# CHAPTER OVERVIEW

## 9: Waves

In physics a wave is a disturbance or oscillation that travels through space accompanied by a transfer of energy, and may be propagated with little or no net motion of the medium involved. In this section we will consider mechanical waves, in which the particles in a material are oscillating. Examples are the waves in the sea, the wave in the crowd at a stadium, and sound. Later on we will encounter electromagnetic waves in which electric and magnetic fields are oscillating, and which can travel through vacuum. Examples are light and radio signals. In quantum mechanics, we will also encounter what are sometimes referred to as *matter waves*, where fundamental objects that we usually think of as particles, such as electrons and protons, can also be considered as waves. Finally, recently *gravitational waves* were discovered, which are vibrations of space time itself.

By observing a particle, we know in which direction it moves at any given time. However, as I just stated,the particles in a mechanical wave have no, or almost no, net motion as the wave passes. The wave does have a well-defined direction though: the direction in which energy is transferred. Some waves spread out uniformly, such as a sound wave emanating from a point source. Others are restricted in their motion by the properties of the material they travel in, such as a wave in a string, or by boundary conditions, such as the end of that string. For waves that move (predominantly) in one direction, we can distinguish two fundamental types, illustrated in Figure 9.1.1. The first type is the case that the particles oscillate in the same direction as the wave is moving (Figure 9.1.1a), which we call a *longitudinal wave*; sound is an example. The second case is that the particles oscillate in a direction perpendicular to the wave motion, which we call a *transverse wave* (Figure 9.1.1b), of which the waves in a pond are an example.



Thumbnail: Surfer at Mavericks, one of the world's premier big wave surfing locations. (Surfer: Andrew Davis). (CC SA-BY 2.0; Shalom Jacobovitz).