Pressure converts an insulator into a metal with enhanced electronic mass

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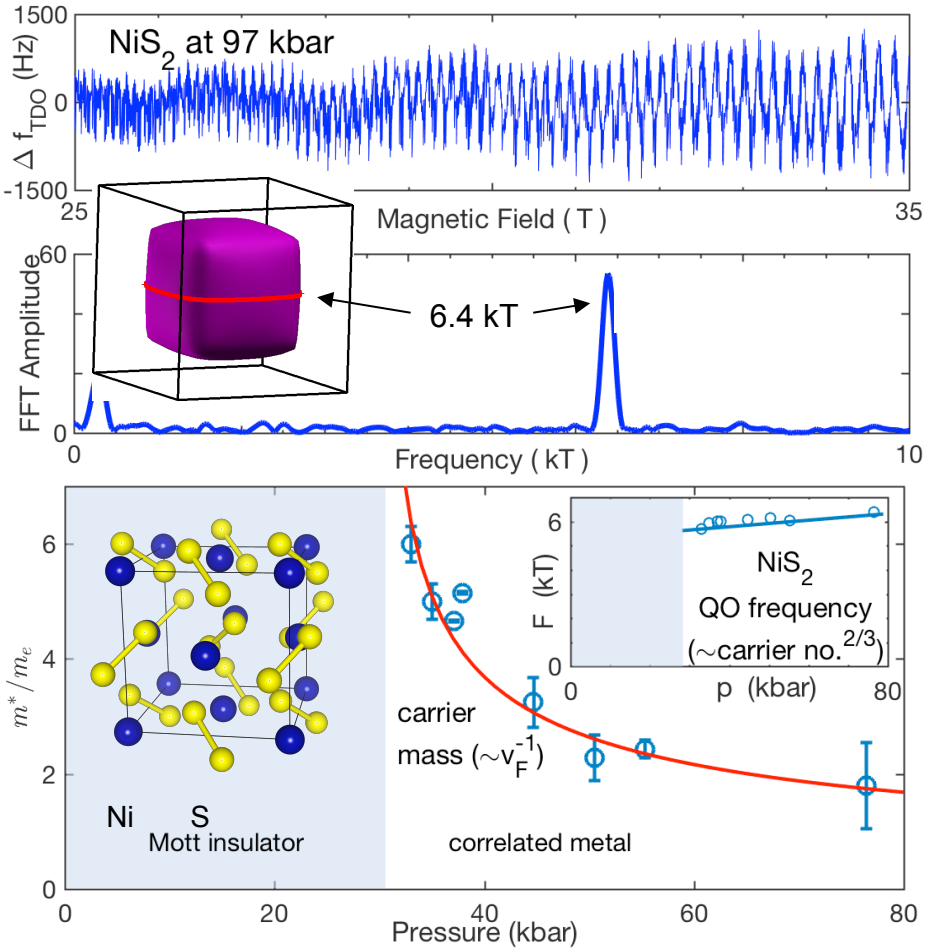
In Mott insulators, electrons are locked into position by their mutual Coulomb repulsions. Varying the lattice density by applied pressure makes it possible to metallize a Mott insulator and study the resulting correlated metallic state, a state in which the formerly grid-locked electrons have become mobile. Understanding correlated metals on the brink of Mott localization is of general interest, as this is the system that hosts high temperature superconductivity in the cuprates. *Foremost among scientific questions about the high-pressure metallic state is the fate of the electronic Fermi surface and the associated charge carrier mass.*

These key properties have been probed by ultra-sensitive quantum oscillation measurements under pressure in high-purity samples of the Mott insulator, NiS_2. The work exploited pioneering high-pressure anvil cell techniques, combined with radio-frequency contact-free resistivity measurements. Data was collected at pressures up to 97kbar in magnetic fields up to 35T, and at temperatures down to less than 0.1K.

Our data demonstrate that the charge carrier density remains constant, although the charge carriers increase their mass dramatically upon approaching the Mott insulating state from the metallic side. These studies open the door to high-pressure electronic structure determination in a host of other correlated systems of long-standing scientific interest.



Top: Quantum oscillations in NiS_2 that appear at pressures above the Mott transition that is at ~30kbar. Bottom: Diverging carrier mass observed near the transition despite the pressure-independent Fermi surface size (inset).

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