Control of the spin and valley in silicene electrostatic quantum dots

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The buckled crystal lattice in silicene [1] allows for opening the energy gap by external electric field [2]. We describe formation of the electrostatic quantum dot confinement by inhomogenous external fields using both the continuum Dirac model [3] and the atomistic tight-binding approach [4]. The spin, valley, angular momentum and/or parity symmetries of states confined in circular quantum dots [5] and in double quantum dots are determined [6]. We show that the Rashba spin-orbit coupling and the valley-orbit coupling induced by the coupling of the confined states to the edge of the crystal allow for control of the spin and valley of confined states by AC electric fields in a electric dipole resonance procedure. We determine the selection rules and transition times for the spin and valley flipping transitions. We solve both the problem of a single confined electron and the problem of an electron pair. For the latter we describe the spin-valley structure of the low-energy spectrum in presence of a strong intrinsic spin-orbit couping and the intervalley scattering introduced by the short range component of the Coulomb interaction.

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