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Laser cooling of a quantum dot by photoinduced vibronic interaction

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Statement of the Problem: Laser cooling of a quantum dot (QD) implies both the translational and internal cooling. Whereas the translational cooling can be implemented by several methods (cavity cooling, feedback cooling), efficient internal cooling has not been reached. In this study, we present the simulation of cooling process of a QD by the method of the dynamical Stark shift.

Methodology & Theoretical Orientation: In our calculations, we use a two-level model of the semiconductor QD which diameter is tens of nanometers. We consider the resonant interaction of the QD with intense laser pulses in the conditions of the AC Stark effect. Heating and cooling processes in the QD are defined and taken into account for obtaining the temperature dependencies.

Findings: The temperature dependencies are determined for different parameters of the laser pulse. It is shown that the main heating process is the two-photon absorption (TWA) in the QD. Namely this process decelerates cooling of the QD. To diminish the effect of the TWA, the decreasing of the intensity of the laser pulse must be implemented during the cooling process.

Conclusion & Significance: Performed calculations show the possibility to decrease the internal temperature of the semiconductor QD by the dynamical Stark shift method. This method is based on the photoinduced vibronic interaction in two-level system and realizes the energy transfer controlled by the parameters of the laser pulse. Proposed method is more effective than the anti-Stokes fluorescence method.

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