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TUNABLE SPIN-ORBIT COUPLING IN A HIGH MOBILITY FEW-LAYER SEMICONDUCTOR

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In a crystal, the two-fold degeneracy of spins is protected by the combined inversion symmetry in both space and time. In the well-known Zeeman effect, an external magnetic field breaks the time reversal symmetry (TRS) and splits the spin degeneracy by $g\mu_B B$, where g is the gyromagnetic ratio and μ_B is Bohr magneton. Alternatively, the spin degeneracy can be lifted by spin-orbit coupling (SOC) when spatial inversion symmetry is broken, even in the absence of a TRS-breaking magnetic field, leading to a variety of magnetic, spintronic and topological phases and applications. In conventional bulk materials, the SOC parameter is a constant that cannot be modified. Here we exploit the tunability of two-dimensional (2D) materials, and demonstrate SOC and zero-field spin-splitting in atomically thin InSe that can be modified over an unprecedentedly large range. From beating patterns in quantum oscillations, we establish that the SOC parameter α is thickness-dependent; it can be continuously modulated over a large range by an out-of-plane electric field, achieving zero-field splitting tunable between 0 and 20 meV. Surprisingly, α could be enhanced by an order of magnitude in some devices, suggesting that SOC can be further manipulated by variations in interlayer spacing induced by stacking and/or electrostatic compression. Our work highlights the extraordinary tunability of SOC in 2D materials, which can be harnessed for *in operando* spintronic and topological devices and applications.

References

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