example-quantum-process-tomography

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1 QuTiP example: Quantum Process Tomography

J.R. Johansson and P.D. Nation

For more information about QuTiP see http://qutip.org

```
In [1]: %pylab inline
```

```
Populating the interactive namespace from numpy and matplotlib
```

```
In [2]: from qutip import *
        from qutip.quantum_info import *
```

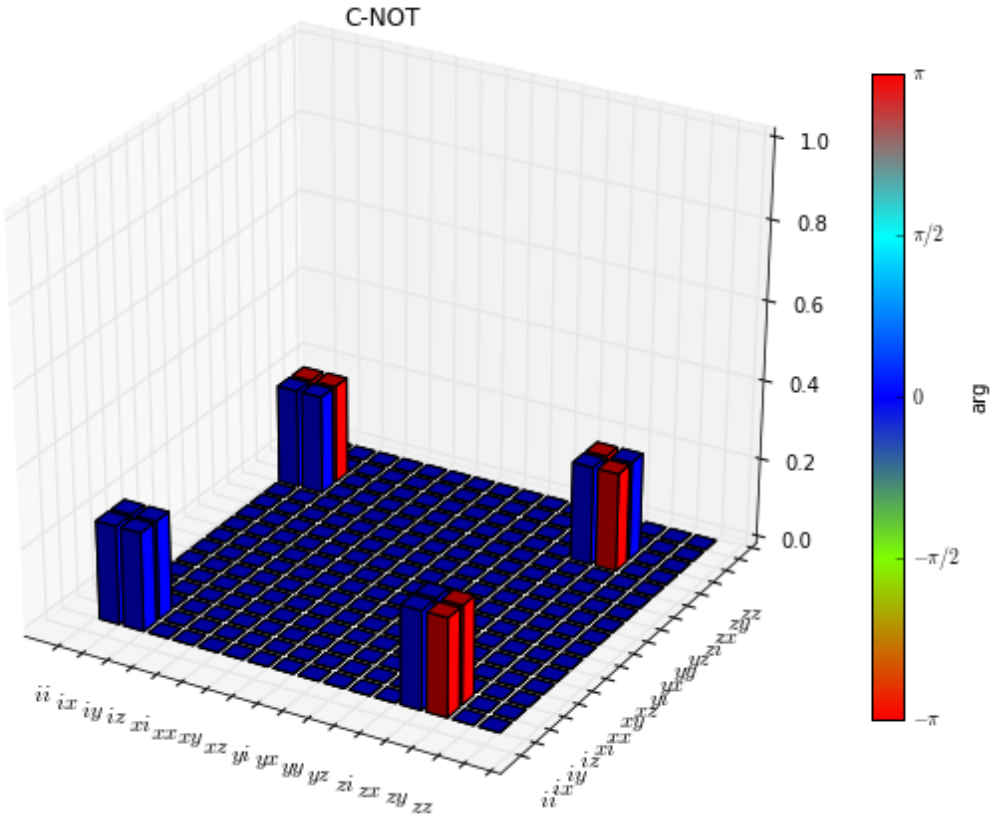
```
In [3]: """
        Plot the process tomography matrices for some 1, 2, and 3-qubit qubit gates.
        """
        gates = [['C-NOT', cnot()],
                 ['SWAP', swap()],
                 ['$i$SWAP', iswap()],
                 ['$\sqrt{i\mathrm{SWAP}}$', sqrtiswap()],
                 ['S-NOT', snot()],
                 ['$\pi/2$ phase gate', phasegate(pi/2)],
                 ['Toffoli', toffoli()],
                 ['Fredkin', fredkin()]]
```

```
In [4]: def plt_qpt_gate(gate, figsize=(8,6)):

            name  = gate[0]
            U_psi = gate[1]

            N = len(U_psi.dims[0]) # number of qubits

            # create a superoperator for the density matrix
            # transformation rho = U_psi * rho_0 * U_psi.dag()
            U_rho = spre(U_psi) * spost(U_psi.dag())

            # operator basis for the process tomography
            op_basis = [[qeye(2), sigmax(), sigmay(), sigmaz()] for i in range(N)]

            # labels for operator basis
            op_label = [["$i$", "$x$", "$y$", "$z$"] for i in range(N)]

            # calculate the chi matrix
            chi = qpt(U_rho, op_basis)
```

