# Transition metal dichalcogenides in the 2D limit: Enhanced superconductivity in atomically-thin 2H-TaS$_2$ layers

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Graphene [1] is one of the most studied materials due to its unique properties such as hardness, flexibility and high electric and thermal conductivity. However, probably the best quality of graphene is that it has opened the field to many other 2D crystals [2], including superconductors and topological insulators.

In this work, the synthesis and characterization of metal chalcogenides are discussed. As an example, thickness-dependent Raman spectra of ZrX$_2$ (X = S, Se) and transport measurements in thin layers of 2H-TaS$_2$ are presented. While no thickness dependence is observed in ZrX$_2$ [3], in 2H-TaS$_2$, it is observed a superconducting temperature (Tc) enhancement by decreasing the number of atomic layers (from 0.6 K in the bulk sample to ca. 2K in a ~3 nm layer, as can be seen in Figure 1) [4]. This behaviour is the opposite of the one reported in other 2D superconductors, as NbSe$_2$ [5]. This effect can be interpreted on the basis of a simple band model and on optical phonons localized in each plane; it shows that the tunneling between the bands decreases the effectiveness of the pairing interaction that in turn is mediated by in-plane phonons.

This result may bring superconductivity into the flatland for their future use in magnetic sensors or low energy applications.

## References

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## Figures

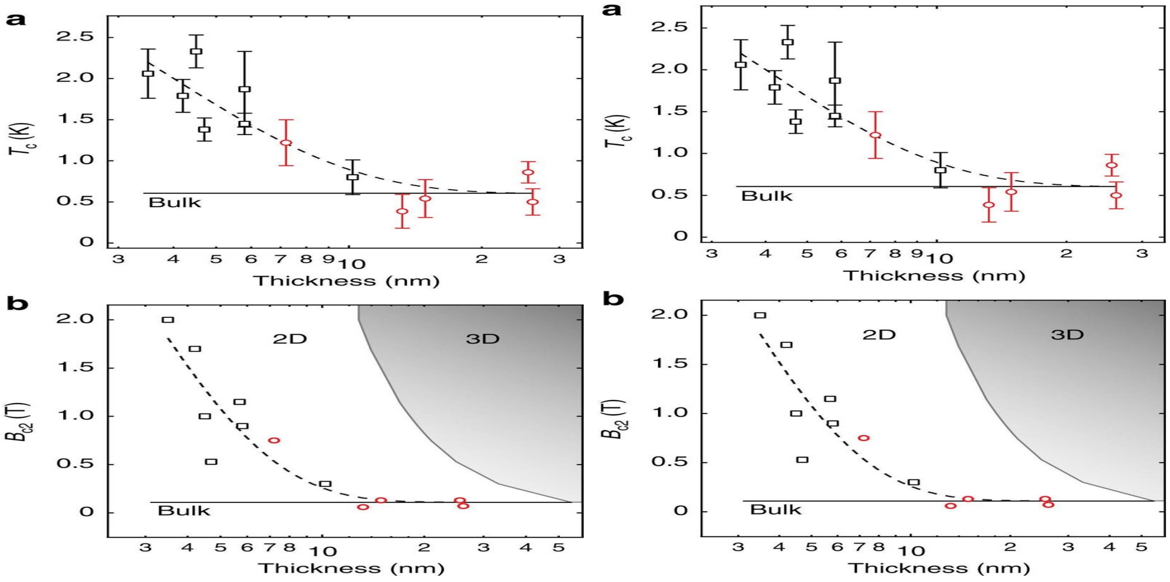

**Figure 1: (a)** Variation of T$_c$ as a function of the thickness of the TaS$_2$ flakes. Devices exhibiting a non-zero residual resistance below T$_c$ are plotted in red. The error bars are given by the temperatures at 10 and 90% of the normal state resistance. The solid

black line marks the bulk $T_c$ of 600 mK. The black dotted line is an exponential trend line, fit to the data starting at the bulk limit. **(b)** Variation of $Bc_2$ as a function of flake thickness. The red circles mark the same devices in **a** having residual resistance. The black solid line indicates the bulk limit upper critical field of 110 mT. The grey solid line plots the Ginzburg-Landau coherence lengths, calculated from the *y* axis $B_{c2}$ values, and marks the edge of the 2D limit.