In [ ]:
```
pip install qiskit
```

```
Collecting qiskit
  Downloading qiskit-1.2.0-cp38-abi3-manylinux_2_17_x86_64.manylinux2014_x86_64.whl.metadata
(12 kB)
Collecting rustworkx>=0.15.0 (from qiskit)
  Downloading rustworkx-0.15.1-cp38-abi3-manylinux_2_17_x86_64.manylinux2014_x86_64.whl.metad
ata (9.9 kB)
Requirement already satisfied: numpy<3,>=1.17 in /usr/local/lib/python3.10/dist-packages (fro
m qiskit) (1.26.4)
Requirement already satisfied: scipy>=1.5 in /usr/local/lib/python3.10/dist-packages (from qi
skit) (1.13.1)
Requirement already satisfied: sympy>=1.3 in /usr/local/lib/python3.10/dist-packages (from qi
skit) (1.13.2)
Collecting dill>=0.3 (from qiskit)
  Downloading dill-0.3.8-py3-none-any.whl.metadata (10 kB)
Requirement already satisfied: python-dateutil>=2.8.0 in /usr/local/lib/python3.10/dist-packa
ges (from qiskit) (2.8.2)
Collecting stevedore>=3.0.0 (from qiskit)
  Downloading stevedore-5.3.0-py3-none-any.whl.metadata (2.3 kB)
Requirement already satisfied: typing-extensions in /usr/local/lib/python3.10/dist-packages
(from qiskit) (4.12.2)
Collecting symengine>=0.11 (from qiskit)
  Downloading symengine-0.11.0-cp310-cp310-manylinux_2_12_x86_64.manylinux2010_x86_64.whl.met
adata (1.2 kB)
Requirement already satisfied: six>=1.5 in /usr/local/lib/python3.10/dist-packages (from pyth
on-dateutil>=2.8.0->qiskit) (1.16.0)
Collecting pbr>=2.0.0 (from stevedore>=3.0.0->qiskit)
  Downloading pbr-6.1.0-py2.py3-none-any.whl.metadata (3.4 kB)
Requirement already satisfied: mpmath<1.4,>=1.1.0 in /usr/local/lib/python3.10/dist-packages
(from sympy>=1.3->qiskit) (1.3.0)
Downloading qiskit-1.2.0-cp38-abi3-manylinux_2_17_x86_64.manylinux2014_x86_64.whl (4.8 MB)
   ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ 4.8/4.8 MB 26.0 MB/s eta 0:00:00
Downloading dill-0.3.8-py3-none-any.whl (116 kB)
   ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ 116.3/116.3 kB 5.8 MB/s eta 0:00:00
Downloading rustworkx-0.15.1-cp38-abi3-manylinux_2_17_x86_64.manylinux2014_x86_64.whl (2.0 M
B)
   ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ 2.0/2.0 MB 24.5 MB/s eta 0:00:00
Downloading stevedore-5.3.0-py3-none-any.whl (49 kB)
   ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ 49.7/49.7 kB 1.9 MB/s eta 0:00:00
Downloading symengine-0.11.0-cp310-cp310-manylinux_2_12_x86_64.manylinux2010_x86_64.whl (39.4
MB)
   ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ 39.4/39.4 MB 13.8 MB/s eta 0:00:00
Downloading pbr-6.1.0-py2.py3-none-any.whl (108 kB)
   ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ 108.5/108.5 kB 4.7 MB/s eta 0:00:00
Installing collected packages: symengine, rustworkx, pbr, dill, stevedore, qiskit
Successfully installed dill-0.3.8 pbr-6.1.0 qiskit-1.2.0 rustworkx-0.15.1 stevedore-5.3.0 sym
engine-0.11.0
```

