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New opportunities in two-dimensional material research

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Two-dimensional (2D) atomic crystals, best exemplified by graphene, have emerged as a new class of material that may impact future science and technology. The reduced dimensionality in these 2D crystals often leads to novel material properties that are vastly different from that in the bulk. We refer to such a recurring scheme as “less is different”. In this talk I will illustrate this scheme with two 2D materials that we found particularly interesting ? black phosphorus and 1T-TaS₂. These two layered materials have vastly different properties. Black phosphorus is a 2D semiconductor, and its superior material quality has recently enabled us to observe the quantum Hall effect. 1T-TaS₂, on the other hand, is a metal with a rich set of charge density wave phases. We explore their electronic properties while the doping and dimensionality of the 2D systems are modulated.