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## Competing Quantum Orders in the Bulk Layered Heterostructure 6R-TaS<sub>2</sub>

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Hydrostatic pressure provides a clean and continuous route to tune competing electronic phases in quantum materials, offering unique insights into the relationship between multiple emergent quantum phenomena. This approach is particularly powerful in layered systems, where pressure directly modifies interlayer coupling and electronic structure without introducing disorder. In this context, the transition metal dichalcogenide 6R-TaS<sub>2</sub> stands out as a natural platform for studying the interplay of charge density wave (CDW) order, superconductivity, and transport anomalies –recently, a hidden order in the intermediate temperature range ( $T^* \approx 35$  K) has been reported, evidenced by strong magnetoresistance and nonlinear Hall effect (NHE). Using  $\mu$ SR, magnetotransport, and hydrostatic pressure techniques, we identify a nodal superconducting state with low superfluid density at ambient pressure, with no spontaneous magnetic order detected below  $T^*$ . This suggests that the NHE is primarily associated with band-structure effects rather than time-reversal symmetry breaking. Under pressures up to 2 GPa, the superfluid density rises markedly in correlation with the superconducting transition temperature, the nodal pairing shifts to a nodeless state, and the CDW onset is reduced by half. Notably, NHE is fully suppressed, and magnetoresistance drops by 50% within just 0.2 GPa, highlighting the fragility of the hidden order. These results reveal an unconventional superconducting pairing in 6R-TaS<sub>2</sub>, competing with both CDW and hidden orders through weakened interlayer coupling and competition for the same electronic states. With a multifaceted approach, we establish a comprehensive phase diagram that reveals the intricate interplay and competition between the intertwined quantum orders in 6R-TaS<sub>2</sub>.

Ref. V. Sazgari et al., arXiv:2503.13944v1

**Author:** KRÁL, Petr (PSI Center for Neutron and Muon Sciences)

**Co-authors:** SAZGARI, Vahid (PSI Center for Neutron and Muon Sciences); GRAHAM, Jennifer Nadine (PSI Center for Neutron and Muon Sciences); ISLAM, Shams Sohel (PSI Center for Neutron and Muon Sciences); GERGURI, Orion (PSI Center for Neutron and Muon Sciences); ACHARI, Amritroop (National Graphene Institute, University of Manchester); TANGERMANN, Janek (Department of Quantum Matter Physics, University of Geneva); GOPAKUMAR, Hrishikesh (PSI Center for Neutron and Muon Sciences); SIMUTIS, Gediminas (PSI Center for Neutron and Muon Sciences); JANOSCHEK, Marc (PSI Center for Neutron and Muon Sciences); BARTKOWIAK, Marek (PSI Center for Neutron and Muon Sciences); KHASANOV, Rustem (PSI Center for Neutron and Muon Sciences); LUETKENS, Hubertus (PSI Center for Neutron and Muon Sciences); VON ROHR, Fabian O. (PSI Center for Neutron and Muon Sciences); NAIR, Rahul Raveendran (National Graphene Institute, University of Manchester); GUGUCHIA, Zurab (PSI Center for Neutron and Muon Sciences)

**Presenter:** KRÁL, Petr (PSI Center for Neutron and Muon Sciences)