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Logical stochastic resonance with a coulomb-coupled quantum dot rectifier

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The exploitation of excess heat and noise has become a topical and significant branch of research, especially in electronics, where an ongoing trend towards sustainable, energy efficient and autonomous systems can be observed. Such a reuse is mainly possible by utilizing nonlinear systems and phenomena like e.g. stochastic resonance (SR) which enhances weak input signals by coupling to a noise floor. Furthermore, noise can improve the operation of logic gates: logical stochastic resonance (LSR) renders logic gates fault tolerant and reliable when the noise is situated in a suitable range. Both LSR and SR have in common the improvement of functional capabilities by application of noise to a system. Here, we present a Coulomb-coupled quantum dot (QD) device that is capable of generating a current through a QD by rectifying voltage fluctuations applied to the other QD. The magnitude and sign of the rectified current can be switched and controlled by external gates, and using these gates as logic inputs, enables the realization of various Boolean logic gate operations. Dependent on the noise amplitude and the control gate voltage, the device features AND, OR, NAND and NOR gate functionalities which can be switched between by either solely changing the noise magnitude or by a sole variation of the control gate voltage.

Biography

Fabian Hartmann studied Physics at the University of Würzburg, Germany, and has completed his PhD from "Technische Physik" (Chair of Applied Physics), University of Würzburg. Currently, he is a Post-doctoral Research Associate in the Nanoelectronics group at "Technische Physik". His current research interests are noise assisted electron transport phenomena in low-dimensional semiconductor devices and resonant tunneling diode based sensors for infrared light detection applications. He has published more than 15 papers in reputed journals.

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