Supplementary information

Strain-induced quantum phase transition in C_3Sc_4 monolayer: Towards to multiple gapless fermions

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Table S1. obtained C_{11}, C_{12}, C_{22}, and C_{44} for C_3Sc_4 at 0 %, 9.5 %, 13 % biaxial strains

Strained	C_{11} (N/m)	C_{12} (N/m)	C_{22} (N/m)	C_{44} (N/m)
0%	150.122	53.251	150.562	53.217
9.5%	110.334	38.301	110.737	37.099
13%	61.125	25.546	60.696	15.865

In Figure S1, we plot the in-plane Young's modulus, Y, and Poisson's ration, ν, along an arbitrary direction specified with the polar angle θ (θ is the angle relative to *a* direction) can be obtained as below[S1]:

$$Y(\theta) = \frac{\Delta}{C_{11}s^4+C_{22}c^4+(\frac{\Delta}{C_{44}}-2C_{12})c^2s^2} \quad \text{Eq (S1)}$$

$$\nu(\theta) = \frac{\left(C_{11}+C_{22}-\frac{\Delta}{C_{44}}\right)c^2s^2-C_{12}(c^4+s^4)}{C_{11}s^4+C_{22}c^4+(\frac{\Delta}{C_{44}}-2C_{12})c^2s^2} \quad \text{Eq (S2)}$$

where $\Delta = C_{11}C_{12} - C_{12}^2$, $c = \cos(\theta)$, and $s = \sin(\theta)$. Using Eqs. (S1) and (S2), and the elastic constants presented in Table S1, the θ dependence of Y and ν on C_3Sc_4 at 0%, 9.5%, 13% biaxial strains are shown with polar coordinates in Figure S1. In such a plot, a fully isotropic elastic behavior is represented by a perfectly circular shape for Y and ν. On the contrary, the shapes of Y and ν in Figure S1 are anisotropic, with major axis and minor axis difference for C_3Sc_4 at 0%, 9.5%, 13% biaxial strains, indicating that the mechanical properties of C_3Sc_4 at 0%, 9.5%, 13% biaxial strains exhibit anisotropy.

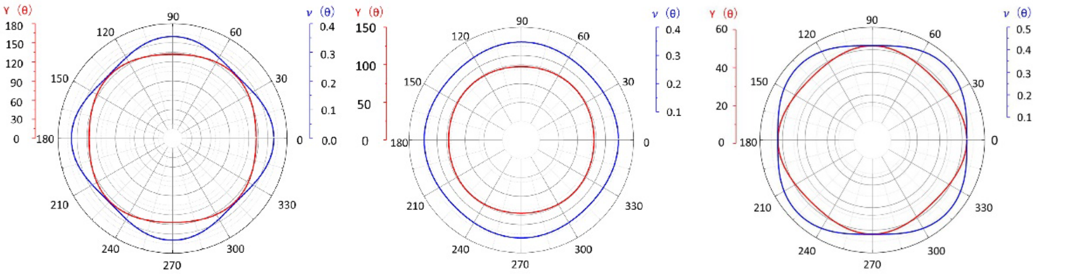

Figure S1. The θ dependence of (a) Y and (b) ν for C3Sc4 at 0% (left), 9.5% (middle), 13% (right) biaxial strains.

Reference

(S1) E. Cadelano, P. L. Palla, S. Giordano and L. Colombo, Phys. Rev. B: Condens. Matter Mater. Phys., 2010, 82, 235414.