Effective Field Theories and the nature of the universe

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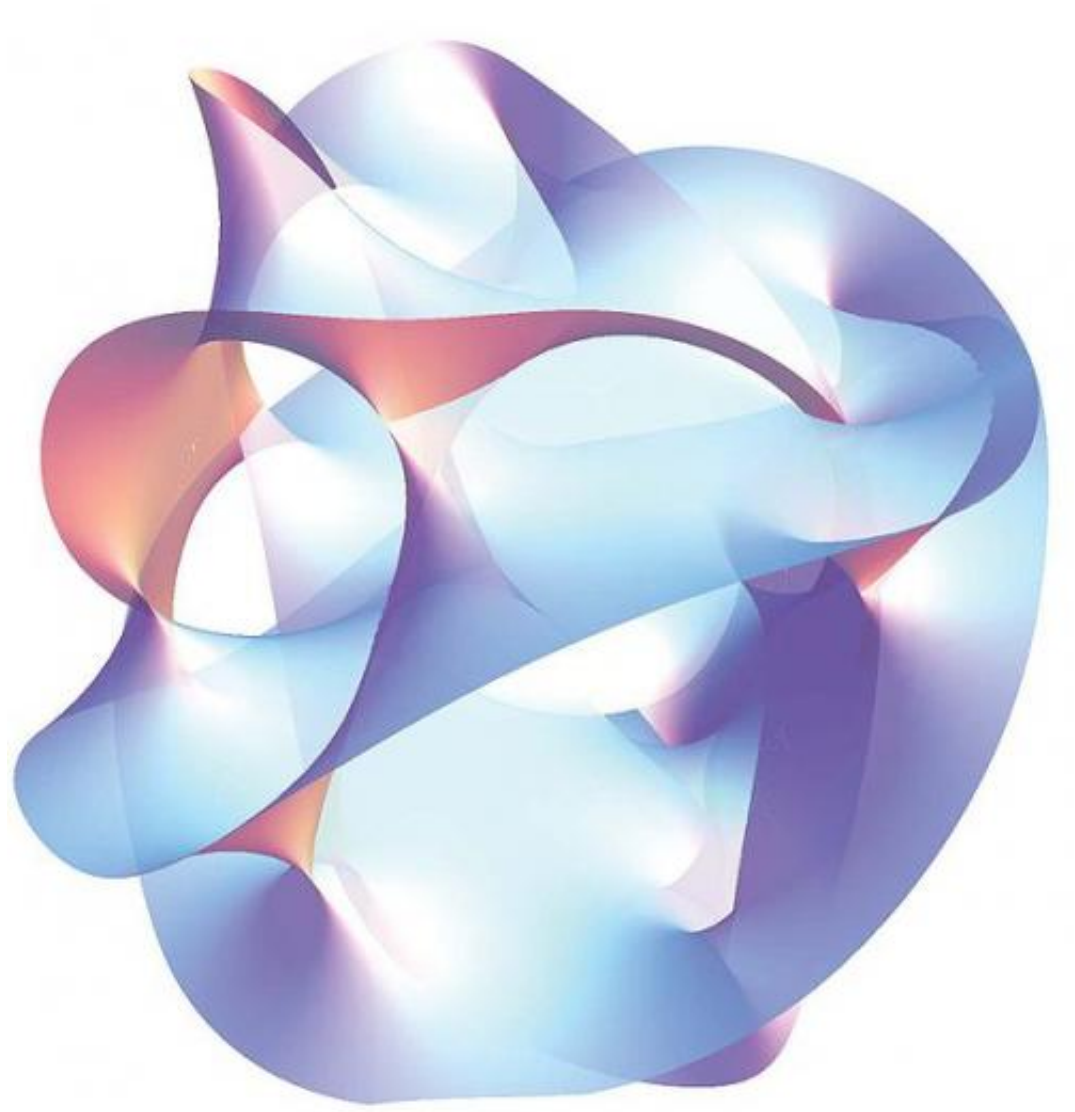

This is an image of a two-dimensional hypersurface of the quintic Calabi-Yau three-fold. Credit: Jbourjai/Wikipedia.

What is the world made of? This question, which goes back millennia, was revisited by theoretical physicist Steven Weinberg from the University of Texas in Austin, TX, USA in the first of an international seminar series, 'All Things EFT.' Weinberg's seminar has now been published as an article in the journal *EPJ H*.

And Weinberg is well placed to discuss both Effective Field Theories (EFTs) and the nature of the Universe, as he shared the 1979 Nobel Prize for Physics for developing a theory to unify the weak and electromagnetic interactions between elementary particles. This fed into the development of the widely used Standard Model of particle physics that unifies these two forces with the strong interaction.

The introduction to the article describes Weinberg as the 'pioneer' of EFTs. In his wide-ranging talk, Weinberg sets out the early history of EFTs from a personal perspective and describes some implications for future research.

Briefly, an EFT is a type of theory or approximation that describes a physical phenomenon at given length or energy scales, while averaging over shorter length or higher energy scales. Weinberg describes how the unifying Standard Model came to be seen as a valid approximation to a more fundamental theory that will likely take over at the highest energies, such as string theory.

He remembers how physicists of 1950s and 1960s had difficulty linking quantum field theory to the strong interaction. Eventually, he and others produced a standardized methodology that could fit observed data at least as well as the rather cumbersome mathematics that was being used. These ideas can be generalized; eventually, he states, "all [physicists'] theories will survive as approximations to a future theory."

As Weinberg explains, the techniques of EFTs apply to diverse areas

including hadronic physics and superconductivity. Weinberg clearly enjoys and values teaching, and his introduction to this key concept of particle physics in this first lecture is both engaging and enlightening.

More information: Steven Weinberg, On the development of effective field theory, *The European Physical Journal H* (2021). DOI: 10.1140/epjh/s13129-021-00004-x

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