

Electrical control of single hole spins in nanowire quantum dots

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1. Bandgap of InSb nanowires

We extract the bandgap of our InSb nanowires using the basic device described in Fig. 1 of the main text. On the left side of Fig. S1, the Fermi level is in the valence band, resulting in a finite current away from zero bias. At less negative V_{BG} , the Fermi level is inside the bandgap and the current is suppressed. On the right side of the figure, at even less negative V_{BG} , current is restored as the Fermi level moves into the conduction band. We extract the bandgap, ~ 0.2 eV, from the extent of the non-conducting region, as shown by the arrow in Fig. S1. This value is in agreement with the gap of bulk InSb (~ 0.17 eV at room temperature and ~ 0.23 eV at low temperatures [1]), and is confirmed by similar measurements in one other InSb nanowire device.

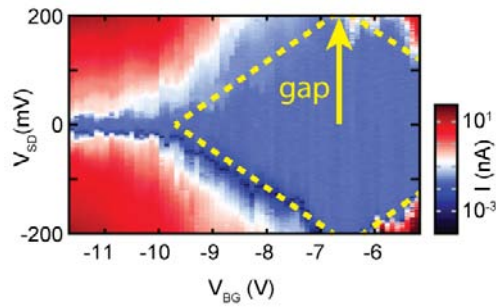


Fig. S1: Current through an InSb nanowire as a function of V_{SD} and V_{BG} .

2. Origin of the background triangles in Fig. 3b:

The additional triangles in the background are consistent with a single quantum dot located in series to the right of the main hole double dot (see figure below). In order not to obscure the main features, this single dot must be strongly coupled to the drain reservoir. Tunnelling between the right hole dot (RD) and this extra dot (ED) leads to the double dot features in the background. This specific spatial configuration is supported by the fact that the double dot associated with the background triangles couples as strongly to V_{RG} and less strongly to V_{LG} than the hole double dot associated with the main triangles. It also explains why the extra triangles are so dim: they are located in gate space regions where the left hole dot (LD) is in Coulomb blockade, meaning that direct tunnelling via LD is suppressed and charge transport is only possible via co-tunnelling [2]. The strong coupling to the drain broadens the levels of ED, as evidenced by the smooth baselines of the background triangles and the uniform current within [3]. The somewhat sharper resonances on the lower sides of two of the background triangles are consistent with resonant tunnelling via the excited states of RD, which are not lifetime broadened. We emphasize that our results are not affected by this dot, since no background triangles were observed near the charge transitions where the EDSR spectra and spin blockade were measured (see Fig. S4b and Fig. S5a).

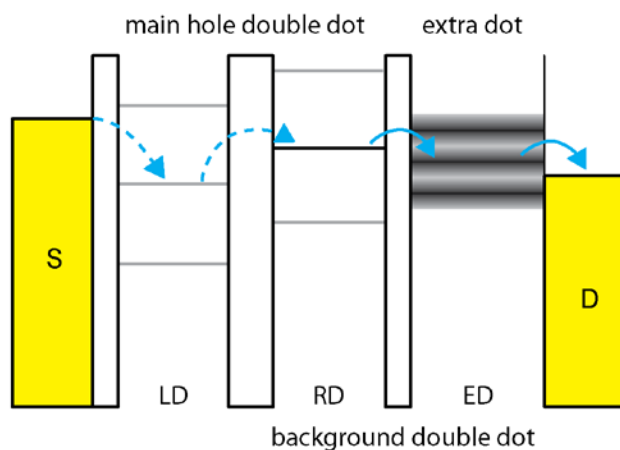


Fig. S2: Schematic of transport through the background triangles in Fig. 3b. The main triangles in Fig. 3b are associated with the main hole double dot. The fainter background triangles are consistent with tunnelling between RD and ED. ED is coupled to the drain through a ~ 100 k Ω Schottky tunnel barrier formed at the interface between the nanowire and the metallic contacts.