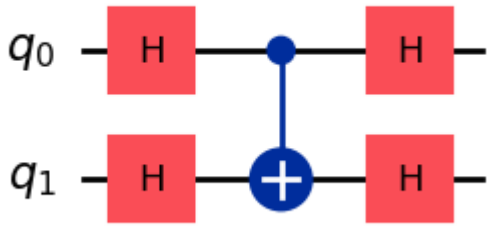
In [ ]:
```
pip install pylatexenc
```

```
Collecting pylatexenc
  Downloading pylatexenc-2.10.tar.gz (162 kB)
     ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ 162.6/162.6 kB 5.0 MB/s eta 0:00:00
  Preparing metadata (setup.py) ... done
Building wheels for collected packages: pylatexenc
  Building wheel for pylatexenc (setup.py) ... done
  Created wheel for pylatexenc: filename=pylatexenc-2.10-py3-none-any.whl size=136817 sha256=
36c3b02f57f5ecd6adad0a7c6debbf3185f4f4d35323dbea8bde2365f8d30c3a
  Stored in directory: /root/.cache/pip/wheels/d3/31/8b/e09b0386afd80cfc556c00408c9aeea5c35c4
d484a9c762fd5
Successfully built pylatexenc
Installing collected packages: pylatexenc
Successfully installed pylatexenc-2.10
```

In [ ]:
```
from qiskit.quantum_info import Operator
from qiskit import QuantumCircuit
from qiskit.visualization import plot_state_city
from qiskit.quantum_info import Statevector
```

In [ ]:
```
qc0= QuantumCircuit(2)
qc0.h(0)
qc0.h(1)
qc0.cx(0, 1)
qc0.h(0)
qc0.h(1)
qc0.draw('mpl')
```

Out[ ]:

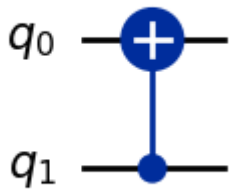


In [ ]:
```
unitary = Operator(qc0)
print(unitary)
```

```
Operator([[1.+0.j, 0.+0.j, 0.+0.j, 0.+0.j],
          [0.+0.j, 1.+0.j, 0.+0.j, 0.+0.j],
          [0.+0.j, 0.+0.j, 0.+0.j, 1.+0.j],
          [0.+0.j, 0.+0.j, 1.+0.j, 0.+0.j]],
         input_dims=(2, 2), output_dims=(2, 2))
```

In [ ]:
```
qca = QuantumCircuit(2)
qca.cx(1,0)
qca.draw('mpl')
```

Out[ ]:

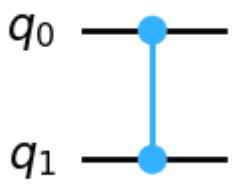


In [ ]:
```
unitary = Operator(qca)
print(unitary)
```

```
Operator([[1.+0.j, 0.+0.j, 0.+0.j, 0.+0.j],
          [0.+0.j, 1.+0.j, 0.+0.j, 0.+0.j],
          [0.+0.j, 0.+0.j, 0.+0.j, 1.+0.j],
          [0.+0.j, 0.+0.j, 1.+0.j, 0.+0.j]],
         input_dims=(2, 2), output_dims=(2, 2))
```

In [ ]:
```
qc= QuantumCircuit(2)
qc.cz(0,1)
qc.draw('mpl')
```

Out[ ]:

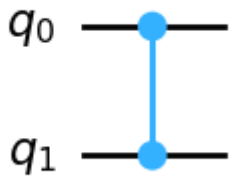


In [ ]:
```
unitary = Operator(qc)
print(unitary)
```

```
Operator([[ 1.+0.j,  0.+0.j,  0.+0.j,  0.+0.j],
          [ 0.+0.j,  1.+0.j,  0.+0.j,  0.+0.j],
          [ 0.+0.j,  0.+0.j,  1.+0.j,  0.+0.j],
          [ 0.+0.j,  0.+0.j,  0.+0.j, -1.+0.j]],
         input_dims=(2, 2), output_dims=(2, 2))
```

