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Gate-Controlled Ionization and Screening of Cobalt Adatoms on a Graphene Surface

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Graphene impurities provide both a source of mobility-limiting disorder as well as a means to alter the graphene electronic structure in a desirable way. While these effects have thus far been primarily studied with spatially averaged techniques, understanding the microscopic physics of such behaviour requires local-probe exploration of the subnanometre-scale electronic and structural properties of impurities on graphene. In this talk I will describe scanning tunnelling microscopy and spectroscopy measurements made on individual Co atoms deposited onto back-gated graphene devices. We observe features in the tunneling local density of states (LDOS) of the Co adatoms related to both atomic resonances and phonon excitations. We also find that the electronic structure of Co adatoms can be tuned by application of the device gate voltage, and that the Co atoms can be reversibly ionized. Large screening clouds are observed to form around Co adatoms ionized in this way, and we observe that some intrinsic graphene defects also show charging behaviour. Our results provide new insight into charged-impurity scattering in graphene, as well as the possibility of using graphene devices as chemical sensors. The relationship between our measurements and recent transport experiments will also be discussed.