Quantum mechanics makes no sense without the mind

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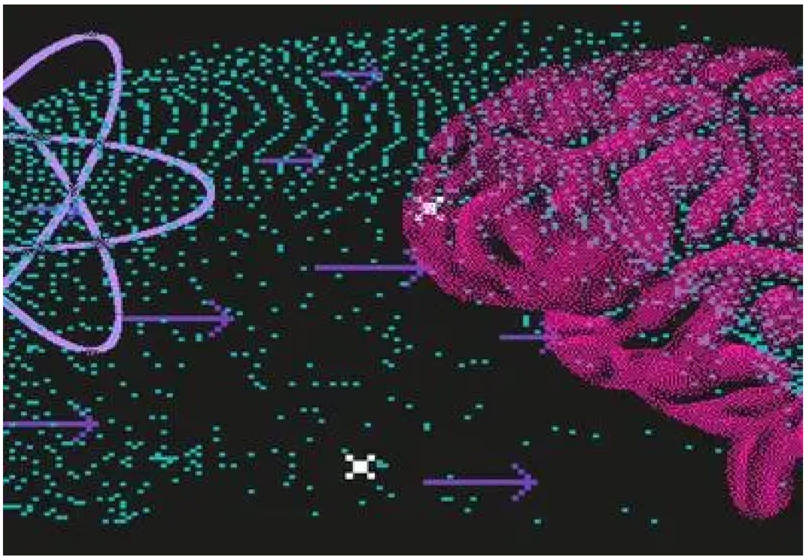
Since the early days of quantum mechanics, physicists and philosophers argued that resolving the measurement problem requires an appeal to the minds of conscious observers. That is still the case today, argues Shan Gao.

Quantum mechanics is a very successful physical theory due to its accurate empirical predictions. But a key puzzle remains at its core: the measurement problem. There seems to be a conflict between what Schrödinger's equation tells us, namely that a system described by the wave function can be in a state of superposition, instantiating apparently conflicting properties, and what experience tells us, namely that when we take a measurement of such a system, we get one, definite result, not a superposition. To use Schrödinger's thought experiment, quantum mechanics would seem to imply that a cat can be both alive and dead at the same time, but we only ever experience cats that are either alive or dead.

There are a number of proposed solutions to the measurement problem, including what has come to be known as the hidden variables theory, which suggests that the wavefunction isn't a full description of a system and does away with states of superposition, and the many-worlds interpretation, that suggests the superpositions are expressed across different universes, each with one definite result. But ever since the early days of quantum mechanics, physicists and philosophers have argued that the human mind is needed to resolve the measurement problem. In order to understand why that's still the case, we need to look at the measurement problem and the proposed solutions more closely.



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Formalizing the measurement problem

In 1995, Tim Maudlin gave a precise formulation of the measurement problem. According to this formulation, the measurement problem originates from the incompatibility of the following three claims:

(C1) The wave function of a physical system is a complete description of the system;

(C2) the wave function always evolves in accord with a linear dynamical equation, such as the Schrödinger equation;

(C3) a measurement yields a single definite result.