In [ ]:
```
qc1= QuantumCircuit(2)
qc1.cz(1,0)
qc1.draw('mpl')
```

Out[ ]:



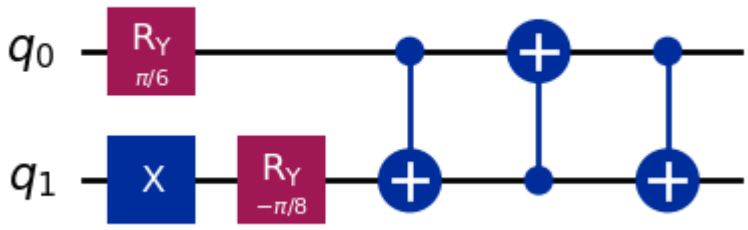
In [ ]:
```
unitary1 = Operator(qc1)
print(unitary1)
```

```
Operator([[ 1.+0.j,  0.+0.j,  0.+0.j,  0.+0.j],
          [ 0.+0.j,  1.+0.j,  0.+0.j,  0.+0.j],
          [ 0.+0.j,  0.+0.j,  1.+0.j,  0.+0.j],
          [ 0.+0.j,  0.+0.j,  0.+0.j, -1.+0.j]],
         input_dims=(2, 2), output_dims=(2, 2))
```

In [ ]:
```
qc2 = QuantumCircuit(2)
qc2.ry(np.pi/6,0)
qc2.x(1)
qc2.ry(-np.pi/8,1)
qc2.cx(0,1)
qc2.cx(1,0)
```

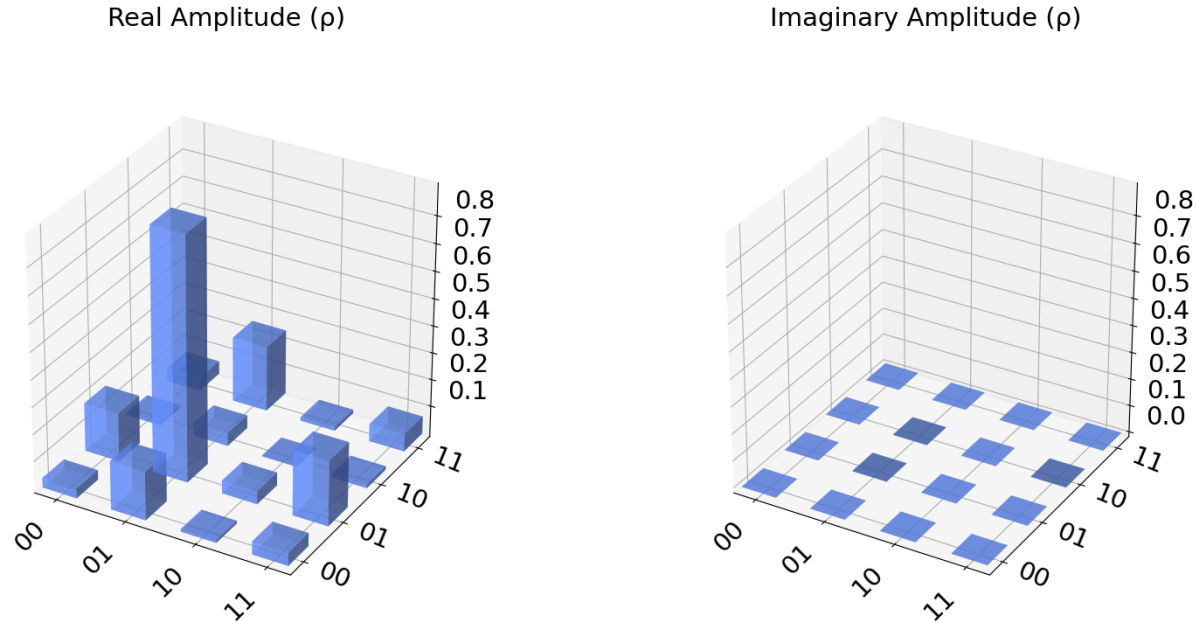
```
qc2.cx(0,1)
qc2.draw('mpl')
```

Out[ ]:



