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Valley-Polarized Interlayer Conduction of Anisotropic Dirac Fermions in $SrMnBi_2$

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We report anisotropic Dirac fermions in a Bi square net of $SrMnBi_2$ and their valley-selective interlayer conduction under in-plane magnetic fields. In contrast to the commonly-observed isotropic Dirac Fermi surfaces, the Dirac Fermi surface in $SrMnBi_2$ is highly anisotropic with strong momentum-dependence of Fermi velocity as well as interlayer coupling. The resulting c-axis resistivity exhibits clear angular magnetoresistance oscillations indicating coherent interlayer conduction. Strong fourfold variation of the coherent peak in the c-axis resistivity reveals that the contribution of each Dirac valley is significantly modulated by the in-plane field orientation. Furthermore, we found a signature of broken valley symmetry at high magnetic fields. These findings demonstrate that a quasi-two-dimensional anisotropic Dirac system can host a valley-polarized interlayer current through magnetic valley control.