An electrically controlled single atom magnetic switch on black phosphorus

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Single atoms at the surfaces of solids have demonstrated rich electronic [1], chemical [2], and magnetic [3-5] properties. In this direction, we demonstrate that we can manipulate the orbital population of a single cobalt atom on a crystalline black phosphorus surface. Using the local electric field generated from an STM tip, individual cobalt atoms residing at the same hollow site can be reversibly switched between two stable states, which correspond to the different orbital configurations. The experimentally observed charge density of each configuration (fig. 1) is corroborated with density functional theory calculations, which reveal distinct high and low total magnetic moments for each state, as well as the electronic properties of the cobalt atom which locally dopes the black phosphorus. We investigate the stability of each configuration, as well as compare the experimentally measured impurity states with DFT calculations. Finally, we study the switching dynamics to determine the underlying mechanism and energy scale of the switch. This system opens up the horizon to explore complex memory based on both the orbital and spin degrees of freedom.

References:

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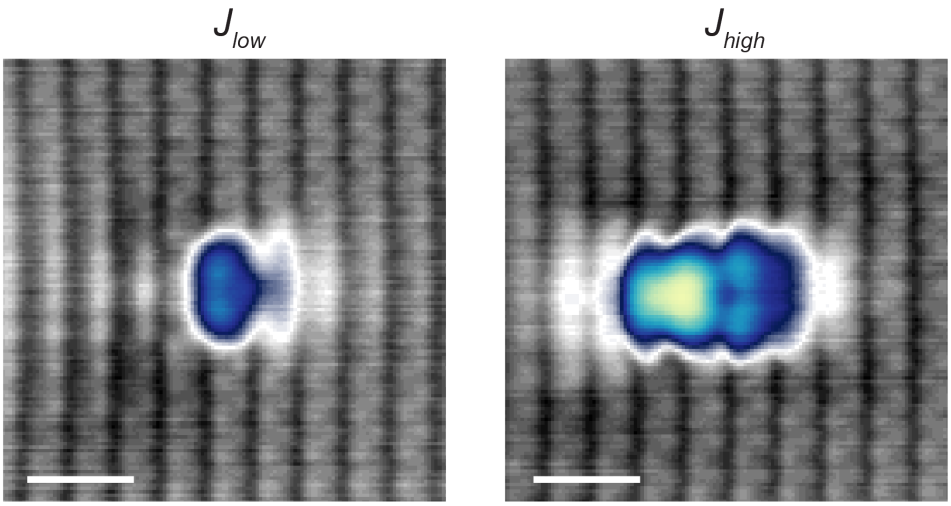

Fig 1. Cobalt on graphene in J_{low} and J_{high} configurations.