Supplementary Information

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At room temperature, !-SnTe has the centrosymmetric rocksalt (space group Fm-3m) structure[1] (Supplementary Figure 1a) and, as temperature is lowered,[2] it undergoes a (ferroelectric) phase transition to the non-centrosymmetric rhombohedral (space group R3m) R-1 structure,[3, 4] where the Te atom is spontaneously displaced along the [111] direction relative to Sn atom. We focus on the bands near Fermi energy around the Z point which exhibits the most pronounced Rashba spin splitting (Supplementary Figure 1b).

In the centrosymmetric rocksalt phase (illustrated by dashed lines in

Crystal structure of centrosymmetric !-SnTe identify with two inversion sectors (pink domain) and (cyan domain). The centrosymmetric phase transfers to a non-centrosymmetric rhombohedral phase as the Te atom displaced from Sn along [111] direction Band structure around the time-reversal invariant momentum

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The rotation symmetry of these eight symmetry operators forms the little group D_{2h} of the ¯-point. The character table of D_{2h} is given in Supplementary Table 1. Note that $BaNiS_2$ as a non-magnetic crystal also contains the time reversal symmetry ˆ.

The distinct band topology along ¯ ¯ and ¯ ¯ of the monolayer $BaNiS_2$ without SOC shown in Figure 1c can be understood from the effective model Hamiltonian. Since the Rashba bands of our interesting around the ¯-point are mainly derived from the Ni *d*-orbits with and character, the atomic *d* states of Ni atom , where *d* denotes a hybridization state of and , are the reasonable choice as the basis of the invariant expansion. The Bloch basis $|\quad\rangle$ can be explicitly expressed as a Bloch sum of the local *d* states,

$$|\qquad\rangle$$

‾ ‾ direction, obtaining forbidden interaction between degenerate states segregated on two inversion-partner sectors and leading to the two-fold degeneracy of the energy bands in agreement with the first-principles calculation,