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From double-slit experiments with single electrons to two-electron entanglement in space-time: A Europe-Asia Physics Project

In a poll of “Physics World” in 2002 among its readers [1] about their opinion on the most beautiful experiment mankind has ever been done, a majority voted for the double-slit experiment with single electrons by Jönsson from 1961 [2]. And indeed, no other experiment shows the ambiguity of our physical world in form of the particle-wave dualism better than this experiment. The variables this dualism is based on are on the one hand the visibility of the interference patterns, what means its contrast, and on the other hand the distinguishability of the two slits through which the electron has passed. These two variables constitute the basis of the entanglement of the particles in ordinary space. Due to technical reasons such an experiment, which corresponds most closely to the suggestion of Einstein, Podolsky and Rosen from 1935 [3], has never been realized. Instead, experiments based on the “molecular double-slit” have been performed in more recent times [4]. These experiments are analogous to the classical double-slit experiment. They regard the photoelectron emission from inversion symmetric two-atomic homonuclear molecules. These intriguing experiments show the entanglement of the space-time variables for the first time unambiguously. Interestingly, they are coincidentally hinting to the entanglement and hence non-locality of time. Should this indirect proof being corroborated by a time resolved experiment, this would be a key experiment concerning the nowadays again questioned compatibility between special relativity and quantum entanglement [5].

References

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