

Introduction to quantum physics

States and measurements

The system is initialised in the state $0.6 |0\rangle - 0.8 |1\rangle$. If the system is found in the state $|i\rangle$, the outcome of the measurement is i . The system has now been measured.

- (i) Can you determine the outcome of the measurement? Explain.

Suppose the result of this measurement is 0. Another measurement is performed right after the first one.

- (ii) Can you determine the outcome of the measurement now? Explain.

1000 identical copies of the original system are made, and each one is measured once.

- (iii) Estimate the number of measurements that will yield 0 and that will yield 1.
(iv) Estimate the mean value of a measurement outcome.

Modelling a measurement to determine a state

Work in pairs. One of you follows the instructions and answers the questions on the left side of the instructions and the other – on the right side. *You will need one or more dice (D6 is fine, but D12 or D20 might be more interesting) for this activity.*

The system is initialised in the state $|\psi\rangle = c_0 |0\rangle + c_1 |1\rangle$. The measurement yields 0 if the system is found in state $|0\rangle$ and 1 if it is found in state $|1\rangle$.

(1) Choose (and note down) which faces of a dice will correspond to the system measured to be in state $|0\rangle$ and which – to be in state $|1\rangle$.

(3) Roll a dice to model the measurement of a qubit. Tell your partner the measurement outcome for the roll (0 or 1), but do not show him/her the actual face of the die.

(2) Your partner will model the measurement. Ask him/her for a result (0 or 1) and note it down.

(4) Repeat the 'measurements' no less than 20 times.

(5) Estimate the probabilities of each of the two outcomes. Conclude how many die faces your partner has chosen to represent the state $|0\rangle$ and how many to represent the state $|1\rangle$.

Discuss: Is the data obtained enough to uniquely obtain coefficients c_0 and c_1 ? Why or why not?

