Can scientists know that they do not know?

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Imagine you knew everything about the current universe – the state of every single particle – and all the laws governing the universe's evolution. Endowed with such knowledge, you could then predict the future, right? French mathematician Pierre-Simon Laplace thought so.

Not so, according to an analysis by SFI Professor David Wolpert – not even for the non-chaotic, non-quantum-mechanical universe that Laplace assumed.

This unknowability, says Wolpert, is the true nature of reality. With the help of a grant from the Foundational Questions Institute, an organization that funds research on physics, cosmology, and the underpinnings of reality, he hopes to extend his ideas from the realm of theory to allow them to be validated experimentally.

To understand Wolpert's claim, start with a philosophy classic: "this sentence is not true." If that's true, then it's false. If it's false, then it's true. Whether it's true is a question without an answer: a mathematical chicken-or-egg problem. Early last century, Alan Turing showed that such unanswerable questions are inevitable in any sufficiently powerful computer.

Wolpert says he's always been dissatisfied with attempts to use Turing's result to analyze the universe – to do so requires an assumption that the elaborate structure Turing created is the foundation for the laws of the universe. Instead Wolpert uses mathematical analysis of what it means for an experimental apparatus to observe a physical system in his effort

to understand how a scientist can accurately know something about the external universe, whether by observing the universe's present, predicting its future, or remembering its past.

Wolpert's approach requires no assumptions about the laws of the universe. But it leads to an even wilder conclusion than Turing's: simply for there to be a physical reality that contains scientists observing, predicting, and recollecting, there must be unanswerable questions.

He has already used the approach to derive results with tantalizing connections to the uncertainty principle of quantum mechanics. He says he plans to investigate other possible connections.

"It would be drop-dead totally cool if the laws of quantum mechanics popped out," he says, though he concedes that's a long shot. At a minimum, he expects the work to further our understanding of the fundamental limitations on what we can know about physical reality.

Provided by Santa Fe Institute

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