Perfect Zeeman anisotropy in ring-shaped orbitals with strong spin-orbit interaction

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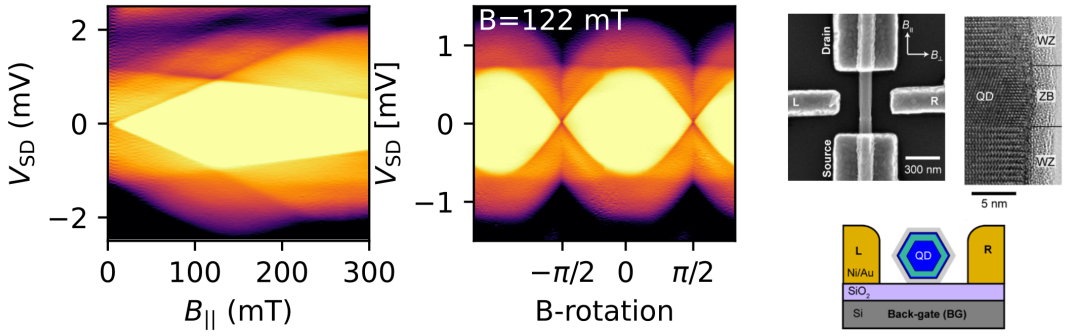
We have achieved extraordinary control over the Zeeman anisotropy of quantum ring states in a nanowire based polytype quantum dot system. Experimentally, we can control the anisotropy of the Zeeman effect for applied magnetic fields along with the symmetry of the confinement potential. We find a complete suppression of the Zeeman effect for fields in the ring plane up to 0.9 T - while increasing the Zeeman coupling by an order of magnitude for fields threading the ring. We then break the symmetry of the confinement potential via external gates, and find that the suppression for in-plane fields is gradually lifted along with the broken symmetry - until the effective g-factor approaches those commonly found for InAs quantum dots. The quantum ring spin states have a significant contribution from orbital motion, resulting in strongly spin-orbit coupled spin-orbital states [1]. The physics of the resulting system bears many similarities to e.g., carbon nanotube systems [2], despite being realized in a III-V nanowire system with a vastly different geometry.



References

[1] H. Potts, I.-J. Chen, A. Tsintzis, M. Nilsson, S. Lehmann, K. A. Dick, M. Leijnse, and C. Thelander, *Nature Communications*, 2019. DOI: 10.1038/s41467-019-13583-7.

[2] F. Kuemmeth, S. Ilani, D. C. Ralph, and P. L. McEuen, *Nature*, vol. 452, 2008. DOI: 10.1038/nature06822.