NanoLab Talk

Politecnico di Milano, Department of Energy, Cesnef (Building 19), via Ponzio 34/3, Milan
Seminar Room 1° floor

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Interlayer charge dynamics in metallic transition metal dichalcogenides

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Layered metallic transition metal dichalcogenides (TMDs) are conventionally seen as two-dimensional conductors, despite a scarcity of systematic studies of the interlayer charge transport. Motivated by the prevailing strategy of functionalizing 2D materials by creating van der Waals heterostructures, we initiated an in-depth study of out-of-plane charge dynamics and emergent properties arising from interlayer coupling. Unprecedented results have been obtained thanks to employing Focused-ion-beam-assisted 3D microfabrication of samples, which enables tailoring geometry and current paths with submicron precision [1]. In this talk, I will present the first transport data revealing c-axis-oriented quasi-one-dimensional electronic states in 1T-TaS_2, —a compound with the richest charge density wave phase diagram among TMDs. Temperature dependence of resistivity shows a robust coherent out-of-plane transport, while in-plane conduction is hindered by the presence of a unique nanoarray of charge density wave domains. Consequently, we interpret the highly debated metal-insulator transition in 1T-TaS_2 as a Peierls-like instability of the c-axis-oriented orbital chains, in opposition to the long-standing Mott localization picture [2]. Among other highlights of our current research are the anomalous transport properties observed in natural heterostructures or arising from stacking faults.

References

[1] Moll, P. J. (2018). Focused ion beam microstructuring of quantum matter. Annual Review of Condensed Matter Physics, 9, 147-162.

[2] Martino, E., Pisoni, A., Ćirić, L., Arakcheeva, A., Berger, H., Akrap, A., ... & Forró, L. (2019). Preferential out-of-plane conduction and quasi-one-dimensional electronic states in layered van der Waals material 1T-TaS2. arXiv preprint arXiv:1910.03817.

About the speaker:

Edoardo complete his Bachelor and Master degrees in Materials Engineering and Nanotechnology at PoliMi, in 2013 and 2015. During the master, he was selected for the Alta Scuola Politecnica, receiving the diploma in management of technological innovation in 2016. During his studies he participated to the activities of the applied superconductivity lab at RSE in Milan, where he contributed to the development of superconducting devices for the power grid. Since 2016 he is pursuing a PhD in Condensed Matter Physics at EPFL. His experiments focus on transport and spectroscopy study of layered materials, performed at EPFL and user facilities in Europe and US.

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