Quantum information can be negative

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Even the most ignorant cannot know less than nothing. After all, negative knowledge makes no sense. But, although this may be true in the everyday world we are accustomed to, it has been discovered that negative knowledge does exist in the quantum world. Small objects such as atoms, molecules and electrons behave radically different than larger objects -- they obey the laws of quantum mechanics.

The discovery, that quantum knowledge can be negative was made by three researchers, Drs Michal Horodecki, Jonathan Oppenheim and Andreas Winter, of the Universities of Gdansk, Cambridge and Bristol. Their work was published in the leading scientific journal Nature on August 4.

What could negative knowledge possibly mean? "If I tell it to you, you will know less," explained Dr Andreas Winter.

Such strange situations can occur because what it means to know something is very different in the quantum world. "In the quantum world, we can know too much," added Dr Oppenheim, "and it is in these situations where one finds negative knowledge." Negative knowledge (or more precisely – 'negative information') turns out to be precisely the right amount to cancel the fact that we know too much.

In the quantum world, there are things we just cannot know, no matter how clever we are. For example, we cannot know both the position and momentum of a small particle exactly. One can also have situations where someone knows more than everything. This is known as quantum 'entanglement', and when two people share entanglement, there can be negative information.

While all this might appear to be very mysterious,Dr Michal Horodecki is quick to point out that the idea of negative information can be put on a rigorous scientific footing. "We can quantify information in terms of how much stuff I need to send you before you get to know something. In the case of negative quantum information, you can get to know something without me sending you any quantum particles. In fact, you will gain the potential to learn more quantum information in the future."

Negative information is due to exotic features of quantum information theory, an exciting new area of physics which includes such phenomena as quantum teleportation and quantum computation. Classical information theory deals with subjects such as classical communication and computation. Quantum information on the other hand, replaces classical 'bits' by quantum 'qubits' which are quantum particles like electrons or atoms. While classical bits can only be in the state 0 or 1, qubits can be both in the 0 or 1 state at the same time. By understanding that quantum information can be negative, researchers hope to gain deeper insights into phenomena such as quantum teleportation and computation, as well as the very structure of the quantum world.

Source: University of Cambridge