they characterize signal strength over large T–R separation distances (several hundreds or thousands of meters). On the other hand, propagation models that characterize the rapid fluctuations of the received signal strength over very short travel distances (a few wavelengths) or short time durations (on the order of seconds) are called *small-scale* or *fading* models.

As a mobile moves over very small distances, the instantaneous received signal strength may fluctuate rapidly giving rise to small-scale fading. The reason for this is that the received signal is a sum of many contributions coming from different directions, as described in Chapter 5. Since the phases are random, the sum of the contributions varies widely; for example, obeys a Rayleigh fading distribution. In small-scale fading, the received signal power may vary by as much as three or four orders of magnitude (30 or 40 dB) when the receiver is moved by only a fraction of a wavelength. As the mobile moves away from the transmitter over much larger distances, the local average received signal will gradually decrease, and it is this local average signal level that is predicted by large-scale propagation models. Typically, the local average received power is computed by averaging signal measurements over a measurement track of 5 λ to 40 λ. For cellular and PCS frequencies in the 1 GHz to 2 GHz band, this corresponds to measuring the local average received power over movements of 1 m to 10 m.

Figure 4.1 illustrates small-scale fading and the more gradual large-scale variations for an indoor radio communication system. Notice in the figure that the signal fades rapidly (small-scale fading) as the receiver moves, but the local average signal changes much more gradually with distance. This chapter covers large-scale propagation and presents a number of common methods used to predict received power in mobile communication systems. Chapter 5 treats small-scale fading models and describes methods to measure and model multipath in the mobile radio environment.

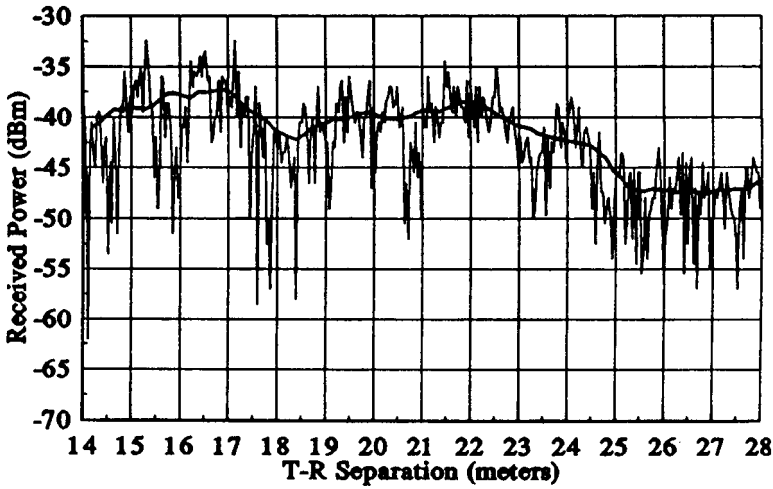

Figure 4.1 Small-scale and large-scale fading.