Wave function engineering in quantum dot-ring nanostructures

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Quantum structures which can be steered from the outside are highly relevant to new technologies in which the control and manipulations of electron spin and wave functions play an important role. We consider quantum nanostructures composed of a semiconductor quantum dot surrounded by a quantum ring (dot-ring nanostructure). The properties of such nanostructures can be strongly modified by changing the shape and the height of the barrier separating the structure and/or the relative position of the minima of the confining potential.

The manipulation of these parameters by, e.g., electrical gating leads to the change of the shape and the radial distribution of wave functions which strongly influence many properties. We show that such wave function engineering can alter [1]:

a) the relaxation time of nanostructure used as spin qubit or memory device by orders of magnitude,

b) the cross-section for intraband infrared or microwave absorption from large to negligible,

c) the transport properties of a single nanostructure and of an array of dot-ring nanostructures from highly conducting to insulating.

[1] E. Zipper, M. Kurpas, and M. M. Maśka, New. J. Phys **14**, 093029 (2012).