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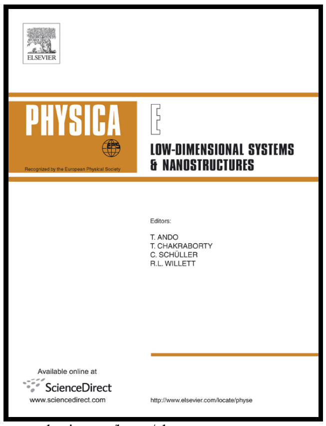

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Temperature Dependent Symmetry to Asymmetry Transition in Wide Quantum Wells

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Abstract

Quasi-two dimensional electron systems exhibit peculiar transport effects depending on their density profiles and temperature. A usual two dimensional electron system is assumed to have a δ like density distribution along the crystal growth direction. However, once the confining quantum well is sufficiently large, this situation is changed and the density can no longer be assumed as a δ function. In addition, it is known that the density profile is not a single peaked function, instead can present more than one maxima, depending on the well width. In this work, the electron density distributions in the growth direction considering a variety of wide quantum wells are investigated as function of temperature. We show that the double peak in the density profile varies from symmetric (similar peak height) to asymmetric while changing the temperature for particular growth parameters. The alternation from symmetric to asymmetric density profiles is known to exhibit intriguing phase transitions and is decisive in defining the properties of the ground state wavefunction in the presence of an external magnetic field, i.e from insulating phases to even denominator fractional quantum Hall states. Here, by solving the temperature and material dependent Schrödinger and Poisson equations self-consistently, we found that such a phase transition may be elaborated by taking into account direct Coulomb interactions together with temperature.

Keywords: Theory and modeling, High-field and nonlinear effects

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1. Introduction

The interacting quasi-two dimensional (2D) electrons are obtained at the interface of two heterostructures, which have different band gaps. The dimensional constriction yields quantized energy levels and the electron systems are commonly assumed to have zero thickness, i.e. strictly 2D. At low or intermediate doping and at sufficiently low temperatures, only the lowest sub-band is occupied and assuming a δ function to describe a 2D electron system can be well justified if the resulting quantum well is narrow. In this situation only a single peak is observed at the density distribution in z direction $n_{\rm el}(z)$, which can be approximated by a $\delta(z - z_{\rm el})$. However, the situation becomes quite

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