## Phase measurement in strong Kondo regime in a self assembled InAs dot superconducting quantum interference device

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For a quantum dot Josephson junction (QDJJ) with an odd number of electrons and the weak spin-1/2 Kondo effect, the dissipationless Josephson current is strongly suppressed and the JJ becomes a $\pi$-junction due to the unpaired spin occupying the QD. This has been detected by the superconducting quantum interference device (SQUID)[1]. On the other hand, when the Kondo temperature ($T_K$) is larger than superconducting gap ($\Delta$), the Josephson current is enhanced due to the screening of the unpaired spin and the junction phase becomes normal (0). Our previous work on single JJ devices studied the QDJJs in the strong coupling Kondo regime[2], however direct phase measurement of the JJ was not realized. Here, we demonstrate the phase measurement in a QDJJ with strong Kondo effect by utilizing a self assembled InAs dot SQUID. We measure the phase of the QDJJ from the superconducting interference with an applied magnetic field. The $\pi$-junction behavior is observed in an odd electron number regime and the $\pi$-0 phase transition is measured by changing the electron number. In the strong Kondo regimes ($k_B T_K > \Delta$), we find that the JJ becomes a 0-junction.

[1]J. Cleuziou et al., Nature nanotech **1**, 53 (2006); J.A. van Dam et al., Nature (2006)
[2]Y. Kanai et al., Phys. Rev. B **82**, 054512 (2010).