3. Classical Newtonian Physics.
The unreasonable effectiveness of mathematics.
The deterministic, billiard-ball view of existence.

Physics and physicists.

To obtain a perspective on quantum mechanics, it is helpful to understand a little of classical Newtonian physics, which was the dominant paradigm from 1700 to 1900 and beyond. But before we do that, it is useful to explain what physicists do. From the point of view of this discussion, their major goal is to find a **mathematical** description of matter, with the mathematics based on a conceptual model of the nature of the universe.

Why should we expect matter, the physical world, to obey mathematics? We have no idea. But in all 'simple' cases, where we can isolate a small part of the physical world, say a "particle" or a planet, it holds true. Wigner, a Nobel-prize winning mathematical physicist called this the "**unreasonable effectiveness of mathematics**" in describing physical phenomena.

Physics comes in the form of theories which are dreamed up—discovered, invented—by insightful physicists. These are conceptual models of matter which have mathematical equations associated with them. Once a theory is discovered or proposed, its mathematics makes numerical predictions about certain events. The experimentalist devises ways to test those predictions by conducting experiments that give numerical outcomes. If the theory is correct, the numbers its equations give will match the numbers the experimentalist finds.

Also, there is also a very strong inclination in physics towards unification—ideally to try to explain all physical phenomena from a single equation (the Theory Of Everything).

Classical Newtonian physics. Determinism.

The first comprehensive mathematical theory of the physical world was that of Newton (1643-1727), whose main work was done just before 1700. He wanted to explain the motion of objects, particularly planets, moons, and projectiles like cannot balls. There were two experimental facts to be explained. The first was Galileo's experimental observation of falling objects here on earth. And the second was Kepler's observations on the motion of the planets, primarily that planets follow elliptical orbits. Before being able to give a mathematical explanation, Newton had to *invent* calculus. (It is necessary to use calculus in a mathematical description of phenomena where quantities like position and speed change continuously in time.) He then found equations which very accurately described both the motion of the planets around the sun and the flight of cannonballs.

But the equations Newton found were constructed so that they could deal with more than just gravitational forces. In fact, they had such a general form that they could be applied in principle to *any* situation involving matter. The classic example is the motion of billiard balls. Once the billiard balls are set in motion, in Newtonian physics, their subsequent motion is completely determined for all time by the equations of motion.

And so Newton's theory of classical physics corresponded to a conceptual 'billiard-ball' model of the universe. **Matter was to be made up of particles**, and once the particles were set in motion, Newton's equations implied that **their motion was completely determined forever**.

This model has been extremely successful in describing much of the physical world. It can correctly predict everything from the optimal shape of an airplane wing to the strength needed for a beam in a building to the design of a power plant to many of the properties of neurons in the brain. The only place it fails is on a very small scale, where quantum mechanics must be taken into account.

Freedom of choice?

From a philosophical point of view, one major consequence of this classical view is that it has dire (in my opinion) implications for free will, our ability to freely make choices. It says there are no real choices because the atoms in our brain, where we imagine choices are made, follow the *deterministic* equations of Newton. And so even though it *feels* like we have free choice in our actions and thoughts, there is **no freedom of choice** in Newtonian physics.

Because the brain is usually assumed to be an object describable solely by classical mechanics, my neuroscientist friends tell me this "no freedom" point of view seems to be the position held by most neuroscientists. In a way, it's a strange view for them to adopt because it is in direct contradiction to their intellectual competitiveness and pride of achievement. But perhaps one should not expect humans to be particularly rational or consistent in their personal lives.

The views of Descartes (1596-1650), a mathematician, scientist and philosopher, are interesting and influential on the idea of free choice. Cartesian dualism is the idea that the human being consists of a physical body plus a non-physical "soul." This soul, according to Descartes, was able to suspend the deterministic laws of nature and freely direct the physical brain to produce such and such a thought or bodily motion.

I find it disconcerting that the non-physical aspect is—in Descartes' view, which was based on deterministic classical physics—able to suspend for an instant the mathematical laws governing nature. And it is of considerable interest that quantum mechanics is different from classical physics in this respect. Because the perceived future is not set by the mathematics, it is conceivable that one could have freedom of choice (of the perceived, experienced future) in quantum mechanics without interfering with the validity of the mathematical equations. We will come back to this idea in Part V.

Evaluation:

Not all scientists would consider no-free-will to be a downside. I would guess the majority of physicists would say they don't think it likely that quantum mechanics leads to free will. And most would agree it is very unlikely the mathematics is interrupted by the consciousness of the observer.