Two-channel Kondo physics due to As vacancies

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We address the origin of the magnetic-field independent $-|A|\,T^{1/2}$ term frequently observed in the low-temperature resistivity $\rho(T)$ of As-based metallic systems of the PbFCl structure type. This low-T behavior is in line with the non-magnetic version of the two-channel Kondo (2CK) effect. Up to date, this type of 2CK physics has never been convincingly verified in any bulk metallic system for two reasons: first, a $-|A|\,T^{1/2}$ term in $\rho(T)$ can also be caused by electron-electron interactions; second, no precise information about the underlying structural defects has yet been provided. The combination of chemical and structural investigations with physical property measurements for two closely related compounds $ZrAs_{1.58}Se_{0.39}$ and $ZrP_{1.54}S_{0.46}$ shows that the B-independent $-|A|\,T^{1/2}$ upturn observed over almost two decades in temperature originates from vacancies in the pnictogen layer. Finally, we offer a theoretical model for 2CK impurity formation near these vacancies in terms of a dynamical Jahn-Teller deformation and the concomitant dynamic bond formation of As dimers or oligomers. Our findings should be relevant to a wide class of metals with disordered pnictogen layers.

References:

[1] T. Cichorek *et al.*, Phys. Rev. Lett. 117 (2016) 106601.