Chapter 8

INFORMATION

INTRODUCTION

The development and the understanding of the basic concepts, methods and results of quantum information theory and of the faithful transmission of quantum information in time and space is the most fundamental problem of quantum information processing. In order to be able to understand and to utilize fully the information processing available in nature, the concepts of classical information theory need to be expanded to accumulate quantum information carriers. Three central problems concerning quantum information and its communication are dealt with, very briefly, in this chapter.

1. **Quantum information theory.** How to rebuild classical information theory on quantum foundations. How to define fundamental concepts of quantum information theory. How to identify and explore the inherently quantum elements of such a theory.
2. **Quantum transmissions theory.** How to use optimally quantum channels to send classical information and how to use optimally quantum and classical channels to transmit quantum information. How to define and determine the capacity of different quantum channels.
3. **Quantum entanglement theory.** How to quantify and manipulate entanglement and how to produce good entanglement.

LEARNING OBJECTIVES

The aim of the chapter is to learn:

1. the basic concepts of quantum information theory;
2. the basic concepts of quantum transmission;
3. the basic techniques of quantum data compression;
4. the basic techniques of communication through a noisy channel;
5. the basic modes and measures of entanglement;
6. the basic quantum entanglement concentration and purification techniques.