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Local well-posedness for the Landau-Lifshitz equation with helicity term

We consider the initial value problem for the Landau-Lifshitz equation with helicity term (chiral interaction term), which arises from the Dzyaloshinskii-Moriya interaction. We show that it is locally well-posed in $\vec{k} + H^s$ for $s > 2$ with $\vec{k} = {}^t(0, 0, 1)$. The key idea is to reduce the problem to a system of semi-linear Schrödinger equations, called modified Schrödinger map equation. The problem here is that the helicity term appears as quadratic derivative nonlinearities, which is known to be difficult to treat as perturbation of the free evolution. To overcome that, we consider them as magnetic terms, then apply the energy method by introducing the differential operator associated with magnetic potentials.