Enhanced thermal transport of strongly correlated electrons

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Abstract: The charge and heat transport of intermetallic compounds with Ce, Eu, and Yb ions are discussed using the periodic Anderson model with crystal field (CF) split f-states. We show that the low-temperature properties are governed by the Fermi liquid (FL) laws with characteristic energy scale T_0, that the high-temperature properties are typical of a local moment (LM) with Kondo scale T_K, and that the ratio T_K=T_0 depends on the density of conduction states. We also show that the effective degeneracy of the f ions with CF splitting changes as temperature is reduced. Using these results, we discuss the thermoelectric response of some typical heavy fermions and valence uctuators. Our calculations show that the low-temperature thermopower can be much enhanced (or reduced) with respect to the predictions based on the single-impurity models that would lead to the same high-temperature behavior as the periodic Anderson model. We also show that the renormalization of transport coefficients in the FL regime can invalidate the Wiedemann-Franz law and enhance the thermoelectric figure-of-merit. As an example of our theory, we explain the large power factor of $YbAl_3$ and the unusually 'slow crossover' between the high-temperature LM regime and the low-temperature FL regime that one finds in that system. As another example, we consider the thermoelectric anomalies and the 'rapid crossover' between the LM and the FL regimes in $YbInCu_4$. Finally, combining the FL theory and the high-temperature perturbation expansion we discuss the modifications of the thermopower and the resistivity induced by pressure, doping or a magnetic field in intermetallic compounds with Ce and Yb ions. The details regarding the work described in this abstract can be found in the following papers:

[1] V. Zlatić, R. Monnier, J. K. Freericks and K. Becker: Relationship between the thermopower and entropy of strongly correlated electron systems, Physical Review B 76, 085122 (2007).
[2] J. K. Freericks, V. Zlatić, and A. M. Shvaika: Electronic thermal transport in strongly correlated multilayers, Physical Review B 75, 035133 (2007).
[3] V. Zlatić, R. Monnier, and J. K. Freericks, Enhancement of thermal transport in the degenerate Anderson Model, Physical Review B 78, 045113 (2008).
[4] S. Burdin and V. Zlatić, Temperature scales of the periodic Anderson model; slave bosons mean-field approach, Physical Review B 79, 115139 (2009).