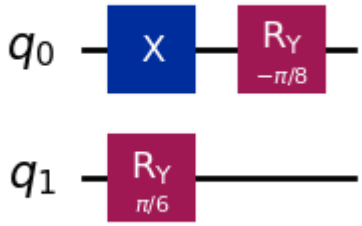
In [ ]:
```
state2 = Statevector(qc2)
plot_state_city(state2, alpha=0.6)
```

Out[ ]:



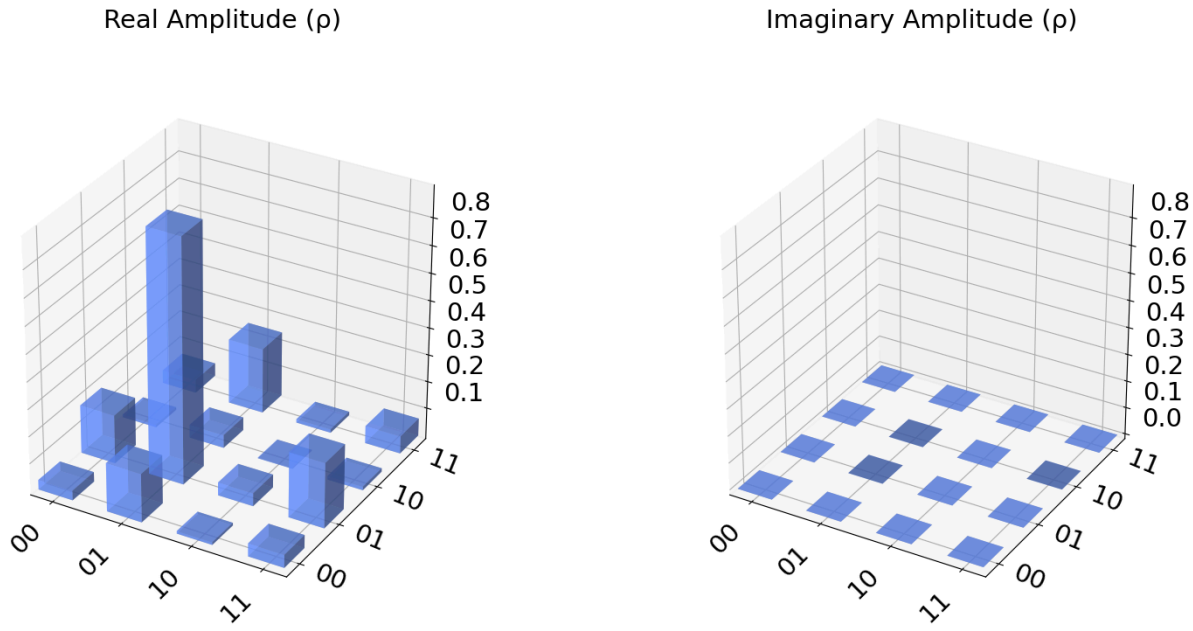
In [ ]:
```
qc3= QuantumCircuit(2)
qc3.x(0)
qc3.ry(-np.pi/8,0)
qc3.ry(np.pi/6,1)
qc3.draw('mpl')
```

Out[ ]:



In [ ]:
```
state3 = Statevector(qc3)
plot_state_city(state3, alpha=0.6)
```

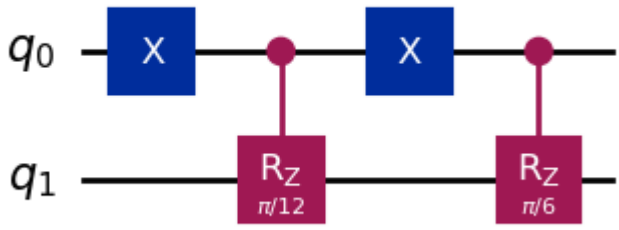
Out[ ]:



