Hall effect in strongly correlated electron systems

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Over the last three decades, the strongly correlated electron systems (SCES) have attracted, increased attention a great many experimental and theoretical scientists of solid state around the world. The essential property of *f*-electron SCES is instability of the *f*-electron shell and in consequence, the *f*-electron in compounds with *sp*- and *d*-elements easily hybridizes with conduction electrons. It is well known that the Hall resistivity of magnetic materials consists of the normal (OHE) and anomalous R_s (AHE) contributions. While the normal Hall effect results from the Lorenz force, the AHE is related with an asymmetric probability of electron scattering on magnetic centers. This means that the Hall effect could be a good probe of both electronic and magnetic properties in SCES. Recently, we have reported Hall effect measurements on some U-based SCES such as heavy-fermion (HF) antiferromagnet UCu_5Al [1], HF semiconductor U_2Ru_2Sn [2], ferromagnetic, under-pressure superconductor UGe_2 [3], and low-carrier density ferromagnet $UCo_{0.5}Sb_2$ [4]. In this contribution we would like to outline and highlight some outstanding and interesting features of these investigations. In all cases, we have observed a strong temperature dependence of the R_H In the paramagnetic state, R_H has positive sign and is proportional to the magnetic susceptibility. R_H can be decomposed into negative R_0 and positive R_s components. The later contribution is dominant, indicating the $R_H(T)$ dependence is mainly due to incoherent skew scattering by the U 5*f* moments. The carrier concentration estimated from the R_0 in one-band model ranges between 0.4 in UGe_2, 0.8 ($UCo_{0.5}Sb_2$), 1.2 (U_2Ru_2Sn) and 4.9 e/f.u in UCu_5Al. For ferromagnets (UGe_2 $-T_C$ = 53 K, $UCo_{0.5}Sb_2$ T_C = 75 K) both skew scattering and side-jump scattering contribute to the Hall effect in the ferromagnetic state. However, the R_s is found to be minor compared to that of the R_0. Interestingly, the Hall coefficient of U_2Ru_2Sn and $UCo_{0.5}Sb_2$ increases rapidly with decreasing temperature below 80 and 100 K, respectively. This behaviour is associated with a decrease in the carrier concentration, that levels off to 0.04 and 0.024 e/f.u at 2 K in U_2Ru_2Sn and $UCo_{0.5}Sb_2$, respectively. As the most important result of our investigations we found a sudden increase in the carrier concentration of UGe_2 below a characteristic temperature T^*, which under pressure tends to T_{sc} when the compound undergoes into the superconducting state. Other important feature to notice is the effective electron mass m^* enhancement observed in all studied compounds, for instance, up to $105m_e$ in the case of UCu_5Al. It should be remarked that the Hall mobility in $UCo_{0.5}Sb_2$ changes sharply with temperature, reaching a maximum value of 450 cm^2/Vs at 20 K and falls down by as many as two orders of magnitude, *i.e.* of 3.7 cm^2/Vs at T = 2 K. This change is just observed in the temperature range, where the weak localization effect seems to exist.

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