$\boldsymbol{k}\cdot\boldsymbol{p}$ subband structure of the $LaAlO_3/SrTiO_3$ interface

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A high-mobility electron gas at the $SrTiO_3/LaAlO_3$ interface [1] showing multisubband Shubnikov-de Haas oscillations with a few meV subband separation has been observed [2]. We analyze these results by calculating the subband structure in the 6-band $\boldsymbol{k}\cdot\boldsymbol{p}$ envelope function approach with an electric field confining the electron gas in the $SrTiO_3$ at the interface. By fitting to DFT band structure calculations we determine the 5 relevant parameters: 3 effective mass parameters for the t_{2g} conduction band edge (d_{xy}, d_{yz} and d_{zx}) of $SrTiO_3$, the spin-orbit coupling and the low temperature tetragonal distortion. The electric field strength F is treated as a variable since we do not incorporate lattice and electron screening in our model. This model leads to anisotropic non-parabolic bands as in Fig. 1. Similar band structures result from tight binding calculations in the 'low density regime'[3].

This model allows a direct comparison to the frequency of the quantum oscillations observed in high magnetic fields through quasiclassical quantization for a given density. Our results are in good agreement with the experiments for an electric field strength $F = 0.1$ meV/Å and a density of 7.1×10^{12} cm^{-2}.

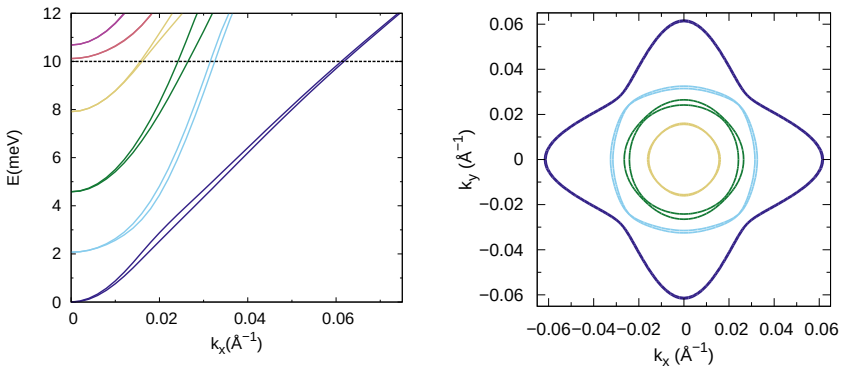

Figure 1: Left: $SrTiO_3$ subbands in an electric field of $F = 0.1$meV/Å. The small spin splittings are due to the asymmetric well in presence of spin-orbit coupling. Right: corresponding equal energy contours at $E = 10$ meV. Note the highly non-parabolic and anisotropic nature of the subbands.

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