

## 【Grant-in-Aid for Scientific Research(S)】

Science and Engineering (Mathematical and physical sciences)



### Title of Project : Quantum information processing using superconducting qubits

Franco Nori

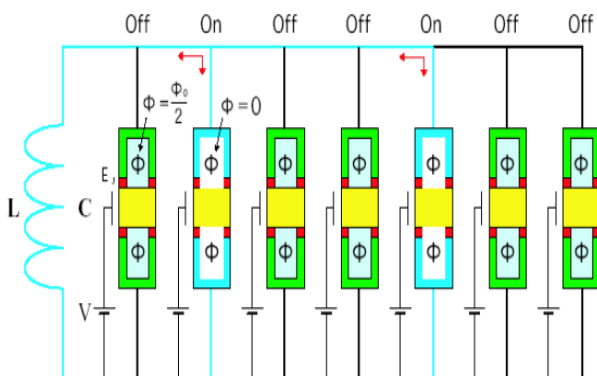
(RIKEN, Digital Materials Team, Team Leader)

Research Area : Theoretical Physics

Keywords : superconducting qubits, nano-mechanical and electromagnetic resonators.

#### 【Purpose and Background of the Research】

We plan to study superconducting (SC) qubits as “Artificial Atoms” and ask similar questions researchers have asked for natural atoms (including how these “giant atoms” interact with light, transmission lines, electro-magnetic resonators, mechanical resonators, etc.). We plan to theoretically study the interdisciplinary field involving quantum optics, atomic physics, condensed matter physics, nanoscience, and computer science. These types of problems include how photons interact with qubits, lasing phenomena using superconducting qubits; single-photon generators; photon-number control (Fock state generation); coupling qubits by a resonator; coupling resonators by a qubit; and also quantum measurements. This is a growing interdisciplinary area of research.

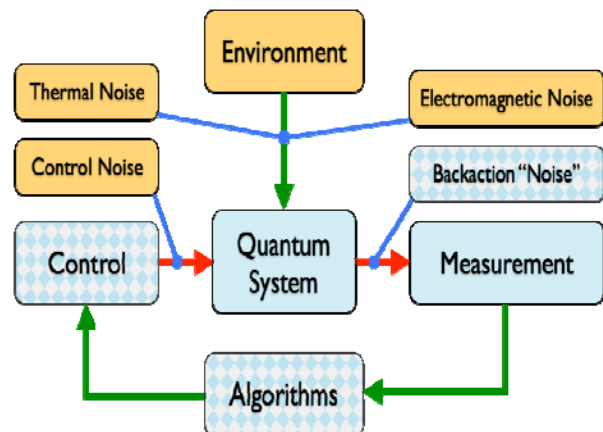


#### 【Research Methods】

Methods used are from atomic physics, quantum optics, condensed matter physics, nanoscience, and quantum information processing. We plan to do analytical and computational studies.

#### 【Expected Research Achievements and Scientific Significance】

We wish to solve several problems which are now limiting experiments (e.g., on controllable inter-qubit couplings in quantum circuits). Also, we plan to design improved SC qubit scalable circuits (e.g., by using a quantized LC circuit or a single-mode cavity field). We also plan to study other atomic physics phenomena using SC quantum circuits. Another goal is to analyze how to extend the coherence time of qubit states in SC circuits by using, e.g., feedback-control via output signals of measurements on the qubit states. We will also explore new research directions in this area.



#### 【Publications Relevant to the Project】

- J.Q. You, F. Nori, Phys. Today **58** (11), 42 (2005).
- S. Ashhab, et al., Phys. Rev. B **77**, 014510 (2008).
- L. Zhou, et al., Phys. Rev. Lett. **101**, 100501 (2008).

【Term of Project】 FY2010-2014

【Budget Allocation】 62,800 Thousand Yen

#### 【Homepage Address and Other Contact Information】

<http://dml.riken.jp/>