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## Orbital magnetism on Dzyaloshinskii-Moriya interaction

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Chiral interaction between two atomic spins due to a strong spin-orbit coupling, which is known as the Dzyaloshinskii-Moriya interaction (DMI), has attracted intense interest. In particular, it has been demonstrated that the DMI at the interface between ferromagnetic (FM) and heavy nonmagnetic metals (HM) plays a major role for the formation of chiral spin textures, such as the skyrmion [1] and the homochiral Neel-type domain wall [2-4], which are attractive for the development of future information storage technology.

We show that orbital magnetism plays a crucial role in the emergence of the DMI. The temperature dependence of the DMI-induced effective field is quantified by magnetic domain-wall velocity measurements, while the temperature dependence of the spin and orbital magnetic moments in FM and HM layers is determined by x-ray magnetic circular dichroism measurements. We find no direct correlation between the increase of the DMI and the proximity-induced magnetic moment in a HM layer, which is contradictory to the results of a previous report [5], but is consistent with recent first-principle calculations [6]. Furthermore, we establish that the strength of the DMI is proportional to the ratio of the in-plane and out-of-plane orbital moments in a FM layer.

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