Spectroscopy of a single Si donor by the resonant tunnelling experiment.

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Resonant tunnelling via single impurities placed in AlAs layer in GaAs/AlAs/GaAs heterostructure was experimentally investigated.

The experiments were performed on submicrometer mesas, at very low mK temperature. For very small mesas, the number of impurities within the junction is small enough to see the contribution of single impurities in the tunnelling current. The investigations on the tunnelling via 0-dimensional states [1], as well as our previous results [2], show that the resonant tunnelling in such systems is a powerful tool to study the properties of the electron gas, i.e. it allows to perform the spectroscopy of electron density of states.

In this paper, we show that by means of resonant tunnelling via 0-dimensional states, it is possible to investigate not only the electron gas in the emitter, but also the properties of the resonant level itself. In the current-voltage characteristics of one of the mesas studied, two groups of peaks are clearly resolved. The first group, at about –0.8V reflects the resonant tunnelling from the disordered emitter via a single impurity [2]. The other structure, at about –1.2V comes most probably from the tunnelling via an excited state of the same impurity. Also other structures possibly related to the tunnelling via ground and excited states of other impurities are resolved. All these issues will be discussed in detail, taking into account the possible phonon participation.

References:
[2]. M.Gryglas et al. PRB 69, 165302 (2004); B.Jouault et al. accepted to PRB

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