



First Science from the 75T Duplex Magnet



Magnet: Doan N. Nguyen, James R Michel, Jason D. Lucero, **Pulsed Field Facility at MagLab/LANL**
Science: Z.Xiang, L.Chen, K-W.Chen, C.Tinsman, Tomoya Asaba, Lu Li, **Univ. of Michigan**; Y.Sato, Y. Kasahara, Y.Matsuda, **Kyoto University**; H.Lu, M.Jaime, F.Balakirev, J. Singleton, **MagLab/LANL**; F.Iga, **Ibaraki University**
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Duplex magnets are designed with two nested coils independently energized by two different capacitor banks to provide more design flexibility in maximizing the peak magnetic fields generated. The MagLab successfully developed a 75T duplex magnet that has been tested to a maximum field of 76.8T and has been serving users since February 2020 with magnetic fields up to 75T and a short cooling time (~1 hour) between pulses.

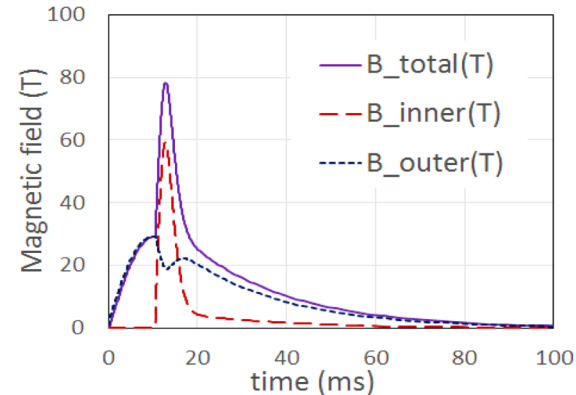
This new magnet was key to a new understanding of quantum oscillations in the Kondo Insulator, YbB_{12} , which were extended - for the first time - deep into a metallic state induced at high magnetic fields. By tracking the Fermi surface area deduced from the quantum oscillations, researchers concluded that the same quasiparticle band gives rise to quantum oscillations in both the insulating state at low magnetic fields and the metallic state at high magnetic fields.

The extra field from the Duplex Magnet enabled the observation of the exotic charge-neutral fermions from the low-magnetic-field state being gradually “drowned” in a sea of normal electrons as the magnetic field was increased. This first-time observation - tracked across a wide range of magnetic field - confirms a strange fact: that charge-neutral carriers at low magnetic fields form a Fermi surface that gives rise to quantum oscillations.

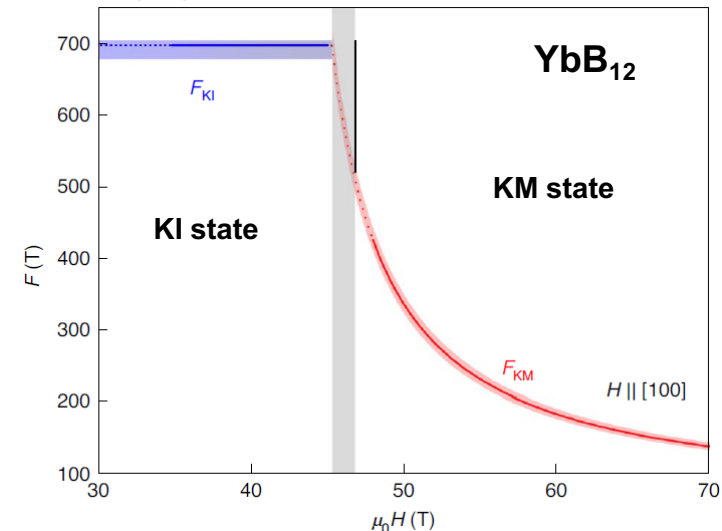
Facilities and instrumentation used: Pulsed Field Facility – MagLab/LANL, with support from the MagLab’s Magnet Science and Technology Division

Citation: [1] J.Michel, D.N.Nguyen, J.D.Lucero, *Design, Construction, and Operation of New Duplex Magnet at Pulsed Field Facility-NHMFL*, **IEEE Transactions on Applied Superconductivity**, 30 (4), 0500105 (2020) doi.org/10.1109/TASC.2020.2970670

[2] Z.Xiang, L.Chen, K-W.Chen, C.Tinsman, Y.Sato, T.Asaba, H.Lu, Y.Kasahara, M.Jaime, F.Balakirev, F.Iga, Y.Matsuda, J.Singleton, L.Li, *Unusual high-field metal in a Kondo Insulator*, **Nature Physics**, (2021) doi.org/10.1038/s41567-021-01216-0



Magnetic field waveforms of the duplex magnet, showing the contributions to the total magnetic field from the inner and outer coils. The total magnetic field reaches 76.8T.



Frequency of quantum oscillations in the Kondo Insulator (KI) and Kondo Metal (KM) states of YbB_{12} . The light gray bar marks the insulator-to-metal transition as the magnetic field is increased. The fit to high field data up to 70T extrapolates back to match the frequency observed in the KI state, indicating the oscillations originate from the same quasiparticle band in both states.