On the origin of universes

The Darwinian theory of evolution through natural selection is increasingly being applied to fields far from biology. In cosmology, theorists are refining the mind-boggling idea that the laws of physics have been fine-tuned by an evolutionary process in which universes produce daughter universes via the formation of black holes.

The eminent physicist Lee Smolin, who first proposed the theory of "cosmological natural selection" 20 years ago, returns to the idea in his new book out next week. At the same time, two Oxford University academics, Andy Gardner and Joseph Conlon, have published research showing that the mathematics of evolutionary biology really can describe the evolution of universes.

At the heart of the theory is the idea that we live in a "multiverse" containing an extremely large number of universes, each with slightly different laws of nature. New universes are born inside black holes. These regions of space-time are so dense that, according to conventional physics, nothing can escape their clutches; but some cosmologists believe they may spawn new universes inaccessible to their mother universe.

The physical constants vary slightly and randomly each time a new universe appears—a process akin to the asexual reproduction of organisms that gives rise to slightly different characteristics through genetic mutations. In each case natural selection favours the universes/organisms that produce the largest number of offspring that then reproduce themselves.

What makes cosmological natural selection such a fascinating theory is that black holes are most likely to appear in a universe containing galaxies, stars, planets and a wide range of chemical elements—the features favouring life.

Therefore the theory helps to explain a great cosmological mystery: why the underlying laws of the universe are so precisely tuned to provide the conditions that have led to life on Earth (and almost certainly elsewhere too).

According to multiverse theory, in a vast multitude of universes, all with different characteristics, some are bound to have values capable of generating life—and of course we live on one of those. Cosmological natural selection takes this a stage further by showing how evolution could drive the process by making universes more capable of forming black holes and, as a consequence, more hospitable to life.

Since Smolin, now at the Perimeter Institute in Ontario, first proposed the theory, evidence has grown that the universe is riddled with black holes—at least a billion billion of them, he estimates.

"This idea of cosmological natural selection is controversial and physicists have pointed out all sorts of problems with it," says Gardner, an evolutionary biologist. "But we were interested in seeing if its basic evolutionary logic actually works."

In a paper in the journal Complexity, Gardner and Conlon, a theoretical physicist, confirm that the mathematical tools of biological evolution—and, in particular, a key theorem in genetics called Price's equation—would in principle allow cosmological natural selection to "design" the universe for the purpose of producing black holes.

"Time Reborn—From the Crisis of Physics to the Future of the Universe", by Lee Smolin, Allen Lane, £30.