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### Enhanced Valley Splitting for Quantum Electronics in Silicon

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Silicon is a placid environment for quantum degrees of freedom with long spin and valley coherence times [1]. A natural drawback is that the same features that protect the quantum state from its environment also hamper its control with external fields. Indeed, engineered nanostructures typically lead to sub-meV splittings between valley states [2], hindering the implementation of both spin [1] and valley [3] based quantum devices. We will discuss the microscopic theory of valley splitting [2,4], presenting three schemes to control valleys on a scale higher than 1 meV: a) in a quantum well, the adoption of a barrier constituted of a layered heterostructure might lead to constructive reflection if the layer thicknesses match the electron wavelength, in analogy with a Bragg mirror [5]; b) the disparity between the high valley splitting in a impurity donor potential and the low splitting in a Si/Insulator interface may be harnessed controlling the tunneling between these two states, so that the valley splitting may be controlled digitally [6]; c) intrinsic Tamm/Shockley interface states might strongly hybridize with conduction states, leading to a much enhanced valley splitting[4], and its contribution to the 2DEG ground state may be experimentally identified [7]. We argue that this effect is responsible for the enhanced splitting in Si/BOX interfaces [8].

- [1] F. Zwanenburg et al., *Rev. Mod. Phys.* **85**, 961 (2013).
- [2] A Saraiva, M. J. Calderón, Xuedong Hu, S. Das Sarma and Belita Koiller, *PRB* **80**, 081305 (2009).
- [3] D. Culcer, A. L. Saraiva, Belita Koiller, Xuedong Hu, and S. Das Sarma, *PRL* **108**, 126804 (2012).
- [4] A. Saraiva, Belita Koiller and M. Friesen, *Phys. Rev. B* **82**, 245314 (2010).
- [5] L. Zhang, J.-W. Luo, A Saraiva, Belita Koiller, Alex Zunger, *Nature Comm.* **4**, 2396 (2013).
- [6] A. Baena, A. L. Saraiva, Belita Koiller, and M. J. Calderón, *PRB* **86**, 035317 (2012).
- [7] A. Dusko, A. Saraiva and Belita Koiller, arXiv:1310.6878 (2013).
- [8] K. Takashina, Y. Ono, A. Fujiwara, Y. Takahashi and Y. Hirayama, *PRL* **96**, 236801 (2006).