



Press Release

AI develops easily understandable solutions for unusual experiments in quantum physics

Researchers once struggled to understand unconventional solutions developed by artificial intelligence – a new approach at the University of Tübingen leads to faster and better understanding

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Researchers at the University of Tübingen, working with an international team, have developed an artificial intelligence that designs entirely new, sometimes unusual, experiments in quantum physics and presents them in a way that is easily understandable for researchers. This includes experimental setups that humans might never have considered. The new AI doesn't just create a single design proposal; instead, it writes computer code that generates a whole series of physical experiments, that is, groups of experiments with similar outputs. The study has been published in the journal *Nature Machine Intelligence*.

The newly developed AI uses a programming language that researchers can easily understand. This allows them to figure out the underlying idea behind the AI's processes much more easily than before. "AI systems usually deliver their solutions without explaining how they work," says Mario Krenn, Professor of Machine Learning in Science at the University of Tübingen and senior author of the study. "We scientists have to try to understand the solutions afterward. This often took us days or weeks – if we understood them at all."

Language models expert in quantum physics

"For our study, we trained a language model that functions a bit like ChatGPT," says Sören Arlt, a doctoral student in Krenn's research group and first author of the study. "Our language model is an expert at writing computer code for quantum physics, specifically in the Python programming language." This code works like a general recipe: when executed, it designs experimental setups for many similar cases and also for more complex versions of the same task. Because Python is easily readable and understandable for humans, researchers can review the code and see which structures are repeated and which constraints are important.

This makes the underlying idea behind the AI's solution process visible to them.

Quantum physics makes it possible to develop entirely new technologies, including quantum computers, that can solve certain problems much faster than ordinary computers. For example, they could calculate the properties of molecules much faster, which is helpful for drug development. Experiments are needed for a better understanding of the effects of quantum physics. Researchers deliberately create quantum particles, such as electrons, atoms, or photons, put them into precisely controlled states, and measure their behavior to visualize effects such as superposition, the overlapping of possible quantum states.

AI can run through more combinations than humans can

Experimental setups in quantum physics are highly complex, and there are countless ways to combine the many different variables of an experiment. Humans can only grasp a fraction of these. AI, on the other hand, can investigate significantly more combinations for an experimental setup than humans. "AI systems are increasingly finding more sophisticated and unorthodox solutions that we humans might never have tried," says Krenn. In some cases, it is expected that the machine-designed experiments will outperform current designs. This could lead to new insights in physics.

"Our work shows one way to make the unorthodox solutions of AI in physics easier to interpret," says Krenn. "Instead of just delivering strong individual solutions, the system is encouraged to express what it has learned in the form of reusable rules – which researchers can then examine, understand, and apply to new problems." The methodology can also be transferred to other fields, such as materials science and engineering.

Professor Dr. Karla Pollmann, University of Tübingen president, says: "This new approach will allow researchers worldwide to more quickly understand the results of AI and accelerate new developments. This is an example of how we can shape future technologies together, instead of just observing them."

Publication:

Sören Arlt, Haonan Duan, Felix Li, Sang Michael Xie, Yuhuai Wu, Mario Krenn: Meta-designing quantum experiments with language models, *Nature Machine Intelligence* (2026), <https://doi.org/10.1038/s42256-025-01153-0>

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