Free Will, Consciousness, and Soul

Clockwork versus Free Will

A clock's chiming within the Paradise of Dante's *Divine Comedy* (1320) is the first reference to mechanical timepieces in European literature. Pre-Reformation art had placed much of our world within the otherworldly, and the medieval was a clockwork universe set in movement by divine cogs and machinery under the power of the Prime Mover, a concept tracing back before Aristotle as that "which moves without being moved" [353] [Metaphysics XII.7]. The technology of each era is often taken as a metaphor for understanding the world, Figure 5.19.

Figure 5.19: Fragment of the Antikythera Mechanism (1 BCE, Greece), an early astronomical clockwork device for computing the positions of the sun and moon.

A clock, though created by humans, ticks along predictably, seemingly with determination. But what of the world we see around us? Some aspects of determinism seem to have been expressed by the Greek atomists Leucippus and Democritus as early as the 5th century BCE. The atomists consider a world order forming when some of the infinite mass of randomly churning atoms forms a circular eddy or swirl, interpreted in some readings as initially forming by chance. The atomists' universe within the swirl appears to be deterministic and purposeless, although this view relies on a single fragment of Leucippus [505, p. 185],

> *Nothing happens at random, but everything from reason and by necessity.*

The first part of the fragment ("nothing happens at random, but everything from reason") asserts the Principle of Sufficient Reason, later associated with Leibniz, while the second part ("and by necessity") makes a stronger causal claim that whatever happens has to happen.

Notions along these lines continued with the Stoics in the 3rd century BCE that include the first recorded disputes over free will and determinism. Epicurus, motivated by the need to reconcile the existence of human free will, included the possibility of objective chance by allowing interruptions without cause into the deterministic motion of atoms by allowing *swerves* in their motion which later became known through Lucretius' *On the Nature of Things* [506]. For example, an atom's falling vertically downward could also include a slight swerve to one side. Such indeterminacies would then make their way up to our macroscopic observable world. The recognition of pure chance also in the initial formation of the swirl by Democritus and the Stoics has been attributed to an ignorance of their causes and not a denial that they have causes [505, p. 187]. Thus, departures from deterministic behavior may have been considered by the Greeks as similar to the origin of classical statistical mechanical properties in the 19th century or the hidden variables sometimes later invoked to account for quantum nondeterminism. Aristotle however rejected the two major concepts of Democritus: atomism and determinism. He asserted that there are both animate and inanimate objects. The animate objects generally behave non-deterministically. Had Aristotle been alive to see the developments in quantum mechanics, he may have argued that Schrödinger's wave equation would not be by itself sufficient to describe the universe as there is no chance inherent in unitary evolution [353],

> *Further, no one could say why a thing once set in motion should stop anywhere; for why should it stop here rather than here? So that a thing will either be at rest or must be moved ad infinitum, unless something more powerful gets in its way.* [Physics IV.8]

> *Chance and what results from chance are appropriate to agents that are capable of good fortune and of action generally. Therefore necessarily chance is in the sphere of actions…Hence what is not capable of action cannot do anything by chance. Thus an inanimate thing or a beast or a child cannot do anything by chance …The spontaneous on the other hand is found both in the lower beasts and in many inanimate objects.* [Physics II.6]

> *But it is a wrong assumption to suppose universally … in virtue of the fact that something always is so or always happens so. Thus Democritus reduces the causes that explain nature to the fact that things happened in the past in the same way as they happen now: but he does not think fit to seek for a first principle to explain this "always": so, while his theory is right in so far as it is applied to*

> *certain individual cases, he is wrong in making it of universal application.* [Physics VIII.1]

However, the nature of probabilities in classical theory is quite different than those in quantum theory as emphasized by Born in his 1926 paper that first introduced probabilities into quantum mechanics: “The classical theory introduces the microscopic coordinates which determine the individual processes only to eliminate them because of ignorance by averaging over their values; whereas the new theory gets the same results without introducing them at all.” [6] The intrinsic nondeterminism of the quantum succeeded the world of the deterministic clockwork but not before determinism reigned in the Newtonian worldview. These two types of randomness, *epistemic* randomness due to lack of complete knowledge of the state of the system and *ontic* randomness that is intrinsic even with complete knowledge of the state of the system, are the paradigms that would continue to compete for their roles within physical theory up to the present day [507]. Currently, the most stringent tests for the intrinsic randomness of quantum mechanics are from measurements showing violations of Bell inequalities, and a central ingredient in that conclusion is that the measurement settings could be freely chosen, at least to some degree [508].