**First Potential Signs of ‘Itinerant’ f-Electron Physics in the Heavy Fermion System YbRh$_2$Si$_2$**

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**Introduction**

The issue of participation of f-electrons in the Fermi surface of heavy fermion systems has been the subject of much recent debate [1]. The physics of 'localised' or 'itinerant' heavy fermion systems is particularly relevant in relation to superconductivity in these systems - a lack of clarity surrounds the role of the f-electrons in each of these systems in the existence or otherwise of superconductivity. In an effort to address this issue, we studied the seminal member of the Yb category of heavy fermionic systems: YbRh$_2$Si$_2$ in the 45T hybrid magnet at low temperatures down to 35 mK. While this system has been argued to be the prototypical 'local moment' system with local magnetic Yb$^{3+}$ moments existing well below the characteristic spin fluctuation or Kondo temperature [2], our measurements reveal a new large sheet of the Fermi surface that instead suggests that YbRh$_2$Si$_2$ may be more itinerant than previously thought, with the f-electrons participating in the Fermi surface.

**Experimental**

Magnetic quantum oscillation measurements have been performed in the dilution refrigerator in the 45T hybrid magnet on YbRh$_2$Si$_2$ for $H \parallel a$. Since the system is highly anisotropic, first measurements were performed with the magnetic field directed in the easy plane (axis). Compared to published magnetic quantum oscillation measurements on YbRh$_2$Si$_2$, our experiments revealed additional sheets Fermi surface sheets (Figure shown), notably the high frequency peak at 10 kT. This Fermi surface sheet is considerably larger in area than any of the previously observed sheets, providing the first indication that the f-electrons in this system may in fact be participating in the Fermi surface, as typical of itinerant instead of localised f-electron systems.

**Results and Discussion**

Our quantum oscillation measurements on high quality single crystals of YbRh$_2$Si$_2$ have shown for the first time that a ‘large’ Fermi surface sheet, perhaps inconsistent with the ‘small’ localized Fermi surface picture may be applicable in this system. More angular dependent measurements and comparison with specialized band structure calculations that may lie somewhere in-between the local and itinerant model for this system could shed further light on this important problem.

**References**