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**Conferencias de divulgación científica de la Real Sociedad Española de Física
en colaboración con la Fundación Ramón Areces
Ciclo Hablemos de Física, Facultad de Ciencias Físicas (UCM)**

From the Einstein-Bohr debate to quantum information: a new quantum revolution

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JUEVES 26 enero 2017, 13.00h

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Abstract

In 1935, with co-authors Podolsky and Rosen, Einstein discovered a weird quantum situation, in which particles in a pair are so strongly correlated that Schrödinger called them "entangled". By analyzing that situation, Einstein concluded that the quantum formalism is incomplete. Niels Bohr immediately opposed that conclusion, and the debate lasted until the death of these two giants of physics.

In 1964, John Bell discovered that it is possible to settle the debate experimentally, by testing the now celebrated "Bell's inequalities", and to show directly that the revolutionary concept of entanglement is indeed a reality. A long series of experiments, started in 1972, have produced more and more precise results, in situations closer and closer to the ideal theoretical scheme.

After explaining the debate, and describing some experiments, I will show how this conceptual discussion has prompted the emergence of the new field of quantum information, at the heart of the second quantum revolution.