Two-dimensional electron gas with orbital symmetry reconstruction at the surface of KtaO3

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The discovery of a high mobility two-dimensional electron gas (2DEG) at the interface of two non-magnetic wide-bandgap oxide insulators, SrTiO3 and LaAlO3 [1], triggered a burst of activity that led to more stunning findings, such as superconductivity and large, spin-orbit mediated, magnetoresistance. Despite the rapid progress in this area of research, a main issue that remains unanswered is the physical origin of these interfacial 2DEGs. This was underscored by the surprising discovery of a 2DEG that is formed at the surface of vacuum-cleaved single crystals of SrTiO3 (STO) [2], which opened a new avenue for the understanding and fabrication of 2DEGs in transition-metal oxides. It was argued that this novel 2DEG arises from surface oxygen vacancies formed when fracturing
the crystal in vacuum, and it was put in evidence that different forms of electron
confinement at the surface of STO may lead to essentially the same 2DEG. The perspective of creating 2DEGs at the surface of multifunctional oxides which may inherit the properties of their parent compounds is exciting. In the present work, we realize a 2DEG at the vacuum-cleaved surface of KTaO3 (KTO). Our main results demonstrate that: (i) the emergence of a 2DEG at an oxide surface, without any external confining field, is not specific to STO, thus likely quite general to undoped insulating perovskites and (ii) that the spin-orbit coupling remains active in the 2DEG, completely reconstructing the orbital symmetries of the 2DEG’s
subbands with respect to the bulk conduction bands.

[1] A. Ohtomo & H. Y. Hwang, Nature 427, 423 (2004).
[2] A. F. Santander-Syro et al., Nature 469, 189 (2011).