

Quantum Measurement

Zeno Effect

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Modeling Quantum Hardware: open dynamics and control
Universität Konstanz

No phenomenon is a real phenomenon until it is an observed phenomenon.

– John Archibald Wheeler 1970

Historical Note

1900 Plank & Einstein: Blackbody Radiation

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1920 Bohr, Heisenberg: Copenhagen interpretation

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Experimental Interest

Projective Measurement

Measurement Operator $\hat{M} = \sum m|m\rangle$ on ψ :

$$p(m) = |\langle m|\psi\rangle|^2$$

$$\psi \xrightarrow{\text{Measuring } m} |m\rangle$$

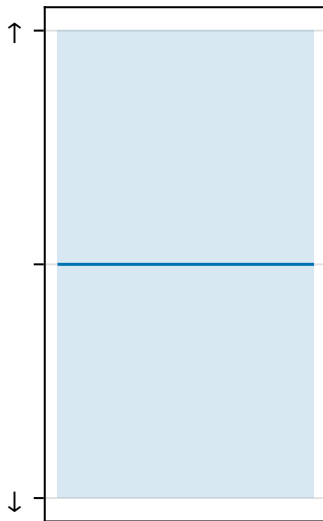
Neglecting Normalization and Degeneracy: POVM Measurement

Qubit Example

$$H = \sigma_z$$

$$|\psi\rangle \propto |\uparrow\rangle + |\downarrow\rangle$$

⇒ Superposition is stable



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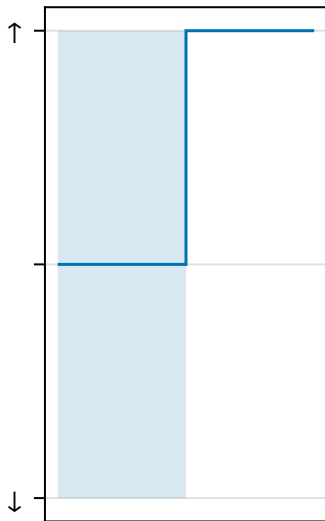
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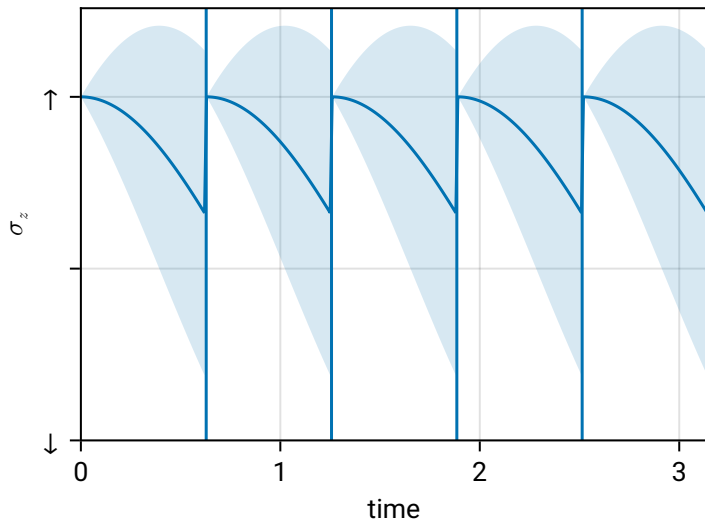
\Rightarrow Superposition is stable

$$M = \sigma_z$$

$$\Rightarrow p(\uparrow) = p(\downarrow)$$



Discrete Zeno



Weak Measurement

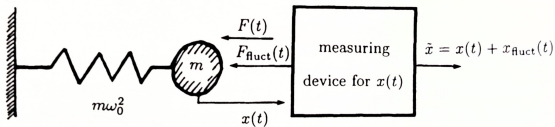
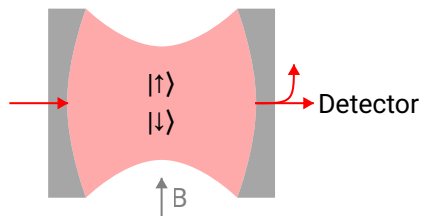


Fig. 8.4 Detection of a classical force by monitoring the coordinate of an oscillator on which it acts.

Rabi Oscillations Setup



$$H = g (a^\dagger a)(\sigma^+ \sigma^-)$$

$$+ g_s (\sigma^+ + \sigma^-)$$

$$- i\beta(a^\dagger - a)$$

$$J = \kappa a$$

$$C = \sqrt{\kappa\eta} a$$

Coupling

Magnetic

Optic

Dissipation

Measurement

Time evolution

