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# (G) Intermediate Valence state in $\mathrm{YbB_4}$ revealed by RXES

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In crystal systems with competing, incongruous, anti-ferromagnetic exchange interactions, geometric frustration is found and often leads to the suppression of long-range magnetic order. On the other hand, in Yb-based systems where the Kondo interaction between local $4f$ and conduction electrons is dominant, hybridization between these also results in the suppression of long-range magnetic order. When the Kondo interaction is strong enough physical hybridization between the $4f$ and conduction electrons occurs, resulting in a quantum mechanically degenerate electronic ground-state, a so-called intermediate valence (IV) state. $\mathrm{YbB_4}$ is a rare system where both mechanisms are plausible explanations for the lack of magnetic order down to at least 0.34 K [1]. $\mathrm{YbB_4}$ crystallizes into a tetragonal crystal structure (space group $P4/mbm$) that can be mapped to the well known geometrically frustrated Shastry-Sutherland Lattice within the ab plane [2]. $\mathrm{YbB_4}$ has also been proposed as a Kondo-dominated system residing in the IV regime but has to date lacked direct confirmation of such via spectroscopic means [3,4]. We study the existence of an IV state in $\mathrm{YbB_4}$ using resonant X-ray emission spectroscopy at the Yb $L_{(1)}$ transition and study the temperature dependence of the Yb valence from 12 to 300 K. We confirm that $\mathrm{YbB_4}$ exists in an IV state at all temperatures and observe that the Yb valence increases gradually from $v = 2.61 \pm 0.01$ at 12 K to $v = 2.67 \pm 0.01$ at 300 K. We compare the temperature scaling of the valence with other Yb-based Kondo lattices and find that $\mathrm{YbB_4}$ and other systems within the IV regime do not obey the universal temperature scale of valence change, $T_v$, observed in weakly mixed-valent Kondo lattices [5]. We find that in the case of IV systems, $T_v$ also does not appear to be linked to the Kondo temperature $T_K$ of the system.

[1] J. Etourneau et al., Journal of the Less-Common Metals 67, 531 (1979).
[2] D. Okuyama et al., Journal of the Physical Society of Japan 74, 2434 (2005).
[3] J. Y. Kim et al., Journal of Applied Physics 101, 09D501 (2007).
[4] A. S. Panfilov et al., Low Temperature Physics 41, 193 (2015).
[5] K. Kummer et al., Nature Communications 9, 2011 (2018).

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