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Control of the emergent inductance in helimagnet YMn6Sn6 via Tb substitution

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The ac current-driven motion of spiral spin textures was shown to give rise to emergent electric fields that provide functionality as an electrical inductor - the so-called emergent inductance phenomenon [1-2]. Most recently, the first such system to display this phenomenon beyond room temperature was identified to be the helical magnet YMn6Sn6 [3]. To deepen the microscopic understanding of emergent inductance and optimise the materials conditions for its realisation, we report the investigation of the effect of partial substitution of Y by Tb. By both small angle neutron scattering and inductance measurements, we reveal that the pinning effect due to Tb doping selectively and largely suppresses the negative component of emergent inductance. In contrast, the positive component is left largely in tact. We find that the latter component can be hosted by both spin helical order, and even a spin-collinear antiferromagnetic structure in the presence of pronounced spin fluctuations. From our observations we extract empirical rules for the selection of either positive or negative emergent inductance effects in short period magnets.
[1] N. Nagaosa, Jpn. J. Appl. Phys. 58, 12090 (2019).
[2] T. Yokouchi et al. Nature 586, 232 (2020).
[3] A. Kitaori et al. PNAS 118, e2105422118 (2021).
[4] A. Kitaori, J.S. White et al., submitted (2022).

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