Observation of the Higgs mode in a strongly interacting fermionic superfluid

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Higgs and Goldstone modes are possible collective modes of an order parameter upon spontaneously breaking a continuous symmetry. Whereas the low-energy Goldstone (phase) mode is always stable, additional symmetries are required to prevent the Higgs (amplitude) mode from rapidly decaying into low-energy excitations. In high-energy physics, where the Higgs boson has been found after a decades-long search, the stability is ensured by Lorentz invariance. In the realm of condensed-matter physics, particle-hole symmetry can play this role and a Higgs mode has been observed in weakly-interacting superconductors. However, whether the Higgs mode is also stable for strongly-correlated superconductors in which particle-hole symmetry is not precisely fulfilled or whether this mode becomes overdamped has been subject of numerous discussions. Experimental evidence is still lacking, in particular owing to the difficulty to excite the Higgs mode directly.
Here, we spectroscopically observe the Higgs mode in a strongly-interacting superfluid Fermi gas. By inducing a periodic modulation of the amplitude of the superconducting order parameter Δ with RF field, we observe an excitation resonance at frequency $2\Delta/h$. For strong coupling, the peak width broadens and eventually the mode disappears when the Cooper pairs turn into tightly bound dimers signalling the eventual instability of the Higgs mode.