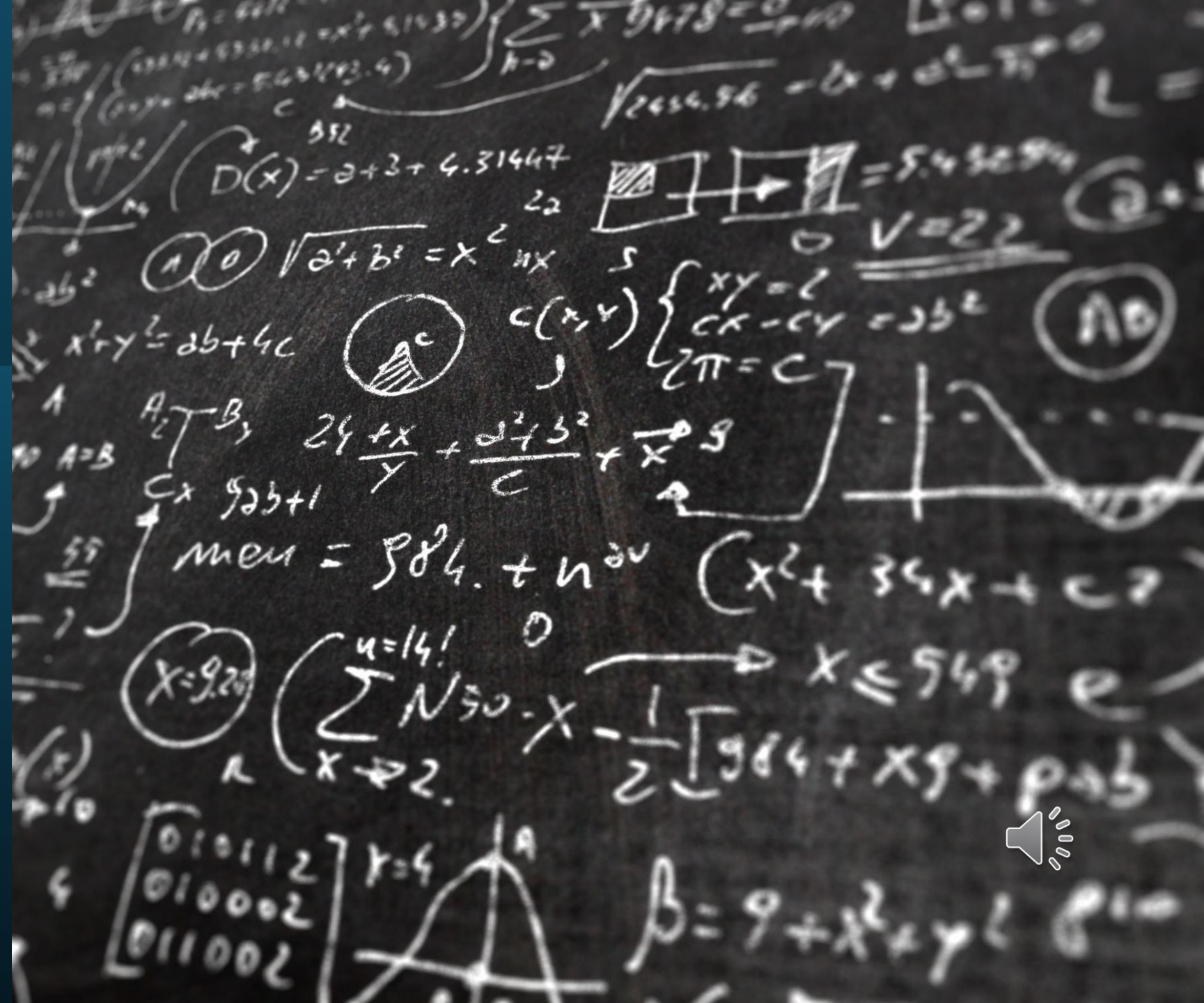# Introduction to superposition state

What is superposition state

A qubit in superposition is written as:

$$|\psi\rangle = \alpha|0\rangle + \beta|1\rangle$$

where:

- ✅ α and β are probability amplitudes (**complex numbers**).
- ✅ The total probability is **always 1**:

$$|\alpha|^2 + |\beta|^2 = 1$$

Example:

A qubit in an equal superposition (like a fair coin flip):

$$|\psi\rangle = \frac{1}{\sqrt{2}}(|0\rangle + |1\rangle)$$

This means:

- **50% chance** of measuring $|0\rangle$
- **50% chance** of measuring $|1\rangle$

Mathematical representation

Visualizing Superposition (Bloch Sphere Representation)

- **Example: Hadamard Gate (H) Creates Superposition**

$$|0\rangle - [H] - \rightarrow (|0\rangle + |1\rangle) / \sqrt{2}$$
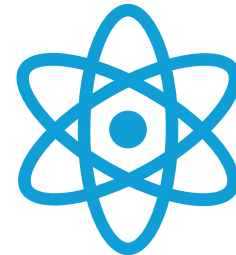
Real-World Analogy: The Spinning Coin

Key Takeaways

Superposition

Measurement collapses

Quantum algorithms