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Cooper pairing protected by spin-valley locking in two-dimensional superconductivity on MoS_2 YU SAITO, The University of Tokyo, YASUHARU NAKAMURA, Kyoto University, MOHAMMAD BAHRAMY, The University of Tokyo, YOSHIMITSU KOHAMA, ISSP, JIANTING YE, The University of Tokyo, YUICHI KASAHARA, Kyoto University, MASASHI TOKUNAGA, ISSP, TSUTOMU NOJIMA, Touhoku University, YOUICHI YANASE, Kyoto University, YOSHIHIRO IWASA, The University of Tokyo — MoS_2 is an archetypal layered semiconductor; monolayer shows out-of-plane spin polarization at the K-points due to intrinsic Zeeman-type spin-orbit coupling (SOC) derived from its in-plane broken inversion symmetry. By ionic-liquid gating, almost all carriers are confined only to topmost layer, realizing two-dimensional superconductivity in this system [1]. We reported the first observation of a huge in-plane upper critical field of about 52 T and a clear saturating behaviour in the low temperatures using pulsed magnetic fields up to 55 T [2]. From first-principles-based tight binding supercell calculations followed by realistic numerical calculations of H_{c2} based on the subband structure, we revealed that this unusual behavior is due to the moderately large Zeeman-type spin splitting of 13 meV at the Fermi level (vicinity of the K points) [3]. This forces Cooper pairs to be completely aligned to out-of-plane direction by spin-valley locking effect, thereby causing the dramatic enhancement of the Pauli limit Our calculation also indicates that even if the carrier density and then spin splitting (9–15 meV) at the Fermi level changes, the Pauli limit is predominantly controlled by both the Zeeman-type SOI and T_c, and the contribution of Rashba-type SOI is negligibly small. [3]. [1] Y. Saito et al. http://meetings.aps.org/link/BAPS.2014.MAR.T52.8 [2] Y. Saito, et al. http://meetings.aps.org/link/ BAPS.2015.MAR.G11.11 [3] Y. Saito et al. Nature Phys. doi: 10.1038/nphys3580. (arXiv:1506.04146).

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