Quantum multiplexor

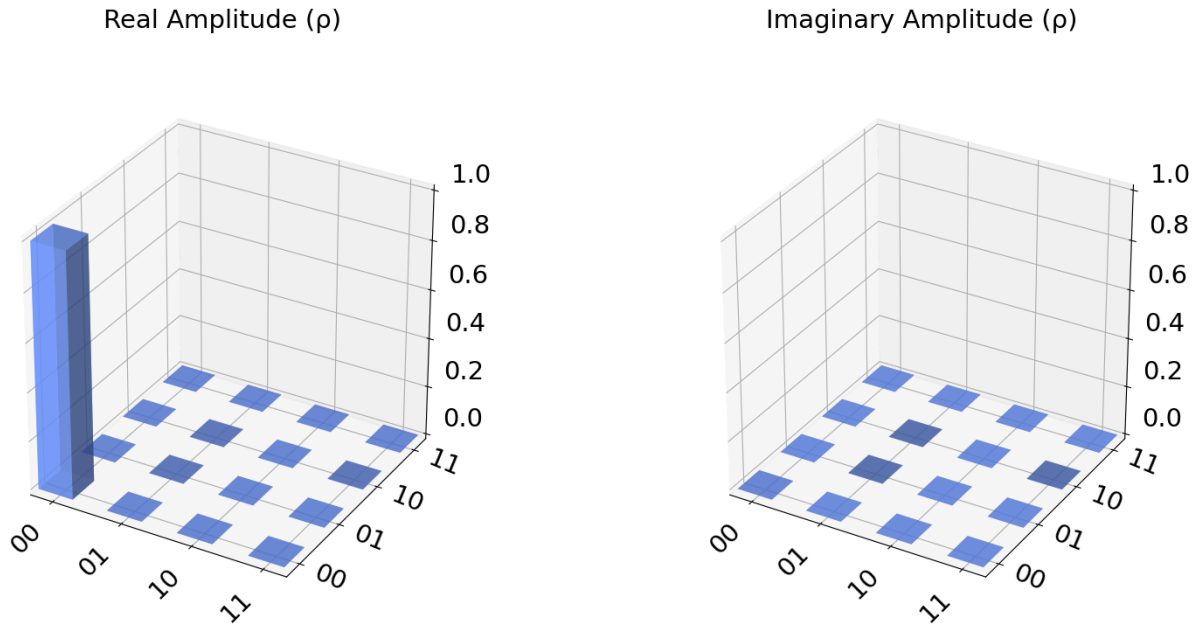
In [ ]:
```
qc4= QuantumCircuit(2)
qc4.x(0)
qc4.crz(np.pi/12,0,1)
qc4.x(0)
qc4.crz(np.pi/6,0,1)
qc4.draw('mpl')
```

Out[ ]:



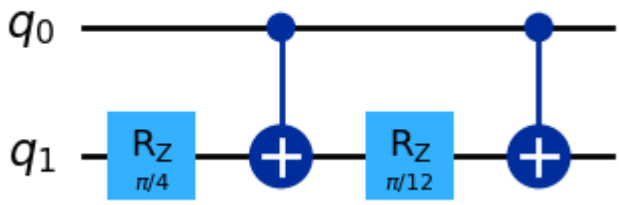
In [ ]:
```
state4 = Statevector(qc4)
plot_state_city(state4, alpha=0.6)
```

Out[ ]:



