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Detection of a finite 5*f* orbital magnetic moment in Curium metal using XMCD

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The precise configuration of the spin and orbital moments in the actinides is a matter of controversy [1, 2]. This is particularly true in the center of the series, around Pu – Am – Cm, when the exchange interaction is increasing with the number of 5*f* electrons, but the spin-orbit interaction is strong and the moments may not be totally localised, i.e. bandwidth also plays a role. Cm lies at the center of the actinide (5*f*) series and if it is like Gd it should have a $^8S_{7/2}$ spectroscopic state, i.e. with no 5*f* orbital magnetic moment. Recent EELS measurements have been interpreted to suggest that, because of the large spin-orbit coupling, Cm follows intermediate coupling with a small, but finite, orbital moment [3]. If an finite orbital moment exists, the total moment will then be < 7 μ_B and be about 6 μ_B, which appears in contradiction to earlier results deduced from the susceptibility [4]. However, the latter study used samples of ~ 1 μg, so there are some uncertainties. We have performed x-ray magnetic circular dichroism (XMCD) experiments on Curium metal (~1mg) to detect the existence of small 5*f* orbital magnetic moment contribution. XMCD have been carried out at the $M_{5,4}$-edges of Curium at 30K and 70K under an applied magnetic field of 17T. We found that the branching ratio which provides the angular part of the 5f spin-orbit interaction is around ~0.70 in good agreement with EELS [3]. Based on atomic multiplet theory, our results confirm that intermediate coupling best describes the coupling between the spin and orbital components of the ground state. Further, we found the existence of a finite 5*f* orbital magnetic moment, which is about 10% of total moment in Curium.

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