A Cooper pair in a one-atom contact between superconductors

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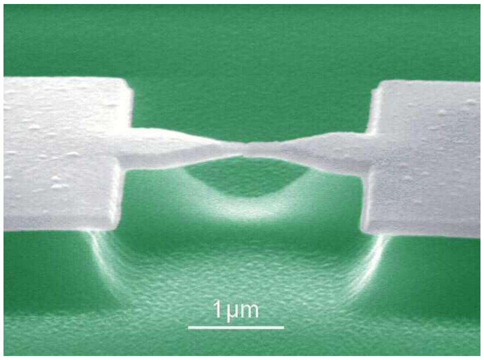

Figure 1.- A one-atom contact between the two superconducting electrodes of a suspended aluminum bridge is achieved through the controlled bending of the substrate.

A supercurrent can flow through a weak-link—such as a thin insulating barrier, nanowire or molecule—between two superconductors. This famous Josephson effect has had a great impact on fundamental science and is the basis for a variety of devices including magnetometers, quantum amplifiers and qubits. Successful as they are, these devices overlook the existence of an internal degree of freedom, inherent to all weak-links, which we reveal here with experiments performed on the simplest possible weak-link[1-5]: a one-atom contact.

Mesoscopic superconductivity predicts that in the ground state of this many-body interacting system the entire supercurrent is carried by a single Cooper pair state localized around the contact. The pair can be excited electrically into another state that can be long-lived and carries an opposite supercurrent. We will show that this microscopic two-level system can be manipulated coherently despite being embedded in a continuous superconducting fluid.

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