Physikalisches Institut
Fakultät für Mathematik und Physik
Albert-Ludwigs-Universität Freiburg

IRTG-Seminar

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“Tunable entanglement resource in elastic electron-exchange collisions out of chaotic spin systems”

Entanglement, introduced by Erwin Schrödinger as "Verschränkung", is one of the most intriguing phenomena in nature and is directly related to fundamentals of quantum mechanics. Investigating entanglement in electronic scattering systems constitutes a new field of research. For this, we are discussing elastic collisions between initially unpolarized electrons and hydrogen-like atoms aiming to analyze the entanglement properties of the correlated final spin system. Explicit spin-dependent interactions are neglected and electron exchange only is taken into account. It is shown that the final spin system is completely characterized by a single spin correlation parameter depending on scattering angle and energy. Its numerical value identifies the final spins of the collision partners to be either in the separable, entangled, or Bell correlated regions. It is demonstrated that strong spin correlations can be produced violating Bell's inequalities significantly. Furthermore, the degree of entanglement can be continuously varied simply by changing either the scattering angle and/or energy. This allows for the generation of tunable spin pairs with any desired degree of entanglement. We suggest to use such non-locally entangled spin pairs as a resource for further experiments, for example in quantum information processes.

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