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**Real-space Observation of Surface-assited Orbital Order**

**by Scanning Tunneling Microscopy**

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Orbital-related physics attracts growing interest in condensed matter research, but direct access to the orbitals is challenging. Here we report on the real-space visualization of an orbital ordered structure observed on a surface of CeCoIn5 by using scanning tunneling microscopy (STM).

Since the tunneling current in STM arises from the overlap of wave functions of the tip and sample surface, slowly decaying electronic states, which are often derived from *sp* orbitals of the constituent surface atoms, mostly contribute to the current and imaging in conventional STM operations. On the other hand, at smaller tip-sample distance localized d-orbital states could be probed if they have substantial density around the Fermi level.

On a cobalt-terminated surface of the heavy fermion superconductor we observed in the small-distance STM images dumbbell-shaped cobalt atoms pointing alternatingly in the [100] and [010] directions. First-principles calculations reveal that this structure is due to the staggered dxz-dyz orbital order assisted by enhanced on-site Coulomb interaction at the surface. The orbital-selective imaging by STM seems to open a new path for exploring orbital-related physics from a microscopic point of view.

Reference

[1] H. Kim, Y. Yoshida, C.-C. Lee, et al., Sci. Adv. 3, eaao0362 (2017).