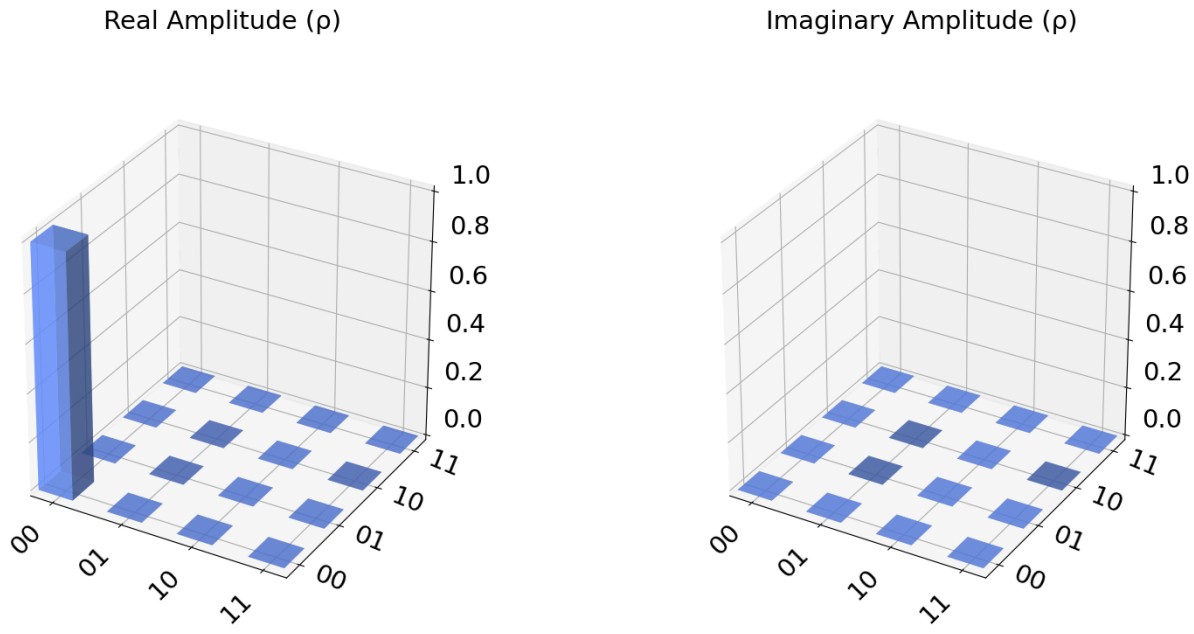
In [ ]:
```
qc5= QuantumCircuit(2)
qc5.rz(np.pi/4,1)
qc5.cx(0,1)
qc5.rz(np.pi/12,1)
qc5.cx(0,1)
qc5.draw('mpl')
```

Out[ ]:



In [ ]:
```
state5 = Statevector(qc5)
plot_state_city(state5, alpha=0.6)
```

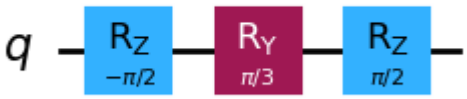
Out[ ]:



Verify Rx(theta) = Rx(-pi/2)Ry(theta)Rz(pi/2)

In [ ]:
```
qc6 = QuantumCircuit(1)
qc6.rz(-np.pi/2,0)
qc6.ry(np.pi/3,0)
qc6.rz(np.pi/2,0)
qc6.draw('mpl')
```

Out[ ]:

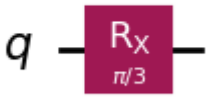


In [ ]:
```
unitary6 = Operator(qc6)
print(unitary6)
```

```
Operator([[ 8.66025404e-01+0.j , -8.32667268e-17+0.5j],
          [ 8.32667268e-17+0.5j,  8.66025404e-01+0.j ]],
         input_dims=(2,), output_dims=(2,))
```

In [ ]:
```
qc7 = QuantumCircuit(1)
qc7.rx(np.pi/3,0)
qc7.draw('mpl')
```

Out[ ]:



In [ ]:
```
unitary7 = Operator(qc7)
print(unitary7)
```

```
Operator([[0.8660254+0.j , 0.       -0.5j],
          [0.       -0.5j, 0.8660254+0.j ]],
         input_dims=(2,), output_dims=(2,))
```

In [ ]:
```

```