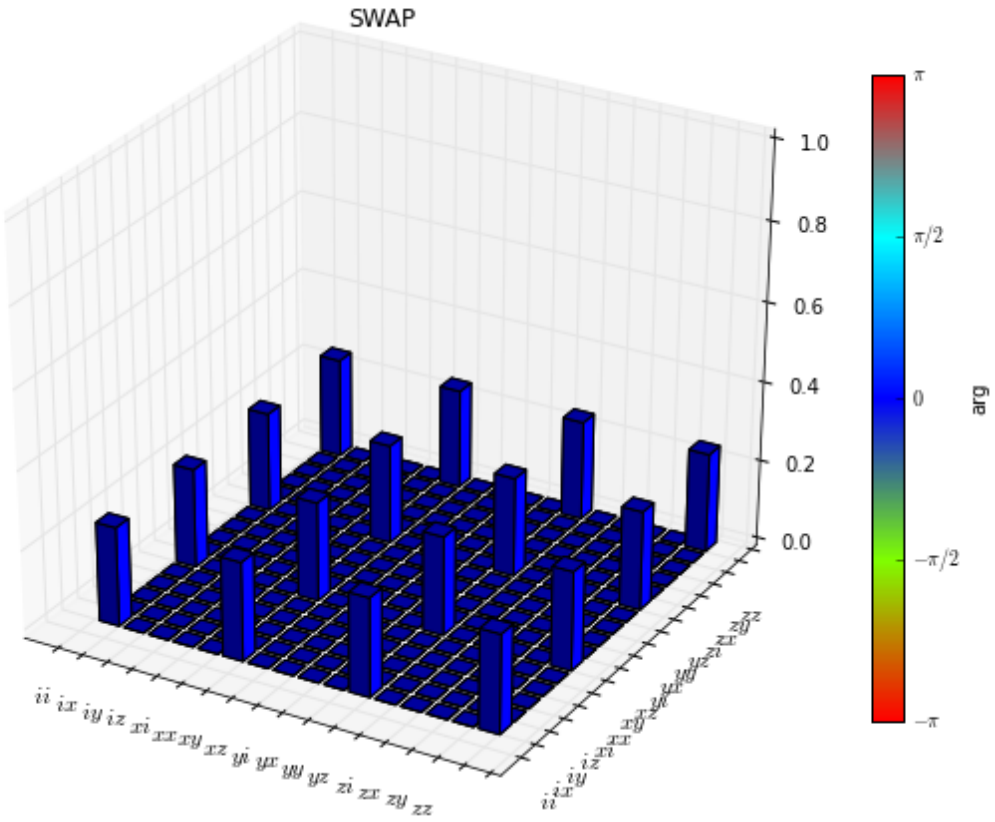
```
            # visualize the chi matrix
            fig, ax = qpt_plot_combined(chi, op_label, name, figsize=figsize)

            ax.set_title(name)

            return fig, ax
```

