4*f* electron-hole analogy in Tsai-type quasicrystalline approximants Au-Al-R (R = Ce and Yb)

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We have studied the effect of composition on the hybridization between 4*f* and conduction electrons, called *c-f* hybridization, in the cubic quasicrystalline approximants Au-Al-R (R = Ce and Yb) by the measurements of magnetic susceptibility $\chi(T)$, electrical resistivity $\rho(T)$, specific heat $C(T)$ and thermoelectric power $S(T)$.

Figure 1 shows the results of $\chi(T)$ for $Au_xAl_{86-x}Yb_{14}$ ($51 \leq x \leq 64$), where the data for x = 51 are obtained from ref. [1]. Below 300 K, a Curie-Weiss behavior is observed only in x = 52 down to 150 K. The effective magnetic moment μ_{eff}, Weiss temperature θ_P and *T*-independent term χ_0 are estimated as μ_{eff} = 4.9 μ_B, θ_P = –160 K and $\chi_0 = -1.9 \times 10^{-3}$ emu/mol-Yb, respectively. The magnitude of χ decreases with increasing x, indicating that the Yb valence of Au-Al-Yb varies from an intermediate state to divalent one due to the enhancement of *c-f* hybridization with increasing the concentration of gold.

On the other hand, all of χ's for $Au_yAl_{84-y}Ce_{16}$ ($62 \leq y \leq 70$) and $Au_{76}Al_{10}Ce_{14}$ obey the Curie-Weiss law down to 50 K, as shown by χ^{-1} vs *T* in fig. 2. The μ_{eff} increases from 2.41 to 2.49 μ_B with increasing y. These values of μ_{eff} are close to 2.54 μ_B for a free Ce^{3+} ion, indicating the stable trivalency of Ce in Au-Al-Ce. The θ_P's are all negative, and the absolute values decrease from 13.5 K for y = 62 to 5.8 for $Au_{76}Al_{10}Ce_{14}$. This feature indicates the suppression of *c-f* hybridization in Au-Al-Ce by the increase of Au, that is opposite to the x dependence of Au-Al-Yb. This contrast should result from the 4*f* electron-hole analogy between the strongly correlated Ce and Yb compounds.

[1] T. Watanuki et al., Phys. Rev. B **86** (2012) 094201.
[2] K. Deguchi et al., Nature Mater. **11** (2012) 1013.

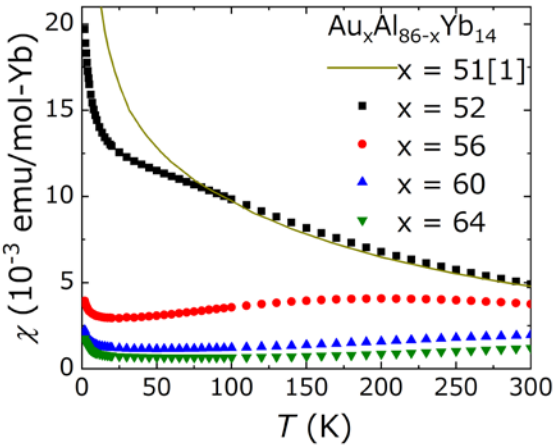

Fig.1: Magnetic susceptibility of Au-Al-Yb quasicrystalline approximants.

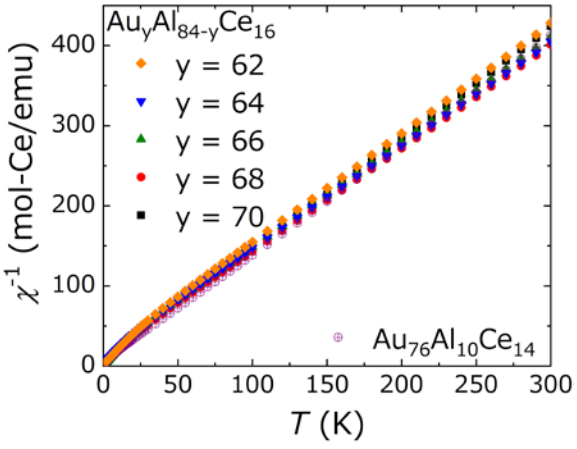

Fig.2: Magnetic susceptibility of Au-Al-Ce quasicrystalline approximants.