase the signal to noise ratio, hence the sensitivity.

In conclusion, I proposed a semiconductor-based fusion setup using PSB to fuse W-type multipartite entangled states to create a larger entangled state. In the second theoretical study, I proposed distant QDs coupled to the microcavity to surpass the classical limit in MSG. These two proposals require checking the existence of PSB and readout of spin in QD. In the experimental part, I succeeded in detecting PSB by RF reflectometry.

備考 ： 論文要旨は、和文 2000 字と英文 300 語を 1 部ずつ提出するか、もしくは英文 800 語を 1 部提出してください。
Note : Thesis Summary should be submitted in either a copy of 2000 Japanese Characters and 300 Words (English) or 1copy of 800 Words (English).