In [5]:
```
plt_qpt_gate(gates[0]);
```

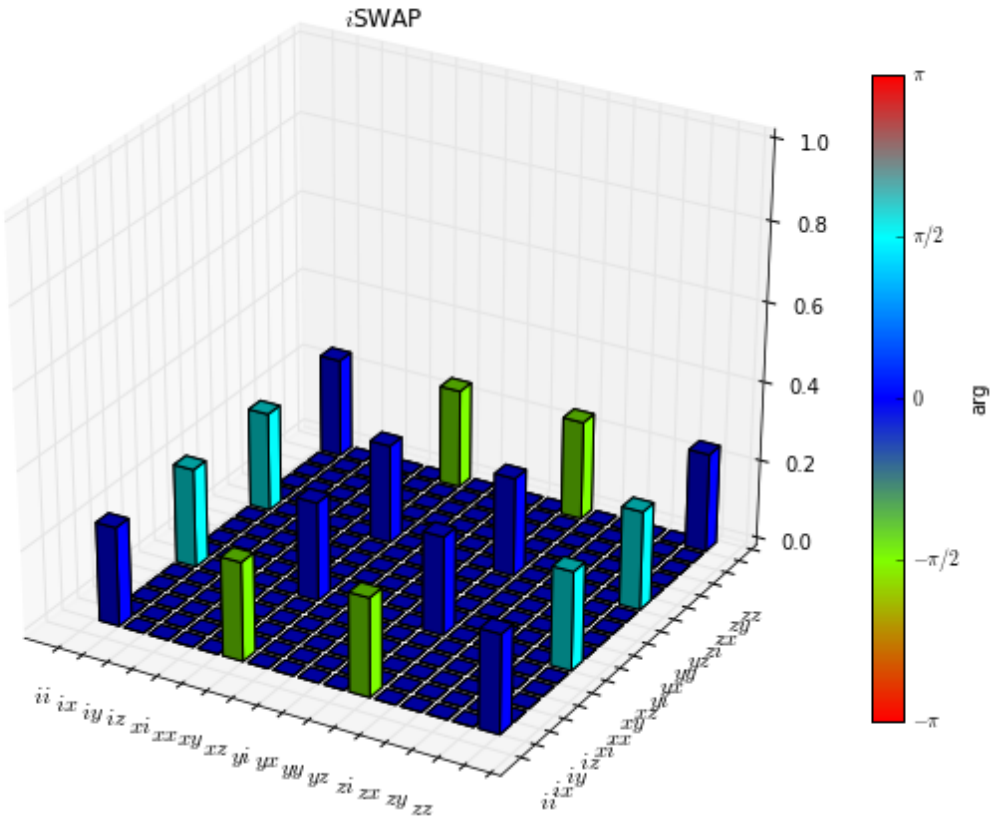
```
/usr/lib/python3/dist-packages/mpl_toolkits/mplot3d/axes3d.py:1673: RuntimeWarning: invalid value encoun
  for n in normals])
/usr/lib/python3/dist-packages/matplotlib/colors.py:395: RuntimeWarning: invalid value encountered in g
  if (c.ravel() > 1).any() or (c.ravel() < 0).any():
/usr/lib/python3/dist-packages/matplotlib/colors.py:395: RuntimeWarning: invalid value encountered in l
  if (c.ravel() > 1).any() or (c.ravel() < 0).any():
```



