Don't have all the information? In the quantum world, that doesn't matter

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(PhysOrg.com) -- When it comes to the rules of the quantum world, it seems that almost everything goes against intuition. In the case of the way ignorance of the whole implies ignorance of at least one of its parts, the situation seems to be counterintuitive. "When viewed in a classical sense, you would be inclined to think that a strong ignorance of the whole has to be accompanied by significant ignorance of at least one of its parts," Stephanie Wehner tells *PhysOrg.com*. "However, this conjecture turns out to be false in quantum theory."

Wehner is a scientist at the National University of Singapore. She worked with Thomas Vidick at the University of California at Berkeley to examine the role of ignorance in quantum theory. Their work can be read in Physical Review Letters: “Does Ignorance of the Whole Imply Ignorance of the Parts? Large Violations of Noncontextuality in Quantum Theory.”

“Originally, we were motivated to study this problem from a cryptographic perspective,” Wehner explains. “However, we soon found that our exploration had implications for understanding the fundamentals of how quantum states work.”

Wehner and Vidick set out to see about exposing ignorance in cases of quantum communication. “Our problem can most easily be described by an example.” Wehner says. “Let’s say that you study a book that has two pages: one and two. You are going to sit an exam in this class, and you only had a small amount of time to study. You don’t know everything

that is on page one and page two. Can I point to a page that you don't know, thereby exposing your ignorance? Classically, this is indeed true: For example, if you only know the information on page one, I can point to page two and expose your ignorance. I can catch you."

Classically, this scenario makes sense. Ignorance of the whole does imply ignorance about at least one of the parts. However, in the quantum world, it doesn't work this way. "Quantumly, there is no way for me to expose your ignorance in this way. If I challenge you, you can guess the information – even if you don't know it all – almost perfectly. It's very counterintuitive."

Wehner points out that the result has some strong implications for our understanding of the quantum world. "We haven't really fully explored this effect yet. There are many weird quantum effects we still know little about, but this one is particularly intriguing as it deals with the basic question of how knowledge itself behaves in a quantum world."

She goes on to point out that this research says something about fundamental differences in classical versus quantum knowledge. "It really makes a difference if the memory you have is classical or quantum. We are merely at the beginning of understanding these differences."

Wehner says that she is planning to look more closely at the structure of quantum states. "Our example demonstrates that this effect can be rather dramatic. But does it always have to be this way? And, how do we tell?"

Additionally, Wehner would like to be able to design an experiment that would show this effect, since she and Vidick approached it theoretically. "In the end," she admits, "our paper probably raises more questions than it answers. But it offers a good place to start, and a good beginning towards a deeper understanding of what distinguishes quantum from

classical knowledge."

More information: Thomas Vidick and Stephanie Wehner, "Does Ignorance of the Whole Imply Ignorance of the Parts? Large Violations of Noncontextuality in Quantum Theory," *Physical Review Letters* (2011). Available online: link.aps.org/doi/10.1103/PhysRevLett.107.030402

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