# Evidence of Striped Electronic Phases in a Structurally Modulated Superlattice

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The electronic properties of materials (crystals) can be manipulated via the application of modulated electric & magnetic fields or via modulations engineered into the structure of the material itself. Similar to the beating sound produced by two tuning forks with slightly different frequencies, the spatial modulation produced between two crystal layers with slightly different (incommensurate) structures creates the conditions (stripes) for intriguing new electronic properties.

In layered $SrTa_2S_5$ such conditions are realized due to the difference in periodic structures of $Sr_3TaS_5$ and *H*-$TaS_2$ (Fig. 1a). These layers are formed as the material crystalizes from the molten base materials as the mixture is cooled in a furnace. The resulting modulation is ~4.4nm in length which is quite long compared to the interatomic spacing in the crystal. Investigating the properties of $SrTa_2S_5$ revealed intriguing superconducting behavior which suggests that the first superconducting state forms at T*~2.3K and is confined within the layers (Fig. 1b) due to the intralayer pairing of the electrons. Further cooling reveals a bulk superconducting state at $T_c$=1.49K with interlayer electron pairing (Fig. 1c).

To better understand why superconductivity behaves this way in $SrTa_2S_5$ measurements of the Fermi surface via quantum oscillations (QO) in resistance and magnetization were performed at the MagLab (Fig. 1d). The QO measurements revealed a complex superposition of frequencies from both the Fermi surface and oscillations resulting from the spatial modulation of the incommensurate interface between layers (Fig. 1e). The data paints a remarkable picture of electron mobility and coherent electron states in $SrTa_2S_5$ considering the low mobility and lack of QO in $Sr_3TaS_5$ & *H*-$TaS_2$ when measured individually.

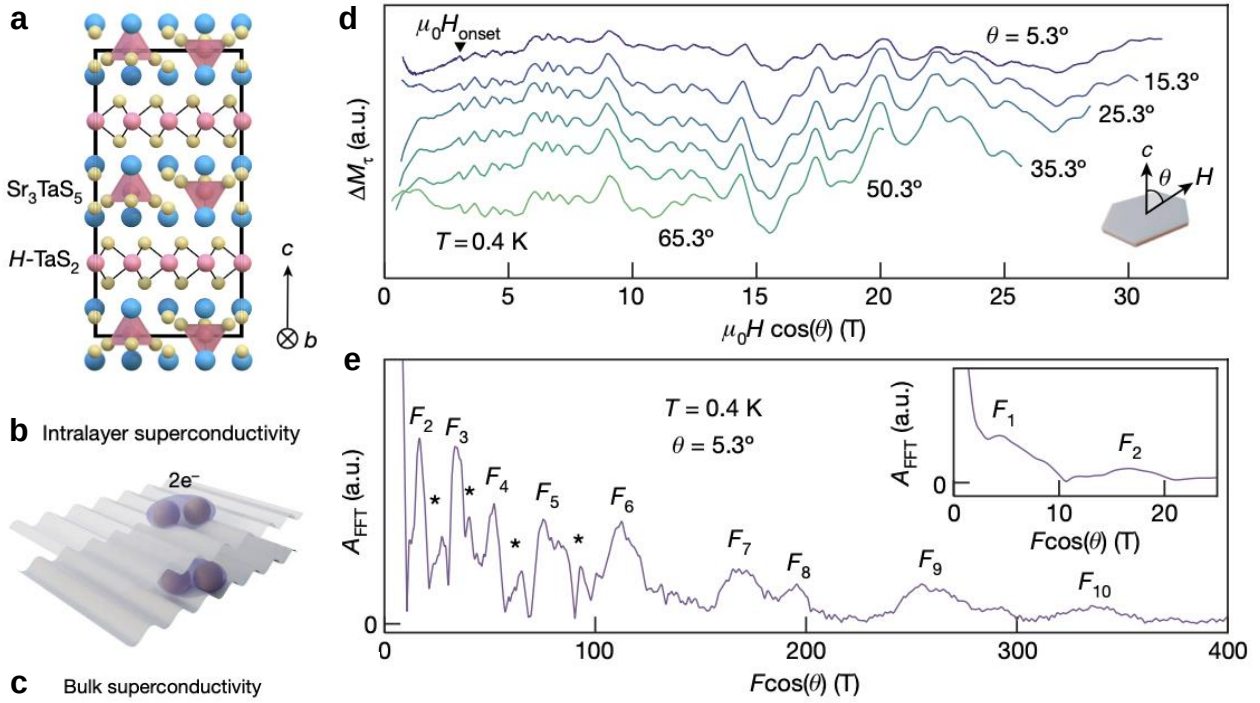


Fig.1: a) Crystal structure of $SrTa_2S_5$, b) Illustration of *intralayer* electronic pairing, c) Illustration of *interlayer* electronic pairing, d) M vs. H traces to 31T showing quantum oscillations, e) Fast Fourier transform of the 5.3 deg. trace in d) showing component frequencies as well as the frequencies due to the modulated structure.

**Facilities and instrumentation used:** DC Field Facility, Cell 9 magnet (31T).

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