Rotating Frames of Reference

From a viewpoint on the ground, motion seems relatively simple. Things at rest remain at rest (if they are on the ground), and a bowling ball can roll straight down the lane with almost constant speed. So except for gravity, which accelerates vertically everything that isn't resting on the ground, objects here seem to obey Newton's first law. If an observer sees Newton's first law of motion hold (in *every* direction), the observer is in an **inertial frame of reference.**

From the platform of a moving carousel at the fair, however, the world at large looks a lot different. The horizon just beyond the riders seems to whirl around. Children hold on, convinced by the feelings in the pits of their stomachs that if they let go they'll be flung outward into that crazy, spinning world. Motion taking place on a rotating platform such as this doesn't look as simple either. Should someone at the middle of the carousel drop a coin or roll something in the direction of someone on the outer edge, it won't behave on that moving platform according to Newton's first law. That is because the person on a moving carousel is *not* in an inertial frame of reference and does not see the world around from the same perspective. That person sees the surroundings from a *rotating* frame of reference. In other words, as the riders circle, they themselves are accelerated *over the ground.* Therefore, to the observer in a rotating frame of reference, something that moves in a straight line *as seen from the ground* seems to accelerate, changing speed and direction, all because of the observer's own acceleration. To put this another way, a rotating frame of reference is not an inertial frame of reference but an **accelerated** frame of reference.

We will investigate the curious motions seen and felt in rotating frames of reference because the ground, indeed all the surface of earth, is actually a rotating frame of reference. Earth's rotation is slow, so the effects on local motions (such as for bowling balls) aren't great, but a few are striking.

Motion in a Rotating Frame of Reference

Suppose two friends experimented with motion on a smooth-topped carousel, rotating with constant angular speed, as in Figs. 8–15 and 8–16. The fellow on board could release a marble, and Fig. 8–15 shows what his friend on the ground would see. The black dots show a strobelike path for the marble, seen by the observer on the ground as moving in a straight line with constant speed—the speed it had as it was released because of his friend's motion.