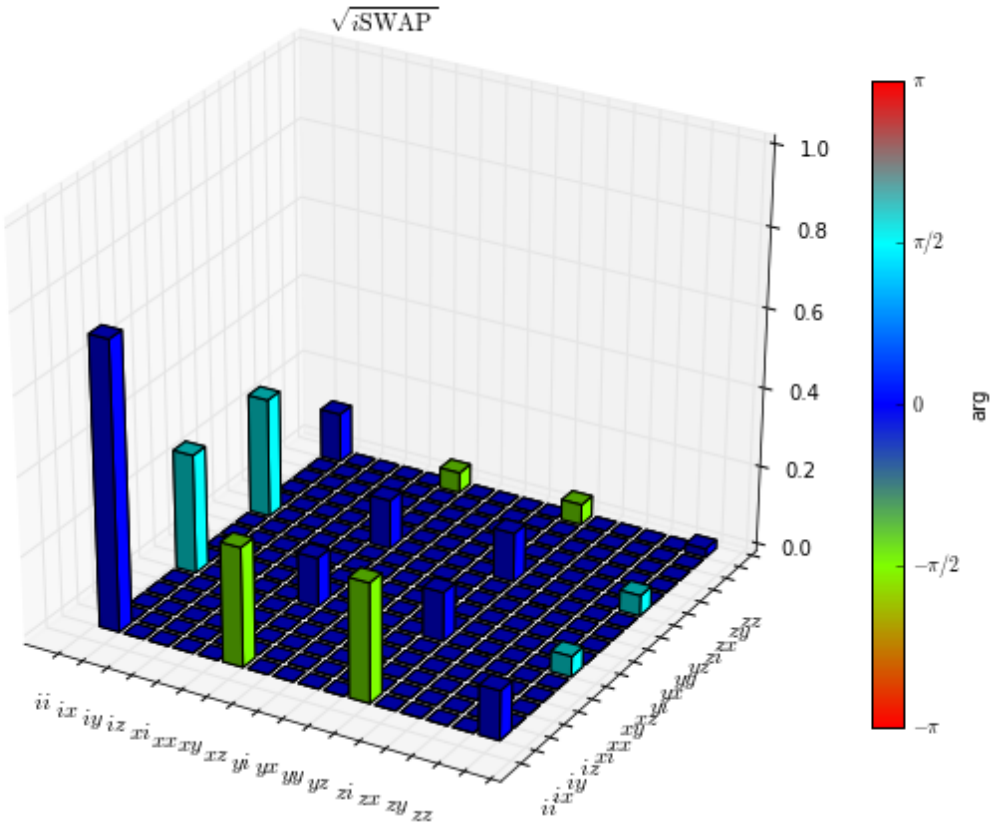
In [6]:
```
plt_qpt_gate(gates[1]);
```



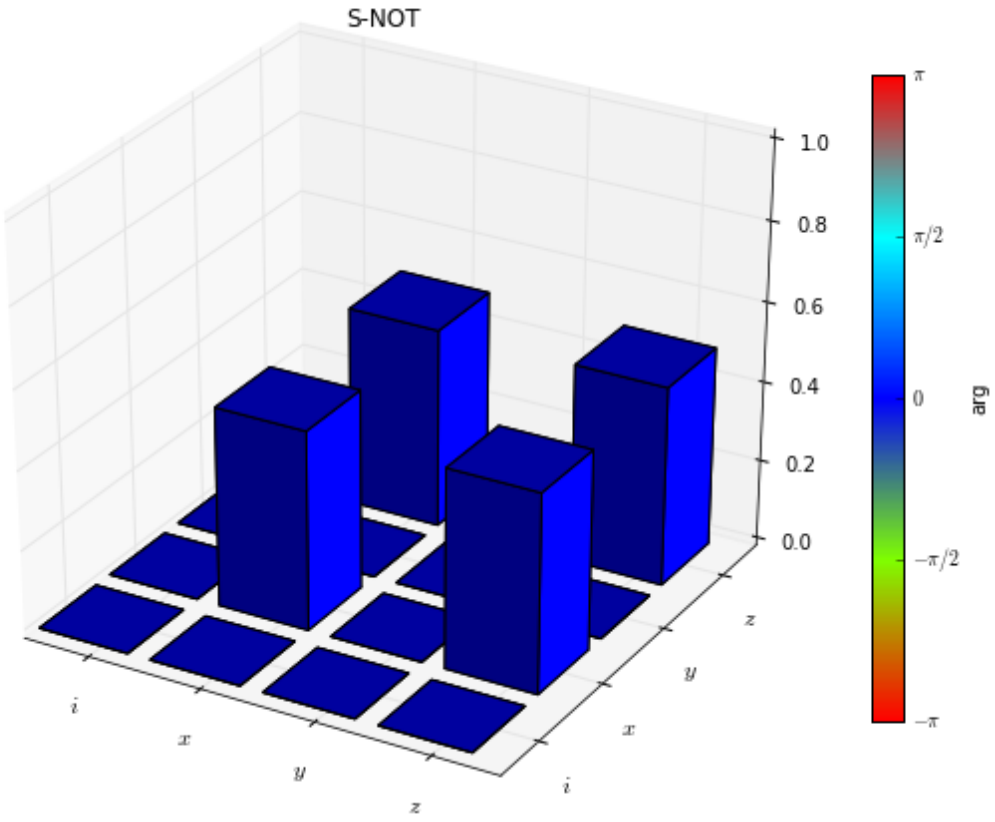
In [7]: plt_qpt_gate(gates[2]);



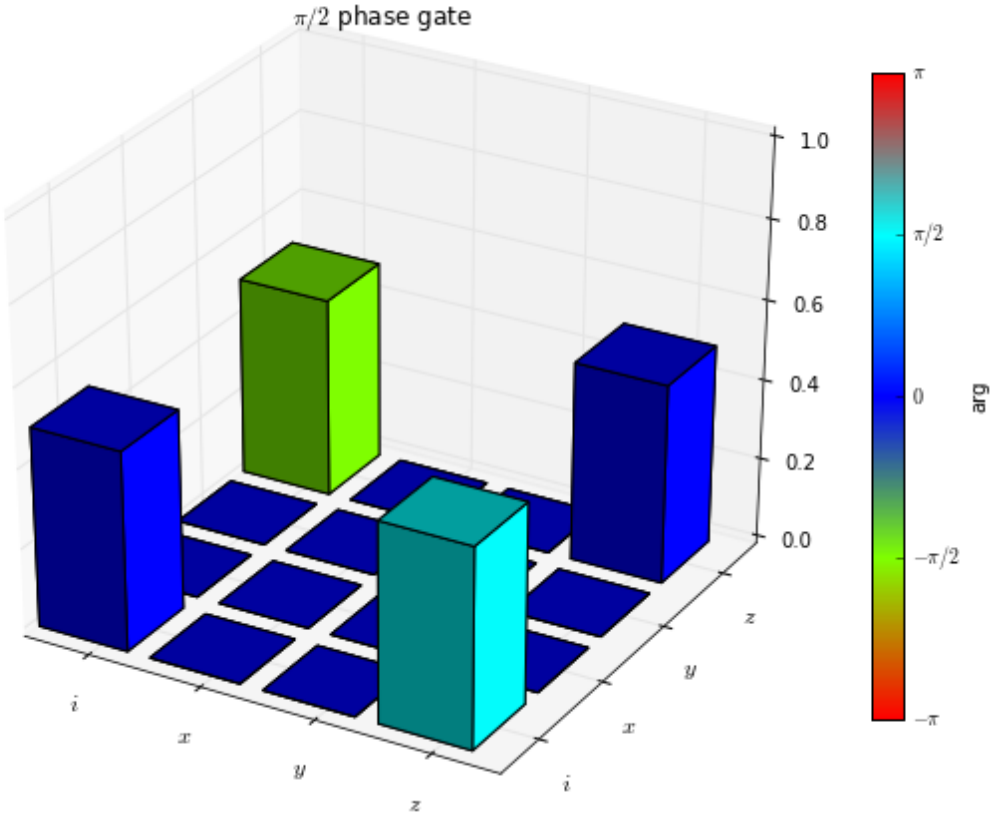
In [8]: plt_qpt_gate(gates[3]);



