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Observation of Majorana fermions in ferromagnetic atomic chains on a superconductor[1]

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Majorana fermions are zero-energy excitations predicted to localize at the edge of a topological superconductor, a state of matter that can form when a ferromagnetic system is placed in proximity to a conventional superconductor with strong spin-orbit interaction. With the goal of realizing a one-dimensional topological superconductor, we have fabricated ferromagnetic iron atomic chains on the surface of superconducting lead [1]. Using high-resolution spectroscopic imaging techniques, we show that the onset of superconductivity, which gaps the electronic density of states in the bulk of the chains, is accompanied by the appearance of zero-energy end-states. This spatially resolved signature provides strong evidence, corroborated by other observations and theoretical modeling [2], for the formation of a topological phase and edge-bound Majorana states in this system. Our results demonstrates that atomic chains are viable platform for future experiments to manipulate Majorana bound states [3] and to realize other related 1D or 2D topological superconducting phases. [1] S. Nadj-Perge, I. K. Drozdov, J. Li, H. Chen, S. Jeon, J. Seo, A. H. MacDonald, B. A. Bernevig, and A. Yazdani, Science 346, 602 (2014). [2] Jian Li, Hua Chen, Ilya K. Drozdov, A. Yazdani, B. Andrei Bernevig, A.H. MacDonald, ArXiv:1410.3453 (2014). [3] Jian Li, Titus Neupert, B. Andrei Bernevig, Ali Yazdani, ArXiv:1404.4058 (2014).

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