Recoil magnetization curves *outside* the major hysteresis loop and intergrain interactions in ferromagnetic systems

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The first word that comes to mind when one hears "magnetism" is, most probably, hysteresis–the noteworthiest and intriguing phenomenon of ferromagnetism. As a general rule, it is accepted that any minor magnetization loop lies *inside* the respective major hysteresis loop. In 2021, we reported a remarkable magnetization reversal in Co, Fe and Ni films, evidencing for the first time an experimental observation of magnetic recoil branches that lie entirely and way *outside* the major loop, see the figure below. This phenomenon, referred to as a recoil-curve overshoot (RCO), might result in a great increase of the hysteresis loop's area. We reproduced key features of systems presenting this striking behavior–RCO, collapsed hard-magnetization axis (i.e., sharp peaks in the major-loop's angular variations of both remanent magnetization and coercivity, centered 90^{o} off the easy-axis position) as well as kinks some loops present–via a model of pairs of exchange-coupled grains with slightly misaligned magnetic anisotropy axes.

This talk will present a discussion on the above findings as well as more recent studies on interactions that influence this peculiar magnetization reversal. Another unforeseen, in thin ferromagnetic films, features have been revealed–(*i*) wholly negative interaction plots, and (*ii*) hysteretic loops with positive recoil fields (i.e., observation of hysteretic instead of the expected reversible magnetization processes in the region between the positive saturation and remanence states). We show that ferromagnetic intergrain coupling might be solely responsible for these features instead of, as routinely assumed, antiparallel dipolar-type interactions. We believe that this should be very general and observed in a variety of ferromagnetic systems. These findings could open the way to further theoretical and experimental investigations.

We acknowledge financial support from CNPq, Brazil (Grants 313624/2020-8 and 406009/2021-0).