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DEPARTMENT OF ENGINEERING
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On the Design of Quantum Communication Systems with non-Gaussian States

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Chapter 1

Quantum Mechanics Abstract

In this chapter, a bief overview of quantum mechanics postulates and of the notation used in this thesis is given. The target of that is to explain to the reader the essential concept [...]

1.1 Postulates

Like every phisics theory, quantum mechanics is builded from few essential postulates. In this section are briefly introduced the six Dirac-Von Newman postulates of Quantum Mechanics.

1.1.1 First Postulate

Postulate 1 (State Representation) *The state of an isolated quantum system is represented by a complex unitary vector in an Hilbert space:*

$$|\psi\rangle \in \mathcal{H}$$

The space of possible states of the system is called state space and is a separable complex Hilbert space.

Observation *Differently to the classical physics, in quantum mechanics the concept of state of system is introduced. In classical mechanics a system is described by his observables, like position or four-wheeled.*

1.1.2 Second Postulate

Postulate 2 (Observables) *Every observables of the system is represented by an Hermitian operator acting on the state space:*

$$\mathcal{M} : \mathcal{H} \to \mathcal{H}$$

The outcomes of the measurement can only be one of the eigenvalue of the operator $\mathcal{M}$.

Observation *The possible outcomes of the measurement are real number because $\mathcal{M}$ is self-andjoint.*

1.1.3 Third Postulate

Postulate 3 (Born's Rule) *The probability to get the measurement λ_i from the observable $\mathcal{M}$ in the system in state $|\psi\rangle$ is:*

$$\mathbb{P}(\lambda_i) = \langle\psi|\lambda_i\rangle \langle\lambda_i|\psi\rangle$$

where $\langle\psi|$ is the correspondent vector of $|\psi\rangle$ in the dual space of $\mathcal{H}$ and $|\lambda_i\rangle$ is the eigenvector correspontent to the eigenvalue λ_i.
Equivalently, it is possible to write:

$$\mathbb{P}(\lambda_i) = \langle\psi| \mathcal{P}_{\rangle} |\psi\rangle$$

where $\mathcal{P}_{\rangle}$ is the projection operator corresponding to λ_i.

1.1.4 Fourth Postulate

Postulate 4 (Wavefunction Collapse)