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Electrical resistivity of $YbRh_2Si_2$ under extreme conditions

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Among the ternary Yb-compounds, $YbRh_2Si_2$ has the lowest magnetic ordering temperature $T_N \approx 70$ mK at ambient pressure. The proximity to a quantum critical point makes $YbRh_2Si_2$ an ideal candidate to study its unusual transport and thermodynamic properties related to quantum criticallity as a function of an external control parameter, like magnetic field [1] or pressure [2,3]. Since pressure stabilizes the $4f^{13}$ (Yb^{3+}) configuration, an enhancement of the weak antiferromagnetic order ($\mu_{\mathrm{eff}} \approx 0.01\ \mu_B$) is expected as pressure increases. Indeed, it was observed that T_N increases up to 0.9 K upon applying a pressure of 2.5 GPa [2]. Moreover, at higher pressures, Mössbauer studies revealed an unusual pressure dependence of T_N, showing a sudden increase of T_N at 10 GPa [3], which might be related to a first order magnetic phase transition from a low moment to a high moment state ($\mu_{\mathrm{eff}} \approx 1.9\ \mu_B$) [3].

Motivated by this, the electrical resistivity $\rho(T)$ of $YbRh_2Si_2$ was measured on a single crystal up to 15 GPa in the temperature range 0.1 K < T < 300 K. Based on this experiment, $T_N(p)$ can be divided in three pressure ranges: (*i*) For p < 4.1 GPa, T_N increases strongly, followed by (*ii*) a quasi-pressure independent behavior in the range 4.1 GPa < p < 8 GPa. After a sudden increase of T_N, the system eventually (*iii*) exhibits a weak pressure dependence above 10 GPa with $T_N \approx 7$ K at 15 GPa. This $T_N(p)$ is in agreement with the dependence deduced from Mössbauer measurements [3]. In regarding to the electronic scattering process at low temperatures, the results might indicate that there is a unique scattering mechanism in the entire pressure range. In addition, the pressure dependence of several high temperature maxima in $\rho(T)$ can be understood as an incoherent Kondo scattering process on the ground state and the excited crystal field levels.

[1] J. Custers, et al., Nature 425 (2003) 525
[2] S. Mederle, et al., J. Phys.: Condens. Matter. 14 (2002) 10731
[3] J. Plessel, et al., Phys. Rev. B 67 (2003) 180403