A hidden twist in the black hole information paradox

February 27 2007

Professor Sam Braunstein, of the University of York's Department of Computer Science, and Dr Arun Pati, of the Institute of Physics, Sainik School, Bhubaneswar, India, have established that quantum information cannot be 'hidden' in conventional ways, or in Braunstein's words, "quantum information can run but it can't hide."

This result gives a surprising new twist to one of the great mysteries about black holes.

Conventional (classical) information can vanish in two ways, either by moving to another place (e.g. across the internet), or by "hiding", such as in a coded message. The famous Vernam cipher devised in 1917 or its relative the one-time pad cryptographic code are examples of such classical information hiding: the information resides neither in the encoded message nor in the secret key pad used to decipher it – but in correlations between the two.

For decades, physicists believed that both these mechanisms were applicable to quantum information as well, but Professor Braunstein and Dr Pati have demonstrated that if quantum information disappears from one place, it must have moved somewhere else.

In a paper published in the latest edition of Physical Review Letters, Braunstein and Pati derive their 'no-hiding theorem' and use it to study black holes which, in Einstein's Theory of Relativity, are characterized as swallowing up anything that comes too close.

In the mid 1970s, Stephen Hawking's showed that black holes eventually evaporate away in a steady stream of featureless radiation containing no information. But if a black hole has completely evaporated, where has the information about it gone? This long standing question is known as the black hole information paradox.

Now, Professor Braunstein and Dr Pati have ruled out the possibility that information might escape from the black hole but be somehow hidden in correlations between the Hawking radiation and the black hole's internal state. Braunstein and Pati's result demonstrates that the black hole information paradox is even more severe than previously believed.

Dr Pati said: "Our result shows that either quantum mechanics or Hawking's analysis must break down, but it does not choose between these two possibilities."

Professor Braunstein said: "The no-hiding theorem provides new insight into the different laws governing classical and quantum information. It shows that there's got to be new physics out there."

"Quantum information cannot be completely hidden in correlations: Implications for the black-hole information paradox" appears in the latest *Physical Review Letters*.

Source: University of York

provided for information purposes only.