Study of Kitaev-Heisenberg model with second-neighbor Heisenberg coupling by DMRG simulations and slave-particle theories

YI-FAN JIANG, Tsinghua University, HONG-CHEN JIANG, KITP, UCSB and Tsinghua University, HONG YAO, Stanford University and Tsinghua University — We study the effect of second-neighbor Heisenberg coupling $J_2$ to the first neighbor Kitaev-Heisenberg model on the honeycomb lattice by doing DMRG simulations and slave-particle theories. In the Kitaev limit, we find that the gapless spin liquid phase at $J_2 = 0$ survives up to a finite critical value $J_{2c}$. In an intermediate range, namely $J_{2c} < J_2 < J'_{2c}$, our results show that a new exotic (possibly a gapped chiral spin liquid) phase emerges. When $J_2$ is further increased beyond $J'_{2c}$, the ground state orders magnetically by spontaneously breaking spin-rotational and lattice translational symmetries. Possible implications of our results to the real materials $Na_2IrO_3$ and $Li_2IrO_3$ will also be discussed.