2 Pendulums somewhat simple

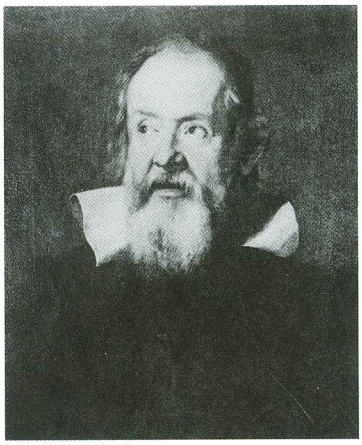

Fig. 2.1
Portrait of Galileo. ©Bettmann/Corbis/ Magma.

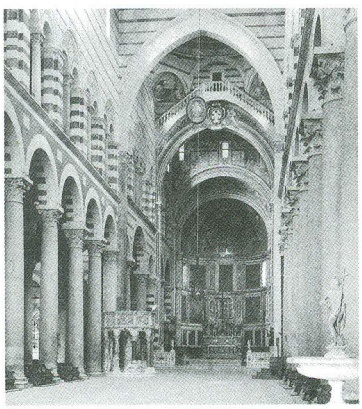

Fig. 2.2
Cathedral at Pisa. The thin vertical wire indicates a hanging chandelier.

There are many kinds of pendulums. In this chapter, however, we introduce a simplified model; the small amplitude, linearized pendulum. For the present, we ignore friction and in doing so obviate the need for energizing the pendulum through some forcing mechanism. Our initial discussion will therefore assume that the pendulum's swing is relatively small; and this approximation allows us to linearize the equations and readily determine the motion through solution of simplified model equations. We begin with a little history.

2.1 The beginning

Probably no one knows when pendulums first impinged upon the human consciousness. Undoubtedly they were objects of interest and decoration after humankind learnt to attend routinely to more basic needs. We often associate the first scientific observations of the pendulum with Galileo Galilei (1554–1642; Fig. 2.1).

According to the usual story (perhaps apocryphal), Galileo, in the cathedral at Pisa, Fig. 2.2 observed a lamplighter push one of the swaying pendular chandeliers. His earliest biographer Viviani suggests that Galileo then timed the swings with his pulse and concluded that, even as the amplitude of the swings diminished, the time of each swing was constant. This is the origin of Galileo's apparent discovery of the approximate isochronism of the pendulum's motion. According to Viviani these observations were made in 1583, but the Galileo scholar Stillman Drake (Drake 1978) tells us that guides at the cathedral refer visitors to a certain lamp which they describe as "Galileo's lamp," a lamp that was not actually installed until late in 1587. However, there were undoubtedly earlier swaying lamps. Drake surmises that Galileo actually came to the insight about isochronism in connection with his father's musical instruments and then later, perhaps 1588, associated isochronism with his earlier pendulum observations in the cathedral. However, Galileo did make systematic observations of pendulums in 1602. These observations confirmed only approximately his earlier conclusion of isochronism of swings of differing amplitude. Erlichson (1999) has argued that, despite the nontrivial empirical evidence to the contrary, Galileo clung to his earlier conclusion,