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Disentangling Surface and Bulk Electronic Structures of EuB_6[1]

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By means of angle-resolved photoemission, the surface and bulk electronic structures of UHV-cleaved ferromagnetic hexaboride EuB_6 have been disentangled to reveal both a variable density surface 2D electron gas and an exchange splitting of the boron p-bands below the bulk ferromagnetic ordering temperature of the localized Eu 4f moments. Surface-slab LDA calculations find (i) a distinct surface-related band residing in the bulk-projected bandgap along X-M, (ii) a 2D X-point electron pocket, and (iii) energy-shifted surface-atom Eu 4f states resulting from an electric dipole at the highly ionic surface. These surface-related features manifest in experiment as time dependent effects, the filling of a small X-point electron pocket of Eu 4d-character, correlated to changes in the overall B-p band structure and a splitting of the Eu 4f states. The time-dependent behavior is explained in terms of clustering of mobile surface Eu atoms on the freshly cleaved surface. Understanding and control of these surface effects then allows the bulk electronic structure to be discerned, including a pinning of the Fermi level to the bulk X-point valence band maximum and the magnitude of the valence band exchange splitting below T_c.

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