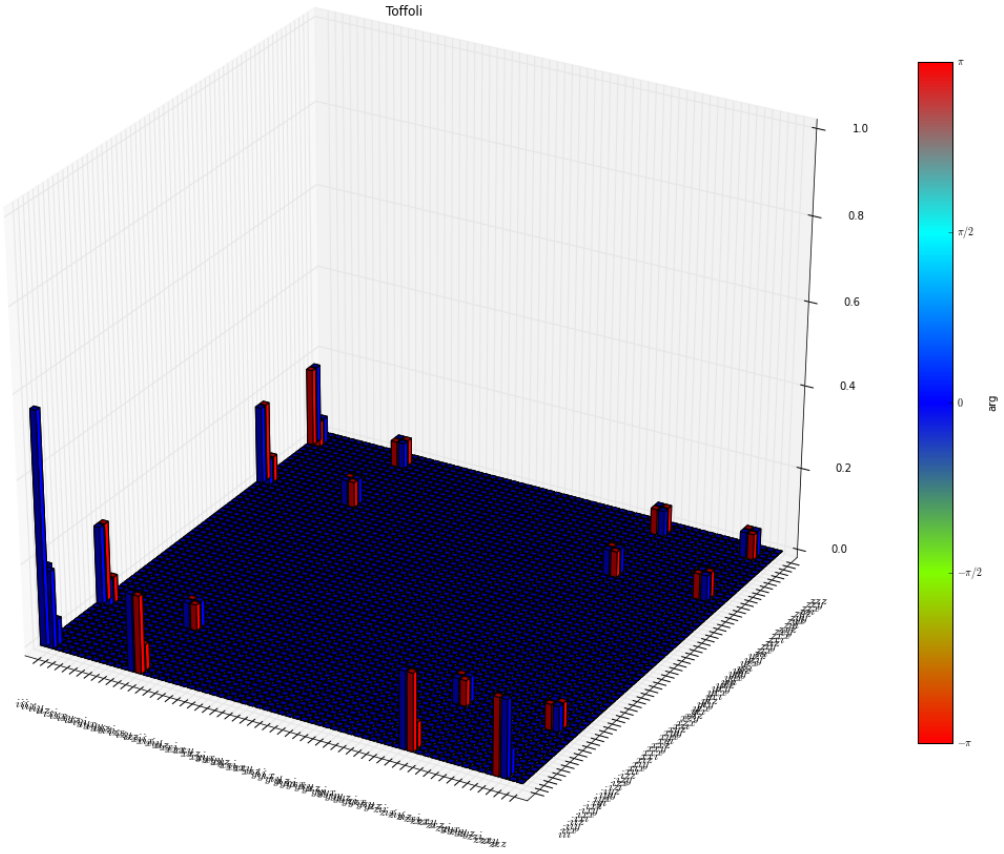
In [9]: `plt_qpt_gate(gates[4]);`



In [10]: plt_qpt_gate(gates[5]);




```
In []: fig, ax = plt_qpt_gate(gates[6], figsize=(16,12))
       ax.axis('tight');
```




```
In []: fig, ax = plt_qpt_gate(gates[7], figsize=(16,12))
       ax.axis('tight');
```

1.1 Versions

```
In []: from qutip.ipynbtools import version_table

       version_table()
```