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Electric control of inverted gap and hybridization gap in type II InAs/GaSb quantum wells LUN-HUI HU, Department of Physics, Zhejiang University, Hangzhou 310027, China, CHAO-XING LIU, Department of Physics, The Pennsylvania State University, University Park, Pennsylvania 16802, USA, DONG-HUI XU, Department of Physics, Hong Kong University of Science and Technology, Clear Water Bay, Hong Kong, China, FU-CHUN ZHANG, YI ZHOU, Department of Physics, Zhejiang University, Hangzhou 310027, China — The quantum spin Hall effect has been predicted theoretically and observed experimentally in InAs/GaSb quantum wells as a result of inverted band structures, for which electron bands in InAs layers are below heavy hole bands in GaSb layers in energy. The hybridization between electron bands and heavy hole bands leads to a hybridization gap away from $\mathbf{k} = \mathbf{0}$. A recent puzzling observation in experiments is that when the system is tuned to more inverted regime by a gate voltage (a larger inverted gap at $\mathbf{k} = \mathbf{0}$), the hybridization gap decreases. Motivated by this experiment [ref. 1], we explore the dependence of hybridization gap as a function of external electric fields based on eight-band Kane model. We identify two regimes when varying electric fields: (1) both inverted and hybridization gaps increase and (2) inverted gap increases while hybridization gap decreases. We analyze the effective model and find that light-hole bands in GaSb layers play an important role in determining hybridization gap. In addition, large exernal electric field can induce strong Rashba splitting and also influence hybridization gap. Our results are consistent with experimental observations. Reference: [1] Lingjie Du, et.al., arXiv:1508.04509 (2015).

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