

**Project Title:**

**Quantum mechanics in superconducting electrical circuits**

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I am using my RICC account for studies of dynamical quantum properties of superconducting electrical circuits, such as qubit circuits as candidates for possible building blocks in future quantum computing devices, and as artificial atoms and quantum field waveguides for fundamental studies on quantum-optics-like problems in the microwave regime.

In these studies I am using two software packages that I have developed myself (qdpack) and together with a colleague at RIKEN (qutip), respectively. Both are frameworks for numerical simulations of quantum dynamics of open systems, which use ODE solvers and sparse matrices for solving quantum master equations and the wave-function Monte-Carlo equations. More information about these open-source tools are available at:

<http://code.google.com/p/qutip/>

I have successfully used the above mentioned tools in a wide range of problems related to open quantum dynamics. Most recently in studies on the strongly driven quantum two-level systems and related transport properties.

For the next fiscal year I would like to continue using the RICC system and use our software framework qutip to conduct further studies of quantum properties of superconducting circuits and semiconductor devices.

In the last couple of month of fiscal year 2012 I have work on porting out Python/C/Fortran based package

for quantum dynamics simulations to the RICC cluster, and it now works great. I have started to use the RICC cluster more actively since this porting of our application was finished, and I am now working on simulating the dynamics of a semiconducting double-quantum-dot system, and I plan to continue this numerical research, using RICC, during the next fiscal year 2013.

## RICC Usage Report for Fiscal Year 2012

### Fiscal Year 2012 List of Publications Resulting from the Use of RICC

#### [Publication]

J.R. Johansson, P.D. Nation, F. Nori, QuTiP 2: A Python framework for the dynamics of open quantum systems, Comp. Phys. Comm. 184, 1234 (2013).

#### [Proceedings, etc.]

J. R. Johansson and P. D. Nation, “QuTiP: A framework for the dynamics of open quantum systems using SciPy and Cython”, Proc. of the 11th Python in Science Conf. (2012).

#### [Oral presentation at an international symposium]

*QuTiP: Quantum Toolbox in Python*, SciPy 2012, Scientific Computing with Python, in Austin, USA, July 16th - 21st, 2012.

#### [Others]

Outreach talk for high-school students

Popular science lecture on, Research with supercomputers.  
Tsuru high school, Yamanashi, March 14th 2012.