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SUPPLEMENTARY INFORMATION
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Single donor ionization energies in a nanoscale CMOS channel

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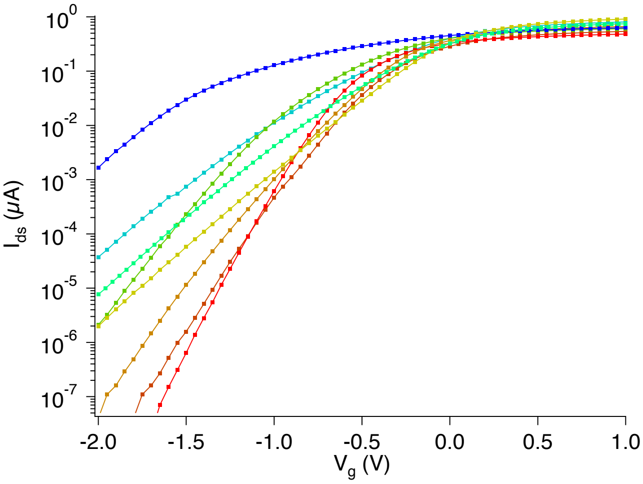

Supplementary Information, figure S1: Room temperature characteristics (drain-source current versus gate voltage) for a set of nominally identical samples from the same wafer. Sample to sample variations are very important, especially below the threshold voltage (-0.5 V for the best device, in red). In the most extreme case (blue curve) the many decades of excess current compared to the best device are attributed to direct transport through individual arsenic dopants which have diffused into the channel after doping and annealing steps. The source-drain voltage is 10 mV for these data.

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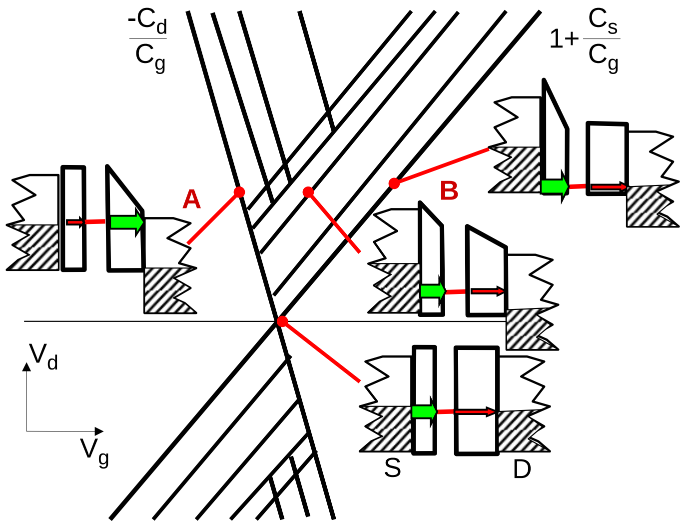

Supplementary Information, figure S2: Sketch for negative or positive differential conductance lines arising from the spectroscopy of the source and drain local density of states (LDOS) probed by a single dopant level. A single dopant level (red line) has a slightly unbalanced tunneling rate to source and drain: the barrier to drain is less transmissive at zero drain bias, represented by a thicker barrier. The drain source differential conductance is dominated by the less transmissive barrier (red arrow, green arrow for the more transmissive ones) and proportional to the LDOS in the corresponding reservoir. At finite bias around point B the lines are due to LDOS fluctuations in the drain, because the drain barrier is less transmissive. On the opposite, at finite bias in A the drain barrier becomes more transmissive than the source barrier due to the electric field (Fowler-Nordheim tunneling): differential conductance lines are then proportional to the LDOS fluctuations in the source.
LDOS fluctuations, which are due to quantum interferences of elastically scattered quasiparticles, mean that the source and drain are not perfect reservoirs [Koenemann, J. *et al.*, *Phys. Rev. B* **64**, 155314 (2001)]. The electronic or hole excitations due to electron transfer in or out the donor cannot diffuse instantly to infinity (or be recombined instantly), because of the finite diffusion coefficient. The correlation energy for this LDOS fluctuation is 1 meV in our sample, as shown in Fig. 3, left panel of the main article. It results from inelastic broadening of the inverse lifetime γ of the quasiparticles: electrons in the source and drain are recombined over a typical distance $L = \sqrt{(\hbar D/\gamma)}$=10 nm, with $D \simeq 10^{-4} m^{-2} s^{-1}$ the diffusion coefficient near the metal-insulator transition in the reservoirs.