Summary

The *Fermi liquid* (FL) theory of Landau has been very successful in describing the low-temperature properties of metals. This description is summarized by the well-known expressions for the specific heat $c(T) = \gamma T$, the magnetic susceptibility $\chi(T) = \text{const}$, and the electrical resistivity $\rho(T) = \rho_0 + AT^2$. It has been a challenging task to also describe *heavy-fermion* (HF) materials as strongly renormalized FL's. However, quite surprisingly, in the past decade, a number of HF systems has been discovered, which does not obey the standard FL behaviour, at least not down to the lowest temperatures experimentally accessible. Detailed studies of such systems have led to the recognition that the FL framework may break down under specific conditions. This so-called *non-Fermi liquid* (NFL) state may be considered as a new type of ground state. In NFL materials, $c(T)/T$ and $\chi(T)$ diverge when $T \rightarrow 0$, while $\rho(T)$ obeys a non-quadratic temperature dependence.

In this thesis it is shown that U_2Pt_2In is the first stoichiometric uranium-based compound which exhibits NFL behaviour at ambient pressure. The specific heat of U_2Pt_2In shows a pronounced diverging behaviour of the type $c/T \sim -\ln(T/T_0)$ over almost two decades of temperature ($0.1 = T < 6$ K), providing solid evidence for the classification of this heavy-fermion compound as a NFL.

At low temperatures, an anomalous behaviour is observed in the magnetic susceptibility of U_2Pt_2In: χ_c goes through a maximum at 7.9 K, which is attributed to the stabilization of short-range antiferromagnetic (AF) correlations, while χ_a increases as $1\text{-}bT^{0.7}$ for $2\text{ K} = T < 10$ K. This is in variance with the standard FL behaviour.

The resistivity of U_2Pt_2In is highly anisotropic below about 80 K with $\rho_c > \rho_a$. At the lowest temperatures, the resistivity does not follow the FL quadratic temperature dependence, instead $\rho \sim T^{\alpha}$ with $\alpha = 1.25$ and 0.9 for currents applied along the a- and c-axis, respectively. Magnetoresistance experiments show a gradual increase of the resistivity exponent α with increasing magnetic field strength, reaching the FL value $\alpha = 2$ at 8 T.

The residual resistivities are unusually high ($\rho_{0,a} \approx 115$ μΩcm and $\rho_{0,c} \approx 210$ μΩcm), even though the structure refinements from X-ray and neutron-diffraction experiments indicate a high sample quality. The large difference between $\rho_{0,a}$ and $\rho_{0,c}$ and the strong field dependence of ρ_0, shows that ρ_0 is largely determined by other scattering mechanisms than impurity or defect scattering.

Resistivity experiments under hydrostatic pressure indicate a recovery of the FL $\rho \sim T^2$ behaviour at low temperatures. This is consistent with predictions from a transport theory for heavy-fermion compounds near an AF *quantum critical point* (QCP). The anisotropy in the resistivity is strongly enhanced under pressure.

Absence of weak magnetic order, at least down to 0.05 K, is confirmed by means of muon spin relaxation and rotation (μSR) experiments. Besides a static magnetic component originating from the indium nuclear moments, the μSR spectra below 10 K reveal the presence of magnetic fluctuations. No evidence was found for Kondo disorder.

The location of U_2Pt_2In at the border line between magnetic and non-magnetic compounds in a Doniach-type of diagram for the U_2T_2X family and the recovery of the FL state in the resistivity of U_2Pt_2In under pressure, yield evidence for U_2Pt_2In being at or close to a QCP.

Other uranium-based heavy-fermion compounds exhibiting NFL behaviour have been studied in this work:

– Specific-heat experiments on the compound $U_3Ni_3Sn_4$ evidence a FL ground state. However, a NFL regime is observed for 0.5-5 K. Resistivity experiments show that the temperature range where FL behaviour is observed increases with applying pressure. The results are consistent with the location of $U_3Ni_3Sn_4$ close to an antiferromagnetic QCP (at the paramagnetic side of the phase diagram).

– A new type of QCP is found for the system $U(Pt_{1-x}Pd_x)_3$. μSR experiments show that the so-called large-moment antiferromagnetic phase appears at the same Pd concentration where superconductivity is suppressed, i.e. the QCP of both superconducting and antiferromagnetic phases coincide. This result suggests that odd-parity superconductivity is suppressed because of a shift of the spectral weight from ferromagnetic to antiferromagnetic fluctuations upon Pd doping.

– The temperature variation of the resistivity of the pseudo-ternary compound $URh_{1/3}Ni_{2/3}Al$ is consistent with NFL behaviour due to a single-ion mechanism.