3.1. Variations on “The Only Mystery”

Strangeness is a relative thing. With varying degrees of sophistication, I have been thinking about physics for more than forty years now, and this has no doubt both strongly and subtly influenced how the world presents itself to my eyes. There are laws and principles as familiar to me as the names of my children; most people are unaware of them and would not believe them even if informed.

As I leave my office, I ball up one last piece of scrap paper and toss it into the recycling box. The paper follows a smooth parabolic arc as it lands. Were I to toss a rubber ball or a steel ball bearing in exactly the same way, I know that (barring air resistance) it would follow the same path in the same time. All objects, irrespective of mass, chemical composition, or any other physical property, fall at the same acceleration at the same location on the surface of the Earth. Galileo allegedly demonstrated this some four centuries ago. Yet, surveys of science “literacy” show that much of the American and British public readily subscribe to the Aristotelian notion that heavy objects intrinsically fall faster than light ones.

It is dark out when I reach my car to start for home. The Moon lies suspended above one of the campus sports fields like an enormous orange. I know, however, that it is falling toward the Earth with an acceleration roughly 1/3600 that of the wadded paper I tossed some moments earlier. I have no fear of being crushed for, although it is falling, the Moon will never reach the Earth—not in my lifetime at least, if at all. An inward radial attraction, in fact, is what makes the Moon go around the Earth in a circular orbit. Again, most people would find that thought strange. Like René Descartes, they imagine some force pushing the Moon tangentially around its orbit.

Upon reaching home, I apply the brakes and my car stops. If I did not apply the brakes, the car would eventually stop anyway (although not in a convenient location) because of friction. Excluding friction (and
eventual obstacles), however, I know that the car would continue to move forward at a constant speed forever. "Move forward by itself forever?," I can hear one of my nonphysicist friends protest; "Impossible! You have to push or pull an object to keep it moving." Yet, even now, the Voyager probes, long since detached from the rockets that launched them, continue to penetrate unimpeded the void of interstellar space.

The various consequences of the laws of gravity and motion addressed above are in some ways strange, but not unimaginably so. They are features of the macroscopic world to which physicists have reconciled themselves and which they can understand in terms visualizable to the mind's eye. Newton, for example, illustrated some three centuries ago in the *Principia* how a sequence of increasingly wide parabolic arcs of a free-falling projectile leads naturally to the circular trajectory of an orbiting satellite. Much later, during the second decade of the 20th century, the mass independence of the law of free fall found its explanation in Einstein's general theory of relativity, which created the imagery of a conjoined space and time (space–time) warped by the presence of matter. The resulting contours of this incorporeal four-dimensional terrain constrain all matter to move along the shortest (actually, the extremal) paths or geodesics.

There is a qualitative difference between the tangible realm of classical physics, to which Newton's and Einstein's laws of motion and gravity belong, and the submicroscopic domain of the elementary particles and their composite structures. The principles governing the latter give rise to strange consequences that, at least to my satisfaction, have never been—and most likely can never be—adequately interpreted in terms of objects or processes drawn from the world of macroscale experiences. The behavior of such systems is unimaginably strange.

"A great physical theory...when it is confirmed, takes on its own impersonal existence in the course of time, becomes completely detached from its originator, and is finally received as self-evident." So wrote the editor of a collection of Erwin Schrödinger's personal correspondence on wave mechanics. Having spent much of my professional life thinking about the intricacies of quantum physics, I am dubious that the theory will ever become self-evident (if, indeed, one can even characterize classical physics that way). Certainly, quantum mechanics is no longer the novelty that it was when its foundations were being laid in the 1920s, and a seemingly endless supply of basic textbooks makes the subject common knowledge throughout the physics community. Nevertheless, familiarity with the fundamentals of quantum mechanics has not, by any means, exhausted the surprises to which these principles still give rise.

The attribute of the quantum world that is responsible in large measure for its strangeness is that the denizens of this world, the ele-