

# Unveiling the interlayer interaction in a 1H/1T TaS<sub>2</sub> van der Waals heterostructure

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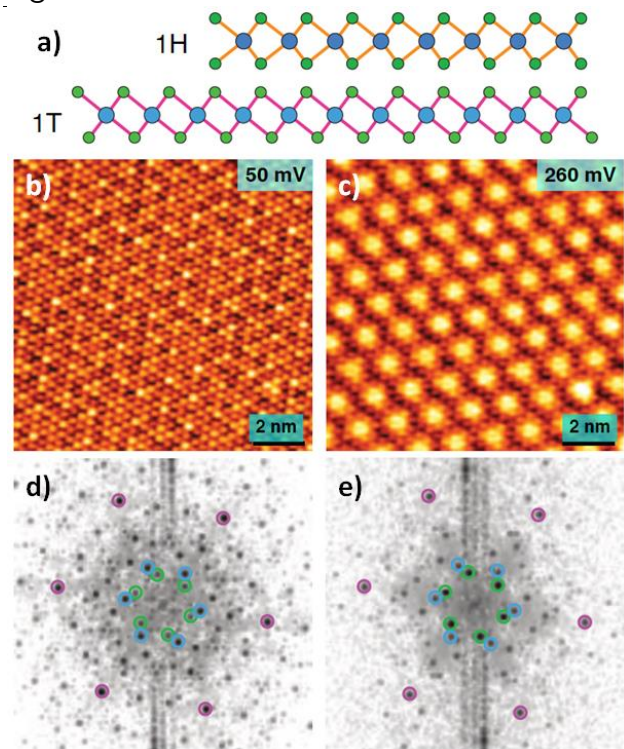
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Different transition metal dichalcogenides heterostructures have been studied in recent years due to their diverse electronic properties and the potential of combining them to create new systems that can host correlated ground states. In particular, TaS<sub>2</sub> is well known to exhibit two distinct structural phases: 1H, a metallic phase with a quasi-(3x3) charge density wave (CDW) below 81K, and 1T, a Mott insulator with a Star of David  $\sqrt{13}\times\sqrt{13}$ -R14° CDW below 183K [1]. When a 1T layer is placed on top of a 1H layer, a Kondo lattice is formed within the system [2]. On the other hand, when a 1H layer is placed on top of a 1T layer, a transparency effect is observed in STM measurements through the top layer [3], as depicted in Figure 1. Some early studies suggested that this effect could be attributed to direct tunneling from the tip to the 1T layer [4]. Here, we propose a new explanation based in a weak but measurable electronic coupling between the 1T and 1H layers, which preserve their structural properties and characteristic CDWs.

## References

- [1] J. A. Wilson, F. J. Di Salvo, S. Mahajan, *Adv. Phys.* 24, (1975), 117-201
- [2] C. G. Ayani, M. Pizarra, I. M. Ibarburu, M. Garnica, R. Miranda, F. Calleja, F. Martín and A. L. Vázquez de Parga, *Small* (2023) 2303275
- [3] R. V. Coleman, B. Giambattista, P. K. Hansma, A. Johnson, W. W. McNairy, and C. G. Slough, *Adv. Phys.* 37, 6 (1988), 559-644
- [4] W. Han, E. R. Hunt, O. Pankratov, and R. F. Frindt, *Phys. Rev. B* 50, 19, (1994), 14746

## Figures



**Figure 1:** Transparency effect on a 1H/1T-TaS<sub>2</sub> heterostructure. **(a)** Ball model of the system, Ta atoms in blue and S atoms in green. **(b-c)** STM images performed on the same area on the 1H layer at 300pA and two different voltages, showing the underlying 1T CDW through the 1H layer. **(d-e)** FFT of the STM images. Atomic lattice spots are marked in purple, 1H CDW spots in blue and 1T CDW spots in green.