The Analytical Effects of a Hydrostatic Pressure on the Ground State Energy of GaAs Quantum Dot at Low-Temperature: Algebraic Method

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This analytical study focused on discussing the collective effects of hydrostatic pressure and temperature on the ground state energy for two electrons trapped in GaAs parabolic quantum dot in the presence of a magnetic field using the effective mass approximation. The electronic interaction was approximated by the Johnson-Payne potential model, where its parameters were carefully chosen to match the Coulomb interaction. It is noted that the ground state energy decreases with an increment in pressure while it increases linearly slightly with increasing temperature. As is customary, it was found that ground state energy decreases with increasing dot size and reach its bulk value as the dot becomes wider. Among the most prominent notes related to this study were as follows: (i) The largest contribution to the total ground state energy is caused by the relative motion since the effect of pressure on this part is more pronounced than the part of the center of mass that often does not feel the presence of pressure. (ii) Ground state energy shows temperature insensitivity while pressure exerts a tangible effect on the ground state energy in the strong magnetic field confinement. (iii) The effect of temperature on the ground state energy is always the opposite of the pressure effect. (iv) With regard to the increase in pressure, it was found that it reduces the electron separation (r), therefore the ground state energy decreases in the presence of the harmonic interaction that is directly proportional to the square of r, but compared to previous works mentioned in the literature, energy showed increased behavior because Coulomb's interaction is inversely proportional to the electron separation. (v) In the region of weak confinement $(R > a_B^*)$, the effect of pressure on ground state energy becomes neglected, while this effect becomes noticeable in the region of ??strong confinement $(R < a_B^*)$.

Keywords: Quantum Dots, Hydrostatic Pressure, Harmonic e-e Interaction.

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