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Two-dimensional massless Dirac fermions, chiral pseudo-spins, and Berry's phase in few-layer black phosphorus[1] SEUNG SU BAIK, HYOUNG JOON CHOI, Dept. of Physics, IPAP, and CCSAEMP, Yonsei University, Korea — Black phosphorus (BP) and its two-dimensional (2D) derivative phosphorene are rapidly emerging nanoelectronic materials with potential applicability to field effect transistors and optoelectronic devices. Unlike the gapless semiconductor graphene, multilayer BP has a substantial band gap of 0.2 eV, and this band-gap size is predicted being sensitive to the external perturbations such as pressure, strain, and electric field. Very recently, a semiconductor-semimetal transition in BP was realized by the surface potassium (K) doping, producing a Dirac semimetal state with a linear dispersion in the armchair direction and a quadratic one in the zigzag direction [1,2]. Here, based on first-principles density functional calculations, we present that beyond the critical K density, 2D massless Dirac fermions emerge in K-doped few-layer BP, and the electronic states around Dirac points have chiral pseudo-spins and Berry's phase. These features are robust with respect to the spin-orbit interaction. The switchable massless Dirac fermions discussed here may open a new way for the development of high performance devices in 2D materials beyond graphene. [1] J. Kim, S. S. Baik, S. H. Ryu, Y. Sohn, S. Park, B. Park, J. Denlinger, Y. Yi, H. J. Choi, and K. S. Kim, Science **349**, 723-725, (2015). [2] S. S. Baik, K. S. Kim, Y. Yi and H. J. Choi, arXiv:1508.04932.

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